Sky-Garden Ltd, Unit 4 Beta, Orchard Industrial Estate, Toddington Glos, GL54 5EB
P: 01242 620905 F:01242 620739
www.sky-garden.co.uk

BREEAM & Green Roofs

BREEAM

The Building Research Establishment (BRE) is a charitable organisation, which is dedicated to research and education in the built environment. The BRE Environmental Assessment Method (BREEAM) is the most well established approach to investigating the total environmental impact of an individual building development. Similar approaches exist outside of the UK, such as Leadership in Energy and Environmental Design (LEED) in North America, and Haute Qualité Environnementale (HQE) in France, but BREEAM is the most widely used, with over 200,000 buildings certified.

BREEAM is accredited using assessors certified under a United Kingdom Accreditation Service (UKAS) training program.

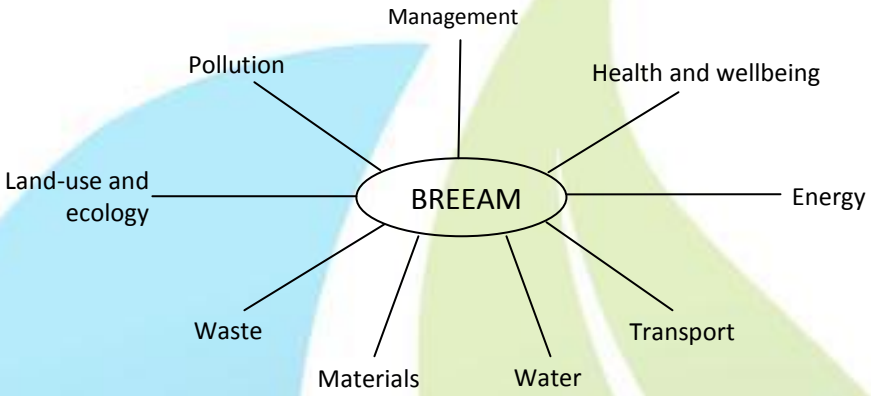
BREEAM is used by four main groups:

1. Developers. *Internationally recognised approach to sustainable development allows comparable certification levels between developments, and allows for higher visible in the marketplace.*
2. Property agents. *To improve environmental credentials and therefore market value of a development*
3. Design teams. *Utilise BREEAM in parallel with existing knowledge to achieve higher levels of building performance.*
4. Managers. *Reduction of running costs, monitoring of building performance, empowerment of staff and improvement of portfolio.*

Whilst there is no legal requirement to undertake BREEAM, it is often a contractual element which therefore forces the relevant persons to achieve a predetermined certification level. These contractual agreements could be a condition of funding, as is the case for all Governmental buildings, or in order to achieve planning permission from the relevant authority.

Sky-Garden Ltd, Unit 4 Beta, Orchard Industrial Estate, Toddington Glos, GL54 5EB
P: 01242 620905 F:01242 620739
www.sky-garden.co.uk

BREEAM is based upon the Green Guide for Specifications. The environmental impact of different construction elements are outlined within this guide, and credits are assigned accordingly within the nine different schemes within BREEAM. These schemes are:



A BREEAM assessment follows five stages, with the two most important being the interim and post construction stages. The former is where the credit potential of the development is assessed, and the latter confirms if the building achieves the predicted level of certification.

1. Pre-assessment stage
2. Design stage assessment
3. Interim 'design stage' BREEAM certification
4. Construction stage review
5. Final 'post construction stage' BREEAM certification (undertaken over the 12 months following development completion)

There are 6 certification levels that can be awarded through a BREEAM assessment.

Unclassified (<30%)
Pass (>30%)
Good (>45%)
Very good (>55%)
Excellent (>70%)
Outstanding (>85%)

Sky-Garden Ltd, Unit 4 Beta, Orchard Industrial Estate, Toddington Glos, GL54 5EB
P: 01242 620905 F:01242 620739
www.sky-garden.co.uk

Green roofs

Green roofs have a magnitude of potential benefits for development:

- Water quantity. *Attenuation and retention of rainwater, and subsequent capacity to behave as a Sustainable urban Drainage System (SuDS).*
- Water quality. *Filtration of roof run-off.*
- Thermal properties. *Regulation of roof surface temperature and reduction of the urban heat island effect. Insulation of the building within.*
- Sound mitigation. *Reduction of sound propagation across a building's roof surface, and further sound proofing of the building from exterior noise.*
- Aesthetic. *Ability to provide amenity value in dense urban centres, and improve the amenity value of a roof.*
- Ecology. *Customisation of species used within the green roof, and creating a range of habitats allows for a green roof to become an ecological refuge for the local fauna and flora.*

However, green roof behaviour with regards to the aforementioned benefits varies due to the two main categories of variables.

1. Climate. *From the individual dynamics of each individual day, to the seasonal patterns of the location, climate affects green roof behaviour, especially water run-off dynamics (Figures 1.1 & 1.2).*
2. Green roof specifications. *The green roof construction varies in accordance to the needs of the client. For example, substrate depth varies in accordance to the weight capacity of the structure in question, and the species utilised varies in accordance to the client's needs.*

Sky-Garden Ltd, Unit 4 Beta, Orchard Industrial Estate, Toddington Glos, GL54 5EB
P: 01242 620905 F:01242 620739
www.sky-garden.co.uk

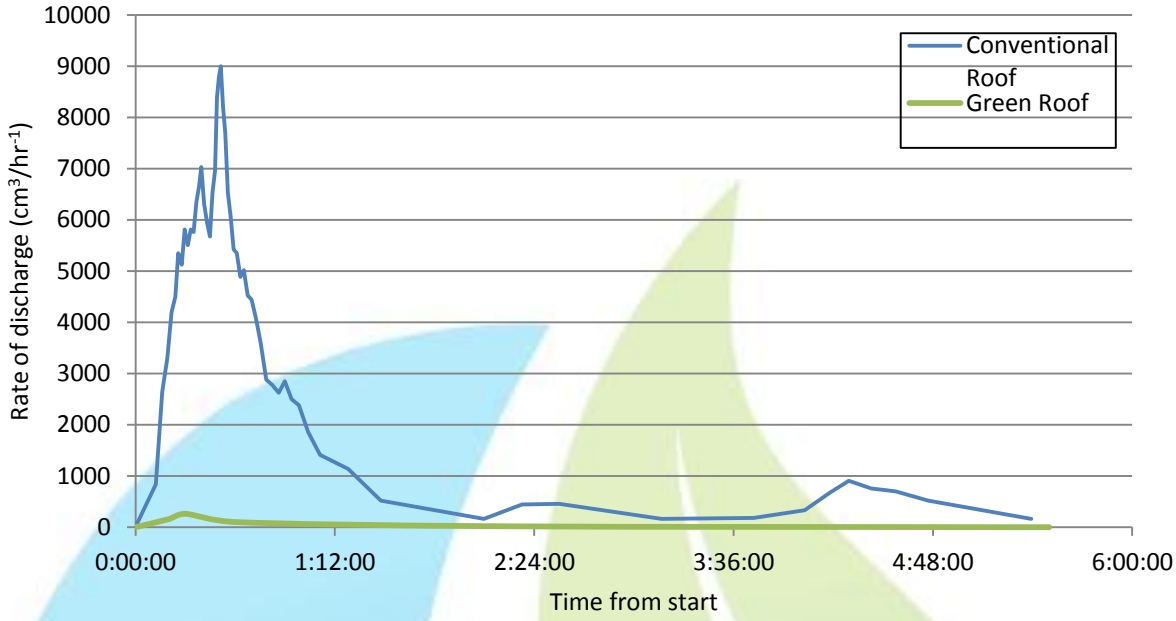


Fig 1.1. Direct comparison of run-off rates between an extensive sedum roof and a conventional roof, for a 1.5mm rain event recorded 30/3/2011. Note the large attenuation (97%) of rainwater run-off by a green roof in comparison to the conventional roof.

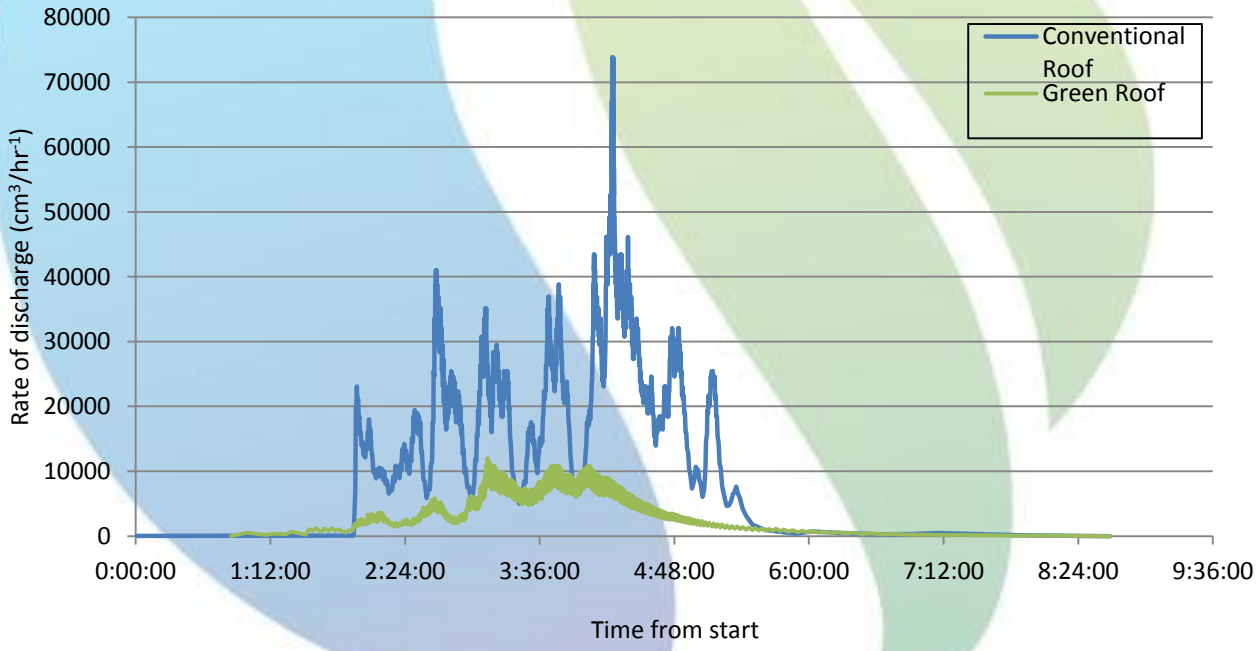


Fig 1.2. Direct comparison of run-off rates between an extensive sedum roof and a conventional roof, for a 16.5mm rain event recorded 25/8/2011. Note the large attenuation (73%) of rainwater run-off by green roof in comparison to the conventional roof.

Sky-Garden Ltd, Unit 4 Beta, Orchard Industrial Estate, Toddington Glos, GL54 5EB
P: 01242 620905 F:01242 620739
www.sky-garden.co.uk

The BREEAM problem

At the moment, green roof usage to gain accreditation within BREEAM is restricted by a lack of quantitative acceptance of green roof benefits. The basis of BREEAM is the Green Guide to Specifications, which outlines the 'cradle to grave' environmental impact of different building elements. This guide states the value of each relevant building factor within regards to BREEAM credits. Certified Environmental Profiles are obtained by manufacturers, through independent analysis by the (BAA), as a means of gaining green guide ratings. However, this approach is of limited use for green roofs, as the credits assume linearity in product behaviour which is not true for green roofs, due to the aforementioned variances in products constructions, and on specific site location.

A possible approach would be to have the individual layers of the green roof system assessed for a base level performance. Discussions are currently underway with British Board of Agrément (BAA) to see how feasible this is.

Despite the current issues with gaining acceptance within BREEAM, green roofs are still able to ascertain in part, or in full, various credits.

Sky-Garden Ltd, Unit 4 Beta, Orchard Industrial Estate, Toddington Glos, GL54 5EB
P: 01242 620905 F:01242 620739
www.sky-garden.co.uk

Green roof accreditation with BREEAM 2011

After consultation with the BREEAM authority, and the 2011 BREEAM New Construction technical manual[1], green roofs have the potential to gain complete credits within the following BREEAM sections:

2011 BREEAM New Construction			Green roof		
Scheme	Section	Criteria number	Potential credits*	Justification	Notes
Health and Wellbeing	Hea05 Acoustic performance	2. Mitigation of rainfall noise.	1	Interception of rainfall by plants, combined with sound proofing properties, mitigates the noise.	Requirements change in accordance to the building type.
Land Use & Ecology**	LE03 Mitigating ecological impact	1. Ecological value of the site is only slightly negatively affected. 2. Ecological value of the site is not negatively affected.	2	Ecological value assessed using plant species richness and habitat areas. Green roofs create new habitat and include new plants species.	Fauna species not included in the calculation of ecological value.
	LE04 Enhancing site ecology	4&5. Up to 6 new suitable plant species added to site. 6&7. More than 6 plant species added to the site.	2	Specific plant species can be included within the green roof to fulfil these criteria.	

* The actual quantity of credits gained by green roofs varies according to location and the construction of the green roof. Only the potential is outlined here, not the definitive attainment.

** Everything within this section has to be verified by a Suitably Qualified Ecologist[1]

1 BREEAM. New construction for non-domestic buildings, technical manual SD5073-2.0:2011 [online], 2011, pp.1-406. Available from: www.breeam.org

2 Woods-Ballard, B., R. Kellagher, P. Martin, C. Jefferies, R. Bray & P. Shaffer. The SuDS manual. *CIRIA C697*, 2007, pp.1-606.

Sky-Garden Ltd, Unit 4 Beta, Orchard Industrial Estate, Toddington Glos, GL54 5EB
P: 01242 620905 F:01242 620739
www.sky-garden.co.uk

Green roofs are also able to substantially contribute towards attaining other credits, although other requirements are required in parallel to achieve the relevant credit/s.

2011 BREEAM New Construction			Green roof		
Scheme	Section	Criteria number	Potential credits*	Justification	Notes
Management	Man04 Stakeholder participation	12. Provision of facilities that can be shared by the relevant parties.	1	Green roofs have the capacity to bring amenity land to a project, especially for developments where space is limited. Subject to the type of green roof, safety of roof access, and the opinions of the relevant parties.	
Energy	Ene01 Reduction of CO_2 emissions	2. Modelling parameters include operational energy demand and CO_2 emissions.	Up to 15	Green roofs can act as carbon sinks, and also act as insulation reducing the energy needs of the building.	Highly dependent on whether green roofs are accepted within the chosen modelling approach.
	Ene04 Low and zero carbon technologies	8f. Building uses evaporative cooling	1	Evapotranspiration occurs from the vegetation, although this requires more research before this credit can be certified, as the insulating properties may negate any evaporative cooling.	Hea03 needs to be achieved as a pre-requisite.
Materials	Mat03 Responsible sourcing	2b. 80% of materials within the site must be responsibly sourced	Up to 3	The retention foam and substrate within the green roof attain a Responsible Sourcing Tier Level 6, as they are recycled materials. If uncontaminated aggregate is available on site, then its reused within the substrate can attain Tier Level 3.	% influence depends on the type of green roof, and its size relative to the site.

Sky-Garden Ltd, Unit 4 Beta, Orchard Industrial Estate, Toddington Glos, GL54 5EB
P: 01242 620905 F:01242 620739
www.sky-garden.co.uk

2011 BREEAM New Construction			Green roof		
Scheme	Section	Criteria number	Potential credits*	Justification	Notes
Materials	Mat04 Insulation	1c,2&5. Thermal performance of roof insulation materials must be determined, with further accreditation for responsible sourcing of materials	Up to 2	Green roof insulates the building within. Green roof thermal performance not in the green guide to specification, but sufficient thermographic surveys should highlight performance. Best results for retrofit.	Roof 1 of 4 building elements assessed.
Waste	Wst01 Construction waste management	4. Diversion of waste from landfill	1	Reusing of aggregate diverts waste from landfill, and also only minimal waste (substrate packaging due to health and safety) produced during installation.	Only part of construction waste.
	Wst02 Recycled aggregates	3. Aggregates used obtained from site, within 30km of site or non-construction post consumer by product.	1	Brick by product used to make substrate, on site aggregate used if uncontaminated.	Influence dependent on size of roof relative to site.
Land Use & Ecology**	LE05 Long term impact on biodiversity	8. New ecologically valuable habitat created.	1	Green roofs create new habitat within a site, and can be optimised to substantially benefit local flora and fauna.	

Sky-Garden Ltd, Unit 4 Beta, Orchard Industrial Estate, Toddington Glos, GL54 5EB
P: 01242 620905 F:01242 620739
www.sky-garden.co.uk

2011 BREEAM New Construction			Green roof		
Scheme	Section	Criteria number	Potential credits*	Justification	Notes
Pollution	Pol03 Surface water run-off (surface water run-off)	7. Peak run-off rates are no greater for post development site than pre.	1	Green roofs have the capacity to attenuate rainwater run-off, and reduce peak run-off rates.	
	Pol03 Surface water run-off (minimising water course pollution)	15&16. Use of source SuDS to retain first 5mm of a rain event, and reduce risk of water course pollution.	1	Green roofs are source SuDS[2], and have the capacity to retain rainwater volume. Also shown to improve water quality of run-off.	
	Pol05 Noise attenuation***	4. Change in noise levels for surrounding buildings should not exceed +5 dB (07:00-23:00) and +3 (23:00-07:00). 5. If criterion 4 is exceeded, noise mitigation measures need to be installed at its source.	1	Twofold potential for green roofs. Act as additional sound proofing, therefore preventing noise entering and exiting the building. The vegetation also reduces the propagation of sound across the roof surface compared to conventional roof surfaces.	Only if mitigation necessary.

* The actual quantity of credits gained by green roofs varies according to location and the construction of the green roof. Only the potential is outlined here, not the definitive attainment.

** Everything within this section has to be verified by a Suitably Qualified Ecologist[1]

*** The British Standard document upon which this section is based[3] predates the research upon green roof sound properties. Consultation with BRE revealed that provided the green roof is shown to perform at a suitable level by the noise impact assessment, the criteria can be deemed to be fulfilled. All acoustic works have to be undertaken by a Suitably Qualified Acoustic Consultant[1].

1 BREEAM. New construction for non-domestic buildings, technical manual SD5073-2.0:2011 [online], 2011, pp.1-406. Available from: www.breeam.org
2 Woods-Ballard, B., R. Kellagher, P. Martin, C. Jefferies, R. Bray & P. Shaffer. The SuDS manual. *CIRIA C697*, 2007, pp.1-606.
3 British Standard Institute. Sound insulation for noise reduction for buildings – Code of Practice. *BS8233:1999*, 1999, pp.1-56.

Sky-Garden Ltd, Unit 4 Beta, Orchard Industrial Estate, Toddington Glos, GL54 5EB
P: 01242 620905 F:01242 620739
www.sky-garden.co.uk

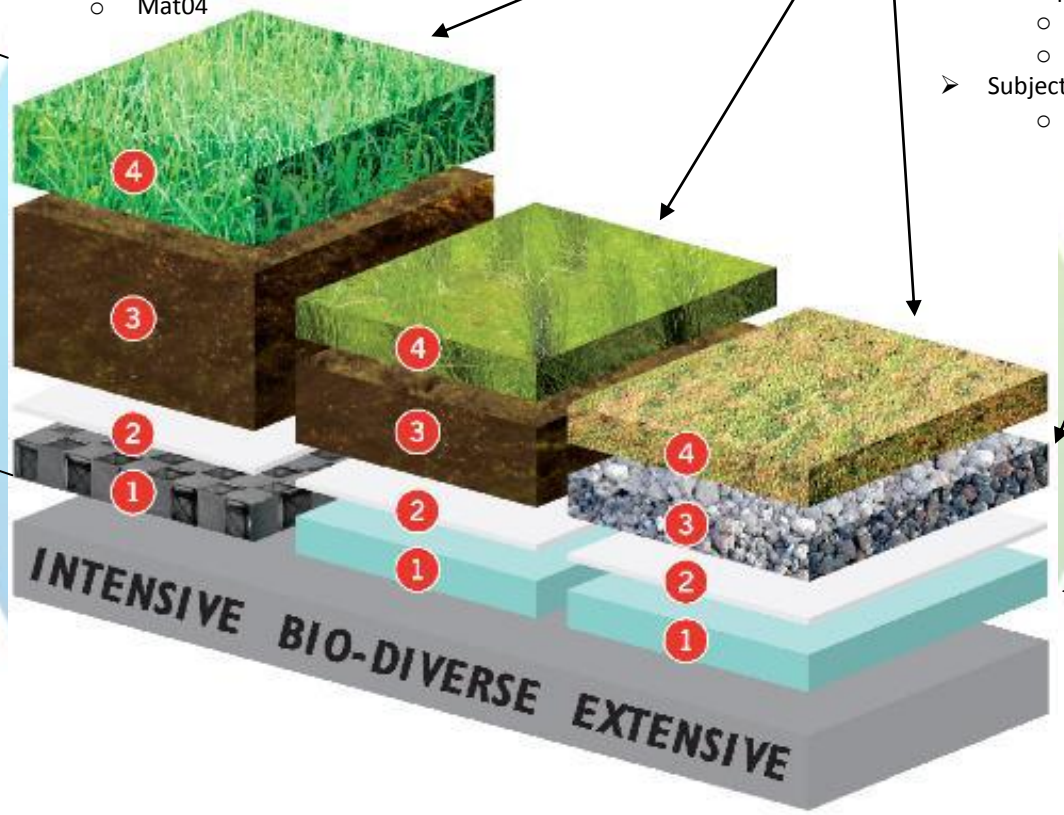
Green roof construction

As a general rule, the thicker the green roof, the greater the BREEAM potential.

Surface improvements
- Habitat features
  - LE05
- Amenity features
  - Mat04

4. Vegetation
- Applicable to all
  - Hea05
  - LE03-LE05
  - Pol05
- If accepted by assessor
  - Ene01
  - Ene04
- Subjective to client views
  - Man04

Increased depth results improves value within:
- Mat04
- Pol03



2.Substrate type determined by vegetation choice. Aggregate content highest for extensive, organic highest for intensive.
- If aggregates recycled
  - Mat03
  - Wst02
- If aggregates reused, above plus:
  - Wst01

1.Drainage layer determined by substrate depth. >50mm require rigid drainage board, <50mm uses biodrain
- Biodrain constructed from recycled foam.
  - Mat03
  - Pol03
- Rigid drainage board

Key
1. Drainage
2. Filter fleece
3. Substrate
4. Vegetation

BREEAM In-Use scheme

The number of existing buildings far outweigh the amount currently under construction. Many of these buildings are energy inefficient, and limit the benefit of sustainable development within the UK. BREEAM In-Use is an environmental assessment methodology and independent certification process which provides an opportunity to substantially improve the environmental performance of existing buildings, as well as reducing the running costs. It improves the efficiency of a building by highlighting underperforming elements which require readdressing. As well as reducing the energy costs of a building, and therefore its environmental impact, BREEAM In-Use certification can be utilised to promote a company's green credentials and social responsibility, as well as gain a higher property value.

BREEAM In-Use covers the same nine environmental issues as the 2011 BREEAM New Construction. Fire and security are also assessed, but these are of limited relevance to green roofs so are not discussed here. The BREEAM classifications used are also the same as 2011 BREEAM, and the certification level is revised on an annual basis, in order to allow for continual improvements to be made, and for these improvements to be verified by an independent and internationally known third party.

Whilst the inherent performance characteristics of a property are taken into context at the start of the assessment process, it can be extremely difficult for a building to retrospectively gain accreditation due to the limited number of building features which can be improved. Roof space is predominantly wasted within properties. The extreme thermal fluctuations experienced across conventional roof surfaces make traditional roofs extremely hostile to wildlife. These roofs also place a stress upon the systems that support urban environments, especially the urban hydrological cycle.

Green roofs present a relatively simple approach to provide a range of aforementioned benefits, and gain recognition within the BREEAM In-Use system.

Potential for retrofit

Green roofs have the potential to retrospectively gain BREEAM credits for developments and buildings in two contexts:

1. When a new development falls short of its predicted accreditation.
2. Gaining credits within BREEAM In-Use for existing buildings.

The Interim BREEAM certification stage within 2011 BREEAM New Construction predicts the amount of credits a project can gain, and therefore the BREEAM certification level the development should achieve. However, projects can easily fall short of the predicted number of credits, despite the recommended 5% accreditation buffer recommended by BRE, as specifications change throughout the construction process. A relatively simple approach would be to compensate through the retrospective installation of green roofs. Similarly, green roofs hold great potential to benefit buildings undertaking BREEAM In-Use assessments.

The exact magnitude of benefit is restricted by the type of green roof utilised, as discussed earlier, which is often determined by the weight bearing capacity of the building in question. Sky Garden Ltd have recently brought a new product, the “retro cassette system”, onto the market specifically for the developments which require retrofitting but have low weight bearing capacities (Appendix A). If designed correctly, green roofs can aid in retrospectively gaining the credits outlined earlier.

Key findings

- The conceptual basis for BREEAM assumes linearity in product performance, yet green roofs behaviour changes according to construction and climate. Green roofs are therefore underused within BREEAM due to lack of acceptance.
- Green roofs can currently gain up to 5 credits independently within Hea05, LE03 and LE04.
- Greens can help towards attaining up to 30 credits within Man04, Ene01, Ene04, Mat03, Mat04, Wst01, Wst02, LE05, Pol03 and Pol05.
- Green roofs can be used to retrospectively gain credits in two contexts
    1. When a development doesn't achieve the number of credits predicted
    2. For BREEAM In-Use for existing buildings