Chapter 12
Do Built Environment Assessment Systems Include High-Quality Green Infrastructure?

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Abstract Green infrastructure is understood to be a critical feature of sustainable cities, providing numerous benefits to people and wildlife. However, there are challenges associated with its planning, design and delivery related to skills and knowledge in the built environment sector and the importance placed on green infrastructure in the development process. The sector often turns to assessment systems to ensure that new developments are sustainable, with the standards and criteria they include being used to inform those responsible for delivering commercial and residential developments. This chapter examines thirteen systems commonly used internationally against the key characteristics of green infrastructure including its form as a multifunctional network, relationship with the strategic objectives for the area and functions for improving health and well-being, climate change resilience and nature conservation. The findings suggest that the majority of systems do not provide a robust assessment of green infrastructure against these characteristics. Although they do recognise many of the functions that green infrastructure can provide, they miss opportunities for the additive benefits that can be provided through a multifunctional network. Many of the systems will accredit developments to some degree with very little or no consideration of green infrastructure, giving the impression that it is not an essential component of new development. Built environment assessment systems play an important role in setting the standard for the sector and, as such, could contribute to improving the quality of green infrastructure in the future.

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12.1 Introduction

Green infrastructure is an essential component of sustainable, healthy and resilient places. Although definitions vary, green infrastructure is generally thought of as a multifunctional network of green and blue features in the built environment (Sinnett et al. 2018; EC 2013; Nowak et al. 2010; Natural England 2009). These features may include street trees and other soft landscaping, green walls and roofs, parks, greenspaces, drainage features, green corridors, nature reserves, cemeteries, allotments as well as rivers, streams, ponds and lakes. The focus of green infrastructure is less on the presence of individual components and more on their role within a network that provides connectivity for people and wildlife within the built environment and between the built environment and the rural hinterland. As such green infrastructure should be strategically planned both across an urban area and within individual developments or neighbourhoods in order to ensure their contribution to the wider network.

Green infrastructure is increasingly featured in planning policy, with many countries, regions and local authorities now having strategies, plans and/or frameworks in place to ensure the creation or maintenance of a multifunctional network (e.g. Ajuntament de Barcelona 2013; Metro Vancouver 2015). However, there is often uncertainty from the built environment professions as to how high-quality green infrastructure can be translated into practice (Sinnett et al. 2017; Khoshkar et al. 2018). This means that although planning policy may have articulated a desire for high-quality green infrastructure, those designing new places or reviewing planning applications struggle to identify what this means or whether this has been achieved or do not have confidence to suggest improvements to the proposals. However, there are a number of characteristics of high-quality green infrastructure that have been developed in the academic literature. These characteristics often focus on the planning and delivering green infrastructure (e.g. connectivity, partnership working; Roe and Mell 2013; Kambites and Owen 2006) or on the benefits or ecosystem services that it should deliver (e.g. stormwater management, public access; Pakzad and Osmond 2016). Despite best intentions at the design stage, the initial quality of green infrastructure often diminishes through the development process so that the final delivery is disappointing. A number of reasons for this have been suggested including the lack of a champion for green infrastructure in the latter stages of development and weak enforcement of the quality of green infrastructure, both of which may be related to the skills and experience of the sector.

In addition to built environment professionals assessing the quality of new development based on their expertise, developers and their clients are also using assessment systems. These built environment assessment systems have been important in raising awareness of sustainable construction and providing an independent measure of the sustainability credentials of individual buildings or neighbourhoods (Ameen et al. 2015). There are many such systems in use globally, for example, the Building Research Establishment's Environmental Assessment Methodology (BREEAM) and Leadership in Energy and Environmental Design by the U.S. Green Building Council

(LEED). Such systems hold the potential to focus professionals' attention on what really constitutes high-quality green infrastructure and address the gaps in skills and expertise seen as a key challenge to its delivery. These professionals may be applying for the award, or simply browsing an award online, without committing to engage in it, in order to structure their understanding of what is considered important in green infrastructure provision and sustainable development in general.

Given that green infrastructure is seen as a critical component of sustainable places and the influence that these assessment systems can have, it is therefore important to examine how they assess the quality of green infrastructure. This is particularly important when there is uncertainty in the sector as to the characteristics of high-quality green infrastructure (Khoshkar et al. 2018). This chapter presents an overview of the common desirable characteristics of green infrastructure and then examines the extent to which these are represented in the most widely used assessment systems, as a way of assessing how effective such systems are at addressing the skills gap in the sector. It then examines the function of the systems in relation to the other key challenge in the delivery of green infrastructure in terms of the importance placed on its delivery as the development progresses to construction. Finally, the implications of the findings are discussed in terms of their impact on the quality of green infrastructure in new development.

12.2 Key Characteristics of High-Quality Green Infrastructure

There is no one size fits all for green infrastructure, and thus it is impossible to come up with a definitive set of criteria against which green infrastructure can be measured. However, several authors have proposed key characteristics, principles or indicators of how green infrastructure should be planned, designed and managed (e.g. Kambites and Owen 2006; Roe and Mell 2013; Meerow and Newell 2017). Broadly speaking these can be broken down into those that are focussed on the planning and delivery of green infrastructure and those that are concerned with the functions of green infrastructure. These are summarised in Table 12.1.

Several of the key characteristics of green infrastructure outlined in Table 12.1 are related to the definitions of green infrastructure. For example, there is an emphasis on the importance of the green infrastructure forming a multifunctional network that is strategically planned in much of the literature (Albert and von Haaren 2014; Khoshkar et al. 2018; Lennon 2015). There is the expectation that these multiple functions will deliver a range of ecosystem services, providing positive outcomes for local people and wildlife as well as contributing to global objectives such as carbon capture and storage (Connop et al. 2016). There is also recognition that this multifunctionality takes place across the network so that the green infrastructure taken as a whole would deliver the full suite of benefits even though individual components may be more targeted in their functions (Kambites and Owen 2006; Roe and Mell 2013). The scale

Table 12.1 Key characteristics of high-quality green infrastructure

Characteristic	Specific examples and functions
Planning and delivery	
Green infrastructure forms a multifunctional network	The planning and design take a holistic approach that provides a range of integrated functions, based on the needs of the area. The network provides connectivity, at the landscape scale, for people and wildlife
Green infrastructure is strategically planned	The planning and design are based on the desired outcomes, character and objectives for the area. The network is planned at the landscape scale, with features at different scales from the micro to landscape, to provide local distinctiveness. It is considered early in the development process in recognition of its vital role in the built environment and makes a genuine contribution to placemaking as well as the better management of urban growth. It is flexible enough to adapt to changing needs and environmental conditions. The planning and design use a range of evidence from academia and practice to inform the overall network as well as its individual components. Evidence can be quantitative, but qualitative assessments are essential in delivering benefits such as neighbourhood satisfaction
Green infrastructure is inclusive	Green infrastructure is seen as a partnership between different sectors, disciplines and the local community. A participatory approach has been taken in the planning and design, to ensure that green infrastructure provides a range of functions, respects the needs of the local community, and provides opportunities for long-term engagement
Green infrastructure is a long-term investment	Green infrastructure has been delivered as planned, and robust mechanisms, including funding and governance structure, are in place for long-term management and maintenance. This also includes opportunities for community involvement and monitoring outcomes
Functions	
Nature conservation	Habitat provision, enhancement of ecological networks, and achieving a net gain in biodiversity

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Table 12.1 (continued)

Characteristic	Specific examples and functions
Climate change mitigation and adaptation	Carbon capture and sequestration and local climate regulation
Improved environmental quality	Improvements to local air quality, noise pollution, and soil quality
Water management	Improved groundwater recharge, stormwater retention, natural drainage and water quality and reduced flood risk
Improved visual amenity	Improvement to the visual landscape, enhanced local attractiveness, and landscape protection and enhancement
Spaces for recreation and physical activity	Opportunities for physical activity, sport, recreation, and food growing close to where people live, and improved access and connectivity across the network for active travel
Better quality of life and neighbourhood satisfaction	Enhanced local identity and sense of place, local heritage and cultural features, provide opportunities to learn about the natural environment and reconnect with nature, improve community cohesion and for community involvement and volunteering
Increased inward investment	Encouraging investment, economic development, attracting new business and workforce

References: Albert and von Haaren (2014), Kambites and Owen (2006), Lennon (2015), O'Neil and Gallagher (2014), Roe and Mell (2013), Khoshkar et al. (2018), Steiner et al. (2013), Sanström (2002), Pakzad and Osmond (2016), Meerow and Newell (2017)

of green infrastructure is also significant in the strategic planning process, both in terms of ensuring that the network operates across the city and landscape, and over the long-term to ensure the network is intact and continues to function for people and wildlife as their needs change (Steiner et al. 2013). Several authors highlight the importance of defining the green infrastructure network early, either in terms of the strategic planning policy for a city or landscape, or when planning a new development to ensure that connectivity is maintained throughout the network and that the green infrastructure is integral to the wider built environment (Steiner et al. 2013; Davies and Lafortezza 2017). Here the significance of proximity to where people live is also recognised as being key to green infrastructure delivering many of the benefits to people (O'Neil and Gallagher 2014; Pakzad and Osmond 2016).

Additional characteristics related to planning and delivery address some of the challenges faced by those attempting to secure high-quality green infrastructure. These include ensuring that a partnership approach is taken (Roe and Mell 2013; Connop et al. 2016) to maximise benefits and reduce risks and that green infrastructure is delivered as intended and is fit for purpose (Kambites and Owen 2006;

Steiner et al. 2013). Finally, the long-term commitment needed to generate the benefits from green infrastructure is vital, therefore a consideration of the management arrangements, funding and governance structure is closely related to the planning and delivery of green infrastructure, particularly in times of budget constraints in local government (Connop et al. 2016; Gavrilidis et al in press).

Many of the functions that green infrastructure provides reflect challenges in the urban environment including loss of biodiversity, lack of space for recreation, physical activity, rest and relaxation, poor environmental quality, flood risk and the impacts of climate change (O'Neil and Gallagher 2014; Lennon 2015; Sanström 2002; Pakzad and Osmond 2016; Meerow and Newell 2017). These functions include evidence from a range of disciplines (Roe and Mell 2013) and tend to match those where there has been intense research activity and advocacy (Sinnett et al. 2018).

Internationally, there seems to be a general agreement of the characteristics of high-quality green infrastructure, despite different planning systems that operate across the world, and their respective priorities (e.g. in the US, there is often a tendency to focus on the water management functions of green infrastructure). This suggests that built environment assessment systems represent an opportunity to address some of the challenges with green infrastructure delivery by setting out what constitutes high-quality green infrastructure and recognising its significance in providing sustainable developments. In this chapter, we explore whether the criteria and standards in commonly used built environment assessment systems and their mode of operation adhere to these key characteristics of green infrastructure. This is used to evaluate the extent to which such systems are likely to aid the delivery of high-quality green infrastructure in new development.

12.3 Methods

In order to understand the representation of green infrastructure, a review of built environment assessment systems relevant to the planning, design and management of new development was conducted. Each system was reviewed to examine the extent to which it considered green infrastructure, as a system or as individual components (e.g. green spaces) and the types of criteria, standards or measures that are included to assess green infrastructure. The point of development at which green infrastructure is assessed was also reviewed to ascertain whether the quantity or quality of green infrastructure might be reduced during the development process. Another focus was on the scoring of the green infrastructure component(s) to investigate whether a 'good' score for green infrastructure is compulsory for successful accreditation or whether it can be circumnavigated with good scores in other areas of performance (e.g. energy and use of resources).

In total, thirteen systems were reviewed. They were selected to give a broad overview of the types of systems used in the built environment sector, at different scales and for different purposes. The list of assessment systems examined was not exhaustive but offers an overview of the systems currently in place in the UK and internationally. The focus of the review was orientated to scope and process; no attempt was made to assess benchmarks' effectiveness or to gauge views from potential assessors and users. The systems related either solely to buildings (both commercial and residential) or to buildings, neighbourhoods and other infrastructure. Although there is overlap between the families of systems (e.g. BREEAM and LEED), the different applications in each system are important to note, given the different spatial scales under which new development takes place and the importance of this in green infrastructure planning. They were:

- BREEAM New Construction, managed by BRE (2018), including the BREEAM Strategic Ecology Framework (BRE 2017);
- BREEAM Communities, managed by BRE (hereafter differentiated from BREEAM New Construction as BREEAM Communities) (BRE 2012);
- Home Quality Mark, managed by BRE (2015);
- Building for Life 12, managed by Design Council CABE, the Home Builders Federation and Design for Homes (Building for Life Partnership 2016);
- Global Sustainable Assessment System (GSAS), managed by Gulf Organisation for Research and Development (GORD) (GORD 2017);
- Greenstar Communities, managed by the Green Building Council of Australia (GBCA 2016);
- LEED Neighbourhood Development, managed by U.S. Green Building Council (USGBC 2018a);
- LEED Homes, managed by U.S. Green Building Council (USGBC 2018b);
- LEED New Build, managed by U.S. Green Building Council (USGBC 2018c);
- Sustainable Sites Initiative (SITES) managed by GBCI (the certification body for the LEED green building program; Sustainable Sites Initiative 2014);
- Lotus Sustainable Building Assessment System Homes, managed by Vietnam Green Building Council (VGBC 2017);
- Lotus Sustainable Building Assessment System Non-residential, managed by Vietnam Green Building Council (VGBC 2015);
- Envision, a rating system applied to infrastructure of all kinds, managed by Institute for Sustainable Infrastructure (ISI 2015).

The technical guidance for these systems was reviewed to examine (a) how they measure the quality of green infrastructure in relation to the key characteristics identified above and (b) how effective they would likely to be at addressing the key challenges in delivering high-quality green infrastructure related to the skills gap in the sector and the importance placed on green infrastructure in the development process.

12.4 Coverage of Green Infrastructure

All thirteen of the built environment assessment systems reviewed included measures relevant to green infrastructure (Table 12.2). For example, they all explicitly recognise achievements in nature conservation, managing flood risk and providing green and/or open spaces. The BREAAM systems, for instance, include a category on ecology, *Building for Life 12* includes a checklist relating to quality of placemaking and *Envision*, include 'the natural world'. The LEED and Lotus systems and GSAS included measurements of ecological value of land, greenery and shade, rainwater run-off, heat island effects and landscape management (GORD 2017; USGBC 2018a, b, c; VGBC 2017). *BREEAM Communities* and *LEED Neighbourhood Development* explicitly include sections on green infrastructure. The former focusses on access to green spaces reflecting the definition of green infrastructure they have taken in the guidance (BRE 2012) and the latter on water management, reflecting the definitions of green infrastructure used in the US.

Although the systems include many of the functions related to green infrastructure, they often do not explicitly recognise that multifunctionality is a key strength of green infrastructure. Thus, they award credit for providing space for nature conservation, managing flood risk and recreation, for example, but because these are spread across multiple categories or themes there is a missed opportunity to design for these functions together. In addition, several systems (e.g. *LEED*) provide several options for achieving credits, one of which may be based on introducing a component of green infrastructure (e.g. green roofs to reduce the heat island; trees to provide shade), but because the additive impact is not explicit (e.g. for water management, biodiversity, improvement to the walking environment), these appear to be single-function features. This is particularly important in systems where the user can target specific categories. The exception is *SITES*, which does have an explicit goal to create multifunctional systems. *Envision* did recognise the opportunity for new infrastructure to integrate with existing assets, but this was not specific to green infrastructure and others recognises the importance of ecological and active travel networks, but in separate categories and not as multifunctional networks. Similarly, *BREEAM New Construction* includes a number of ecosystems services that ecological systems may deliver but often does not translate this across to other areas of the system where the outcomes of these services are considered.

Related to this, very few systems recognised the importance of working at the landscape scale, even with respect to ecological networks, so credits are awarded for providing networks or green corridors on site without necessitating consideration of how these interact with networks in the surrounding landscape. Whilst project teams might have the knowledge and skills to make these connections, a skills gap related to green infrastructure in the sector is repeatedly held up as one the challenges in delivering high-quality green infrastructure (e.g. Sinnett et al. 2017; Khoshkar et al. 2018). The assessment systems are all designed to work on the individual site (or development) scale, so it is perhaps to be expected that any consideration of the landscape scale will be limited. However, many municipalities have published green infrastructure strategies that do operate at the landscape scale, which should be considered within development plans particularly in the case of large strategic developments of thousands of homes.

Unsurprisingly, the systems reviewed all awarded credits for considering the needs of the area, either in relation to local policies, analysing existing character, urban

Table 12.2 Summary of the characteristics of high-quality green infrastructure that are considered in thirteen built environment assessment systems

	Characteristic		BREEAM new construction	BREEAM communities	Home quality mark	Building for life	GSAS	Greenstar communities	LEED N'hood development	LEED homes	LEED new build	Lotus homes	Lotus non-residential	SITES	Envision
Planning and delivery	Green infrastructure forms a multifunctional network	Multifunctionality	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Network		✓										✓	✓
		Landscape scale				✓	✓							✓	✓
	Green infrastructure is strategically planned	Needs of area	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Local distinctiveness	✓	✓		✓	✓	✓			✓			✓	✓
		Early consideration	✓	✓	✓	✓								✓	

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Table 12.2 (continued)

	Characteristic		BREEAM new construction	BREEAM communities	Home quality mark	Building for life	GSAS	Greenstar communities	LEED N'hood development	LEED homes	LEED new build	Lotus homes	Lotus non-residential	SITES	Envision
	Green infrastructure is inclusive	Inclusive design	✓	✓					✓	✓	✓	✓	✓	✓	✓
		Stakeholder engagement	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓
	Green infrastructure is a long-term investment	Management	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
		Ownership	✓	✓	✓	✓		✓	✓					✓	
		Monitoring	✓	✓					✓	✓	✓			✓	✓
Functions	Nature conservation	Protection	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
		Enhancement	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Disturbance	✓	✓	✓				✓			✓	✓	✓	

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Table 12.2 (continued)

	Characteristic		BREEAM new construction	BREEAM communities	Home quality mark	Building for life	GSAS	Greenstar communities	LEED N'hood development	LEED homes	LEED new build	Lotus homes	Lotus non-residential	SITES	Envision
	Climate change mitigation and adaptation	Heat island	✓	✓			✓		✓	✓	✓	✓	✓	✓	✓
		Mitigation	✓				✓					✓	✓	✓	
	Improved environmental quality	Water	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
		Soil, air	✓						✓		✓			✓	✓
		Noise, light	✓				✓							✓	✓
	Water management	Run-off	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Conservation					✓	✓	✓	✓	✓	✓	✓	✓,	
	Improved visual amenity	Streetscape		✓			✓		✓		✓		✓	✓	✓

(continued)

Table 12.2 (continued)

	Characteristic		BREEAM new construction	BREEAM communities	Home quality mark	Building for life	GSAS	Greenstar communities	LEED N'hood development	LEED homes	LEED new build	Lotus homes	Lotus non-residential	SITES	Envision
		Views from inside									✓		✓	✓	✓
	Spaces for recreation, physical activity	Active travel		✓		✓	✓		✓					✓	
		Recreation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Food growing	✓	✓	✓			✓	✓		✓			✓	
	Better quality of life			✓		✓.								✓	
	Increased inward investment							✓							✓

form and facilities, or from community engagement. They all also recognised the importance of involving stakeholders and communities in the design and decision-making process. However, only in a very few cases was this specific to the green infrastructure. For example, *BREEAM New Construction* includes alignment with existing green infrastructure to maximise the benefits, and *SITES* awards credits for basing the design of greenspaces on an analysis of likely users and their needs. Several systems recognised the need to bring ecologists into the design process early; however, this only appeared to apply if there was some sensitivity with respect to existing ecological systems, giving the impression of a reactive rather than proactive approach to green infrastructure provision.

Most of the systems included some recognition that management and maintenance need to be in place for at least some components of green infrastructure. Primarily, this was focussed on sustainable drainages features, or those explicitly for nature conservation, particularly the management of pre-existing habitats that will be incorporated into the new development. For example, *BREEAM New Construction* recognises the importance of maintaining ecological features and SUDS. Only a few of the systems, and this was probably mainly a reflection of the climatic conditions under which they operate, awarded credits for designing green infrastructure to be low maintenance, specifically to reduce the amount of water required by choosing native or climate-adapted species or ensuring irrigation systems are water efficient and do not rely on potable water supplies (e.g. *LEED, Lotus, Greenstar).*

Looking at nature conservation as a specific function, most of the focus is on protecting existing systems and habitats from development, with the potential for new development to enhance or restore habitats, or create new ones being seen as an additional activity. Indeed many of the systems (e.g. *LEED and Lotus*) award credits for retaining a proportion of land undeveloped instead of pushing the user to consider the most beneficial functions or their spatial configuration. This can give the impression that incorporating nature into new development will always reduce the amount of developable land, particularly when there is no explicit recognition that this can be combined with other functions such as water management or amenity use. For example, *LEED New Build* does allow the proportion of habitats to include green roofs, and the *BREEAM* systems draw attention to the opportunity for habitats to also provide other functions.

Similarly, some of the systems specify the sizes and functions of, or amenities in, greenspaces for recreation and physical activity or the distance they should be from homes. Generally, the systems that are focussed on new neighbourhoods as opposed to individual buildings, whether homes or non-residential, are far more detailed in their requirements for green and open space. For example, *BREEAM Communities* specifies green spaces, nature reserves or woodlands should be within 1 km of homes, whereas play parks, sports fields or tennis courts should be within 650 m. *LEED Neighbourhood Development,* however, requires smaller civic or passive use spaces within 400 m of 90% of homes and recreational spaces within 800 m. Several of the systems recognise the importance of providing quiet spaces and seating for social interaction, and most award credits for the provisioning of food growing spaces either within the footprint of homes or in the public realm. This focus on quantitative measures, whilst simpler to use, does miss the importance of the quality of green infrastructure in terms of its visual appeal and function.

Overall, the systems reviewed do reward the protection, enhancement or creation of green infrastructure components within new developments. However, their focus on individual functions of these components as well as their failure to require that green infrastructure is planned, designed and managed as a multifunctional network means that opportunities are likely to be missed in providing high-quality green infrastructure by following these systems alone. Some of the gaps in the systems reflect their individual foci, and that, in some cases, systems in the same family can work together, for example, *BREEAM Communities* and *BREEAM New Construction*. In general, *SITES* comes the closest to offering a comprehensive assessment of green infrastructure against the characteristics outlined in the literature. This has been designed for the US market and to work alongside LEED (Sustainable Sites Initiative 2014) supplementing the landscape-based elements (Steiner et al. 2013) and addressing sustainable construction in general (e.g. responsible sourcing).

12.5 Appropriateness of Assessment Systems for Green Infrastructure

Two of the key challenges in delivering high-quality green infrastructure are related to the perceived importance of green infrastructure in new development. First, in terms of the quality of green infrastructure diminishing through the development process and second, in acknowledging that high-quality green infrastructure is a critical component of sustainable developments.

Often planned green infrastructure is not delivered or maintained adequately in the long-term, so it is important that the benchmark is awarded at the right point in the development process and that green infrastructure is not allowed to evaporate as the development progresses. The assessment systems were reviewed to ascertain at which points in the development cycle projects were assessed generally, and where relevant, specifically in relation to green infrastructure.

Most of the systems can assess the scheme at all stages of development, including having a compulsory ‘as built’ stage to ensure that the features included in the design stages have been delivered. Examples include *Building for Life 12*, *Envision*, *Global Sustainability Assessment System*, *Greenstar* and *LEED*, although the *Building for Life* seems to emphasise the pre-application and planning stages. The *Home Quality Mark* is assessed at design and construction phase, whereas *BREEAM Communities* has three steps in the general assessment, all of which are pre-construction reflecting its focus on master planning (BRE 2012, 2015).

In terms of assessing green infrastructure-related elements more specifically, *BREEAM’s Strategic Ecological Framework* seeks to incentivise the consideration of ecology and landscape quality throughout the life cycle of a development. The framework considers ecology an important category that relates to ‘all master planning, infrastructure and buildings' BRE (2017). However, *SITES* provides perhaps the most comprehensive assessment as it considers site context, pre-design, planning, construction, and operations and maintenance. As there are a number of prerequisites in the initiative that relate to aspects of green infrastructure, it can be understood that the initiative assesses these elements of green infrastructure throughout the development process (Sustainable Sites Initiative 2014). Importantly then, it appears that there is recognition within the sector that schemes should demonstrate that their commitments have been maintained throughout the development process, including post-completion.

Another vital issue with regards to the structure of the scoring in the assessment systems is whether it is possible to secure the accreditation without including green infrastructure. For example, are there mandatory criteria, or can those criteria related to green infrastructure discussed above be circumvented with credits in other areas. All the systems reviewed break the assessment down into five to fifteen themes or categories. The themes are often subdivided into specific criteria for which credits are awarded. In some cases (e.g. *BREEAM* and *LEED*), these different categories are weighted, and a differing number of credits have to be achieved in order to secure different levels of accreditation. This means that applicants being able to choose which, and how many, credits they implement.

In some assessment systems, there are green infrastructure-related themes that are mandatory to secure the accreditation. For example, in *Lotus Non-residential*, the ecology theme includes the prerequisite to include an 'Environmental Impact Assessment or Environmental Protection Commitment' (VGBC 2015, p. 14). However, the criteria that assess the inclusion of ecological features, or their management in the ecology theme, are worth nine points in total. Given that the total points across the system is 110, and only 44 points are needed to secure the most basic level of accreditation (VGBC 2017), this means that opportunities to enhance or provide new habitats can be missed as long as the prerequisite assessments are completed, although clearly the findings of the assessment must be acted upon. A similar pattern is observed across the majority of the systems reviewed. For example, in *BREEAM New Construction,* there are no minimum standards for the land use and ecology category, which is worth 13% of the credits in a fully fitted building when the basic 'pass' level of accreditation requires 30% of the credits to have been achieved (BRE 2018). Like *Lotus*, *BREEAM Communities* contains minimum requirements across a number of areas relevant to green infrastructure, but these are limited to assessments and strategies, for example, flood risk assessment, and ecology strategy (BRE 2012). Similarly, *Building for Life* includes a checklist relating to quality of placemaking. To achieve this accreditation only nine of the twelve categories are needed to obtain a 'green' pass (Building for Life Partnership 2016). Although 'habitats and landscapes features' are in one category and 'public spaces' are in another category, green infrastructure does not feature prominently in the other categories. However, to achieve an 'outstanding' mark, all twelve categories would need to be passed, meaning some consideration of green infrastructure is likely to be included, although, as already discussed, this might not be as a multifunctional network. However, *SITES* does include a number of prerequisites related to green infrastructure and is perhaps the most impressive system reviewed. These include aspects such as managing precipitation on site, using appropriate plants, and conserving habitats for threatened and endangered species (Sustainable Sites Initiative 2014).

One could argue that the lack of mandatory requirements for green infrastructure across the systems is counterbalanced by the fact that it is scattered across multiple categories. So, for example, although an applicant may not consider the ecological function of green infrastructure, they could still incorporate green infrastructure when considering health and well-being, heat island or flood risk management. However, in many of the systems, there are multiple options for delivering these functions some of which do not necessarily include any vegetation (e.g. reflective surfaces, permeable paving, and civic squares). What this means is that the lack of mandatory requirements for green infrastructure components is exacerbated by their failure to include green infrastructure as a multifunctional network.

In terms of their ability to address the challenges in green infrastructure delivery, it is reassuring to see that most of the assessment systems apply at different stages of the development process. Their focus on the design stage means that it is more likely that green infrastructure will be considered early on, which is seen as key to ensure that it is viewed as fundamental component of the built environment, and the inclusion of a compulsory assessment post-construction means that commitments made early on are more likely to be realised when the scheme is delivered. However, this is only likely to achieve high-quality green infrastructure if this is seen as critical to the achievement of healthy, sustainable places and unfortunately the majority of systems do not place enough importance on the delivery of green infrastructure. The only exception being *SITES* which stands out in its approach to green infrastructure.

12.6 Conclusions

It is essential that healthy, sustainable cities include high-quality green infrastructure. Yet new commercial and residential developments can be accredited as sustainable without more than a tokenistic inclusion of green infrastructure. Most of the assessment systems commonly used in the built environment do not recognise, or reward, the additive effect of the multifunctionality of green infrastructure, which misses opportunities to deliver multiple objectives for health, climate resilience and nature conservation and, crucially, to use space efficiently. They also focus on individual spaces and vegetation in the site boundary, whereas many of the functions of green infrastructure are most effective when considered as a network operating at the landscape scale. There are challenges associated with the planning, design and delivery of green infrastructure. Built environment assessment systems are well placed to address these by signposting opportunities to create and enhance green infrastructure as a multifunctional network and ensure that all new development includes the provision of high-quality green infrastructure. Built environment assessment systems should reflect the understanding of the key characteristics of high-quality green infrastructure in order for it to be seen as a critical feature of sustainable development.

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