



UK GREEN  
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*Full Report*

# DEMYSTIFYING GREEN INFRASTRUCTURE



CAMPAIGN FOR A SUSTAINABLE BUILT ENVIRONMENT

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# 1.0 INTRODUCTION

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Green infrastructure (GI) is a catch-all term to describe the network of natural and semi-natural features within and between our villages, towns and cities. These features range in scale, from street trees, green roofs and private gardens through to parks, rivers and woodlands. At the larger scale, wetlands, forests and agricultural land are all captured by the term GI.

As well as its intrinsic value, it is becoming increasingly clear just how important GI is for climate change adaptation, [Biodiversity](#) and human health and wellbeing. Clearly, the protection and enhancement of our GI is vital, and the construction and property sector must play a central role in achieving this.

This report seeks to consolidate existing information for those working in the built environment, providing a simple, accessible guide. It helps to define the topic and its scope, and crucially attempts to highlight the business case for creating and maintaining GI – aimed primarily at the developer and client. The resources identified have been made available through UK-GBC's online platform [Pinpoint](#), which signposts to the most relevant and peer reviewed information.

## Why 'Demystifying green infrastructure?'

The term GI is often misunderstood, as is its multi-functional role and the impact it can make at different spatial scales. There are also a wide variety of different types of green infrastructure, which can lead to confusion. There is therefore a need to ensure that the construction and property industry can understand the relevance of GI to development. Crucially, they need to understand the business case for it, and access the most appropriate sources of advice, to ensure that designs provide the intended benefits – for the sector, for end-users and for the environment.

The sheer volume and complexity of information that exists on GI, its design enhancements and maintenance can be bewildering. Finding appropriate GI information and guidance can therefore be challenging for non-specialists within the construction industry, and it can be difficult to understand what to trust and how to implement it.

## Why is green infrastructure rising up the agenda?

There is increasing national and European policy that supports the need to conserve, enhance and create GI that delivers the widest range of benefits for society (sometimes called [Ecosystem Services](#)). For example, the European Commission recently consulted on their paper '*Policy options for an EU no net loss initiative*' which supports the implementation of the European Commission biodiversity target set in 2010.

Following the European Commission target the UK government set the strategy for England '*Biodiversity 2020: A strategy for England's wildlife and ecosystem services*'. The mission for the strategy for the next decade, is: '*to halt overall biodiversity loss, support healthy well-functioning ecosystems and establish coherent ecological networks, with more and better places for nature for the benefit of wildlife and people.*'

GI also forms part of the UK National Planning Policy Framework, which re-iterates the need to move from a net loss of biodiversity to net gains for nature and is a key mechanism for delivering the aspirations for ecological networks as set out in the Natural Environment White Paper.

Developers and clients, therefore, already have a responsibility to demonstrate how they are addressing this issue and ensuring biodiversity is not lost.

Other organisations such as the Natural Capital Committee (an independent advisory board to the Government set up in 2012) have been tasked with understanding the value of the [Natural capital](#) in England, and setting recommendations on how best to maximise its benefits. The output from this work is also likely to influence planning requirements in future, and hence the approach developers and clients will need to take when designing the GI for each project.

In 2009 the UK-GBC ran a task group on biodiversity, which made recommendations for improving the content and availability of information on this topic and provided useful guidance for developers, landowners, contractors and consultants on how to approach biodiversity. This guidance is still useful and can be accessed [here](#).

The Task Group has brought together a cross section of construction and property representatives and experts on GI. We are grateful to the task group members that contributed their time; a list of all task group members and contributors can be found on the back page of this document.

## 2.0 WHAT IS GREEN INFRASTRUCTURE?

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There is no single established definition of [Green Infrastructure](#) (GI) but the following quote provides a concise description;

*“Natural or semi-natural networks of green (soil covered or vegetated) and blue (water covered) spaces and corridors that maintain and enhance ecosystem services.”*

Green infrastructure, therefore, can be described as the network of natural and semi-natural features within and between our villages, towns and cities – reaching out into the wider countryside. These features range in scale, from individual street trees, green roofs and private gardens through to parks, rivers and woodlands, transport corridors, verges and, at the larger scale, wetlands, forests and agricultural land. Some examples of GI can be found in [Figure 1](#).

What unites this wide range of examples under the term ‘green infrastructure’ is that they all have the potential, when integrated properly into the built environment (and the wider greenspace beyond) to provide a vast array of functions and benefits to all stakeholders.

Multi-functionality is a key concept for GI – i.e. making the best use of land to provide a range of valuable goods and services. As a result, it is critical in achieving sustainable development and sustainable management of resources. This is of increasing importance in the UK, a small and in some areas densely populated island facing a wide and often competing range of demands and challenges being placed on a finite land resource.

In recent years there has been some confusion surrounding the GI term. There are times when it is used as a way of describing low-carbon infrastructure such as rail or electric car networks. It is important to clarify here that this report does not cover this type of infrastructure.

While the design and maintenance of quality GI can provide a range of direct and tangible benefits to the developer (see [Table 1](#) in [Section 3.0](#)), of course many of the services provided by GI such as enhancing biodiversity, improving health and wellbeing, reducing pollution and mitigating the effects of climate change are also beneficial to society and the country at large.

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1 Naumann S, Davis M, Kaphengst T, Pieterse M, Ratment M (2011) Design, Implementation & Cost Elements Of Green Infrastructure Projects, Final Report to the EU Commission (Ecologic Institute and GHK Consulting).

The multifunctional nature of GI is underpinned by the concept of 'Ecosystem Services'. Between 2009 and 2011 the UK National Ecosystems Assessment (UK NEA) analysed the natural environment in terms of the benefits it provides for economic prosperity and society. The research found that economic productivity, health and wellbeing depend on the range of services provided by ecosystems and their constituent parts, such as water, soil, nutrients and organisms. These services include:

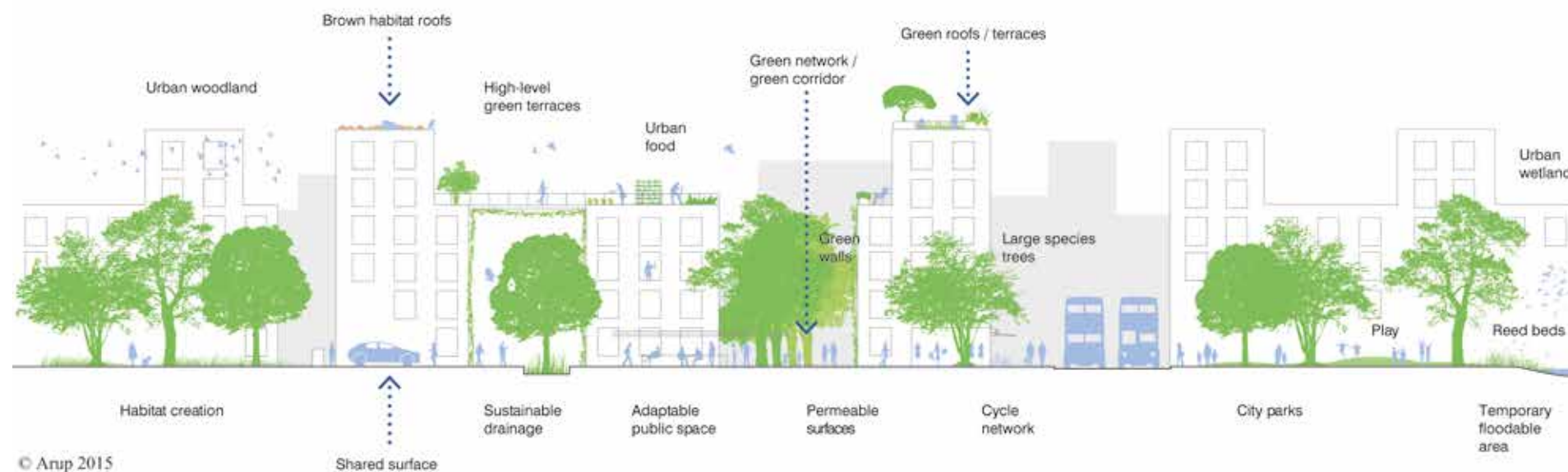
- Supporting services – those necessary for all other ecosystem services, such as soil formation and photosynthesis;
- Provisioning services – such as food, fibre and fuel;
- Regulating services – including air quality and climate;
- Cultural services – such as recreational activities and wellbeing, aesthetic values and sense of place.

Approaching land use planning, design and management and thinking about the land's potential to act as service-providing infrastructure, invites us to pay greater attention to the overall cost/ benefits that it can provide. This should be central to policy and decision-making in the development process.

The GI approach to land use planning, design and management enables us to demand and deliver more from the land and its associated natural features and systems in a way that is sustainable. By considering the widest range of functions natural features can simultaneously perform, GI can enhance the primary use of land and unlock the greatest number of benefits. At its heart, the aim of GI is to manage the many, often conflicting, pressures being placed upon our finite land resource. In doing so, we can maximise the benefits to be derived from the ecosystem services for the economy, people and the environment. [Section 6](#) provides guidance on how to go about ensuring GI is designed and implemented effectively to maximise these benefits.

GI needs to be part of a shared vision, requiring a holistic approach that embraces many disciplines and ecosystem service benefits while providing a network of connections at every landscape scale. It therefore permeates every level of the planning, design and management process, and is relevant at every scale of development. A positive and proactive approach to GI will enable us to make best use of the land, providing tangible returns on investment and increased functionality, together with attention to the biodiversity and landscapes potential character and beauty.

## What does green infrastructure look like...



**Figure 1:** Example of Green Infrastructure integrated into an urban landscape  
(Adapted by ©Arup – from 'Cities Alive' [http://www.arup.com/Homepage\\_Cities\\_Alive.aspx](http://www.arup.com/Homepage_Cities_Alive.aspx))

## 3.0 WHAT IS THE BUSINESS CASE FOR GREEN INFRASTRUCTURE?

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Whilst green infrastructure (GI) and the biodiversity it supports may sometimes be perceived as an unnecessary cost, and something that must be done because of law or planning policy, there are in fact many business opportunities that GI can deliver in terms of cost, time savings, enhanced performance and overall market advantage. There are also business risks associated with failure to incorporate GI into planning, design, construction and operation. Ultimately, the associated risks and benefits can result in financial gains and result in better environments for all stakeholders.

Below is a matrix listing the risk and opportunities associated with the implementation of GI, and in the final column is a list of associated guidance documents and case studies to support the highlighted risks and opportunities. The intention is to highlight the specific benefits of GI for the client/developer in relation to the specific risks and opportunities associated with their business. For information on the additional benefits of GI, not specifically associated with the business case, refer to [Figure 2](#).

The table provides a summary of the key elements to consider when weighing up the risks and benefits of GI and promoting biodiversity.



**Table 1: Green infrastructure: Risks and opportunities resulting in financial gains**

Risk	Opportunity	Case Study/Reference
<b>Planning</b>		
<p><b>Planning permission refused or delayed:</b> Not considering GI adequately can lead to refused planning permissions due to lack of policy implementation or can cause delays due to a large number of conditions, resulting in financial escalation and potential loss of funders.</p>	<p><b>Rapid permissions:</b> Where GI has been considered as key aspect of the design, planning permission may be granted with fewer conditions.</p> <p>Incorporating requirements for meeting biodiversity policy, open green space requirements, accessibility etc. into multifunctional GI results in a very robust sustainability statement.</p> <p>It can also result in a project gaining BREEAM/CEEQUAL credits/points at no additional cost.</p> <p>If it can be demonstrated that the green space will boost the economy by encouraging investment, the local planning authority may also look more favourably on the development.</p>	<p><b>Case study 1:</b> Kilnwood Vale – Example showing the importance of having good relationships with Local Planning Authorities</p> <p><b>Case study 2:</b> Tadpole garden village – Example of how working with local partners sped up the planning process</p> <p><a href="#">National Planning Policy Framework (NPPF)</a></p> <p><a href="#">TEEB: Nature and its role in the transition to a green economy</a></p> <p><a href="#">BS 42020:2013 – Biodiversity – Code of practice for planning and development</a></p>
<p><b>Poor water quality:</b> There is a risk of failing Water Framework Directive Screening, which would require additional engineering solutions</p>	<p><b>Water quality attenuation:</b> Discharging comparatively cleaner water into the system requiring less other attenuation means reducing cost (in both installation and maintenance) and gaining permissions.</p>	<p><a href="#">‘Improving Water Quality’ Directive from DEFRA (2013)</a></p>
<b>Construction</b>		
<p><b>Increased programme costs:</b> To remove existing natural systems and replace with hard engineered systems.</p> <p><b>Habitat:</b> Loss of valuable habitat</p>	<p><b>Reduced installation costs:</b> Soft landscape costs less to install than hard landscape.</p> <p>Retain and enhance existing landscape and habitats and use natural systems as engineering solutions.</p> <p>Natural systems are more effective than expensive man-made systems.</p>	<p><a href="#">Banking on Green: A Look at How Green Infrastructure Can Save Municipalities Money and Provide Economic Benefits Community-wide 2012</a></p> <p><a href="#">The Economic Value of Green Infrastructure: The public and business case for investing in Green Infrastructure and a review of the underpinning evidence, Natural Economy North West, 2008</a></p> <p><a href="#">Delivering biodiversity benefits through green infrastructure</a></p> <p><a href="#">Microeconomic Evidence for the Benefits of Investment in the Environment 2 (MEBIE2)</a></p> <p><a href="#">Multi-Functional Urban Green Infrastructure CIWEM 2010</a></p> <p><a href="#">Victoria Improvement District Green Infrastructure Audit Best Practice</a></p>



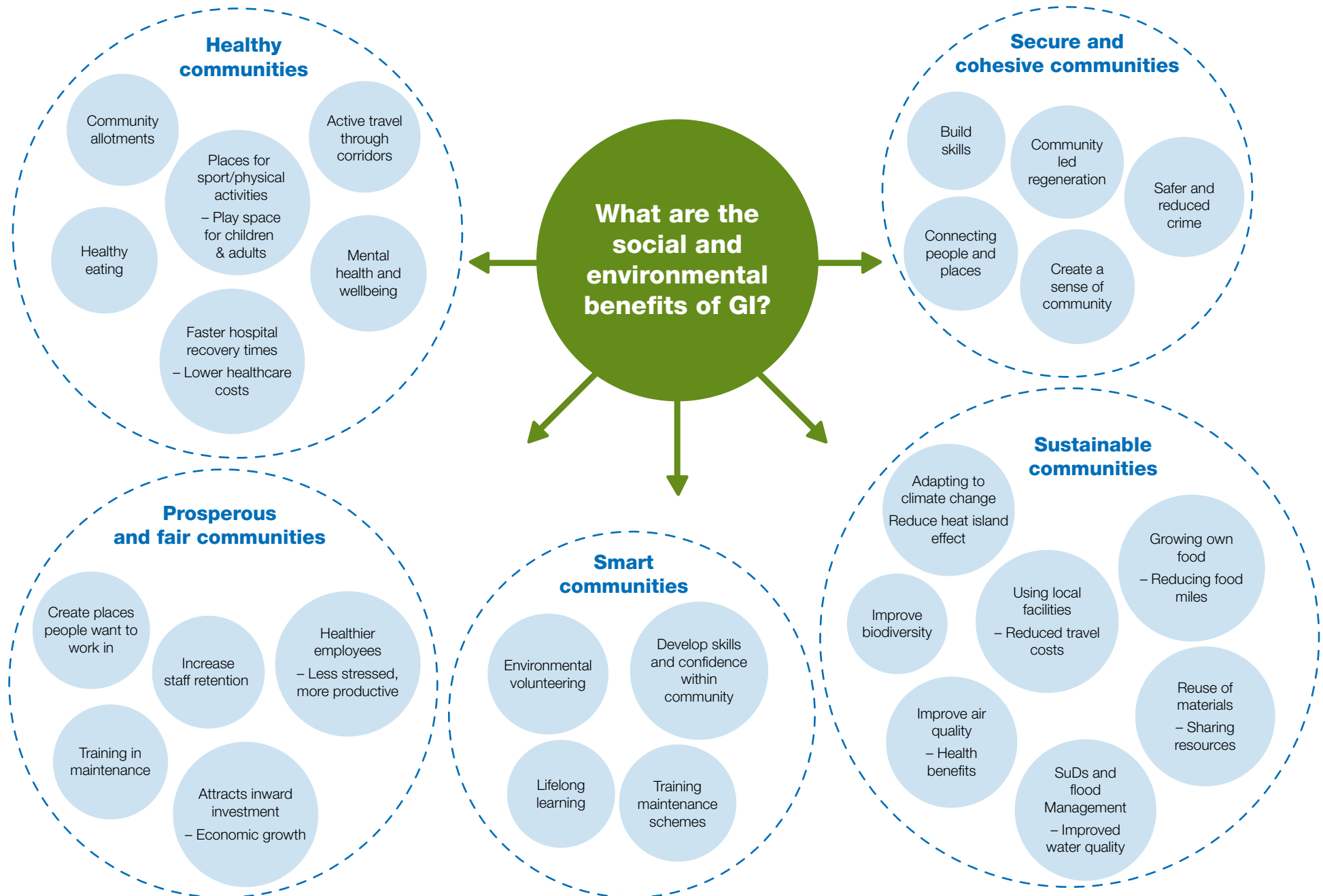
Risk	Opportunity	Case Study/Reference
<b>Operation</b>		
<p><b>Flooding:</b> Risking reputation, loss of revenue, devaluation of building, time spent out of productivity, increasing insurance bond requirements for occupier.</p>	<p><b>Flood attenuation:</b> Using GI rather than hard landscaping to attenuate flood provides savings on the cost of hard infrastructure solutions and multiple benefits can be reaped from the same GI. This can be small scale rain gardens or large scale SuDS solutions. Some SuDS solution (such as rainwater harvesting) can reduce water utility bills for occupants. Flood attenuation measures can also be retrofitted.</p>	<p><b>Case study 3:</b> Queensbury recreation ground – Example of Multi-functional GI including SuDS.</p> <p><b>Case study 4:</b> Trumpington Meadows – Example of Multi-functional GI including SuDS.</p> <p><a href="#">SUSDRAIN case studies</a></p> <p><a href="#">SUSDRAIN: Demonstrating the multiple benefits of SuDS</a></p> <p><a href="#">CIRIA: Demonstrating the benefits of SuDS – developing a business case</a></p>
<p><b>Temperature increases heat island effect:</b> Changes to the climate risk warping of infrastructure and additional maintenance costs due to heat.</p> <p>It can also lead to an excessive reliance on air conditioning.</p>	<p><b>Living walls, roofs and courtyards:</b> These can be used to reduce the temperature/passive cooling thus reducing the cost of air conditioning, benefiting end users and reducing accelerated degradation of materials due to excessive heat.</p> <p>Their use can even cool the air and slow the temperature-dependent reaction that forms ground-level ozone pollution (smog).</p>	<p><b>Case study 5:</b> Birmingham New Street Station – Example of green wall.</p> <p><a href="#">Victoria Business Improvement District Best Practice Guide</a></p> <p><a href="#">Hong Kong Green Roof Study Urbis Limited reported in Landscape Institute Position Statement on GI</a></p> <p><a href="#">Banking on Green: A Look at How Green Infrastructure Can Save Municipalities Money and Provide Economic Benefits Community-wide 2012</a></p>
<p><b>Maintenance:</b> Hard engineered solutions for flooding such as attenuation tanks often require more maintenance than green infrastructure which typically requires lower levels of maintenance.</p>	<p><b>Reduction of management Costs:</b> Where maintenance is considered in the design process, it can result in a reduced frequency and rigour of grass cutting.</p> <p>In many cases, no strimming around trees and margins would be needed. Less intensive management leads to reduced costs while increasing biodiversity value. Maintenance regime must be communicated to end users.</p> <p>When water is managed on the surface problems are more visible, therefore easier to identify and consequently more accessible to repair</p>	<p>Benchmark GM (a grounds maintenance company working in both the commercial sector and the public sector) have provided their key tips for success on design solution that reduce maintenance (see <a href="#">Appendix B</a>).</p>

Risk	Opportunity	Case Study/Reference
<b>Reputation</b>		
<p><b>Loss of client relationships/investment:</b> Funders and end users place considerable value on the reputation of a company, loss of reputation could result in falling behind competitors.</p> <p>Visibly demonstrates corporate social responsibility.</p>	<p><b>Leaders in sector – Marketing:</b> Attraction of high value funders, clients and staff, reduction in actual marketing costs as becoming a brand leader will result in “free marketing”.</p> <p>Flagship projects can be used for internal and external promotional material leading to quicker sales etc.</p> <p><b>Engagement:</b> Involving occupiers/end-users in biodiversity is an excellent means of engagement and will provide educational benefits that can positively reinforce reputation, increase staff retention and attract the highest quality staff.</p> <p><b>Innovation:</b> Demonstrating a project has incorporated GI using innovative techniques and ideas show a forward thinking organisation and can in some instances be rewarded with Industry awards.</p>	<p><b>Case study 6:</b> Kidbrooke village – Example of integrating GI throughout a regeneration housing development</p> <p><b>Case study 7:</b> Pirbright Institute – Example where employees were actively engaged with the project, carrying out reptile surveys and setting up their own biodiversity group.</p> <p><b>Case study 8:</b> King’s Cross – Example of Community crop growing and local business involvement, led by ‘Meanwhile Green Infrastructure’.</p> <p><b>Case study 9:</b> Church Street and Paddington Green INfrastructure and public realm plan – Award winning project regenerating londons street scape in this area.</p>
<b>Staff productivity and retention</b>		
<p><b>Staff wellbeing:</b> Time lost due to staff illness or loss of quality staff due to unappealing work place.</p>	<p><b>Health benefits:</b> Proven better health (direct links to reduced obesity in children) due to improved opportunities for walking and cycling, whether for leisure purposes or travel.</p> <p>Proven improved mental well being when there is regular and frequent access to higher levels of biodiversity. This can lead to an increase in efficiency and staff retention, lower stress levels meaning less time off work.</p> <p>90% of a business’s costs are its staff, therefore staff wellbeing can have a huge impact on the productivity of the business.</p>	<p><a href="#">Biodiversity and Community Health Initiative (BaCH)</a></p> <p><a href="#">Fuller, R.A., Irvine, K.N., Devine-Wright, P., Warren, P.H. &amp; Gaston, K.J. 2007. Psychological Benefits of Greenspace Increase with Biodiversity. <i>Biology Letters</i> 3 (4): 390-4.</a></p> <p>Bambra, C. and P. Norman. 2006. “What is the association between sickness absence, mortality and morbidity?” <i>Health and Place</i> 12: 728-733.</p> <p>Bringslimark, T., T. Hartig, et al. 2009. “The psychological benefits of indoor plants: A critical review of the experimental literature.” <i>Journal of environmental psychology</i> 29(4): 422-433.</p> <p><a href="#">World Green Building Council, 2014. “Health, wellbeing and productivity in offices: The next chapter for green buildings”</a></p>

Risk	Opportunity	Case Study/Reference
	<p><b>Improved Air quality:</b> Reduction in particulates and even ozone levels resulting in less time off due to sickness.</p> <p>There are also regulatory efficiencies. High traffic densities in urban areas can result in pollutants exceeding EU and UK targets for NO<sub>2</sub> (linked to asthma) and PM10.</p>	<p><a href="#">MEDICAL NEWS TODAY. 2009: Traffic-related air pollution linked to repeated hospital encounters for asthma.</a></p> <p><a href="#">NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE (NICE). 2008: NICE issues guidance on inhaler systems for under 5s with asthma.</a></p> <p><a href="#">Green Infrastructure and urban air quality, Institute of Air Quality Management (IAQM), London, 28 June 2012</a></p> <p><a href="#">Urban Trees Brochure, Lancaster University and centre for Ecology and hydrology</a></p>
<b>Product differentiation and future proofing</b>		
	<p><b>Increasing land/property value:</b> GI can increase the value of land and property. This provides benefits for both sale and rental markets for the client. This can also benefit the local authority by increasing the value of the land, therefore encouraging inward investment, which can help in processing the planning application more swiftly.</p> <p>Well planned improvements to public spaces encompassing GI within town centres can boost commercial trading by up to 40%<sup>1</sup>.</p> <p>Future proofing sometimes means that the immediate benefits of GI aren't just felt on the site itself, but cumulatively city/UK wide, which then may benefit future developments.</p> <p>Indirect economic benefits felt by the planning authority include, NHS mental health treatment, benefits for farming subsidies (improved pollinators, improved crop yields, cheaper food).</p>	<p>Dunse, N., M. White, et al. 2007. "Urban Parks, Open Space and Residential Property Values." Royal Institution of Chartered Surveyors Research Papers 7(8): 1-37.</p> <p><a href="#">The Green Edge: How Commercial Property Investment in Green Infrastructure Creates Value</a></p> <p><a href="#">The Economic Value of Green Infrastructure: The public and business case for investing in Green Infrastructure and a review of the underpinning evidence, Natural Economy North West, 2008.</a></p> <p><a href="#">Microeconomic Evidence for the Benefits of Investment in the Environment 2 (MEBIE2) – Natural England Research report – NERR 057</a></p> <p><a href="#">Green Infrastructure Added Value (BE Group for Mersey Forest</a></p> <p><a href="#">Victoria Improvement District Green Infrastructure Audit Best Practice</a></p>
	<p><b>Crime reduction:</b> Permeability of site and quality surroundings encourages end users to value the area more, resulting in reduced vandalism and crime.</p>	<p>Troy, A., J. M. Grove, et al. 2012. "The relationship between tree canopy and crime rates across an urban-rural gradient in the greater Baltimore region." Landscape and Urban Planning 106: 262-270.</p> <p><a href="#">Safe places: The planning system and crime prevention (2004)</a></p>
<p><sup>1</sup> <a href="#">Victoria Improvement District Green Infrastructure Audit Best Practice</a></p>		

**Table 1** presents the financial risks and opportunities associated with GI, which are of course important to the client/developer of a project, however there are also many wider socio-economic and environmental benefits of implementing GI which should not be forgotten. **Figure 2** presents a more in depth examination of some of these benefits. In many circumstance financial benefits will also be felt, but they may not directly or immediately relate to the GI provider (developer/client), but will provide an overarching benefit to the community and also the local authorities.

It should be noted that some of these benefits of GI are automatic and intrinsic, whilst others very much depend on what the GI is and how it is planned and implemented. A GI design should aim to include as many of these benefits as possible. Many of the benefits highlighted in the diagram are connected, for example creating a sustainable community by encouraging them to grow their own vegetables will also create healthier communities by enabling the local people to eat more fresh fruit and vegetables.



**Figure 2:** The wider socio-economic and environmental benefits of green infrastructure

## 4.0 VALUING GREEN INFRASTRUCTURE

### What are the benefits of valuing green infrastructure?

As demonstrated, green infrastructure (GI) can deliver a broad variety of benefits. Valuation can be used to help shape a development, but it is important first to understand the benefits that are most relevant to the specific circumstances. This could be the local landscape, planning context or type of development proposed. It is important to ensure that any valuation is relevant, realistic and robust, and avoids any double counting.

In addition, values might be considered from the perspective of;

- What value the project can deliver in its wider context – for example how it might contribute to issues or opportunities identified in any local Green Infrastructure Strategy, which may help manage community interests and planning considerations etc.
- What value the GI may bring to the development specifically – for example by helping to provide sustainable drainage systems, contribute to the quality of a development, help to mitigate climate change impacts such as urban heat island effect, or provide opportunity for wildlife.
- What value the GI may bring to the developer as a business or future asset owners/managers.

Recent work looking at the value of GI to commercial property development/management in the North West of England has identified that “Green Infrastructure is one of a number of factors that can affect viability” of commercial developments (Green Infrastructure Added Value (BE Group for Mersey Forest)). The report identifies that there is some evidence that high quality green environments can contribute to uplift values with some case study examples that suggest rental uplifts of up to 20% have been achieved (relative to similar local competitor locations).

The report puts forward an adapted financial appraisal for how increased values might be estimated (taking development values and deducting developments costs) to identify whether there is a surplus which can provide profit to the developer. The model incorporates consideration of rental levels, incentives, void periods and the cost of GI invested and suggests that rental uplifts of around 5 or 6% might be “modest” estimates but that there may also be reductions in business risks that could otherwise “reduce yield rates by 0.1 to 0.2 %”. Such reduced risks can increase profit margins. However, GI should not be considered as a single factor but needs to be part of the quality mix, or package of measures for a development.

Rental uplifts of up to 20% as a result of Green infrastructure

## What is the value of green infrastructure?

Valuing GI can help to inform the project decision making and design processes. Values come in a variety of forms and it is important to value those things that are relevant both to an individual project and to the wider society affected by a scheme.

Values may be viewed as economic, social or environmental, although in practice most benefits are a combination of these, and are often collectively termed as ecosystem services. They may also be viewed as:

- Direct – where the GI is delivering a direct financial value
- Indirect – where the benefit delivered is valued in societal or environmental terms
- Cost reduction – where GI, or the improvement of its quality, can lead to reduction in costs such as those associated with maintenance, energy use or water management
- Risk/resilience management – where a GI system can be used to reduce risks, especially future climate risks, associated with problems such as local flood risks, thus reducing the probability of incurring associated costs.

Indirect values include aspects such as intrinsic value, amenity provision and associated health benefits and are often the most subjective benefits, and therefore commonly the most challenging to measure. Despite this, these values and the contributions they make need to be recognised within the decision-making process.

Value can also be expressed either through monetisation (a monetary value), quantification (a quantified but not monetised value) or qualitatively (where only a narrative of the value can be provided). There are a variety of valuation tools available and some are listed below. However despite considerable recent advances in valuing the benefits of GI (or the risk management that it secures) valuation remains a technically challenging activity. It will usually require the input of a specialist to ensure that the valuation is given appropriate context and caveats, is up-to-date, relevant to purpose, realistic in proposition and avoids such pitfalls as double counting or optimism bias etc.

Qualitative valuation is a useful tool to inform the decision-making process and should be used to compare and test the relative merits of different design options and can form one of the key tools in the decision making process. Just because we cannot always place a market value or price on an aspect of GI, it does not make it any less important in the decision making process.

## What tools are available?

### Economic valuation tools and toolkits

Tailored approaches can be taken when assessing the economic value of GI, but this often requires very specific expertise. Several tools, developed by economists and industry practitioners, do exist to enable the client to broadly measure the economic impact of the proposed design. It is important to understand that no tool has the ability to assess every aspect of GI. A good GI design will provide many benefits and each benefit is likely to be measured in a slightly different way. For example GI may include SuDS systems to provide the primary purpose of surface water run-off control but may also offer biodiversity benefits through the creation of habitats. These two aspects are both benefits as a result of the GI, but each benefit would be measured using different tools.

In September 2013, Natural England reviewed the main valuation tools that can provide a form of economic impact assessment ([Natural England Commissioned Report NECR126, 2013](#)) and provided guidance on the scope of each tool and how to decide when each tool would be best used.

In their evaluation process, Natural England assessed the tools in terms of their adherence to the principles of scientific and economic analysis, and applicability to the UK for small scale GI projects. As a result of their review, they identified the tools listed in [Table A1 \(Appendix A\)](#), which provides an overview of their scope. The Natural England report provides further details on each of these tools and how they can be best applied to individual projects.

The tools identified are:

- [CAVAT](#)
- [GI Northwest's Green Infrastructure Valuation Toolkit](#)
- [Guide to valuing Green Infrastructure from the Centre for Neighbourhood](#)
- [HEAT](#)
- [Helliwell](#)
- [i-tree tools](#)
- [inVEST](#)

### Environmental and Social Valuation Tools and Toolkits

The above provides a summary of the tools that exist to evaluate the economic value provided by the implementation of GI. There are also a range of broader "sustainability" assessment tools which measure other impacts of GI such as its flood mitigation benefits or increase in biodiversity. Below lists a selection of the tools that exist to help put a value on these environmental and social benefits. (A more detailed summary can be found in [Appendix A.](#))

- [GRaBS toolkit](#)
- [GI Northwest's Green Infrastructure Valuation Toolkit](#)
- [STAR Tools](#)
- [NEAT – national Ecosystem approach toolkit](#)
- [Ecosystem Value Toolkit \(EVT\) by Earth Economics](#)
- [Toolkit for Ecosystem Service Site-based Assessment \(TESSA\)](#)

### Future tools

#### Sustainable drainage systems (SuDS)

Use of sustainable drainage systems (SuDS) can have positive impacts for which there is no clear market or price information. As a result, these impacts (typically social and environmental) have often been overlooked in the past and often assigned a value of 'zero' and excluded from the decision making process.

However, well-designed SuDS can deliver multiple benefits, and CIRIA is launching a 'Benefits Evaluation of SuDS Tool' (BEST) in spring 2015 (more information can be found [here](#)). The purpose of BEST is to ensure the wider benefits, financial, social and environmental, can be captured and included in decision making around drainage infrastructure investments. It will provide a practical means of assessing and, where feasible, valuing these multiple benefits. BEST will help users to:

- Undertake a more robust economic appraisal for different drainage strategies to support decision making for different stakeholders;
- Adopt a robust, standard approach to assessing the benefits of SuDS, enhancing transparency of benefits associated with SuDS,
- Improve understanding of who benefits and hence who may implement, manage, maintain and pay for drainage improvements.



## Natural Capital

The Government has published a consultation proposing the inclusion of the value of natural capital into the UK Environmental Accounts by 2020. With these new policies being proposed there are likely to be new toolkits produced to meet the needs of these proposals.

The Natural Capital Committee have piloted a Corporate Natural Capital Accounting framework with the Crown Estate, the National Trust, United Utilities and Lafarge. The aim of the framework is to enable organisations to record the value of natural capital assets associated with their business. More information can be found [here](#) and within [Section 5](#) of this report.

The valuation and validation of GI is an evolving process. Although valuation is technically difficult it is an important tool. Alongside this increasing the general understanding and awareness of the benefits of GI will ultimately help to improve the value of GI.

## 5.0 WHAT IS THE POLICY CONTEXT FOR GREEN INFRASTRUCTURE?

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### European Level

The EU describes Green Infrastructure (GI) as a successful tool for providing ecological, economic & social benefits through natural solutions.

The EU commission has adopted a Green infrastructure Strategy (May, 2013)<sup>2</sup> to 'promote the deployment of green infrastructure in the EU in urban and rural areas'. This GI strategy is a step towards implementing the EU 2020 Biodiversity Strategy and specifically Target 2<sup>3</sup>, which requires 'by 2020, ecosystems and their services [to be] maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems.'

### EU Public Consultation

To continue working towards the GI agenda, the European Commission convened two Working Groups.

The first working group on GI, (2011), was set up to contribute to the development of a European Green Infrastructure policy (2011) and provided concrete recommendations including that GI should be deliberately created, designated and preserved and that GI should be integrated into other policies at a national level with special focus on spatial planning. Efforts of national initiatives, such as the National Ecological Networks, Green Belt, etc. need to be acknowledged and they should form integral part of the GI in order to avoid possible duplication. The recommendations can be read in detail [here](#).

2 [http://ec.europa.eu/environment/nature/ecosystems/index\\_en.htm](http://ec.europa.eu/environment/nature/ecosystems/index_en.htm) (May 2013)

3 [http://ec.europa.eu/environment/nature/biodiversity/comm2006/pdf/2020/1\\_EN\\_ACT\\_part1\\_v7%5B1%5D.pdf](http://ec.europa.eu/environment/nature/biodiversity/comm2006/pdf/2020/1_EN_ACT_part1_v7%5B1%5D.pdf)

In addition the EU via the European Parliament Intergroup on 'Climate Change, Biodiversity and Sustainable Development' in partnership with the International Union for Conservation of Nature (IUCN) and the European Commission, are promoting 'nature-based solutions'. This initiative considers the enormous challenges facing Europe in years to come, looking at efforts to mitigate climate change, enhance resilience to natural disasters, safeguard water and air quality and protect biodiversity. The EU recognises that nature can play a strong role in tackling these challenges.

## National Level

In England, responsibility for green infrastructure is, in effect, split between various government departments. Defra is responsible for landscape and the countryside; DCLG for urban green spaces and planning policy; other departments' work and policies can also have an impact on GI.

## Planning Policy

At the National Level, the National Planning Policy Framework<sup>4</sup> recognises the importance of GI in meeting the challenge of climate change, flooding and coastal change. The framework states that:

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

The framework also notes the benefits of GI in conserving and enhancing the natural environment stating that local planning authorities should:

*'... Plan positively for the creation, protection, enhancement and management of networks of biodiversity and green infrastructure...'*

Local Authority GI Strategies should be used to articulate local GI policy. This then ensures that GI plays its role in helping to deliver the key policy objectives for an area (for example growth, health and well-being, biodiversity, water and flood risk management) and ensure that future developments can conserve, enhance and/or create green infrastructure to meet the identified needs.

## Transport infrastructure

[The National Infrastructure Plan 2014](#) sets out a national vision for the future of our infrastructure along with addressing the government's commitment to investment, quality and performance of national infrastructure. A long term challenge set out in the plan identifies that climate change will shape the future of UK infrastructure, testing the sustainability and resilience of our networks and assets. Well-designed infrastructure schemes that incorporate GI as an integral part of the infrastructure will be needed to address strategic aims of this plan.

[The National Networks National Policy Statement \(2014\)](#), referred to as 'NPS', sets out the need for, and Government's policies to deliver, development of nationally significant infrastructure projects (NSIPs) on the national road and rail networks in England. The policy states that as a general principle, transport network developments "should avoid significant harm to biodiversity and geological conservation interests, included through mitigation and consideration of reasonable alternatives" and also highlights the importance of applicants including appropriate GI as an integral part of their proposed development.

4 DCLG, (2011); National Planning Policy Framework. DCLG.

**Case study 10:** Canary Wharf Crossrail station – Example of GI being incorporated into a large scale infrastructure project.

### Natural Environment White Paper and Biodiversity 2020

The [2011 Natural Environment White Paper](#) (NEWP) recognised that *“a healthy, properly functioning natural environment is the foundation of sustained economic growth, prospering communities and personal wellbeing.”* It set the objective for Government: “to be the first generation to leave the natural environment in a better state than it inherited”. The paper set out to establish a clear institutional framework to achieve the recovery of nature. This includes reforms of the planning system, setting up Local Nature Partnerships (LNP’s) and creating Nature Improvement Areas (NIAs). Since 2011 the Government has been regularly reporting on the progress of this work, which can be found [here](#).

The [Biodiversity 2020: A strategy for England wildlife and ecosystem services](#) also published in 2011, sets out the strategic direction for biodiversity policy on land and at sea. It also provides a comprehensive picture of how we are implementing our international and EU commitments. The mission for Biodiversity 2020 is *“to halt overall biodiversity loss, support healthy well-functioning ecosystems and establish coherent ecological networks, with more and better places for nature for the benefit of wildlife and people”*.

### Natural Capital Committee

As mentioned above, the Natural Capital Committee (NCC) was established in 2012 as an independent advisory body to Government with a fixed term to September 2015. The Committee’s role is to advise the Government on how to ensure England’s ‘natural wealth’ is managed efficiently and sustainably, thereby unlocking opportunities for sustained prosperity and wellbeing.

It has published a [series of reports](#).

- The first State of Natural Capital report (April 2013) reviewed evidence on recent trends and drivers affecting the state of natural capital in England and proposed a number of options to measure and value changes in natural capital as an important first step towards better management.
- The second report (March 2014) presented a framework for assessing which of the benefits derived from natural capital in England might be at greatest risk and estimating the potential economic gains from their recovery.
- The third report (January 2015) calls for Government, working closely with the private sector and non-governmental organisations (NGOs), to develop a strategy and corresponding 25 year plan. The strategy needs to have three parts: building blocks; investment; and financing.

The Natural Capital Committee has also published guidelines and methodology for Corporate Natural Capital Accounting which have been piloted by the Crown Estate, the National Trust, United Utilities and Lafarge. The Natural Capital Committee has identified areas for investment in natural capital, including green infrastructure.

### UK Biodiversity Action Plan

The UK Biodiversity Action Plan was created in 1998 in response to the habitats and species that were most threatened in the UK and required material consideration during planning determination. As a result of new drivers and requirements, the [‘UK Post-2010 Biodiversity Framework’](#), published in July 2012, has succeeded the UK BAP. Due to devolution and the creation of country-level biodiversity strategies, much of the work previously carried out under the UK BAP is now focused at a county level.

The UK BAP lists of priority species and habitats remain important and valuable reference sources. Notably, they have been used to help draw up statutory lists of priority species and habitats in [England](#), [Scotland](#), [Wales](#) and Northern Ireland (see [NI species](#) and [NI habitats](#) lists), as required under [Section 41](#) (England) and [Section 42](#) (Wales) of the

Natural Environment and Rural Communities (NERC) Act 2006, [Section 2\(4\) of the Nature Conservation \(Scotland\) Act 2004](#), and [Section 3\(1\) of the Wildlife and Natural Environment Act \(Northern Ireland\) 2011](#).

### Green Infrastructure Partnership (GIP)

The [Green Infrastructure Partnership](#) supports the development of GI in the UK, identifying and developing solutions to enhance GI to strengthen ecological networks and improve communities' health, quality of life and resilience to climate change. The GIP was launched by DEFRA in October 2011, following the Government's *Natural Environment White Paper*, 'The Natural Choice: securing the value of nature,' and was taken on by the TCPA in April 2014.

The GIP brings together a network of stakeholder organisations and individuals. It provides a platform for members to share their research, news, and best practice and to co-ordinate influencing key decision makers about the value of GI.

Many members of the GIP supported and endorsed the '[Planning for a healthy natural environment – good practice for green infrastructure and biodiversity](#)' which was published in 2012 and provides additional useful information on policy context and provide guidance on implementation and maintenance of GI.

### Regional Level

The below list is not comprehensive, it simply acts to demonstrate some of the work that is taking place in relation to GI across the UK.

#### North-West

The website for [Green Infrastructure North-West](#) has a wealth of resources from International to local level and includes: Building natural value for sustainable economic development: Green Infrastructure Valuation Toolkit. More information on this tool can be found in [Section 4](#) and on their website [here](#).

Some of the more recent local plans in this area have been listed below for information. For more details, see [here](#):

- [Sankey Valley Green Infrastructure Plan \(The Mersey Forest, 2014\)](#)  
A closer look at the green infrastructure of the Sankey Valley in Merseyside, building upon the city region framework [Wirral Waters Indicative Economic Assessment \(The Mersey Forest, August 2011\)](#)  
A quantification and [valuation](#) of the economic benefits of a proposed programme of improvements to the green infrastructure in the areas around the development at Wirral Waters.
- [Greening the UK for greater dividends – The Triangle case study \(Horticultural Trades Association, 2011\)](#). A case study applying the [Green Infrastructure Valuation Toolkit](#) to a residential development in Swindon called The Triangle

#### London

The London Plan<sup>5</sup> is the overall strategic plan for London and sets out a fully integrated economic, environmental, transport and social framework for the development of the capital to 2031.

- Policy 2.15 recognises the importance of development proposals in town centres contributing towards an enhanced environment, urban greening, public realm and links to GI.
- Policy 2.18 commits to the Mayor working with all relevant strategic partners to protect, promote, expand and manage the extent and quality of, and access to, London's network of GI.

5 The Greater London Authority (GLA), (2013); The London Plan (2011 and Revised Early Minor Alterations 2013), GLA.

The development of Area Frameworks – identifying the projects that will deliver London’s green infrastructure



**Figure 3: London Area frameworks** (Source: GLA, 2014, <http://www.london.gov.uk/priorities/environment/greening-london/improving-londons-parks-green-spaces/all-london-green-grid/all-london-green-grid-area-frameworks>)

The All London Green Grid (ALGG): The ALGG Supplementary Planning Guidance<sup>6</sup> is a policy framework to promote the design and delivery of GI across London and support the London Plan. Eleven Green Grid Areas (GGAs) have been established, and ALGG Area Frameworks have been produced for each to expand on the implementation points and strategic opportunities set out in the ALGG SPG (See [Figure 3](#) below).

### All Green Grid Area Frameworks

London also has the ambition to become the first Urban National Park, see [here](#) for more details.

### London Infrastructure Plan 2050

The [Mayor's London Infrastructure Plan](#) dedicates a chapter to GI. Chapter 15 states that it is important for Londoners to have access to high-quality green spaces even as the city increases in density in the future. Simply to keep pace with the projected population increase, the plan states that London will need to create the equivalent of an additional 9000 ha of accessible green space to meet existing standards.

A [green roof map](#) has been produced by the GLA and the Green Roof Consultancy by studying aerial images of London taken in 2013 (by The Geoinformation Group), and will continue to be updated.

<sup>6</sup> All London Green Grid (ALGG): The ALGG Supplementary Planning Guidance

## Local Level

The importance of GI is also being acknowledged at a more local level with some local plans and policies forming strategies and procedures for conserving and enhancing their green spaces, examples of which can be found later in this chapter.

## VALUE project

VALUE- 'Valuing Attractive Landscapes in the Urban Economy' was a GI project that ran through 2007-2012 and was funded through the European Union. The project demonstrated the economic value of GI in cities and regions and brought together 9 partner organisations from Belgium, Germany, the Netherlands and the UK. The UK partners were the South Yorkshire Forest Partnership, the University of Sheffield and Community Forests North West.

10 sites were invested in across Europe, including four in the UK. Evaluation was carried out to determine the link between GI & economic value & environmental quality and the project determined that GI was economically viable for urban developments and can help to support the social and ecological needs of a location and economic growth at city and sub-regional level. Further information on one of the UK Investment Sites, the Wicker Area in Sheffield can be found [here](#).

## VALUE +

VALUE+ is a follow on project and is again an EU funded project, with 12 partner organisations across North West Europe. Partners from the UK remained the same as the VALUE- project with the addition of Sheffield City Council.

One of the investment sites, the [Edward Street Breathing Space](#), created a vibrant flexible community & sports space in the heart of urban Sheffield.

## Examples of Green Infrastructure at a local level

### Birmingham

In Birmingham the [Green Living Spaces Plan](#) was brought in to action in 2013 to provide guidance on securing, enhancing and ensuring the effective long term maintenance of the city's natural green and water spaces, which Birmingham City Council recognises are essential for an adapted & healthy city.

The Plan introduces seven key principles: an Adapted City; the City's Blue Network; a Healthy City; the City's Productive Landscapes; the City's Greenways; the City's Ecosystems; and the City's Green Living Spaces. The plan will eventually act as support for the Your Green and Healthy City Supplementary Planning Document (SPD) which is currently in draft and under consultation.

### Sheffield

Sheffield is known as the greenest city in Britain, and Sheffield City Council cites green spaces as one of its most valuable assets. It is actively working on the GI agenda and has a Green & Open Space Strategy (2010-2030) which sets out the long-term strategy for these areas, focussing on the wide range of benefits and opportunities of green and open spaces.



## Manchester

The Manchester Core Strategy sets out the importance of green and blue infrastructure to the city, in the context of its plans for growth and in terms of the range of benefits that it provides, from health and wellbeing, to flood risk management and biodiversity. Manchester City Council feel that green and blue infrastructure is central to creating an attractive, liveable city, helping current and future residents to enjoy the quality of life expected in a world class city.

The Core Strategy sets out the commitment to produce a GI Strategy, in order that the full potential of the city's GI can be realised, and that a targeted approach can be developed in support of the city's wider plans for growth and regeneration.

The Manchester Green Infrastructure Strategy is in progress with mapping of the city's GI, partner consultation, evidence base scoping and research was undertaken in 2013. This identified the need for a robust local evidence base to be produced to underpin the strategy, for GI to be embedded across a range of Council policy documents, and the key role that external partners could play in its delivery.

The extensive mapping of Manchester's GI resource has been completed, showing that, in 2014, 58% of the city is made up of non-man-made surface, or GI. Of this GI, 30% is private or domestic garden space, 9% is woodland, 6% is public park or garden, and 2% is made up of rivers, canals, lakes and ponds. A similar level of detail is not currently available for most UK local authority areas.

The Progress Report provides a summary of the work to date. It describes the need to establish a clear understanding of the value of the city's GI, in terms of its contribution to a range of social, economic and environmental objectives, and the work currently underway to establish this evidence base. It also provides an overview of a range of on-the-ground activities, setting out that work to continue to enhance the city's GI resource is ongoing, running in parallel with the development of the strategy.

Finally, it includes the next steps for production of the strategy, including working with the stakeholder Steering Group for the city's climate change action plan (*Manchester – A Certain Future*) which similarly contains a commitment to produce a Manchester Green Infrastructure Strategy.

The University of Manchester has also been involved in the development of spatial modelling and web-GIS tools for climate change adaptation planning in urban areas including Star Tools (see [Section 4](#) for further information on Star Tools).

**Case study 11:** Manchester City Council – Describes the work they are doing to focus on their GI strategy and provides an example of temporary use of land awaiting development



## 6.0 WHAT SHOULD CLIENTS AND DEVELOPERS BE DOING ON GREEN INFRASTRUCTURE?

To be truly effective, green infrastructure (GI) should be integrated into the design of development from the early stages. If it is considered early on in the design process then it can provide multiple benefits for the site, as well as make construction easier and more cost effective. GI can be incorporated on any scale, the important aspect is determining the right design. As a summary [Figure 4](#) outlines key actions to be taken alongside the RIBA plan of work stages, and is a useful reference in establishing how to integrate GI into a project.

As a client it is important that you are clear about the development of a GI strategy from the outset. Both new and regeneration projects of all scales provide opportunities for GI to be incorporated and enhanced. New GI features can help link existing GI in the surrounding areas which will help to develop the network of GI in our towns and cities, reducing pressures on over stretched traditional systems such as our drainage networks.

### Developing a GI Strategy

When developing a GI strategy the approach is simple – do it early, think it through and get lots of help from local experts. A good GI strategy requires a knowledge of hydrology, technical drainage solutions, ecological design, pollution management, landscape architecture and more. Ensure you get advice from the right sources bringing in experts early in the planning process to steer your GI design to ensure nothing gets overlooked and tailor the GI to the site.

There is a wealth of information already in existence on the Internet (and in particular via UK-GBC's [Pinpoint](#) platform), don't reinvent the wheel, here are a few points on how to get started on a strategy:

1. What has already worked well? Be careful when coming up with a strategy that you don't overlook what is existing on site, green space present on site may well be acting to capture and filtrate rain water. Often designs 'reinvent' benefits that were already there in the first place when 'creating' infrastructure, for example developing (often at great expense) over a wet woodland system and then adding expensive underground water storage and new drainage simply to replace the service the wetland was providing. Existing mature trees are highly valued by people and provide many other services to wildlife, they take a long time and are incredibly expensive to replace. See if you can retain and incorporate the valuable greenspace into the design.
2. Stakeholder engagement – It takes a lot of people and a lot of information to make places people truly love and this will require working with others; e.g. local planning authorities, architects, ecologists, community groups, wildlife trusts, contractors and other neighbouring developers. Don't be afraid to communicate or to share or accept new ideas, if you can think holistically for a site, you'll get a much better result.

**Case study 12:** Windmill Estate Development (Fulbourne Swifts) – Example of preserving a community of Swifts that were found to be nesting within homes that were due to be regenerated.

3. Don't forget about ecology – all too often an ecologist or landscape architect gets involved at the last minute to help score sustainable rating points, help win an award, or to 'add to a design'. Bring them in early. They should be considering aspects such as: what ecological features already exist on site? What could be impacted by the proposed development? How can the existing valuable habitat be enhanced rather than lost? How can you provide habitat links/wildlife corridors for wildlife?

Get a nature-led design, highlight its importance, and the outcome will be more cost effective and of a higher quality, than trying to retrofit nature into a grey site half way through (or worse, during construction).

4. Start at the end – Consider who is going to own/manage the land on completion. Managing GI is one of the most significant issues in its success or failure. Consider the long term implications of management and maintenance – who will pay and how much will this cost annually? Failing to plan for ownership and therefore management is one of the biggest barriers to progression of GI in urban regeneration. With every failed effort due to poor planning, GI is set back, continuing a belief that it doesn't work or it is too expensive, which if planned properly, simply isn't true.
5. Size simply doesn't matter – GI can be introduced **on any site**, even if it's a small rain garden, or a green roof on an outbuilding. Any action to slow down rainfall or introduce biodiversity can reduce pressures on systems and generate an opportunity for nature. Never fall into the trap that because you don't have acres of land you can't do GI on your site.
6. Get connected – by connecting GI to existing features you can maximise the benefits. An urban site is rarely an island. Don't forget to review what's going on outside the red-line planning boundary. Consider if there other GI features that can be linked. Linking GI is great for biodiversity, creating routes to migrate, and opening new territories for species and maximising the value of your GI (recognising potential hydrological loads on other systems of course). Long expanses of green also help create routes for people, making walking or cycling along green corridors pleasurable when getting from A to B and can increase the footfall on your site, which can be of great commercial and community benefit.
7. Think about multi-functionality – GI works in multiple dimensions in a number of ways, for example a green roof provides a home for nature, has thermal benefits for the building, sound proofing, storm water retention, visual amenity, and pollution control to name just a few benefits. When looked at in this context the business case really does stack up for GI. It's not just about drainage!
8. Be bold! - Challenge existing practices. Members of the team may be afraid to commit to change due to fear of increased costs. To continually drive innovation in this area, it is important to be bold and experiment. Planning in some experimentation, some small, some more significant which are then evaluated, will help to drive change in the industry and increase learning.
9. Involve real people – if you want a GI design that is loved by people it's best to involve them. Remember GI is all about "place making" when considering people. The public are the true owners of GI, getting buy in and support makes all the difference in getting a scheme to work and have people take pride in the green spaces that are created. Look at all aspects of society, is your pond loved by children (and safe for them to enjoy), does your *swale* create a barrier for the elderly or your green roof look good for those looking down on it – stakeholder opinions should matter to you, this will help lead to a truly sustainable design.

**Case study 13:** Long Barrow– Example of extensive community engagement and consideration of GI in order to get permission to build a single dwelling on greenfield land.

10. Learn from others, learn from yourself – theory is great and design drawings are often pretty, but there's no substitute for practice. If you're planning on introducing GI on a scheme go visit some real life examples, there are a growing number in the UK, but be prepared to travel if need be, learning from those that have already made mistakes will save you in the long run, and make sure when you put in your system you monitor it, and use it as an example for others. GI's success will rely on a network not just for infrastructure itself, but examples of it working in practice.

**Case study 14:** The Crown Estate London Ecology Masterplan – example of data collation, continuing to monitor and measure the outcomes of added GI.

**Case study 15:** Nene Valley – Example of GI being incorporated into the regeneration of a previous mineral extraction site.

## Applying Green Infrastructure to the RIBA Plan of work



This diagram sets out the RIBA 2013 plan of work and highlights the key considerations that are needed at each stage.

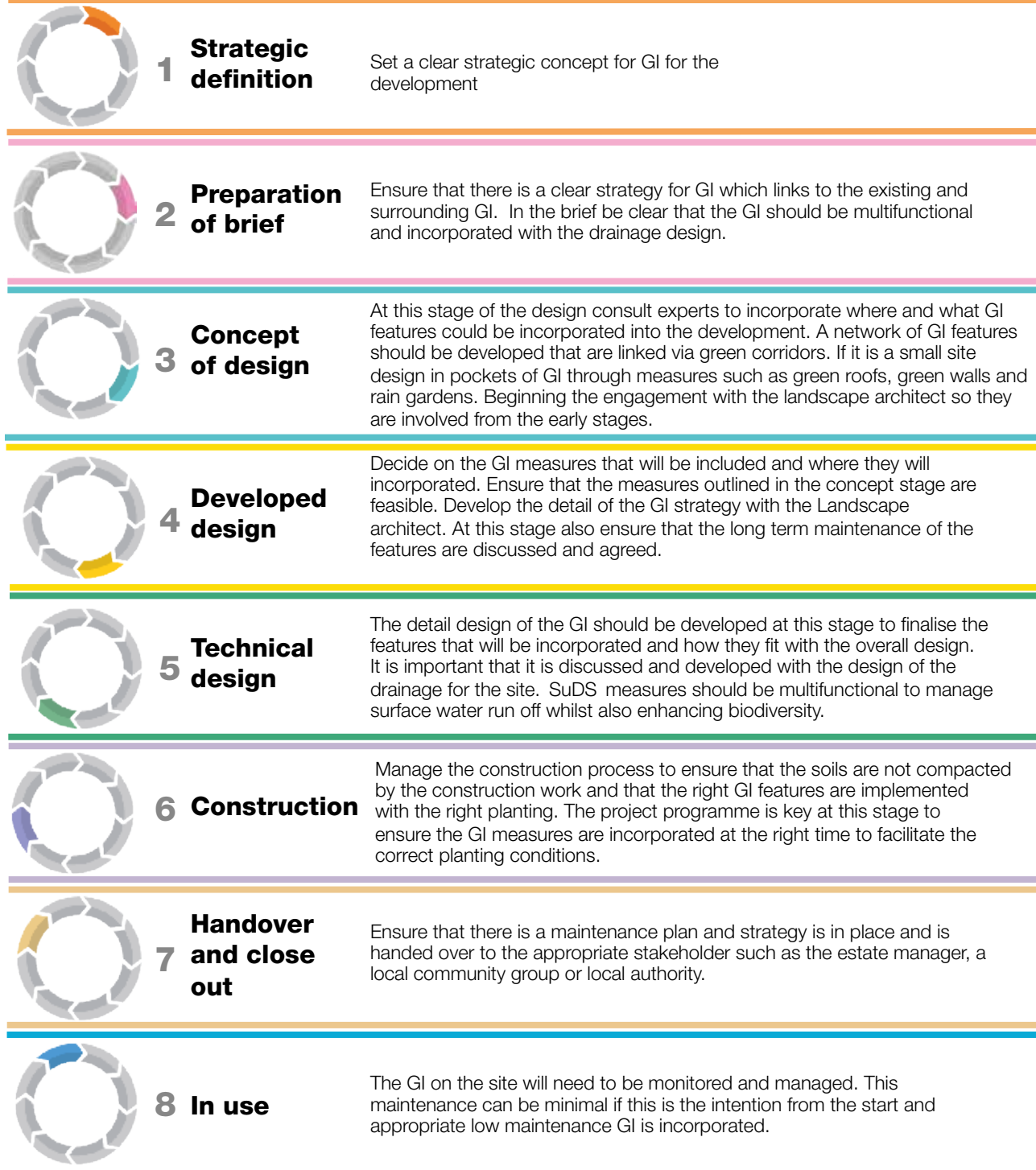


Figure 4: Applying GI to the RIBA plan of works

## Maintenance

“Why?” is the most important question when it comes to maintenance. Questions such as the following will all need to be asked in order to ensure appropriate maintenance of the features specified: Why is the feature there? Is it to convey water? Slow down rainfall? To act as an ecological habitat feature? Visual amenity for local residents? A child’s play feature?

The purpose of each GI feature should govern its maintenance regime and it is crucial to think about it at the earliest stages of the design. All too often priority habitats are damaged or even removed because no one thought to write a management plan based on ecological requirements, or a green roof fails because of poor design or a lack of access to maintain it. Therefore when thinking about maintenance the following is crucial.

- Management plans are essential both for people maintaining GI as well as wildlife. Keep it simple and explain why it needs to be managed, any plan is far more likely to succeed if people know why they’re doing it. Involve local people and local experts where possible in the process to find out what matters to them, get technical help where needed but create these alongside designs. Not only will this help designers think about what it is they are proposing, but also ensure it can be managed and maintained to work as planned. (See [Appendix B](#) for some additional tips on how to reduce maintenance costs and increase biodiversity.)
- Timing is everything. GI is a living system, if it needs to be maintained to a schedule to work properly, slipping dates, or putting off scheduled maintenance will compound the problem. It is far more cost effective to maintain GI as planned than having to replace elements of it due to lack of maintenance. Often mature schemes become easier to maintain than those newly installed, it is important to have an awareness of the design intention for aspects such as how large vegetation will grow, how long will it take to grow etc? Knowing approximately what the scheme will look like after 6 months, 2 years, 5 years, 25 years+, will help when managing maintenance regimes.
- Don’t be put off by the presence of protected species, but be aware of the risks created. If you do end up with something special on site, plan for it – for example bats roosting, birds in the breeding season, water voles and great crested newts among other protected species all need to be managed in specific ways. Additional wildlife should not incur additional costs if adequately planned for. Be aware of site designations and other legal duties and manage accordingly – it’s never a problem if you plan for it.
- The local community should be engaged in some aspects of maintenance, this helps create a sense of ownership and can really create a positive social dimension through events and activities. However this should be managed. Training and supervision of contractors, and the general public is essential to ensure that management is carried out correctly, safely and on plan.
- Undertaking qualitative and/ or quantitative measurement of the impact of GI on sales values and overall customer satisfaction/ quality of life post-occupation is an aspect to be incorporated into the maintenance regime. The results of this should be fed back and the knowledge gained applied on future developments.

**Case study 16:** Cambourne – interesting arrangement for maintenance of the land with the Wildlife Trust.

## Stakeholders

Consultation with experts from organisations such as The Wildlife Trusts, RSPB etc. and local interest groups to help develop the GI strategy is crucial. These organisations will provide further information not only on the technology involved, but crucially on the local context of the site, being able to suggest the right habitats, features and species to connect with the wider landscape. It is important to facilitate the collaboration between these organisations and the landscape architects involved to create multi-functional green infrastructure.

Working with local planning authorities can also prove invaluable, not only to support planning guidance and legislation but also taking on board a wealth of knowledge on other schemes in the area and any larger plans for GI that can be connected.

Finally, public stakeholder engagement sized to the scheme is always useful, often on larger projects focus groups or steering committees can help elicit responses that may not have been thought of by design teams (especially around unanticipated impacts). Even smaller schemes can canvas opinion from the public. These always present opportunities to test ideas, gauge responses and present an opportunity to explain what GI is for to help build support from the community.

## 7.0 ENSURING SUCCESS

Here are our **top tips** for ensuring success when you get into the detail of integrating green infrastructure (GI) into your projects:

- Allocate budget within the overall development for GI design prior to land purchase.
- Specifying the GI requirements into the standard engineering specifications to ensure it gets considered. Making the information as clear and detailed as possible makes for accurate costings, reducing the likelihood of elements such as green infrastructure being value engineered out.
- Have clarity of the vision for the overall scheme and have an understanding of how GI can add value. There needs to be a culture which fully embraces GI at the masterplan stage.
- Consider the design early on in the process, this should be from 'Strategic Design' and follow through to concept and detailed design, as per the RIBA stages figure above.
- Having a biodiversity/green infrastructure 'champion' on major developments helps to protect GI from 'value engineering' and ensures that what was designed gets implemented.
- Ensure the GI for the project is kept on the agenda for all key design team meetings to ensure it is always kept in mind. It's important for everyone on the design team to understand why certain features have been included and to be fully aware of their role in terms of implementing the design.
- Ensure that the appropriate and relevant level of expertise, tailored to each project, is involved at the appropriate time (usually as early as possible). The importance of having the right expertise on the project is critical in ensuring the right outcome.
- Ensure any seasonal constraints relating to the design or plant type have been factored into the implementation plans.
- Another way to help prevent GI falling off the radar during construction is to register the project with an appropriate certification scheme e.g. BREEAM, CEEQUAL, The Wildlife Trusts Biodiversity Benchmark.
- Identify clear responsibility for the landscape management during the construction phase and on completion. Identify a clerk of works roles and responsibilities for the construction phase to ensure skilled people are on the ground providing implantation advice.

**Case study 17:** Portbury Wharf – Interesting example of how maintenance costs were managed for the nature reserve on completion.

- Ensure a GI management plan is handed over to the individual or team maintaining the area going forward.
- Developing strong & mutually beneficial relationships/ partnerships with local partners such as The Wildlife Trusts can assist in design, delivery and speedy approvals through planning. Local Partners such as The Wildlife Trusts and the RSPB can help to promote the benefits of the GI to customers and the local community, generating interest and excitement through community days, butterfly walks etc.

**Case study 18:** Oakfield Village – Barratts have worked closely with the RSBP to incorporate 50% green space within the development, enhancing biodiversity and wildlife habitats

## 8.0 CASE STUDIES



## Case study 1: Kilnwood Vale

<b>Location:</b>	Faygate, West Sussex
<b>Type of Project:</b>	Mixed-use development – 2500 new homes plus commercial units
<b>Developer:</b>	Crest Nicholson
<b>Architects:</b>	Barton Willmore & Broadway Malyan
<b>Ecologist:</b>	SLR & Derek Finnie Associates
<b>Landscape Architects:</b>	SLR and David Jarvis Associates

### Summary

The driving vision and ambition behind Kilnwood Vale is to restore and regenerate the area between Crawley and Horsham into a vibrant residential centre with community and green infrastructure. The whole development is 122.62 ha in total and will be built over five phases. Crest worked closely with Wessex County Council, Horsham District Council and Crawley Borough Council to ensure the development met all the objectives set by all the affected local planning authorities.

The site was previously made up of two distinctly different types of land, arable fields and a former inert landfill and waste recycling centre. Neither area was used by the public and both required significant remediation. The masterplan retains the important original landscape features that gave the site its sense of place to begin with, and then builds upon it. It also draws on key elements of the Crest Nicholson Garden Village concept.

The finished landscape design will include features such as:

- Open spaces, on-site ancient woodlands, two brooks, established hedgerows, parkland, woodland, nature walks, holding ponds and a network of green corridors (including cycle and footpaths).



One third of the total site area will be green open space

### Aims of the Green Infrastructure design

- To retain the original features, make the ancient woodlands and brooks accessible to the public and blend in with the surroundings
- Improve the ecology and biodiversity across the whole site

### Sustainable outcomes

As a result of the drive to embed green infrastructure into the landscape plan, many sustainable outcomes hope to be achieved:

- Regenerating and revitalising a dis-used area
- Protecting and enhancing the ancient woodlands on site and the surrounding area and making them more accessible
- Creating ecological enhancements throughout the site, increasing the ecological value
- Supporting economic and social benefits through the creation of infrastructure, local amenities, and services, resulting in local job creation and providing new community assets
- Supporting healthy living by providing opportunities for people of all ages to walk, cycle, play, sports activities, and have access to nature
- Supporting well-being by opening up areas of natural beauty to the public, including woodlands, Bewbush Brook, and outside the site.

I am delighted to see this site being built up. People do not realise how long it takes to bring a site from the strategic level to construction. This is a good example of co-operation between neighbouring authorities. Cllr Ian Howard, Horsham District Council's Cabinet Member for Living and Working Communities

## Case study 2: Tadpole Garden Village

<b>Location:</b>	Wiltshire
<b>Project classification:</b>	Large Housing development – Garden City
<b>Project type:</b>	Nature Park
<b>Project team:</b>	Developers – Crest Nicholson

Tadpole Garden Village is a modern day 21st Century Garden Village located to the north of Swindon, a short distance from the village of Blunsdon and the River Ray. The development, comprising approximately 143 hectares, will feature 1,695 residential homes as well as a school, shops, a pub, and a community centre. Inspired by the original Garden Cities principles and Crest Nicholson's own Garden Village Framework, the vision is for a holistically planned, new community with strong character, design, landscaping, and public open spaces. The green infrastructure is supported by a strategy for its long term management and maintenance by the Wiltshire Wildlife Trust.

As former farmland, the site has been designed and developed around many existing natural features, including hedgerows, established woodland, ponds and ditches. In total more than 68 hectares of green space weave through the village landscape offering open spaces, sports pitches, woodland, play areas,

cycle routes, footpaths and a new Nature Park for both people and wildlife. Crest Nicholson are working in partnership with Wiltshire Wildlife Trust to create the Nature Park, which will see the conversion of more than 48 hectares of arable land to wildflower species-rich meadows, providing essential habitat for plants, invertebrates, bats, birds and mammals, such as the brown hare. The Nature Park will also provide vital links in the green corridor that runs along the River Ray to the north Wiltshire countryside.

Crest Nicholson are funding the creation of the Nature Park with the Wiltshire Wildlife Trust committing to a 125 year lease to assist in its quality design and implementation, as well as ensure its successful long term management and maintenance. The Trust will also provide 100 days of engagement activities to secure community interest and pride by local residents. The Nature Park is supported by an endowment from Crest Nicholson and an annual service charge payable by residents.



## Case study 3: Queensbury Recreation Ground

<b>Location:</b>	Harrow and Brent
<b>Type of Project:</b>	Reinvention of Queensbury recreation ground
<b>Developer:</b>	Harrow City Council
<b>Advisors/Designers:</b>	AECOM

### Summary

Kenton Brook is a main river that drains an urban catchment in Harrow and Brent. A 1km open channel drains through Queensbury Recreation Ground joining the Wealdstone Brook and eventually the River Brent. It is a significant pathway for flood flows that contributes to flooding downstream and is recognised as a 'Critical Drainage Area' in the Harrow Surface Water Management Plan. There has been notable flooding along its length in the past however; no detailed flood modelling was previously available and flood risk was measured using coarse national-scale modelling.

A Feasibility Scoping Study was funded by the EA to determine the constraints and opportunities to reduce flood risk along the river corridor. It was recognised that there was an opportunity to make better use of the flood area, to open it up to the local community and reduce flood risk whilst also increasing the biodiversity of the area. They also hoped that this would reduce ongoing maintenance costs.

In order to achieve these ambitious aims, the solutions implemented on the site included:

- Material reuse
- Biodegradable blankets and planting used to offer erosion protection to bank slopes
- New local native planting
- Summer and winter channels included to mitigate the effects of the flashy nature of the river.



Before



After

### Project outcomes

As a result of the changes many benefits have been felt by both the local community and the local council, including:

- Provision of space to store flood water and integration of river with wider landscape setting
- Improvements in biodiversity and habitat— in stream features, ponds and wetlands
- Improved amenity space for the local community
- Water quality improvements
- Working with the local schools, community, Brent Catchment Partnership & Thames 21 to develop the amenity and make use of the potential educational benefits and aspects for their school curriculum.

**Harrow Council Core Strategy (2012)** includes, as part of its spatial vision to 2025, a commitment to maintain and enhance Green Belt, Metropolitan Land and other open space within the Borough as an interconnected network of GI and open watercourses supporting biodiversity and healthy lifestyles. Queensbury Recreation was seen as an opportunity to put this into practice by using GI SuDS whilst also achieving many other objectives to improve amenity, biodiversity, habitat, water quality, education and flood risk management. In this project, Harrow council have truly demonstrated how well designed and effective green infrastructure (GI) can provide multiple benefits to all stakeholders involved.



## Case Study 4: Trumpington Meadows

<b>Location:</b>	Cambridge
<b>Project classification:</b>	Sustainable urban extension with green infrastructure
<b>Project type:</b>	Green Infrastructure – New Country Park
<b>Project team:</b>	Landowner and developer – Trumpington Meadows Land company (Grosvenor and Universities Superannuation Scheme); landscape architect – Terence O'Rourke; Engineering – WSP; Ecological advice & land management – the Wildlife Trust for Bedfordshire, Cambridgeshire & Northamptonshire
<b>Identified stakeholders:</b>	Local Authorities, parish councils, Trumpington residents

### Summary

Trumpington Meadows is a development of 1,200 homes and forms part of a string of developments on the southern fringe of Cambridge. Respecting Cambridge's character as a compact city with networks of green space connecting the city to surrounding rural areas, the new developments aim to link into these green corridors.

Trumpington Meadows Land Company wanted to create a high quality development with its own character and sense of place and viewed a new country park as integral to this. It carried out extensive consultation with local communities and stakeholders prior to submitting the planning application, which reduced objections and highlighted concerns at the outset.

The Wildlife Trust was selected in advance as the land managing organisation and engaged with the landscape architect on design and creation of the development's green infrastructure to help secure better outcomes and limit future problems. By overseeing the creation of new habitats, the Wildlife Trust was able to work with trusted local suppliers and contractors resulting in significant financial savings.

Local play areas, swales and tree avenues are included throughout the development and the 58 hectare country park is designed to be both a space for people and a 'nature reserve'. Its staged creation which includes areas of existing arable land, as well as new species-rich meadows, hedgerows, woodlands and restored floodplain meadows, began prior to the building of the first houses to allow the landscaping and habitats time to mature.

The country park was designed to follow the River Cam and include its floodplain. A river restoration scheme was developed with the local authority ecologist to improve the river habitat and re-connect the river with its floodplain meadows, providing a small reduction in flood-risk downstream. New houses were built away from the flood plain to reduce flood risk and the drainage system is engineered to include a balancing pond with overflow area and open ditch (swale) features. All of which provide additional habitat and biodiversity benefits.

Image courtesy of Martin Baker, The Wildlife Trusts for Bedfordshire, Cambridgeshire and Northamptonshire



## Case Study 5: Birmingham New Street Gateway

<b>Location:</b>	Birmingham
<b>Type of Project:</b>	Train station refurbishment
<b>Developer:</b>	Network Rail
<b>Project Landscape Architect</b>	Atkins (in association with concept architect AZPML/FOA)

### Summary

The Birmingham New Street Station Gateway project is the remodelling and refurbishment of the station at the heart of the city of Birmingham – one of the busiest in the UK, with a new train arriving every minute during peak times. The project creates a world class gateway to the UK's second largest city, improving passenger facilities and the station environment, as well as access and city links. The installation of a green living wall as part of the project improves the urban environment and public realm and will help to support the regeneration of the areas around the station. The selected living wall system includes a high density of planting (112 plants per m<sup>2</sup>) with no bare areas on the face. All the planting was pre-grown in the planting panel modules prior to mounting on the wall support framing. It is 76 metres long and with an average height of 4 metres it incorporates 300m<sup>2</sup> of planting consisting of over 33,000 plants. Below the planted face is a low wall which provides informal seating alongside a new pedestrian walkway.

### Project aims

- The living wall is designed to have both an aesthetic value (a striking wave pattern that also acts as a screen to buildings behind) and an ecological value (the design specification requires planting shall include at least 25 species/varieties of ecological value). The Birmingham New Street Station Public Realm Strategy requires that “species and varieties will be selected on the basis of their visual appearance, seasonal characteristics, ecological value, suitability to site conditions, durability in a people dominated environment, and maintainability”.
- The living wall and its associated pedestrian walkway effectively create a new piece of greenspace right in the city centre. The south facing feature is already a popular place to sit next to, particularly on sunny days.
- As well as its biodiversity value there are thought to be a number of other environmental benefits of the living wall which need to be explored further. These include interception of rainfall, interception of airborne particulate pollution, urban microclimate effects, and acoustic effects due to massing of soil.



## Case Study 6: Kidbrooke Village

<b>Location:</b>	Kidbrooke, London, SE3
<b>Type of Project:</b>	Mixed-use development, 4800 new homes plus commercial units
<b>Developer:</b>	Berkeley Homes

### Summary

Kidbrooke Village is a large-scale, new suburban community in south London. It is currently one of the largest regeneration projects in the UK and has been planned to transform the former Ferrier Estate into a new mixed-used community including homes, schools, shops, health facilities, restaurants, offices and community facilities. The site will also create 50 acres of new parkland and open space across the development and include the planting of 2000 new trees.

The estate had become one of the most economically deprived areas in the country, due to bad design and an enclosed, inward-facing layout isolating it from neighbouring areas. There was little green space available and nothing encouraging biodiversity. The new masterplan focuses on permeability and connections with intertwined green spaces of varying uses and scale and provides a link to Sutcliffe Park located on the southern boundary of the development.

### Aims of the green infrastructure design

The project, now 5 years in, has reclaimed 14 hectares of brownfield land, and already delivered new parkland and open space. Improving connectivity through the site was a crucial aspect of the design alongside increasing the amount of green space. Routes across the development were previously underused and so the design aimed to open these up to create greater connectivity between the new development and the surrounding area. This approach has allowed the parks and open spaces to be used by both the existing community and new residents.

### Green infrastructure features

A new park (Cator Park), creates a central spine through the development. From the park spreads tree lined streets and smaller pocket parks, providing robust and visual links through the development. The green spaces range from new large parks through to small scale aspects such as green roofs and planted beds, providing a diversity of green infrastructure through the development.



With a site of this scale trees have been a key green infrastructure element with existing mature trees being retained wherever possible. The planting strategy has included incorporating rare species trees that have been identified in the local BAP including Black Poplars.

To help minimise the risk of flooding and help cope with anticipated changes in climate, sustainable urban drainage system (SuDS) have been incorporated through the development. The features include ponds, swales, brown roofs and permeable paving. The SuDS features help manage the rainfall at source, remove pollutants and reduce run-off. In addition, they can provide localised cooling to the surrounding area through evapotranspiration.

### Sustainable outcomes

As a result of the regeneration and the drive to provide green infrastructure for the development, many sustainable outcomes hope to be achieved:

- Creating ecological enhancements throughout the site, increasing the ecological value
- Supporting healthy living and wellbeing by providing green spaces for people of all ages to walk, cycle, play and have access to nature
- Supporting the local economy by creating investment and new job opportunities in the area.

The residents of the first 1000 homes at the Village have already given positive feedback on the green spaces through the site (Source: Kidbrooke Applications feedback from local residents):

“The best aspect of the development overall”

“Thoughtful and understanding of what residents will see”



## Case Study 7: The Pirbright Institute

<b>Location:</b>	Pirbright, Surrey, GU24 0NF
<b>Type of Project:</b>	Construction of a new 11,065m <sup>2</sup> high containment research laboratory
<b>Designer/ advisors:</b>	AECOM

### Summary

At The Pirbright Institute in Surrey, the BBSRC National Virology Centre: The Plowright Building, a new 11,065m<sup>2</sup> high containment research laboratory complex, was constructed. During construction the Institute employees discovered that some of Britain's rarest animals, including the declining venomous adder, had taken up residence in spoil heaps on the construction site. It was necessary for the development team to conduct a large reptile translocation project within the works area due to the protected status of these reptiles. Employees volunteered to get involved in the process and from this passion an Institute Biodiversity Group was formed with the aim to enhance biodiversity across the entire Pirbright site.

The project aim was to enhance biodiversity. The legal requirement for the construction project was the protection of the native reptile species and to relocate the animals away from the development. The Biodiversity Group then set out to enhance the site for all wildlife, including:

- A 6.5 hectares of grassland transformed into a reptile receptor site including a mosaic of five scarpes with different textures, ten hibernacula, four grass snake egg-laying areas and six brash piles. 1,024 reptiles were trans-located to new habitats created on site. The receptor sites are now regularly monitored by the Biodiversity Group.
- The small two acre woodland was given a biodiversity overhaul: a pond that had previously dried out was cleared and refilled; various insect habitats were created using log piles, brash piles, standing dead wood and building a large bug hotel; and bird boxes were installed.
- House martin nest boxes were fitted on carefully selected posts and trees and a stag beetle habitat was created from decaying oak logs.
- Enclaves were created for bee keepers with bee hives.

- Native plant species policy adopted and integrated within construction landscaping plans – there are plans to plant approximately 3,000 different native plant species.
- A five-acre wild flower meadow is planned to be created upon completion of construction in 2020.
- All materials used were recycled from waste materials and vegetation found on site.

In this example of green infrastructure, engagement with the employees was the key to its success. Involving employees in the biodiversity plan for the site provided educational benefits to the staff and helped to bring staff together. The nature of the Institute, with scientists often working within bio-secure laboratories supported by operations staff on the outside, can lead to a situation where the two groups do not get many opportunities to interact. The formation of the Biodiversity Group provided a great opportunity where staff from all departments could get together and work towards a common goal. This type of project is extremely beneficial in helping to increase staff morale and break down barriers, ultimately leading to an increase in staff retention and productivity.





## Case Study 8: King's Cross – Community and sustainability led by Meanwhile Green Infrastructure

<b>Name of project:</b>	The Global Generation Skip Garden
<b>Location:</b>	King's Cross, London
<b>Type of Project:</b>	Meanwhile Green Infrastructure – Infinite Possibilities
<b>Delivery:</b>	Global Generation, King's Cross Central Limited Partnership (KCCLP) & Argent (Property Development) Services LLP

### Summary

The Skip Garden brings together young people, businesses and the natural world in a potent mix of entrepreneurialism and ecology, which is transforming both the physical and the social environment in this new part of London.

The project is run by Global Generation – a charity which gives young people opportunities to create the sustainable world they want to live in. The garden was part-funded by the Big Lottery and The King's Cross Partnership. Income is now derived through venue hire and offering learning and development opportunities

for local businesses along with grants from the Local Authority and other grant making trusts.

In the middle of the King's Cross development site, the Skip Garden is an urban oasis in which herbs, chillies, apples, sweet potato and cabbages grow out of skips and planters made out of scaffold boards and other reclaimed materials from the King's Cross development site that have been upcycled to give them a new purpose and functionality. This has involved all of the onsite contractors, Carillion, Bam Construct, Bam Nuttall and Kier. The garden has developed through a workshop process and twilight garden sessions involving young people, business employees and local residents, transforming the space into 'a garden of a thousand hands'.

It is now a fertile platform for a range of activities which combine supporting bees, carpentry, urban food growing, cooking and eating together with dialogue, story, creative writing and opportunities for silence and stillness.

Photo credit: John Sturrock



### Great Outcomes

Due to the nature of the King's Cross site and the on-going building process, the portable nature of the Skip Garden means that it can move to different locations on the site as and when land is developed. However, the great work that the Global Generation is doing for the local community has resulted in plans to find a permanent location for the project at King's Cross.

At the heart of the Skip Garden are the opportunities that are offered to people of all ages to enable them to grow their understanding of who they are and their role in the world around them. Bringing to life the idea that we are all part of a connected ecological story lays the foundation to encourage an engaged and positive attitude towards the environment, as well as providing further training, enterprise and employment opportunities, leading to a smarter community.

The garden was created, and is looked after by "the Generators" – the name given to the young people involved with the project – working with volunteers from Global Generation, the Guardian newspaper and King's Cross construction workers. Those involved in the project have learnt about sustainability, construction, how to grow food, as well as how to market and sell their produce.

The emphasis is for hands on activities with young people, working alongside business volunteers to develop and implement ideas that have a positive impact on the environment in and around King's Cross. Some of the activities that volunteers get involved with include:

- Increasing biodiversity and learning about bees as part of the Honey Club
- Using site materials to build the garden and the planting containers
- Gardening and maintaining the Skip Garden through Twilight Gardening sessions and corporate volunteer and training days
- Helping run the Skip Garden kitchen and Skip Garden café – supporting local businesses
- Supporting BTEC Business and Sustainability students with business plans

The Global Generation philosophy has spread beyond first principles to now be key to delivery of business activities at King's Cross. Global Generation have also created and continue to maintain the planters around the terrace of many of the restaurants at King's Cross and the Generators are working to enhance the biodiversity of the site's green roofs.

### Lessons Learnt:

Since 2009 Argent and Global Generation have been working in partnership and learning together to realise the benefits of the green infrastructure created as a result of the Skip Garden. The project's commitment to inclusivity and ability to bring all parties influenced by the development together, has facilitated shared experiences, creating a platform upon which to engage further. Like nature itself, the project did not derive from a master plan, but rather through consciously creating the conditions for beneficial relationships to develop and creative ideas to grow.

What has moved from an opportunity for the enlivenment of meanwhile space has grown to a place where the community relationships and engagement is seen as key to the longevity and success of the development.

## Case study 9: Church Street and Paddington Green Infrastructure and Public Realm Plan

<b>Location:</b>	London
<b>Type of Project:</b>	Public realm
<b>Lead Landscape Architect:</b>	Grant Associates
<b>Ecologist:</b>	Biodiversity by Design
<b>Architect:</b>	Feilden Clegg Bradley Studios
<b>Engineer:</b>	Buro Happold

### Summary

The Church Street and Paddington project has won the landscape institute award for neighbourhood planning. This area has many social, economic and environmental issues that need to be tackled including: poor air quality, over-capacity drainage and flooding, summer heat and drought, deficient open space for informal play and lack of contact with nature, high instances of poor physical and mental health as well as the lowest average life expectancies for men and women compared to the whole of Westminster, low land values compared to the neighbouring areas, poor evening economy and insufficient and poorly managed infrastructure.

In the past there have been improvements to the public realm implemented within the Paddington and Church Street area but they have been largely piecemeal and proven to be ineffectual. The land ownership of the streets and many of the buildings and associated garden spaces fall under the ownership of Westminster City Council which provides a unique opportunity to assess the public realm as a whole, and the approach for regenerating it is equally unique.

The Infrastructure and Public Realm Plan, which was developed with extensive public consultation with the local residents, acknowledges that there is a need for a more holistic and dramatic step-change required in the public realm in order to address many of the issues in the area and create one of London's most liveable neighbourhoods. The project aims to create a model for future estate and neighbourhood renewal in Westminster and could set an example for sites across the UK.



The overarching vision of the project is to bring under-utilised spaces, into the public realm to bring multiple benefits to the community and address the issues that were highlighted.

Solutions such as sensitively reworking of on-street car parking and the introduction of shared surfaces enabled the team to develop a new north-south linear park (Green Spine). This distinct element combines informal play spaces, productive gardens, rain gardens and tree planting to create a place unique to Church Street. The Green Spine links many of the individual estates and schools, delivering a new green community space that complements the redeveloped Church Street and vibrant market.

This is a large scale project spans 43.3 hectares and will be completed over the next 15-20 years. The project will result in the existing disjointed green spaces being rationalised and connected in a way that will help to regenerate the area and massively increase the amount of accessible green space for the local community. The long term success of this project will rely on maintenance and management of the spaces and this has been considered throughout the design process. More information on this project can be found [here](#).

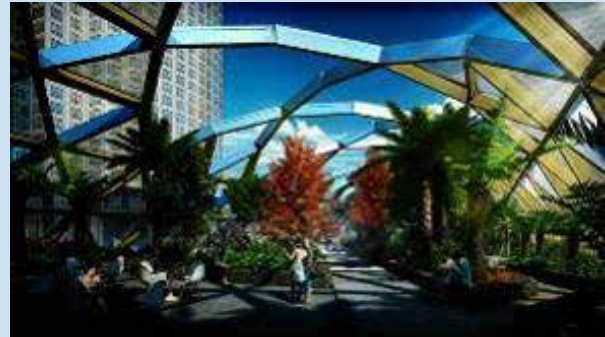
## Case Study 10: Canary Wharf Crossrail Station

<b>Location:</b>	Canary Wharf London
<b>Type of Project:</b>	Commercial Development with Integrated Green Infrastructure
<b>Designer/advisors:</b>	Gillespies Landscape Architects

### Summary

The new Crossrail station at Canary Wharf presents a major sustainable development opportunity, and includes significant aspects of Green Infrastructure.

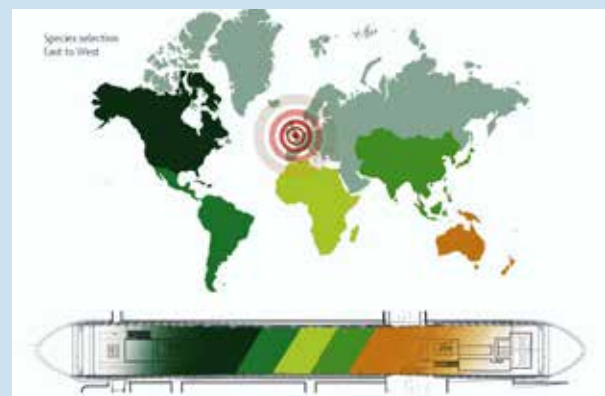
Plans to submerge the new station at the bottom of the 200 year old West India Import Dock mean that an 'over-site' commercial development opportunity is possible. With the space above the new station and ticket hall providing new retail and leisure space, the development is topped off with a spectacular timber lattice roof structure, partially covering a new publicly accessible roof park.



The spectacular new park is the jewel in the crown of the development, providing valuable and accessible public realm. Sitting within West India Dock the Crossrail Park can be seen as a metaphorical ship laden with unusual specimens from across the globe. The soft landscape design of the roof park seeks to draw on the exoticism of these ships and the cargos they carried, collected from the regions they visited around the world. The park is a collection of wide-ranging species that are typical of Western and Eastern Landscapes.

The aim of the garden is the creation of an appealing, legible and well managed publicly accessible space that will complement the existing open space provision within the vicinity of Poplar and Canary Wharf.

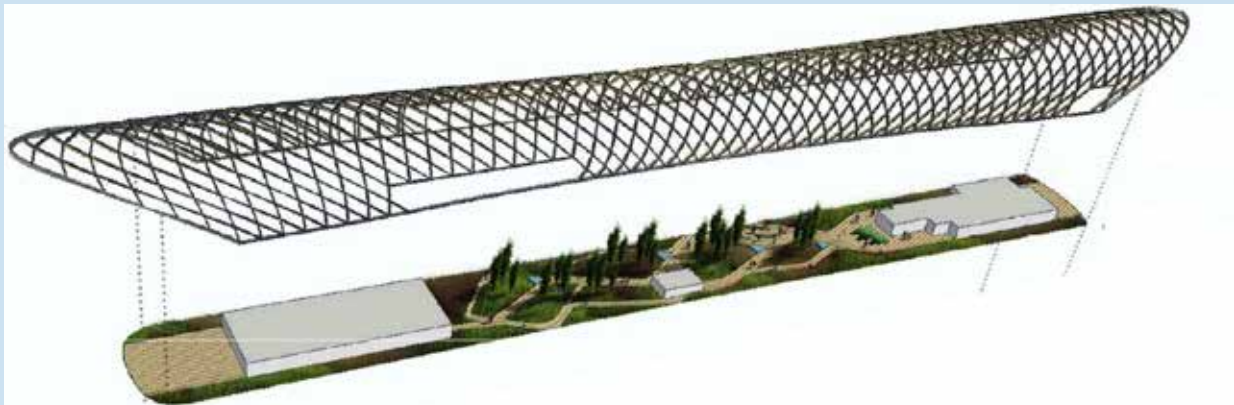
The design of the park responds to the language of the roof in the creation of a unique and sheltered planting environment. As well as the ecological value of the space, a range of amenity uses for community, business and recreational visitors, are possible with the creation of an amphitheatre for all to use and the installation of educational panels throughout the planting.



### Habitat Creation, Improved Water Quality

At dock level, an opportunity to create a sunken garden within a flood storage attenuation system, adjacent to the dockside promenade, is also realised. In concert with Local Biodiversity Action Plans an integrated planting and weir system has been introduced. This helps the development provide additional habitat zones and improve water quality by aiding water flow in otherwise static dock waters.

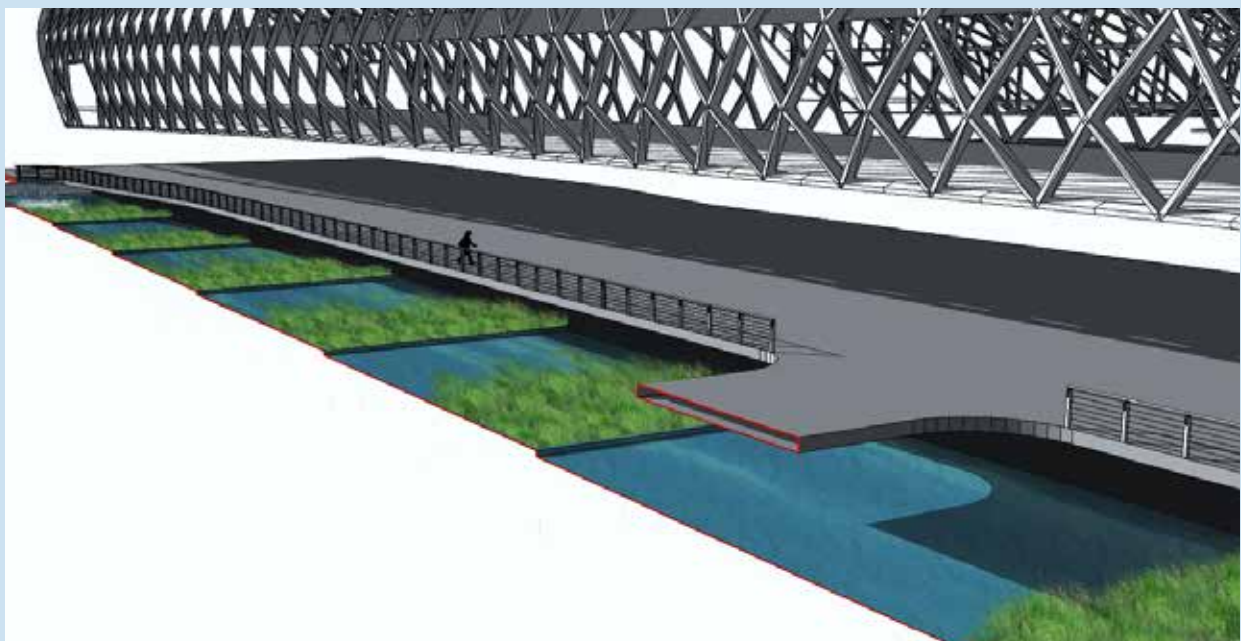




A series of stepped terraces lie perpendicular to the dock edge. These contain shallow pools of water that tip over the front edge of each terrace in a slow moving shallow water feature.

Water will be directed from either end of the sunken garden through a series of weirs set within terraces (200mm height) which are offset and staggered to encourage water circulation. Each terrace will contain three 'ponds' of varying depths of water and soil material in order to support different types of reed planting and some open water and pebble surface where the shallow pools of water will cascade from the terrace above.

Whilst the reed beds and water terraces at dock level provide passive measures bringing improved water quality and further habitat opportunity, the new roof level park establishes a valuable new amenity and wildlife resource as part of the wider network of green spaces.



## Case Study 11: Manchester Green and Blue Infrastructure Strategy

<b>Location:</b>	Manchester
<b>Type of Project:</b>	Understanding the value of GI to economic growth and providing a framework for collaborative working to improve GI Assets
<b>Designer/ advisors:</b>	MCC/ BDP/ Countryside/ Eftec

### Summary

Manchester has much experience of investing in its green infrastructure (GI), driven through a range of initiatives. These include the Biodiversity and Tree Strategies, launched in 2005 and 2006 respectively, the management and delivery of new GI as part of wider regeneration plans, and ongoing investment in parks and green spaces, resulting in the highest number of Green Flag Parks for any local authority area in 2012.

A strong understanding of the biodiversity value of the city's GI has been developed over the last decade, but more recently the need to understand the value of GI in achieving the City's objective of economic growth has been identified. This has been one of the drivers for work on a GI Strategy which has also involved consideration of the benefits of GI to land & property values, health & wellbeing, tourism, labour & land productivity.

Another driver has been the changing traditional role of the public sector as funder and provider of open space, requiring new and innovative ways of investing in the City's green and blue assets to be explored and encouraged.

The City was already involved in much collaborative work with a wide range of stakeholders including academics, statutory bodies, special interest groups, and land and waterways managers. This involvement has been crucial for providing the basis both for work on the Strategy and for beginning to create an Action Plan.

The intention is for the strategy to be supported by technical analysis (currently underway) of the proven socio-economic value of GI. It will include



specific local case studies\* to demonstrate a wide range of replicable activities and partnerships which have already been successful across the city. These will be complemented by a selection of national and international approaches which could also be replicable locally. The strategy once approved by Council will be supported by an action plan, aligned with the vision and objectives for investment in green and blue infrastructure across Manchester, to be delivered by a range of partners.

### **\*Case Study example: Wythenshawe Meanwhile Site (temporary use of site awaiting development)**

This site was a low quality area of incidental open space, within an existing residential/ commercial area; a maintenance liability which had the potential to attract anti-social behaviour. Local business and the local community were involved in the transformation of the derelict site to create a local food growing space. Local families are now benefiting from the locally grown fresh produce.

**Resources:** MCC and European grant funding; volunteers; Groundwork and Red Rose Forest, land supplied by McDonalds.

**Outcomes and benefits:** Labour & land productivity, Health & wellbeing, Quality of place, Community cohesion including reduced anti-social behaviour.

## Case study 12: Windmill Estate Redevelopment (Swifts)

<b>Location:</b>	Cambridge
<b>Project Classification:</b>	Housing Estate Redevelopment
<b>Project Type:</b>	Swift Conservation
<b>Project team:</b>	South Cambridgeshire District Council; Hunters Architects; Accent Nene Ltd; Kier Partnership Homes and Swift Conservation.
<b>Identified stakeholders:</b>	Local community



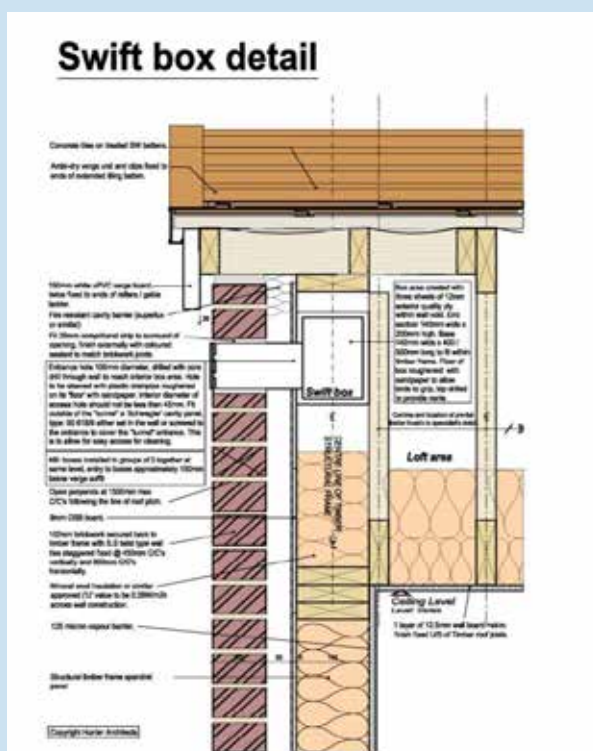
The planned redevelopment and regeneration of the Windmill Estate in South Cambridgeshire by South Cambridgeshire District Council, Accent Nene Ltd (Registered Social Landlord) sparked significant interventions to conserve the local swift population.

Assessment of the 160 homes across the estate showed that each building was offering eight or more nest sites for swifts – a bird species that is known to return to the same nest site year on year. The potential disruption to the birds' traditional nest sites was addressed by undertaking a phased re-development. This meant that a good proportion of active nests were retained to ensure breeding birds remained on the estate and a range of alternative nest boxes could

be trialled. Before the first houses were demolished in 2009, surveys confirmed 72 active nests, making this, at the time, the largest known swift colony in East Anglia and possibly England.

A number of different external nest boxes were trialled, the success of which, were considered to be relatively low. Consequently the local authority ecologist in liaison with the architects and Swift Conservation proposed the use of internal nest boxes, fitted between the studs of the buildings' internal construction, on walls with no or few windows to reduce future conflict between birds and people. In the first phase 125 new swift nest sites were installed with similar numbers planned for the phases thereafter.

The district council has engaged the community in a swift survey, where interested local residents have recorded where the birds have been nesting. Conversations with residents have also found that those aware of their presence, are generally in favour of the swifts and the nest boxes. The former Windmill Estate has now been re-branded as The Swifts, demonstrating how species conservation can be good for the local community and housing associations alike.





## Case study 13: Long Barrow

<b>Location:</b>	Poulton, Gloucestershire
<b>Type of Project:</b>	Construction of a new Passivhaus dwelling
<b>Designer/ advisors:</b>	IID Architects, Charcon, Aggregate Industries

### Summary

This project was originally as a result of a young family not being able to find somewhere to buy in the area that they had grown up. A member of the family had a small holding, on green field land, and it was decided to see if planning could be achieved for a new build in this location. Local practices and planning consultants had advised that planning would not be achievable as the local planning rules stipulated no new buildings on any green field locations throughout the district. The family however believed that given the changes in regulations coming from the government that it would be possible. In order for planning to be achieved they were then required to go to a planning committee public vote. The family wanted to ensure that the local community were onside with regards to the designs and what was happening. They therefore undertook a lengthy community consultation process before any planning submission was to take place.

A number of proposals were put forward and presented at the first of three public consultations held with the local community. Key to the proposals were:

- Passivhaus construction (ultra low energy)
- development to significantly enhance local ecology (green infrastructure)
- development for local family (local interest)
- longevity of design and construction (flexibility of future design)



It was clear from the first meeting that this project was controversial and a number of attendees viewed the proposals negatively. However by the end of the first meeting it was clear to the locals that a lot of thought had gone into the proposals and the approaches had managed to persuade all the 'doubters' that this project was a viable and beneficial project to the local area. In all response forms received the green criteria were highlighted as being of most importance. The views as to which design was preferred was evenly split amongst all attendees. A number of useful comments provided, ensured that the designs evolved significantly before the second meeting.

Over the course of the next 6 months three more meetings were held each presenting 2 or 3 completely different designs. By the last consultation everyone had agreed on a single design. The design included a number of features to increase the biodiversity of the site such as a wildflower meadow roof that flowed into the fields, a traditional orchard, and storm water runoff has been managed by including a new biodiverse pond and bio-swale. Nesting sites and specialised planting for insects have been included in the design to develop the land. The building was also lowered a floor into the ground to ensure that there was minimal visual impact for the locals and to give the building the sensation of being part of the landscape.

The proposals were submitted to the planners in October 2013 and another letter posted to the locals. This resulted in an unprecedented 70+ letters of support being written to the planners. The council granted permission in February 2014. The local support and ecological credentials, increasing the biodiversity of the site, were confirmed as the reasons that this had happened. Work started onsite in January 2015.

## Case study 14: The Crown Estate London Ecology Masterplan

<b>Location:</b>	West End, London
<b>Type of Project:</b>	Establishment of an Estate-wide Ecology Masterplan
<b>Strategic Advisors:</b>	Arup

### Summary

The Crown Estate is working to establish a green corridor in London's West End, connecting two major parks; Regent's Park and St James's Park.

Adopting an innovative, Estate-wide approach, an Ecology Masterplan has been prepared by Arup to guide the installation of contextually valuable green infrastructure (GI) throughout The Crown Estate's London portfolio. This will provide valuable habitats for wildlife on and around the buildings, and improve the experience for people who live, work and visit the area. In adopting the Masterplan, this has enabled The Crown Estate to take a long-term approach to ensuring the integration of GI within new developments, existing assets and the public realm.

### Beneficial outcomes

Whilst the development of the Masterplan began with the objective of enhancing ecology and biodiversity, the importance of the additional direct and indirect benefits to the local environment and health and wellbeing of tenants and visitors has also been recognised by The Crown Estate. These benefits include improved air quality and odour, reduced heat island effect, increased stormwater retention and a more visually attractive environment. It also creates engagement opportunities, and potentially leads to increased dwell time for visitors and attraction and retention of tenants, contributing to the value of the portfolio.



### Measurement and monitoring

A key aspect of the Masterplan approach is the use of target-setting and measurement to guide implementation and monitor its success. In order to measure the establishment of a green corridor, a corridor has been defined as an area of significant green space (100m<sup>2</sup> or greater) with a maximum separation of 100 metres. Key Performance Indicators have been set for establishment of a total area of green space, and observation of increases in species type and number over a defined period of time.

Monitoring will track the success of the implementation in terms of its benefits to biodiversity, the local environment and health and wellbeing. Baseline bird and bat surveys have been undertaken, identifying the species currently present within and adjacent to the Masterplan area. Sightings were recorded of many different bird species. Recordings were also made of several bat species using bat detectors. Surveys will be repeated at regular intervals. Opportunities exist to engage with local universities to support and extend the learning from the monitoring process. At a project specific level, the intention is to



monitor roof and air temperatures and stormwater retention associated with green roofs. The Crown Estate also intends to measure the benefit via tenant satisfaction surveys, impacts on voids, turnover and rental prices.

The Crown Estate is now extending the benefits of this strategic approach throughout the West End, looking to create a partnership with neighbouring property owners. This will broaden the intended biodiversity benefit, contribute to the value of the local area, encourage knowledge sharing and broaden engagement opportunities.

Consultation is ongoing with key stakeholders, enabling the approach to be aligned with local and regional initiatives. Those consulted include Westminster City Council, Greater London Authority, Transport for London, London Wildlife Trust, RSPB, Natural England, Cross River Partnership, West End Partnership and Royal Parks, as well as surrounding landowners, with positive feedback received from all parties.



## Case study 15: Nene Valley

<b>Location:</b>	Upper Nene Valley, Northamptonshire
<b>Type of Project:</b>	Mineral extraction site
<b>Designer/advisors:</b>	Landscape Architect- Hanson

### Background

The sand, gravel, rock and clay we extract from the ground plays a key part in creating the infrastructure that supports our lives with products that are basic but essential. They are used to build homes, roads and railways, schools, hospitals and places of work and to provide clean drinking water and effective sewerage systems. In addition, the restoration of mineral extraction sites provide major opportunities for the creation of green infrastructure, which can enhance biodiversity, provide recreational open space and help with flood alleviation.

Quarries are often sited close to towns and villages and when exhausted have the potential to contribute to the green infrastructure of both urban fringe and rural areas. Through the planning process which controls the permitting of mineral extraction, a variety of stakeholders are consulted and involved from the original concept of plans through to implementation, ongoing management and aftercare. This helps to facilitate the development of multifunctional landforms that can deliver a variety of ecosystem services.

### Summary

An excellent example of landscape scale green infrastructure provision is the Upper Nene Valley nature reserve in Northamptonshire which has been created from a 16 mile long string of six restored former Hanson sand and gravel quarries. The reserve stretches from Earls Barton in the south to Irthlingborough and Stanwick, and has been linked by footpaths and waterways to create one of Europe's newest Special Protection Areas for vulnerable bird species. The site lies at the heart of the Wildlife Trust's 'Living Landscape' for Northamptonshire, and is located in one of the first Nature Improvement Areas.

The nature reserve replaces a landscape of intensive farming with a progressively restored and managed river-floodplain wetland, which brings huge biodiversity benefits and habitat connectivity. It also enhances the river making it a feature of ecological and landscape benefits, in addition to providing a drainage channel. The site won the 'landscape scale restoration' category at the Mineral Products Association's 2013 biodiversity and restoration awards.

Although historically the provision of minerals has been the driver behind the selection of extraction areas, the potential benefit of the restored landform to create green infrastructure will increasingly influence decisions taken in mineral planning.





## Case study 16: Cambourne

<b>Location:</b>	Cambourne, Cambridge
<b>Type of project:</b>	Three interlinked villages, 4,200 dwellings
<b>Project partners:</b>	Terry Farrell (Initial Master-planning), Randall Thorp Associates (Landscape Architects); Taylor Wimpey (Developer), The Wildlife Trusts for Bedfordshire, Cambridgeshire and Northamptonshire; Local authority and Cambourne Parish Council



### Summary

The new settlement of Cambourne was conceived in the 1990s as a series of three interlinked villages and comprises 4,200 dwellings. The settlement's design respected the existing landscape character, identifying existing habitat features and using them as the building blocks for the network of green spaces.

The green spaces framed, joined and permeated each of the three villages – giving residents and wildlife easy access to the whole network. This consideration to design has made Cambourne a safe and attractive place where people want to live and engage with their local environment and where wildlife can thrive.

Green space makes up 60% of the settlement and includes pre-existing and new woodlands, meadows, lakes, amenity grasslands, playing fields, allotments and formal play areas. There are 12 miles of new

footpaths, cycleways and bridleways and 10 miles of new hedgerows. The new grassland areas are rich in ground nesting birds such as sky larks, meadow pipits and corn buntings which have had great breeding success over the years. The lakes and ponds that serve to prevent flooding also provide great habitat for wildfowl and dragon flies.

Management of the green spaces is undertaken by the new Cambourne Parish Council and The Wildlife Trust for Bedfordshire, Cambridgeshire & Northamptonshire. The land will eventually be transferred to each of these organisations. Negotiations between The Wildlife Trust, developers and the local authorities secured an agreement that the Trust would manage the green spaces in return for office premises, initially rent free, with full ownership after ten years. Cambourne is still evolving and The Trust continues to work closely with the developer.



Images courtesy of Matthew Roberts, The Wildlife Trusts

## Case study 17: Portbury Wharf Nature Reserve

<b>Location:</b>	Port Marine, North Somerset
<b>Type of project:</b>	2,650 houses and an adjoining nature reserve
<b>Project team:</b>	Persimmon (main developer), Avon Wildlife Trust, North Somerset Council and residents of Port Marine.

### Summary

Portbury Wharf Nature Reserve is a condition of the 2,650 dwelling, Port Marine development and the outcome of a unique partnership between North Somerset Council, the developers, the residents and Avon Wildlife Trust.

Located between the town of Portishead to the west and the Royal Portbury and Avonmouth Ports to the east, Portbury Wharf is a gateway to the wildlife-rich Gordano Valley – providing a green link for people and wildlife between the Severn Estuary and the Gordano Valley. It lies next to the foreshore of the Severn Estuary, where the second highest tidal range in the world is found – making it unique and important for wading birds and wildfowl, and as a feeding ground for migrating birds.

The Reserve comprises 47 hectares of wetland, open water, grazing marsh areas, hay meadows and hedgerows and is home to many rare and endangered species including water voles, brown hares, curlews, skylarks, lapwing, snipe, oystercatchers greater horseshoe bats and otter/s (spraints have been found).

Persimmon were largely responsible for the creation of the Reserve. This involved extensive earth moving and landscaping; the creation of open water in large ponds and scrapes; the construction of footpaths and bridleways; the erection of fencing, gates, footbridges and signposts; the installation of 'public art' features and the construction of boardwalks and 3 bird hides.

Avon Wildlife Trust has managed the Reserve since October 2010 and will become the full owners upon completion of the development. The ongoing costs for the reserve are met by the owners of the new houses. The annual charge to residents is fixed each autumn by an intermediary management company. The revenue funding received by the Trust pays for reserve management and community engagement. In return, residents qualify for free membership of the Trust, a regular newsletter, and access to nature on their doorstep.

Image courtesy of Avon wildlife Trust



## Case study 18: Oakfield Village, Kingsbrook

<b>Location:</b>	Aylesbury, Buckinghamshire
<b>Type of Project:</b>	Urban Extension
<b>Client:</b>	BDW North Thames & Ashfield Land Ltd
<b>Principle Consultants:</b>	BDP Design, Bidwells, C&A Consulting Engineers, Engage Planning, James Blake Associates, Southern Ecological Solutions



### Summary

At Kingsbrook, BDW Trading Ltd. and Ashfield Land Ltd. are working in close partnership with Aylesbury Vale District Council and the RSPB to set a new benchmark for housing development that delivers not just biodiversity recovery but real biodiversity gains, disproving the common conception that development and biodiversity are mutually exclusive.

The masterplan provides 2,500 homes, schools, employment and community facilities forming an urban extension to the east of Aylesbury. 50% of the site (excluding private gardens) is green infrastructure (GI) providing a fully integrated network of open space permeable for both people and wildlife. The first phase, Oakfield Village includes:

- Retention, enhancement and creation of wildlife habitat – wetland, grassland and woodland;
- A programme for the cultivation and planting of nationally important Black Poplar;

- Multi-functional areas of open space – formal and informal parks, natural play areas and a community orchard; and
- Residential areas with tree lined streets, planting, sustainable drainage and other features providing habitats and permeability for wildlife.

Kingsbrook will significantly contribute to the effective establishment and maintenance of a coherent, resilient ecological network. Providing a vibrant environment that local residents and visitors can feel pride in their shared heritage, whilst enjoying the health benefits of outdoor recreation set amongst thriving wildlife.

Communities will be invited to embrace the idea of living and working in a nature-friendly development and to become active participants in green spaces and conservation projects.

Kingsbrook will set the standard for commercially viable development which addresses biodiversity loss, supports healthy well-functioning ecosystems, with better places for the benefit of nature and people.





# GLOSSARY

Term	Definition
Biodiversity	Biodiversity encompasses the number, abundance and distribution of all species, the genetic diversity within species and the range of habitats that support them. Biodiversity also includes humans and human interactions with the environment. <sup>1</sup>
Ecosystem Services	The multitude of resources and processes that are supplied by natural ecosystems. <sup>1</sup>
Green Infrastructure	<p><b>Natural England</b></p> <p>GI is 'a network of high quality green and blue spaces and other environmental features. It needs to be planned and delivered at all spatial scales from national to neighbourhood levels'.</p> <p><b>The Landscape Institute</b></p> <p>'The role of GI in addressing the challenges of the 21st Century cannot be underestimated. It is a natural service-providing infrastructure that is often more cost effective, more resilient and more capable of meeting social, environmental and economic objectives than "grey" infrastructure'.</p> <p><b>European Union</b></p> <p>'GI is addressing the spatial structure of natural and semi-natural areas but also other environmental features which enable citizens to benefit from its multiple services. The underlying principle of Green Infrastructure is that the same area of land can frequently offer multiple benefits if its ecosystems are in a healthy state. Green Infrastructure investments are generally characterized by a high level of return over time, provide job opportunities, and can be a cost-effective alternative or be complementary to 'grey' infrastructure and intensive land use change. It serves the interests of both people and nature'</p> <p><b>Department for Communities and Local Government</b></p> <p>"A network of multi-functional green space urban and rural, which is capable of delivering a wide range of environmental and quality of life benefits for local communities." (Department for Communities and Local Government, 2012, p.52).</p>
SuDs (sustainable drainage systems)	Sustainable drainage systems (SuDS) mimic natural drainage processes to reduce the effect on the quality and quantity of runoff from developments and provide amenity and biodiversity benefits <sup>3</sup> .
Swale	A shallow, broad and vegetated channels designed to store and/or convey runoff and remove pollutants <sup>4</sup> .
Natural capital	The term 'natural capital' is used to describe the parts of the natural environment that produce value to people. Natural capital underpins all other types of capital – manufactured, human and social – and is the foundation on which our economy, society and prosperity is built. <sup>5</sup>

1. CIRIA, K Dale, C Thomson, J Kelly, D Hay, K MacDougall (2011). Delivering Biodiversity benefits through green infrastructure.
2. CIRIA, K Dale, C Thomson, J Kelly, D Hay, K MacDougall (2011). Delivering Biodiversity benefits through green infrastructure.
3. <http://www.susdrain.org/delivering-suds/using-suds/benefits-of-suds/SuDS-benefits.html>
4. <http://www.susdrain.org/delivering-suds/using-suds/suds-components/swales-and-conveyance-channels/swales.html>
5. <https://www.naturalcapitalcommittee.org/natural-capital.html>

## APPENDIX A

**Table A1: Summary scope of main economic GI valuation tools (adapted from NECR126, 2013)**

Tool	Scope
<a href="#">CAVAT</a>	Provides a method for managing and valuing trees as public assets. Designed to be a strategic tool and aid to decision-making in relation to the tree stock as a whole, and to be applicable to individual cases, where the value of a single tree needs to be expressed in monetary terms.
<a href="#">GI Northwest's Green Infrastructure Valuation Toolkit</a>	A valuation framework for assessing the potential economic and wider returns on investment from GI and environmental improvements. It consists of a variety of spreadsheets that collate various data. The tool has been used to evaluate ecosystem services provided by GI, property values, labour productivity, investment and tourism.
<a href="#">Guide to valuing Green Infrastructure from the Centre for Neighbourhood Technology Chicago</a>	This tool brings together current research on GI performance and presents methods for calculating related benefits in water management, energy, air quality, climate, and community liveability.
<a href="#">HEAT</a>	Developed by WHO (World Health Organisation) to estimate the economic savings resulting from reductions in mortality as a consequence of regular cycling and/or walking. It enables users to estimate the value of new infrastructure to health policies or programmes.
<a href="#">Helliwell</a>	The system allocates scores under a number of different factors such as tree size, life expectancy, suitability to setting etc. These scores are then combined to give an overall comparative score for a tree or woodland. It is then possible to attach a value to this score using a monetary conversion factor.
<a href="#">i-tree tools</a>	A software suite from the USDA (United States Department of Agriculture) Forest service, providing urban and community forestry analysis and benefits assessment tools. It quantifies the environmental services that trees provide, and the structure of the urban forest. There are a suite of tools that can be used some using economic valuation which can potentially be applicable to the UK.
<a href="#">inVEST</a>	A suite of software models used to map and value the goods and services from nature that sustain and fulfil human life. Enables decision makers to assess quantified trade-offs associated with alternative management choices and to identify areas where investment in natural capital can enhance human development and conservation.

**Table A2: Summary scope of additional GI valuation tools**

Tool	Scope
<a href="#">GRaBS toolkit</a>	<p>The Green and Blue Space Adaptation for Urban Areas and Eco Towns (GRaBS) INTERREGIVC project<sup>7</sup> (2008-2011) created a network of leading pan-European organisations involved in integrating climate change adaptation for urban areas into local and regional planning policies. The key output of the project was generic guidance on the Adaptation Action Plan for local authorities. This has been followed by the new Covenant of Mayors EU-wide Mayors-Adapt<sup>8</sup> initiative with Greater Manchester, Leicester and Newcastle already signed up.</p> <p>The GRaBS project also resulted in the TCPA/University of Manchester Risk and Vulnerability Assessment Tool and User Needs and Requirements Assessment for GI in urban areas.</p> <p>The Assessment Tool focuses on flooding and heat stress by assessing the vulnerability of urban areas to climate change impacts, with an additional assessment of relative patterns of spatial risk where suitable data is available. The Tool aids stakeholder networks and members of communities to visualise vulnerability, exposure and climate hazards within a particular location, thus raising awareness, aiding decision-making and facilitating community and stakeholder participation in formulating appropriate adaptation responses.</p>
<a href="#">GI Northwest's Green Infrastructure Valuation Toolkit (Green Infrastructure calculator)</a>	<p>This tool was also listed in Table A1, as it evaluates the economic value associated with GI, such as property values, but it can also be used to assess the value provided for other aspects.</p> <p>It can assess the value of green assets across a wide range of potential areas of benefit, e.g. climate change, health, water management and biodiversity, although wherever possible results are given in monetary terms.</p> <p>Toolkit includes a user guide and also sets out the evidence base and rationale supporting each of the assessment tools.</p> <p>Note that the calculator is quite complex and its use would normally require input and advice from an economist to ensure appropriate use.</p>
<a href="#">STAR Tools</a>	<p>Selection of spatial modelling and web-GIS tools for climate change adaptation planning in urban areas using Star Tools. These allow users to assess the potential of GI in adapting their areas to climate change. They include a surface temperature tool and a surface water run-off tool. The STAR tools can be used at neighbourhood scale (in the North West of England and beyond) to test the impact of different land cover scenarios of greening and development under different temperature and precipitation scenarios</p>
<a href="#">NEAT – national Ecosystem approach toolkit</a>	<p>The NEAT is a useful resource which directs the reader to relevant resources to meet their needs. It consists of a tree which provides guidance for selecting and using tools that have been adapted to incorporate the principles of the Ecosystem Approach.</p>
<a href="#">Ecosystem Value Toolkit (EVT) by Earth Economics</a>	<p>The EVT seeks to accelerate the adoption of ecosystem service valuation by providing a comprehensive, searchable online database of values for nature and tools for calculating the value of natural assets. These outputs can then be utilized by planners, watershed managers, forest owners, natural resource agencies, scholars and businesses to communicate the previously unrecognised value of these assets for conservation, restoration, or other land use decisions.</p>
<a href="#">Toolkit for Ecosystem Service Site-based Assessment (TESSA)</a>	<p>BirdLife International, Cambridge, Southampton and Anglia Ruskin Universities, the RSPB (BirdLife in the UK) and the United Nations Environment Programme World Conservation Monitoring Centre are among 15 institutions that have jointly developed an innovative approach to putting a value on ecosystem services. Authors from the collaborating institutions have published an overview of TESSA in the journal <i>Ecosystem Services</i>, including examples of how it has been applied at sites around the world.</p>

# APPENDIX B

## TOP TIPS WHEN DESIGNING THE MAINTENANCE STRATEGY

Too often the long term maintenance requirements for green infrastructure (GI) are overlooked, preventing the full biodiversity potential of sites being realised.

Benchmark Grounds Maintenance Ltd, who provide grounds maintenance to many commercial and public sector clients, addresses this throughout its regular maintenance activities, by implementing some low-cost and sustainable measures to ensure continued biodiversity benefits while not compromising the aesthetics of the habitats.

Table B1 provides just some of the simple do's and don'ts that benchmark apply on the sites they work on, to help their clients get the best out of their green infrastructure.

**Table B1 Top tips for designing and maintain your green infrastructure to reduce costs**

Maintenance Requirement	Don't	Do
<b>Grasslands</b>	Don't use trimmers to mow around the bottom of tree trunks, it's time and labour consuming and damages trees through accidental cutting	Do leave some edge areas long and mow them rotationally only once every few years to save time and provide shelter habitat for invertebrates and small mammals
<b>Hedgerows</b>	Don't cut hedgerows during the breeding bird season (March to August inclusive) if possible as it is likely to disturb nesting birds	Do recognise fruit bearing species (such as hawthorn, blackthorn, dog rose and ivy) to persist over winter to provide food, February is ideal where possible
<b>Water Use</b>	Don't irrigate existing mature planting, these should be adapted to the prevailing climate, only consider in extreme weather conditions	Do use wood chippings spread on top of bare earth to prevent evaporation and retain moisture during dry weather
<b>Clippings Disposal</b>	Don't burn grass or hedge clippings or take them off site to waste disposal sites	Do retain these clippings on site in areas that won't be disturbed, these will provide shelter and nesting opportunities for amphibians, reptiles, small mammals and invertebrates alternatively use them for making mulch or compost

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