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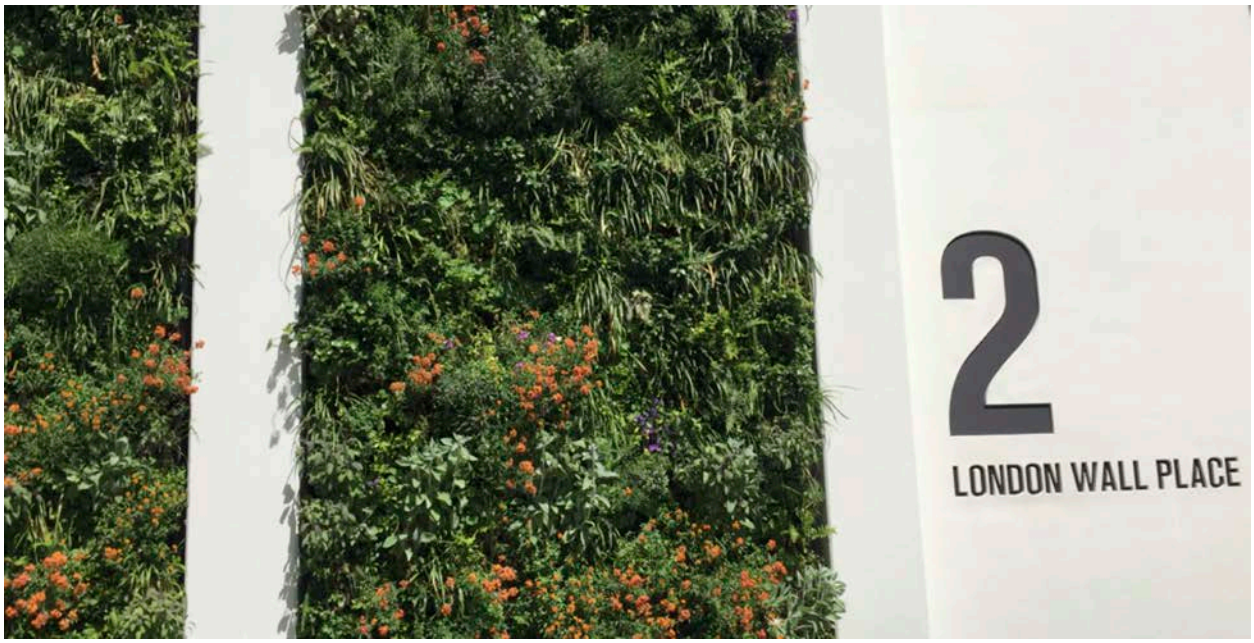

Urban Greening Factor Study

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Client:

City of London

Department of the Built Environment

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1. Introduction and purpose

1.1 The City of London continues to renew itself. New builds and refurbishments tend to result in an increased density of development. Dense and compact development supports efficient public transport systems and reduced energy demand, however, increasing density and other factors result in significant additional pressures on existing green spaces and this also increases the requirement for natural features.

1.2 There is growing awareness of, and an associated body of evidence for, the multiple benefits of green infrastructure (see Chapter 2), including measurable net positive impacts on physical health and mental wellbeing. It is also the case that green infrastructure will have a critical role in improving the City's capacity to adapt to climate change. New approaches to the provision of green infrastructure will, therefore, need to be adopted, and novel ways of providing additional greening within the built environment will have to be found to ensure that the City remains a place in which soil, water and vegetation are an integral part of the fabric of the urban environment. Given its limited space at ground level, the City will need to incorporate more green roofs, green walls and other novel features into the built environment.

1.3 The Draft New London Plan (2017) includes a draft *Policy G5*[1] on urban greening which includes a planning policy tool, the Urban Greening Factor (UGF), that is modelled on similar mechanisms used by city authorities in Europe and North America. The purpose of UGF schemes is to increase the quantity and functionality of green infrastructure in the built environment, by assessing development projects submitted for approval.

1.4 Although the London Plan has a number of policies that promote the provision of green infrastructure within new developments (including Policy 5.10 – Urban Greening and Policy 5.11 – Green Roofs) it has been suggested in the Draft New London Plan that these policies may need to be complemented by a Urban

Greening Factor in order to assist developers and planners to determine the appropriate level of urban greening required to address particular local issues such as surface water flooding, lack of local green space or biodiversity conservation.

1.5 The City of London has enjoyed success in encouraging the installation of green infrastructure. The Local Plan (2015)[2] promotes the creation of green roofs and green walls through Policy DM 10.2 (Design of green roofs and walls) and Policy DM 19.2 (Biodiversity and urban greening).

1.6 This report summarises the benefits of green infrastructure and describes how UGF schemes (commonly known as the Green Space Factor), work in general. This report also explores how a UGF scheme might be applied in the City of London. The application of the GLA's proposed scheme to several approved planning applications in the City is described and there are suggestions on how a UGF scheme might operate and might need to be adjusted for the City.

2. Benefits of green infrastructure

2.1 Green infrastructure (GI) is defined by the UK government as a network of multifunctional green space, urban and rural, which can deliver a wide range of environmental and quality of life benefits for local communities. As a network it includes parks, open spaces, playing fields, woodlands, but also street trees, allotments and private gardens. It can also include streams, canals and other water bodies and features such as green roofs and walls.[3] It is the urban elements of GI which are of relevance to this study.

2.2 The components of GI have traditionally been valued for the amenity that they bring to the urban environment, that is, the way that they make peoples' outlooks more pleasant and their living and working environments more attractive. There has been a realisation in recent years, however, that GI brings a range of benefits and there is now a considerable, and growing, body of evidence that GI can assist with climate change adaptation, can improve mental and physical health, provide habitat for wildlife, improve air and water quality and can have economic benefits. These benefits are considered in turn in the paragraphs that follow.

2.3 Climate change is predicted to increase the frequency and intensity of both heatwaves and heavy downpours.[4] Heavy rain can cause surface water flooding. GI has been shown to reduce the severity of these problems by providing summer cooling and by absorbing rainwater that might otherwise exacerbate surface water flooding.

2.4 The Urban Heat Island (UHI) effect occurs when summer sunshine beats down upon the dense materials (including asphalt, concrete, masonry and brick) that make up the built environment. Energy is absorbed into dense materials and is re-radiated at night, which is the main cause of the UHI effect, which can make the centre of a city up to 10 degrees Centigrade warmer than its rural hinterland in the middle of a summer day.[5] The UHI effect exacerbates heatwaves and leads to an increase in energy consumption, through the increased intensity of use of air

conditioning.[6] The UHI also exacerbates air pollution (see paragraph 2.11 for a discussion on air pollution).

2.5 The soil, vegetation and water in GI prevents heat islands from developing by reflecting sunlight and providing shade. Water evaporating from soil and water bodies and transpiring from leaves provides evaporative cooling. On hot summer days, the ambient temperature of vegetated areas can be up to 4 degrees Centigrade cooler than those areas of the city where there is no vegetation.[7] The difference in surface temperature between conventional roofs and green roofs on hot summer days is even more marked, with the temperature difference often exceeding 20 degrees Centigrade.[8]

2.6 The soil in GI is important as a store of water, which can provide evaporative cooling, as has been described, however soil (whether in the guise of green roofs, tree pits, rain gardens or other planted features) is also important as an absorber of rainwater, which would otherwise go straight into downpipes and drains, which can be overwhelmed during extreme rainfall events, causing surface water flooding. Extensive green roofs, for example, have been shown to absorb the first 5mm of rain that falls upon them. Approximately half of the rain that falls on a typical extensive green roof over the course of a year is retained within the substrate (soil) and subsequently lost through evapo-transpiration.[9] Rain gardens and tree pits at street level can be designed to intercept and store large volumes of stormwater.[10]

2.7 The mechanisms connecting GI with improved health and wellbeing include:

- access to greenspace whereby people maintain good health through exercise
- exposure to vegetation and natural features which facilitates social interaction, lowers stress and improves mental health and wellbeing
- reduction in pollutants that can cause disease

The evidence for these is considered in turn and summarised in the paragraphs that follow.

2.8 Epidemiological studies (including for example, the major study by Mitchell & Popham published by the Lancet in 2008)[11] have shown that access to nearby

greenspace encourages increased physical activity, lowers rates of obesity and lowers morbidity. The reasons for this are complex, however an important factor is that a greener environment increases the prevalence of walking and other physical activity. The importance of exercise in preventative medicine is now being emphasised by health professionals, who recognise that easy, local access to GI is essential if prescriptions for exercise are to be effective.[12] [13]

2.9 The sight of vegetation, outside as well as inside, releases stress, lowers blood pressure and helps concentration.[14] [15] Cognitive development in children and the recuperation of patients are also reported to be improved when vegetation is visible. Productivity is increased and the symptoms of conditions including Alzheimer's disease, dementia, depression and ADD may be alleviated.[16]

2.10 Green spaces, gardens and even shaded spots beneath trees have been shown to encourage informal social interaction and cohesion. These interactions are especially important for the lonely, elderly and other more vulnerable groups. In the City of London, green and open spaces are also valued and enjoyed by many of workers who commute into the Square Mile each working day. Overall, social interaction reduces stress and improves mental health and wellbeing.[17]

2.11 Health is also improved when noise is reduced, and air quality is improved. Soil and vegetation dampens noise, in contrast with man-made surfaces, which tend to reflect it. Trees and shrubs have been shown to reduce sound by 6dB over a distance of 30m.[18] Green roofs and green walls have been shown to be particularly effective at shielding people in buildings and building courtyards from traffic noise.[19]

2.12 Health is also impacted by poor air quality. Air pollutants of concern in London are particulates and nitrogen dioxide. In London in 2008, there were an estimated 4,300 premature deaths associated with exposure to particulates and in 2010 an estimated 5,900 premature deaths were caused by exposure to nitrogen dioxide.[20] The vegetation that makes up green infrastructure has been shown to improve air quality by filtering particulates and absorbing gases. Studies have shown that planting on buildings in street-canyons reduces street-level concentrations by as much as 40% for nitrogen dioxide and 60% for particulate matter. [21]

2.13 In the City of London, green infrastructure provides direct economic benefits and benefits to the productivity of workers. Green infrastructure is important in ensuring that the City is a more desirable place to work, thereby attracting and retaining companies. The various benefits provided by GI combine to provide economic benefits in terms of energy savings, fewer insurance claims (for example, after flooding), fewer working days lost, preventative health measures, reductions in crime, increased productivity, increased property values, increased footfall for businesses and increased inward investment. The health benefits of urban GI, in terms of reductions in provision by the health service are estimated at £2.1 billion in the UK.[22]

2.14 The economic and monetary valuation of GI is the subject of various methods (necessary because of the wider spectrum of benefits) and the process can be difficult and controversial (because it is argued that some attributes of nature cannot, meaningfully, have a value assigned to them), however work has been undertaken to place monetary values on green infrastructure assets in London. London's public parks have a gross asset value in excess of £91 billion and the GLA estimates that for every £1 invested in parks, Londoners reap £27 in benefits.[23] Another example of the monetary valuation of GI is the iTrees method, developed in the US, which has been used to estimate the value of London's trees (in terms of carbon sequestration, removal of water from drains and improved air quality) to be £133m per annum.[24] In addition to these various indirect economic benefits, the planning, design, installation and maintenance of GI is an economic activity in itself. For example, the UK annual expenditure for extensive green roofs, which is centred on London, exceeded £26m for 2017.[25]

3. Introduction to Urban Greening Factor schemes

3.1 Urban Greening Factor schemes have been applied in several cities around the world, beginning with Berlin in the 1990s. Similar schemes have spread to other German cities (including Hamburg) and then overseas, including Sweden (Malmö), the United States (including Seattle and Washington DC) and Canada (Toronto). The City of Southampton was the first UK planning authority to develop a scheme. A partnership led by the Red Rose Forest, developed a GI Toolkit, based on a GSF approach, for England's North-West region in 2008.[26]

3.2 The City of Berlin has operated the Biotop Flächenfaktor or Biotope Area Factor (BAF) since 1994.[27] Berlin was the first city to formally adopt an UGF scheme, having explored the approach in the Western Sector during the 1980s. The BAF is applied, in combination with Landscape Plans, in several Berlin's inner-city neighbourhoods. Landscape Plans address spatial issues and opportunities and the BAF ensures that adequate green space is provided within each development parcel. BAF targets are adjusted according to land use, with sites with educational use, for example, requiring the highest scores. Minimum scores for sites within neighbourhoods covered by the scheme vary between 0.3 and 0.6. Problems with surface water flooding and an overall lack of green space were the catalysts for the BAF initiative, and surface cover types are assigned scores (between 0 for impermeable surfaces and 1 for vegetated surfaces completed connected with the soil below) based on their ability to infiltrate, store and evaporate water. The BAF is viewed positively by city planners, architects and developers, who have praised its simplicity and flexibility, however, it is recognised that it cannot be used to assess the environmental impact of a scheme.[28]

3.3 A UGF scheme was trialled in 2001 in a new residential development in the post-industrial Western Harbour area of Malmö, Sweden. The original purpose was to ensure that adequate green space was provided on every plot and that sealed surfaces were minimised. A minimum score of 0.5 was set. The scheme was subsequently revised after the quality of some developments did not match the planning authority's expectations. The scheme has also been supplemented by a Green Points System designed to improve the quality of landscape design and to

encourage the inclusion of features that increase biodiversity. The scheme is now being applied to a wider area within Malmö as well as the neighbouring town of Lund.[29]

3.4 Seattle, in the State of Washington, adopted an UGF in 2006 and expanded the scheme in 2009. It was modelled on the Berlin BAF with modifications. The three priorities of Seattle's scheme have been: live-ability; ecosystem services; and climate change adaptation. As with other schemes, Seattle's has a catalogue of landscape elements, each with its own score, and a requirement for project proposals to meet a minimum overall score. Minimum scores vary according to zones, with residential zones requiring the highest scores and commercial and industrial areas, lower scores. To qualify for certain scores, landscape features must comply with detailed standards set by the city. For example, bio-retention facilities must include adequate soil volumes.[30] Increased diversity of planting is also encouraged. The scheme includes a provision for bonus credits for drought tolerance, irrigation with harvested rainwater, landscape features visible to passers-by and food cultivation. For a scheme to be awarded a score, it must be submitted with a landscape plan and landscape management plan and be submitted by a licensed landscape professional. A landscape professional must also verify that the landscape scheme has been installed in conformance with the approved plan. Since the scheme was adopted, Seattle's Department of Planning and Development has noted higher quality and better-integrated landscape design, with increased use of permeable paving, green roofs, and green walls.

3.5 Washington DC has the Green Area Ratio (GAR).[31] It was introduced in 2013 and revised in 2016 and is very similar to the Seattle scheme. It has been established by regulation and applies to all applications for building permits for new buildings and major renovations (with a few exemptions). The satisfactory implementation of a landscape scheme, that has met the minimum GAR score, must be demonstrated by a Certified Landscape Expert, before a certificate of occupation may be granted. The scheme gives high scores for trees (measured by canopy size), intensive green roofs and the conservation of existing soil. Target scores vary according to planning

zones, with differentiation between residential, mixed use and downtown (city-centre) areas.[32]

3.6 Helsinki, Finland, considered a UGF scheme as part of its Climate-Proof City – Tools for Planning (ILKKA) project (2012-2014).[33] The approach was to test the operation of a tool and to use the tool to assess design options in two new development sites (Kuninkaantammi and Jätkäsaari). A unique scoring system was developed by a panel of local experts. Issues considered were ecology, functionality, amenity and maintenance, with the ecological and functional goals prioritised over amenity and maintenance. Minimum scores were set for various land use classes, including residential (0.5), office (0.4), commercial (0.3) and industrial/logistics (0.2), with an expectation that higher targets would be met. These targets reflect the typical differences in the extent of greenspace provided within these development types in Helsinki.

3.7 In Singapore, which has promoted the 'City in a Garden' vision, has explored a Green Plot Ratio (GnPR), which measures overall leaf area and compares this with site area. Typical leaf area indices for trees, palms, shrubs and grasses are used in the calculations and it is hoped that the GnPR approach will assist in evaluating green infrastructure on tall buildings.[34] Singapore has also been at the forefront of promoting green roofs and green walls on tall buildings through its Skyrise Greenery scheme of incentives and awards.[35] Singapore is also notable for promoting high-rise bridges and gardens, which provide opportunities to exercise and relax without descending to the ground (e.g. the Pinnacle@Duxton skybridge).[36]

3.8 Using a UGF tool is a requirement for applications within Southampton's City Centre Action Plan (AP 12), which in 2015, required 'all developments (and especially key sites) to assess the potential of the site for appropriate green infrastructure improvements by using the Council's Green Space Factor, and to improve the score for the site.'[37] For other sites not within the City Centre, the council encourages, but does not require, use of the tool. Scores are assigned according to the rate of infiltration of rainwater for each landscape element.[38] The scoring system considers

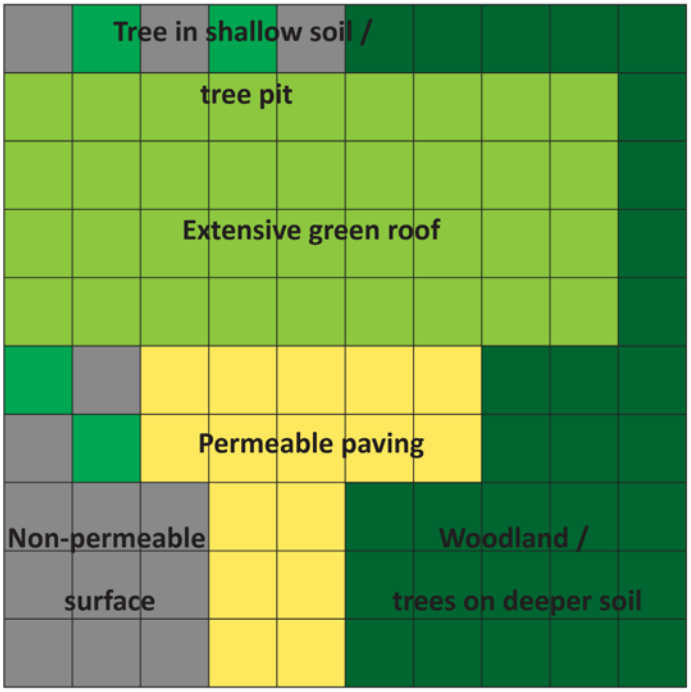
existing land cover, encourages retention of existing features and requires an overall increase in score compared with the existing condition. Performance requirements for surface cover types are not prescribed (as they are in the US for example). A completed spreadsheet is submitted as part of an application; however, there is no requirement for a suitably qualified professional to do this and no mechanism for verifying that a scheme has been implemented satisfactorily.

3.9 All schemes allocate scores to various categories of surface cover included in planning proposals. In effect, scores are a simplified measure of the various benefits (ecosystem services)[39] provided by soils, vegetation and water and are usually based on the potential for rainwater infiltration. This because the water-holding capacity of surface cover and associated soil is a good proxy for their ability to provide the range of benefits associated with natural systems. Ecosystem services provided by urban landscapes include supporting services, provisioning and cultural services (therapeutic benefits), however there is a special interest in regulating services (notably climate regulation and the cleaning of water and air). In all schemes, scores between 0 and 1 (in increments of 0.1) are allocated to each surface cover, with impermeable surfaces such as concrete and asphalt assigned a score of 0 and the most natural surface cover such as open water/trees or woodland on deeper soils, awarded a score of 1.

3.10 In calculating an overall UGF for any given proposed development it is necessary to measure the overall area of the site and then to map and measure the coverage of various surface cover types within the site (see Figure 1). Typical surface covers defined by authorities operating schemes, include sealed surfaces, permeable paving, amenity grassland, trees and shrubs, extensive green roofs, roof gardens and green walls (for list of surface cover types for London see Chapter 4). Once the various parcels have been measures and categorised, then the total coverage of each surface cover can be quantified. Scores (as provided by the authority operating the scheme) are then assigned to each surface cover. Then the calculation of the overall green space factor can begin. The score for each surface cover within a site is multiplied by its area. This generates a series of figures which are

then added together. This new total is then divided by the site overall site area to give an overall UGF score (as set out in Figure 2). This score can then be compared with a target set by the authority.

Figure 1: Diagram of simplified theoretical development site to demonstrate how the UGF works (modified from Southampton City Council's Guidance notes)[40]



$$\frac{(0.7 \times 36) + (0 \times 14) + (0.2 \times 16) + (1 \times 30) + (0.7 \times 4)}{100}$$

Score = 0.61

Target = 0.5

Site = 100m²

		Factor	Area (m²)
	Extensive green roof	0.7	36
	Non-permeable surface	0.0	14
	Permeable paving	0.2	16
	Woodland / trees on deeper soil	1.0	30
	Tree in shallow soil / tree pit	0.7	4
			100

The diagram and table show a theoretical square development site of 100 square metres, showing how the site has been analysed in terms of surface cover and areas of each type.

Figure 2: Formula for calculating the overall GSF score

$$\frac{(Score\ A \times Area) + (Score\ B \times Area) + (Score\ C \times Area) + (Score\ D \times Area)\ etc.}{Total\ Site\ Area}$$

3.11 Depending on how a scheme is operated by an authority, failure to meet the target can result in rejection of a planning application, or an indication that a proposal needs to be amended, to include a larger area of green infrastructure overall, or elements with higher functionality. Cities usually set a minimum score that must be achieved, and some have targets to encourage developers to be more ambitious and innovative, or they may have requirements which relate to the delivery of a specific function or outcome (e.g. stormwater management).

3.12 UGF schemes are usually applied to high-density zones or districts where large-scale urban renewal is planned, where rapid development is expected, or where particular problems (including, for example, biodiversity losses, surface water flooding or deficiency of accessible green space) could be exacerbated by inappropriate development.

3.13 UGF schemes are tools to help translate policy objectives into practice. They are used in combination with the full suite of policies that relate to amenity, green infrastructure and biodiversity and are usually applied in concert with combinations of green infrastructure and biodiversity strategies, district plans, neighbourhood plans, landscape plans, masterplans and design codes. UGF schemes do not replace policies, strategies, plans or codes, but help planners and designers to understand how designs interpret these.

3.14 As UGF schemes are part of a response to the problems associated with the increasing density of cities, they are usually applied in locations that tend to be dominated by multi-storey developments. Achieving a satisfactory GSF score in developments with limited or no ground level greenspace (where a building covers most or all a site) will normally require green roofs to be included. GSF schemes may also score for green walls, which introduces the possibility of sites scoring more than 1, because the total external surface area of the buildings, including the facades, can exceed the application site area. Although tall buildings have the potential for the overall surface area that is greened to be increased, there is also the question of whether target scores should be increased to reflect this potential and to address the higher demands associated with taller buildings. Conventional green infrastructure planning is usually characterised by ground-level mapping that overlooks the potential to green the roofs, terraces and facades of buildings. With high-rise developments with green roofs and walls located on multiple levels and aspects it will be increasing important that not only UGF schemes, but all policies related to green infrastructure, biodiversity and climate change adaptation, take account of the challenges and opportunities and challenges associated with denser developments and taller buildings. The Green Plot Ratio proposals, Skyrise Greenery

campaign and related initiatives, pioneered in Singapore, may need to be emulated in the City of London (see also paragraph 3.7).

3.15 With increasing building heights and the increasing complexity of building forms, with many terraces, roofs and facades at different levels and aspects and the importance of understanding the thermal performance of buildings, their influence on microclimate and city-wide phenomena like the urban heat island, researchers in Germany are looking at ways of modifying planning to take account of these factors. An example of this is the Green Density Factor, which provide guidance on how much extra greenery may be required on the roofs and facades of taller buildings, and the related Green Cooling Factor, which will calculate the cooling effect of green roofs and facades and compare this with the energy used in heating, ventilation and air conditioning of buildings.[41] Whilst these approaches are in their infancy, they are an indication of how UGF schemes may be adjusted in the future to take account of the issues associated with providing adequate green infrastructure on and around taller buildings.

3.16 In those cities where they have been adopted, UGF schemes have been shown to increase the amount of green space within developments, as well as increasing functionality, particularly with respect to surface water drainage. Depending on how they are operated, UGF schemes may also have the aim of requiring, or encouraging, more developers to take specialist advice (usually from landscape architects) in order to ensure that their plans meet the planning authority's requirements. With most UGF schemes, the purpose is easily explained and understood and the calculation of the overall score is a relatively straightforward and inexpensive process. Schemes allow flexibility with respect to plot layout and landscape design and are not prescriptive. Scores for particularly desirable features can be increased in order to encourage use.

3.17 The benefits of UGF schemes include,

- A reported increase in the use of multifunctional green infrastructure features

- Urban greening on restricted sites in densely developed areas
- A simple mechanism easily understood by non-specialists
- Facilitation of conversations between developers and planners
- Empowerment of local authorities, who may successfully argue the case for more greening
- Flexibility: scores and targets can be adjusted to reflect local priorities

3.18 UGF schemes may be perceived as an unnecessary additional administrative burden. This is more likely to be the case in cities, like those in the United States, for example, where the attainment of a score is a pre-requisite of the permitting process. It has been suggested that fragile landscape features (like intensive green walls for example) could be included in plans for meeting a target, with those features subsequently failing if not properly installed or maintained. It should be noted that artificially engineered features tend to require more maintenance and are more vulnerable to failure than retained existing features or more traditional planting in natural soils.

3.19 Although scoring schemes are relatively simple, the score assigned to any surface cover may vary from city to city and the assignment of a score to a landscape treatment can be subject to debate. There is the potential for low quality features (for example green roofs with inadequate substrate depth) to be used to formulate unsatisfactory schemes that meet the target score. These difficulties can be overcome by providing good definitions and accurate descriptions of the various types of surface cover. If necessary, scoring schemes can be reviewed to address persistent shortcomings.

3.20 UGF schemes have been confused with certification or benchmarking methods designed to measure the sustainability or environmental performance of developments. BREEAM, for example, which assesses the sustainability of building and infrastructure projects, includes five assessment categories included under the themes of landscape and ecology.[42] These categories are: site selection; ecological value of sites and protection of ecological features; mitigating ecological impact; enhancing site ecology and long-term impact on ecology. In contrast with the UGF

calculation process, these BREEAM assessments require detailed baseline surveys, calculations and reports, which must be undertaken by suitably qualified persons. BREEAM schemes may also incur substantial costs. Although BREEAM is a valuable way of measuring environmental performance and encouraging designers to strive for excellence, it has not been devised as a tool for planners and could not be readily applied to the task of improving green infrastructure provision across entire planning zones or neighbourhoods. The City of London, does, however, require major developments to achieve a BREEAM rating of Excellent or Outstanding and the UGF would support the attainment of BREEAM credits for landscape and ecology.

3.21 Potential issues (depending on how a UGF is implemented) can include the following:

- given that a UGF determines only the quantum of broadly described categories, the design quality of each treatment cannot be assessed in detail;
- there is a possibility of the UGF scheme being too rigidly interpreted, with proposals meeting, but not exceeding, targets;
- Not promoting green roof and green walls could result in insufficient green infrastructure being created in schemes with tall buildings and a small ground-level curtilage.

3.22 In light of these issues, it will be essential to be clear and precise about how a UGF relates to the full suite of policies that influence greenspace planning and design. Planning authorities will need to make clear that the UGF will be an assessment tool and will not be the sole method of assessing GI proposed as part of a development scheme. Planning tools cannot be a replacement for good design. If adopted, a UGF would need to be promoted as a tool to complement and help deliver policies and standards on, urban greening, wellbeing, biodiversity and climate change adaptation, including summer cooling and sustainable drainage.

4. The GLA Urban Greening Factor proposal

4.1 The Draft New London Plan (2017) includes a draft Policy G5[43] on urban greening, which includes a recommendation that UGF is adopted as a planning policy tool, Most cities apply a UGF to city centres, districts or neighbourhoods where there is a risk of sealed surfaces predominating, and it is suggested that London follows this approach, with local planning authorities require developers to use the tool for all major development proposals. The scheme could also be used in a voluntary way to evaluate any development in any location, especially where there is a concern that development is resulting in an overall loss of green cover in the locality. Minimum scores can be suggested by each local planning authority based on local planning parameters, including urban morphology, building density and height, and local issues, for example, risk of surface water flooding or a requirement to strengthen the local or regional ecological network.

4.2 The proposed London UGF scoring system for various categories of surface cover is presented in Table 1. The table covers most eventualities, however, if a surface cover type is encountered which is not listed, it has been suggested that it is assigned the same score as the category in the table that is most functionally similar. The scoring system could act as a guide to be adapted by local authorities for their own purposes. Scores are like those used in other cities, with 0 assigned to sealed surfaces and 1 assigned to the most natural or permeable features. The draft London Plan suggests that an interim overall minimum score of 0.3 is adopted for predominantly commercial development and 0.4 for predominantly residential development, with this adjusted if required, following testing of options in particular areas. The draft London Plan recognises that London is a diverse city, so it is appropriate that each borough develops its own approach in response to local circumstances.

Table 1: GLA New London Plan Proposed UGF Scores

Surface Cover Type	**Score**
Semi-natural vegetation (e.g. woodland, flower-rich grassland) created on site	1
Wetland or open water (semi-natural; not chlorinated) created on site	1
Intensive green roof or vegetation over structure. Vegetated sections only. Substrate minimum settled depth of 150mm – See livingroofs.org for descriptions.[44]	0.8
Standard trees planted in natural soils or in connected tree pits with a minimum soil volume equivalent to at least two-thirds of the projected canopy area of the mature tree -see Trees in Hard Landscapes for overview. [45]	0.8
Extensive green roof with substrate of minimum settled depth 80mm (or 60mm beneath vegetation blanket) – meets the requirements of GRO Code 2014.[46]	0.7
Flower-rich perennial planting – see Centre for Designed Ecology. [47]	0.7
Rain gardens and other vegetated sustainable drainage elements – See CIRIA for case studies.[48]	0.7
Hedges (line of mature shrubs one or two shrubs wide) – see RHS for guidance [49]	0.6
Standard trees planted in pits with soil volumes less than two thirds less than the projected canopy area of the mature tree.	0.6
Green wall – modular system or climbers rooted in soil – see NBS Guide to Façade Greening for overview. [50]	0.6
Groundcover planting – see RHS Groundcover Plants for overview [51]	0.5
Amenity grassland (species-poor, regularly mown lawns)	0.4
Extensive green roof of sedum mat or other lightweight systems that do not meet GRO Code 2014. [52]	0.3
Open water (chlorinated) or unplanted detention basins	0.2
Permeable paving - see CIRIA for overview [53]	0.1
Sealed surfaces (e.g. concrete, asphalt, waterproofing, stone)	0

5. GLA scheme applied to City of London

5.1 A total of 9 schemes were analysed using the proposed GLA UGF method. The schemes were selected in order to understand how the scheme might work across a range of projects, including Listed Buildings in a Conservation Area, Listed Buildings not in a Conservation Area, Buildings in a Conservation Area that are not listed and buildings not Listed and not in a Conservation Area. In addition, a tall building was included. The list includes buildings that have been completed and others with approved designs, which are still under construction.

5.2 The UGF method was applied to each project using drawings available on the City of London Planning Portal.[54] Required drawings are a 'red line' plan showing the extent of each site, as well as plans showing proposed landscape and green roofs (where applicable). Landscape features shown on the drawings were assigned to one of the GLA categories, extent was measured and the UGF calculation made. Table 2 (overleaf) lists the projects and UGF scores. Drawings and calculations are presented in Appendix 1.

5.3 5 of the projects had UGF scores of less than 0.1 and are discussed in the paragraphs that follow.

5.4 10 Trinity Square is a refurbishment of an historic building which is now a hotel with residential apartments. Greenspace has been increased by extending an existing garden and there was limited scope for green roofs. The UGF scheme would be able to demonstrate that the area of greenspace has been increased, however this is a scheme that would be exempt from ambitious targets because of the constraints associated with the existing historic building.

Table 2. Development schemes assessed

Planning Ref. No.	Development Name	Address	Brief description	Commenced (Decision)	Landscape	UGF Score
10/00569/FULMAJ	*St Dunstan's Court*	*133 - 137 Fetter Lane, EC4Y*	Refurbishment for residential use. Not listed but in CA	2012	Retained and enhanced gardens	0.31
11/00228/FULL	*Carmelite House*	*50 Victoria Embankment EC4Y*	Refurbishment of listed building in CA	2011	3 extensive green roofs	0.27
16/00215/FULMAJ	*24-30 West Smithfield*	*24-30 West Smithfield, EC1*	Conversion and part-demolition to create hotel. In CA but not listed	(2016)	Extensive green roofs	0.19
14/00780/FULMAJ	*4 Cannon Street*	*2 - 6 Cannon Street, EC4M*	New 7-storey office building not listed and not in CA	(2015)	Extensive green roof, courtyard garden	0.18
11/00049/FULEIA	*1 & 2 New Ludgate*	*30 Old Bailey & 60 Ludgate Hill, EC4*	2 new office and retail buildings not in CA	2011	Trees, extensive green roofs intensive green roofs	0.08
11/00317/FULMAJ	*Ten Trinity Square*	*10, Trinity Square, EC3N*	Listed building in CA converted to hotel	2013	Ground-level garden extended	0.07
16/00075/FULEIA	*1 Undershaft*	*1 Undershaft, EC3P*	73-storey office tower	(2016)	Street level trees and planted beds	0.07
12/00811/FULMAJ	*8 Finsbury Circus*	*7 - 11 Finsbury Circus, EC2M*	9-storey office building behind retained facade	2013	2 extensive green roofs	0.04
11/00935/FULEIA	*Bloomberg Place*	*Land Bounded by Cannon St, Queen St, Queen Victoria St, Bucklersbury & Walbrook, EC4*	2 new office and retail buildings in CA	2012	3 small extensive green roofs	0.03

5.5 8 Finsbury Circus is a new building behind a retained façade. There are two small areas of extensive green roof. There is an area of photovoltaic panels (PVs) that could have been combined with an extensive green roof (biosolar roof).[55] The area of green roofs is relatively small. There are large areas of roof where the opportunity to green may have been missed. Use of the UGF may have played a useful role in demonstrating to the applicant that the roof greening effort lacked ambition.

5.6 Bloomberg Place has two new buildings. These have 3 very small extensive green roofs, although a number of trees were also planted. It may be that there are large areas of roofs on these buildings which could have been greened. If green roofs were not compatible with the design, perhaps a case could have been made for green walls? A UGF may have been a useful way of demonstrating the inadequacy of the green infrastructure in the scheme.

5.7 1 & 2 New Ludgate is the site of 2 new office buildings. There is adequate ground level landscape, however the extensive green roofs are limited to strips. There are ranks of PVs that could have been combined with extensive green roofs (biosolar roofs). There may also have been opportunities to create green walls. A UGF may have been useful in demonstrating the inadequacy of the extent of green roofs or encouraging the designers to look at the possibility of greening walls.

5.8 1 Undershaft is a tall building with street-level landscaping. With high volumes of pedestrian traffic predicted, there are limited opportunities for greening pavement and piazza, however it would be relatively easy for a tall building, such as this, to provide more GI with green walls (compare with 20 Fenchurch Street), other vertical greening or balcony-like features. A UGF scheme could be a useful way of demonstrating the quantity of green walling required to meet a target.

5.9 A further 4 projects had a significant more extensive GI and scored between 0.18 and 0.31. One project met the GLA suggested target of 0.3. These are described in the paragraphs that follow.

5.10 Carmelite House is a refurbished listed building. The drawing shows good coverage of extensive green roofs. One, labelled moss, has been interpreted as sedum mat and has attracted a lower score than a GRO Code[56] compliant roof. A compliant green roof would increase the score to more than 0.3, which would meet the GLA suggested target.

5.11 St. Dunstan's Court Is a project that retains an existing garden. A UGF scheme would be able to demonstrate that the area of greenspace has been maintained, however this is a scheme in a Conservation Area, where there would have been an expectation that the existing greenspace be retained.

5.12 4 Cannon St is a new 7-storey office building. There is a ground-level garden and about half of the roof is covered by an extensive green roof. There may have been potential to increase the area of extensive green roof in the design and a UGF scheme may have been a useful tool for demonstrating how the scheme could have been improved. Green walls may also have been an option.

5.13 24-30 West Smithfield is a scheme to part-demolish and convert a building into a hotel. Significant sections of roof are to be greened. There may have been potential to increase the area of extensive green roof in the design and there may also be options for greening walls. A UGF scheme may have been a useful tool for demonstrating how the scheme could have been improved.

5.14 Preliminary observations are as follows:

- Some of the schemes have very low UGF scores and there is therefore a suggestion that the quantity of GI is inadequate in some of these cases. A UGF scheme would make this plain.
- There are historic buildings (e.g. Ten Trinity Square) where the options for greening are limited and the utility of a UGF is limited.
- Where GI proposals are more ambitious, a UGF target may have been a useful way of securing improvements
- With tall buildings, a UGF scheme could be a useful tool for demonstrating the need for green walls or other vertical greening features.
- None of the 9 schemes meet the draft GLA UGF target of 0.3/0.4. With minor improvements to one of the schemes (Carmelite House), it would meet the GLA UGF target of 0.3

- The GLA UGF target of 0.3/0.4 would be reasonable for the City of London, given that most of the projects fall short, but that it has been demonstrated that it can be met.
- The GLA landscape categories work for projects in the City of London. Some categories may only be encountered very occasionally, but it will be useful to include these in order to illustrate the scoring system and the spectrum of landscape types.

5.15 The greening elements that contributed to the UGF scores in the nine City of London case studies are shown in Table 3 (over the page). Sealed surfaces features in all projects and this is to be expected. The most frequently encountered elements are trees (trees in all categories were encountered 6 times), followed by extensive green roofs (these feature 5 times), with hedges, groundcover planting (including shrubs), amenity grassland, intensive green roofs and green walls all featuring occasionally.

5.16 In order for the projects in the case studies to achieve higher scores, larger areas of the elements used would be required as well as the use of other features in most cases. Opportunities for ground-level improvements are relatively scarce in the City – often there is little or no ground level curtilage and where there is public realm at street level, high volumes of pedestrian traffic limit the space for greening.

Table 3. UGF elements that appear in the City of London case studies (No. refers to number of appearances in the case studies – see Appendix 1).

Surface Cover Type	**Score**	**No.**
Semi-natural vegetation (e.g. woodland, flower-rich grassland) created on site	1	0
Wetland or open water (semi-natural; not chlorinated) created on site	1	0
Intensive green roof or vegetation over structure. Vegetated sections only. Substrate minimum settled depth of 150mm – See livingroofs.org for descriptions.[57]	0.8	1
Standard trees planted in natural soils or in connected tree pits with a minimum soil volume equivalent to at least two-thirds of the projected canopy area of the mature tree -see Trees in Hard Landscapes for overview. [58]	0.8	4
Extensive green roof with substrate of minimum settled depth 80mm (or 60mm beneath vegetation blanket) – meets the requirements of GRO Code 2014.[59]	0.7	2
Flower-rich perennial planting – see Centre for Designed Ecology. [60]	0.7	3
Rain gardens and other vegetated sustainable drainage elements – See CIRIA for case studies.[61]	0.7	0
Hedges (line of mature shrubs one or two shrubs wide) – see RHS for guidance [62]	0.6	3
Standard trees planted in pits with soil volumes less than two thirds less than the projected canopy area of the mature tree.	0.6	2
Green wall – modular system or climbers rooted in soil – see NBS Guide to Façade Greening for overview. [63]	0.6	1
Groundcover planting – see RHS Groundcover Plants for overview [64]	0.5	2
Amenity grassland (species-poor, regularly mown lawns)	0.4	2
Extensive green roof of sedum mat or other lightweight systems that do not meet GRO Code 2014. [65]	0.3	5
Open water (chlorinated) or unplanted detention basins	0.2	0
Permeable paving - see CIRIA for overview [66]	0.1	0
Sealed surfaces (e.g. concrete, asphalt, waterproofing, stone)	0	9

Table 4. How higher UGF scores might be obtained

Planning Ref. No.	Development Name	Address	Brief description	Landscape	UGF Score	0.4	0.6	1
10/00569/FULMAJ	*St Dunstan's Court*	*133 - 137 Fetter Lane, EC4Y*	*Refurbishment for residential use. Not listed but in CA*	*Retained and enhanced gardens*	*0.31*	*n/a*	*n/a*	*n/a*
11/00228/FULL	*Carmelite House*	*50 Victoria Embankment EC4Y*	*Refurbishment of listed building in CA*	*3 extensive green roofs*	*0.27*	*Larger green roof*	*n/a*	*n/a*
16/00215/FULMAJ	*24-30 West Smithfield*	*24-30 West Smithfield, EC1*	*Conversion and part-demolition to create hotel. In CA but not listed*	*Extensive green roofs*	*0.19*	*Larger green roof*	*Green walls*	*More green walls*
14/00780/FULMAJ	*4 Cannon Street*	*2 - 6 Cannon Street, EC4M*	*New 7-storey office building not listed and not in CA*	*Extensive green roof, courtyard garden*	*0.18*	*Larger green roof*	*Green walls*	*More green walls*
11/00049/FULEIA	*1 & 2 New Ludgate*	*30 Old Bailey & 60 Ludgate Hill, EC4*	*2 new office and retail buildings not in CA*	*Trees, extensive and intensive green roofs*	*0.08*	*Larger green roof*	*More green roofs, green walls*	*More green walls*
11/00317/FULMAJ	*Ten Trinity Square*	*10, Trinity Square, EC3N*	*Listed building in CA converted to hotel*	*Ground-level garden extended*	*0.07*	*n/a*	*n/a*	*n/a*
16/00075/FULEIA	*1 Undershaft*	*1 Undershaft, EC3P*	*73-storey office tower*	*Street level trees and planted beds*	*0.07*	*Green roof*	*Green walls, balconies*	*More green walls*
12/00811/FULMAJ	*8 Finsbury Circus*	*7 - 11 Finsbury Circus, EC2M*	*9-storey office building, retained facade*	*2 extensive green roofs*	*0.04*	*Larger green roof*	*Green walls*	*More green walls*
11/00935/FULEIA	*Bloomberg Place*	*Bounded by Cannon St, Queen St, Queen Victoria St, Bucklersbury & Walbrook, EC4*	*2 new office and retail buildings in CA*	*3 small extensive green roofs*	*0.03*	*Larger green roof*	*Green walls*	*More green walls*

5.17 Table 4 sets out how each of the projects featured in the case studies might reach the higher scores of 0.4, 0.6 and 1. In the case of Listed Buildings, where facade greening would not be permitted or where existing conventional roofs must be retained, it would not be possible to achieve the very highest scores (for which roof greening, green walls or vertical greening would be required). With most

projects, attaining a score of 0.3 or 0.4 will require roof greening. For the highest scores (0.6 and 1) green walls and vertical greening elements (e.g. green balconies) will be required.

5.18 At a recent workshop, a group of City of London officers considered the relative importance of that should be given to various benefits provided by green infrastructure. Table 5 lists these benefits in order of priority. These results conform with the City of London's priorities, which are:

- Air quality
- Surface water management (rainwater attenuation)
- Temperature
- Biodiversity
- Amenity
- Health/wellbeing

Table 5. GI functionality in order of priority

Priority	Factor	Score (% of officers)
1st	Amenity/Recreation	25
2nd	Health/Wellbeing	21
3rd	Air Quality	15
4th	Rainwater attenuation (surface water management)	14
5th	Biodiversity	9
6th	Temperature/Shade (Summer cooling)	8
7th	Noise	6
8th	Others	1

5.19 Table 6 considers the relative importance of these benefits in terms of their provision by the various elements in the GLA list. The analysis (by the authors) is based on the review of the evidence cited in the chapter on green infrastructure benefits (Chapter 2) and the scoring systems developed by cities already using UGF schemes (Chapter 3). All elements have multiple benefits; however, some perform much better with respect to particular functions. For example, a rain garden is much more effective in managing surface water run-off than a conventional green wall. However, it is important to note that the actual performance of any given element

may vary, depending on the location and setting, design, soils used, planting and maintenance.

Table 6. GLA landscape elements and benefits

A/R=Amenity/Recreation; H/W=Health/Wellbeing; AQ=Air quality; RA=Rainwater attenuation; B=Biodiversity; T=Temperature; N=Noise. += low benefit; ++=moderate benefit; +++=high benefit. S=Overall score									
Surface Cover Type	**GLA Score**	**A/R**	**H/W**	**AQ**	**RA**	**B**	**T**	**N**	**S**
Semi-natural vegetation (e.g. woodland, flower-rich grassland) created on site	1	++	+++	+++	+++	+++	+++	+++	20
Wetland or open water (semi-natural; not chlorinated) created on site	1	+++	+++	+	++	+++	+++	+	16
Intensive green roof or vegetation over structure. Vegetated sections only. Substrate minimum settled depth of 150mm	0.8	+++	+++	+	+++	++	+++	++	17
Standard trees planted in natural soils or in connected tree pits with a minimum soil volume equivalent to at least two-thirds of the projected canopy area of the mature tree	0.8	+++	++	++	+++	++	+++	++	17
Extensive green roof with substrate of minimum settled depth 80mm (or 60mm beneath vegetation blanket)	0.7	+	+	++	+++	+++	+++	+	14
Flower-rich perennial planting	0.7	++	++	+	++	++	++	+	12
Rain gardens and other vegetated sustainable drainage elements	0.7	++	++	+	+++	++	+++	+	14
Hedges (line of mature shrubs one or two shrubs wide)	0.6	++	+	++	++	++	++	++	13
Standard trees planted in pits with soil volumes less than two thirds less than the projected canopy area of the mature tree	0.6	++	++	+	+	+	++	+	10
Green wall – modular system or climbers rooted in soil	0.6	+++	++	++	+	++	+++	+++	16
Groundcover planting	0.5	++	++	+	++	++	++	+	12
Amenity grassland (species-poor, regularly mown lawns)	0.4	+++	+	+	++	+	+++	+	12
Extensive green roof of sedum mat or other lightweight systems that do not meet GRO Code 2014 [67]	0.3	+	+	+	+	+	++	+	8
Open water (chlorinated) or unplanted detention basins	0.2	++	+	+	+	+	+++	+	10
Permeable paving	0.1	+	+	+	++	+	+	+	8
Sealed surfaces (e.g. concrete, asphalt, waterproofing, stone)	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

5.20 Estimates of the costs of creating the various green infrastructure elements are provided in Appendix 2. In order to estimate the additional costs associated with increasing UGF scores to 0.4, 0.6 and 1, sample calculations were prepared for two of the case studies in Appendix 1. The costs do not include paving or other hard landscape elements. Case studies were chosen where the attainment of these higher scores would be feasible, assuming no unexpected technical issues. The two examples selected were 1 Undershaft (16/00075/FULEIA), where higher scores would be attained by the use of green walls on the 73-storey tower, and 24-30 West Smithfield (16/00215/FULMAJ), where higher scores would be attained through a combination of an increased area of green roofs as well as green walls. Tables 7 and 8 set out the estimated costs and cost increases for the two projects. Costs are indicative and assume a basic specification. Higher costs would be associated with the most expensive products or systems and particularly complicated designs. They are provided to illustrate the likely magnitude of increase in each case. Where there is a range of costs for an element the lower price is used given the large scale of these projects.

Table 7.
1 Undershaft (16/00075/FULEIA) – Estimate of costs of attaining various UGF scores

UGF Scores	**0.07**	**0.4**	**0.6**	**1**
Elements & (Areas) m^2	17 Trees (478), Flower-rich perennial (149), Hedges (93)	Trees (478), Flower-rich perennial (149), Hedges (93), Green walls (4000)	Trees (478), Flower-rich perennial (149), Hedges (93), Green walls (6000)	Trees (478), Flower-rich perennial (149), Hedges (93), Green walls (11500)
Cost	£ 29,650	£ 629,650	£ 929,650	£ 1.75m

Table 8.
24-30 West Smithfield (16/00215/FULMAJ) – Estimates of cost of attaining various UGF scores

UGF Scores	**0.19**	**0.4**	**0.6**	**1**
Elements & (Areas) m^2	Extensive green roofs (485)	Extensive green roofs (1021)	Extensive green roofs (1021), Green walls (600)	Extensive green roofs (1021), Green walls (1770)
Cost	£ 48,500	£ 102,100	£ 190,000	£ 367,600

5.21 Tables 7 and 8 show significant increases in cost would be associated with the attainment of the 0.4 target. To achieve very high target UGF scores (for example 1),

would involve tripling of costs when compared to the 0.4 target. Although the sums quoted are large, it is worth noting that they would represent a relatively small proportion of the overall cost. The construction cost of 1 Undershaft, for example, is likely to be significantly higher than that for The Shard (completed 2012), which is the same height, and which cost £435m to build.

6 Recommendations for a City of London UGF

6.1 The City of London could operate a UGF scheme as a way of promoting green infrastructure and increasing the quantity and quality of green infrastructure. There are important reasons for this, including the need to adapt to climate change and the emerging evidence of the many benefits of increasing the quantity and quality of green infrastructure in urban areas. Although opportunities to add more vegetation to certain buildings (e.g. Listed Buildings with pitched roofs), may be limited, the study has shown that there are opportunities to add greenery to new buildings and refurbished buildings in Conservation Areas as well as zones which are not specially designated. Therefore, a UGF should be applied across the City, with the understanding that there may be a few exemptions, for example historic buildings, or projects on sites with particular circumstances, where the application of the UGF scheme would be of limited use.

6.2 The UGF scheme would be used as a planning tool and to facilitate discussion. Planning applications for major developments in the City would be expected to include a UGF calculation with their plans, and applicants should continue to expect searching questions about their schemes should they show no interest in green infrastructure or if their UGF scores fall short of the minimum target without reasonable explanation. UGF scores may be calculated for application sites, buildings, buildings and their ground-level curtilage or street-level public realm.

6.3 This study has shown that it is likely that the adoption of the GLA's suggested minimum target scores of 0.3 for predominantly commercial developments and 0.3/0.4 for predominantly residential developments would drive up standards in the City. Planning officers in the City have noted that other cities are more ambitious and that a higher target score would be achievable. It is suggested here that minimum target scores of 0.3/0.4 are adopted when the scheme commences. Targets can be increased, if it can be shown that the UGF scheme has been

operating successfully for a period of two years, that there is the potential for further gains, and that there is an appetite to extend the scheme.

6.4 Designs for taller buildings can easily meet the 0.3/0.4 target scores by including green roofs and green walls or by vegetating balconies and other features on upper floors. At this time, the 0.3/0.4 target scores are sufficient for the purposes of encouraging the designers of taller buildings to include these elements, however it has been noted that should the City of London wish to encourage a more ambitious level of greening for taller buildings a higher target score might need to be set. This issue is outside of the scope of this study and would need to be the subject of a more detailed look at the various categories of taller building currently being developed and likely to be considered in the future, as well as the issues and opportunities associated with greening taller buildings. The work undertaken in Singapore to develop a Green Plot Ratio (see paragraph 3.7) is particularly relevant.

6.5 It has been suggested by planning officers in the City of London that the GLA's proposed scoring scheme is amended for the City, in order to encourage certain categories of greening, particularly tree planting, good quality green roofs (of adequate soil depth) and green walls. The planting of trees which are large at maturity and provide more biomass, shade and amenity, is an example of a type that the City would like to encourage. The ways in which these interventions can help the City to meet its objectives are shown in Table 6. Table 9 below shows the GLA suggested scores with suggestions of enhanced City of London scores for selected categories. The table includes categories that would not be encountered in the City of London, however these are retained in order to provide context.

Table 9: Proposed City of London (CoL) UGF Scores compared with GLA scores

Surface Cover Type	GLA	CoL
Semi-natural vegetation (e.g. woodland, flower-rich grassland) created on site	1	1
Wetland or open water (semi-natural; not chlorinated) created on site	1	1
Intensive green roof or vegetation over structure. Vegetated sections only. Substrate minimum settled depth of 150mm – See livingroofs.org for descriptions.[68]	0.8	0.9
Standard trees planted in natural soils or in connected tree pits with a minimum soil volume equivalent to at least two-thirds of the projected canopy area of the mature tree -see Trees in Hard Landscapes for overview. [69]	0.8	0.9
Extensive green roof with substrate of minimum settled depth 80mm (or 60mm beneath vegetation blanket) – meets the requirements of GRO Code 2014.[70]	0.7	0.8
Flower-rich perennial planting – see Centre for Designed Ecology. [71]	0.7	0.7
Rain gardens and other vegetated sustainable drainage elements – See CIRIA for case studies.[72]	0.7	0.7
Hedges (line of mature shrubs one or two shrubs wide) – see RHS for guidance [73]	0.6	0.6
Standard trees planted in pits with soil volumes less than two thirds less than the projected canopy area of the mature tree.	0.6	0.7
Green wall – modular system or climbers rooted in soil – see NBS Guide to Façade Greening for overview. [74]	0.6	0.7
Groundcover planting – see RHS Groundcover Plants for overview [75]	0.5	0.5
Amenity grassland (species-poor, regularly mown lawns)	0.4	0.4
Extensive green roof of sedum mat or other lightweight systems that do not meet GRO Code 2014. [76]	0.3	0.3
Open water (chlorinated) or unplanted detention basins	0.2	0.2
Permeable paving - see CIRIA for overview [77]	0.1	0.1
Sealed surfaces (e.g. concrete, asphalt, waterproofing, stone)	0	0

6.6 In conclusion, it is recommended that the City of London adopts the Urban Greening Factor as a tool to increase the quantity and quality of greening of development schemes subject to planning applications. The City would expect applicants to participate in using the UGF tool, unless there are good reasons to be exempted. The City of London's scoring scheme for categories of greening would be

modified from the proposed GLA scheme in order to further encourage tree planting and the establishment of high quality green roofs and green walls. The GLA overall minimum targets of 0.3 for predominantly commercial buildings and 0.4 for predominantly residential buildings can be used in the first instance, with the possibility of increasing this after operating the scheme for two years and undertaking an evaluation. For the time being, taller buildings can be included in the scheme, however a separate study should be undertaken to consider any particular issues and opportunities associated with vegetating taller buildings and whether they should be subject to a modified UGF scheme or subject to their own Green Plot Ratio (GnPR) scheme.

6.7 Should the City of London wish to operate a UGF scheme, it is suggested that a short explanation, combined with a sample calculation, is made available for applicants to download from the City of London's website.

References

[1] https://www.london.gov.uk Search: New London Plan Policy G5

[2] https://www.cityoflondon.gov.uk Search: Local Plan

[3] https://www.gov.uk Search: Green Infrastructure

[4] http://ukclimateprojections.metoffice.gov.uk

[5] https://www.epa.gov/ Search: Heat Island Effect

[6] Kolokoroni *et al*. 2012. London's urban heat island. Energy and Buildings. Vol 47

[7] Qiu Guo-yo et al. 2013. Effects of Evapotranspiration on Mitigation of Urban Temperature. Journal of Integrative Agriculture. Vol 12. Issue 8.

[8] DeNardo *et al*. 2005. Stormwater mitigation and surface temperature reduction by green roofs. Transactions of the ASAE. Vol 48.

[9] https://livingroofs.org Search: Stormwater runoff

[10] UK Rain Garden Guide. Downloadable from raingardens.info

[11] Mitchell & Popham 2008. Effect of exposure to natural environment on health inequalities. The Lancet. Vol 372

[12] Walking for Health Initiative. See website walkingforhealth.org.uk

[13] Pretty, J., R. Hine, and J. Peacock. 2006. Green Exercise: The Benefits of Activities in Green Places. *Biologist 5*3, 3: 143-48.

[14] Shibata, S., and N. Suzuki. 2002. Effects of the Foliage Plant on Task Performance and Mood. *Journal of Environmental Psychology* 22, 3: 265-272.

[15] Chang, C.Y., and P.K. Chen. 2005. Human Response to Window Views and Indoor Plants in the Workplace. *Hortscience 4*0, 5: 1354-59.

[16] University of Washington Urban Forestry/Urban Greening Research Project: Green Cities: Good Health. Available from University of Washington website

[17] Health Council of the Netherlands. 2004. *Nature and Health: The Influence of Nature on Social, Psychological and Physical Well-Being. H*ealth Council of the Netherlands and RMNO, The Hague.

[18] Arboricultural Association. See website trees.org.uk

[19] Van Renterghem, T. *et al*. 2013. The potential of building envelope greening to achieve quietness. Building and Environment, 61, 34– 44. DOI:10.1016/j.buildenv.20 12.12.001

[20] https://www.london.gov.uk Search: Air Quality

[21] Pugh et al. 2012. Effectiveness of Green Infrastructure for Improvement of Air Quality in Urban Street Canyons. Environmental Science and Technology. Vol 46

[22] Natural Capital Committee Annual Report 2018

[23] GLA. 2017. Natural Capital accounts for public green space in London.

[24] Forestry Commission. See website https://www.forestry.gov.uk Search: iTree

[25] https://livingroofs.org Search: Green roof market report 2017

[26] Mersey Forest Green Infrastructure Valuation Toolkit – available from Mersey Forest website

[27] Biotope Area Factor – see Berlin.de website

[28] Darla Nickel, Wenke Schoenfelder, Dale Medearis, David P. Dolowitz, Melissa Keeley & William Shuster (2014) German experience in managing stormwater with green infrastructure, Journal of Environmental Planning and Management, 57:3, 403-423, DOI: 10.1080/09640568.2012.748652

[29] Anna Kruuse 2011. GRaBS Expert Paper 6. The green space factor and the green points system

[30] City of Seattle. 2015. Director's Rule 30-2015: Standards for Landscaping, including Green Factor.

[31] Washington DC zoning codes – see District of Columbia Office of Zoning website

[32] Washington DC zoning codes – see District of Columbia Office of Zoning website

[33] Helsinki Green Factor – see website http://ilmastotyokalut.fi

[34] Council on Tall Buildings. 2012. Issue 1. Greening the Urban Habitat. Singapore

[35] NParks Singapore – see Skyrise Greenery on website

[36] Search: The Pinnacle@Duxton Skybridge

[37] Southampton City Centre City Centre Action Plan, Adopted Version 18 March 2015.

[38] Southampton City Council. See website and search for Green Space Factor Tool

[39] UK National Ecosystem Assessment http://uknea.unep-wcmc.org/

[40] Southampton City Council. See website and search for Green Space Factor Tool

[41] Green Density Factor and Green Cooling Factor http://www.betzler.net

[42] BREEAM. See bream.com

[43] https://www.london.gov.uk Search: New London Plan Policy G5

[44] https://livingroofs.org Search: Intensive green roofs

[45] Trees and Design Action Group. Trees in Hard Landscapes.

[46] GRO Code 2014. Available from: https://livingroofs.org

[47] Centre for Designed Ecology, University of Sheffield. See case studies at website: cfde.co.uk

[48] The Community for Sustainable Drainage. Website: http://www.susdrain.org/

[49] Royal Horticultural Society website: rhs.org.uk

[50] https://www.thenbs.com/knowledge/the-nbs-guide-to-facade-greening-part-two

[51] https://www.rhs.org.uk/ Search: Ground cover plants

[52] https://livingroofs.org/ Search: The Code of Practice for Green Roofs

[53] http://www.susdrain.org

[54] http://www.planning2.cityoflondon.gov.uk/ Search: Online applications

[55] Bauder biosolar roof: See website: bauder.co.uk

[56] GRO Code 2014. Available at: livingroofs.org

[57] https://livingroofs.org Search: Intensive green roofs

[58] Trees and Design Action Group. Trees in Hard Landscapes.

[59] GRO Code 2014. Available at: livingroofs.org

[60] Centre for Designed Ecology, University of Sheffield. See case studies at website: cfde.co.uk

[61] The Community for Sustainable Drainage. Website: http://www.susdrain.org/

[62] Royal Horticultural Society website: rhs.org.uk

[63] NBS Guide to façade greening. Available at: thenbs.com

[64] Royal Horticultural Society website: rhs.org.uk

[65] GRO Code 2014. Available at: livingroofs.org

[66] The Community for Sustainable Drainage. Website: http://www.susdrain.org/

[67] GRO Code 2014. Available at: livingroofs.org

[68] https://livingroofs.org Search: Intensive green roofs

[69] Trees and Design Action Group. Trees in Hard Landscapes.

[70] GRO Code 2014. Available at: livingroofs.org

[71] Centre for Designed Ecology, University of Sheffield. See case studies at website: cfde.co.uk

[72] The Community for Sustainable Drainage. Website: http://www.susdrain.org/

[73] https://www.rhs.org.uk/ Search: Hedges: selection

[74] https://www.thenbs.com/ Search: The NBS guide to façade greening (Part Two)

[75] https://www.rhs.org.uk/ Search: Ground cover plants

[76] GRO Code 2014. Available at: livingroofs.org

[77] The Community for Sustainable Drainage. Website: http://www.susdrain.org/