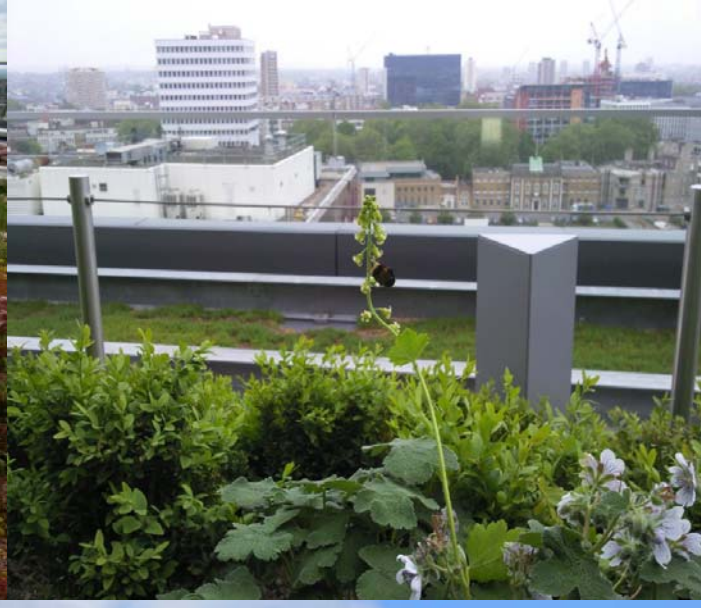

City of London Green Roof Case Studies

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Green Roof Case Studies
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Acknowledgement is given to the developers and architects who provided information to assist with the development of these case studies.

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1 Poultry

Client Name:	***Wallbrook***
Green Roof Supplier:	***Euro Roof***
Landscape Architect:	***Arabella Lennox-Boyd Landscape & Architectural Design***
Development Type:	***Mixed use – Office, retail, Restaurant***
Date Completed:	***1998***

Context

1 Poultry sits west of Bank Junction dividing Poultry and Queen Victoria Street. The building was finally completed in 1998 after a long planning battle and controversial removal of the Mappin and Webb Building. On the roof of the building is a restaurant with an intensive green roof. There are beds containing trees and shrubs as well as a pergola draped with grapes and wisteria with crab apples planted in the garden. The apex garden is a grass area with clipped hedges and views out onto the Bank of England, the Royal exchange and beyond.

Total Roof Area (m^2):

- 2500

Roof Area Greened (m^2):

- 450
- 18% green coverage

Type of Green Roof:

- Intensive Hard Landscaping and Planting in the inner and outer gardens.
    - Planter Substrate Depth: 750mm
- Intensive Soft Landscaping of the apex garden.
    - Apex Substrate Depth: 200-750mm

(Source: Arabella Lennox-Boyd Landscape & Architectural Design)

Key Drivers for the Green Roof:

- Initial concept for the roof garden at 1 Poultry was to have an open green space in the City of London for public use. However it has since become exclusive to a restaurant and bar.
- The Landscape Architect saw the roof as an ideal opportunity to improve the roof environment taking inspiration, in the case of the Apex Garden, by the ridge and furrow of the wider landscape. In contrast to the Inner Garden which is more domestic and of culinary use to the restaurant.

- The development of the site was in the planning system for many years, the roof garden was part of the design when consent was given and therefore there could be no further alterations to the building design.

Barriers Faced:

- The controversial development took a long time to gain consent, the Landscape Architects involvement with the roof garden spanned over several years.
- The conditions on the roof can be challenging due to heat rising through the building and the more severe weather conditions, this had to be considered in the design and plant selection.
- Soil and roof materials had to be brought up to the roof manually via the lift and stairs. Trees were positioned on the roof by crane.
- The planters on the outer gardens had to comply with St Paul's Heights; they were restricted to 1.5m above the parapet.
- The maintenance cost has been mitigated by the visitors numbers in the garden and the value of the private function hire of the garden-restaurant.
- The substrate depth is not constant throughout the garden due to a sloping roof. At the most shallow point the substrate depth is 200 mm; this is at the eastern end of the apex garden, this restricted what could be done with the space and capability to support plants.

Benefits of Green Roof:

- Improves the roofscape, the roof is not overlooked by many other buildings but the trees in of the outer gardens are visible along Poultry and Queen Victoria Street.
- The roof garden is an outdoor amenity space for the restaurant; the unique location of the roof garden distinguishes it from other restaurants in the City.
- The roof garden has thermal insulating properties.
- The majority of the roof has deep enough substrate levels to attenuate rainwater run off, helping reduce the localised flood risk.

Biodiversity Consideration

- The plants such as herbs, grapes and crab apples were initially selected for culinary use however they also encourage biodiversity attracting insects, bees, moths, butterflies and birds. Birds have also nested there.
- Evergreen and seasonal plants have been specially chosen to allow further biodiversity throughout the year.

(Source: Arabella Lennox-Boyd Landscape & Architectural Design)

Further Information:

- The Landscape Architects has since created roof gardens in Hong Kong, Newcastle and London.

107 Cheapside

Client Name:	***Menolly Group & Carlyle Group***
Green Roof Supplier:	***Briggs Amasco & Alumasc***
Architect:	***John Robertson Architects***
Development Type:	***Office & Retail at Ground Floor***
Date Completed:	***2008***

Context

107 Cheapside is located within the prime business district between St Pauls and Bank. The development includes a retrofit of the existing building and an additional 50% new build extension. 107 Cheapside features a sedum blanket on the main roof and two further terraces at levels 7 and 8 featuring planters.

(Source: John Robertson Architects)

Total Roof Area (m^2):

- 1187.63

Roof Area Greened (m^2):

- Sedum – 44.5
- Hard Landscaping with planters – 188.81
- 20% green roof coverage

Build Cost (m^2):

- £145

Type of Green Roof:

- Extensive Alumasc Sedum Blanket green roof.
    - Crushed Red Brick Sedum Substrate Depth: 70mm
- Intensive hard landscaped terraces with planters.
    - Total roof build up 277mm

Key Drivers for the Green Roof:

- As 50% of this development was an existing building refurbishment, the architects were determined to demonstrate 107 Cheapside exhibited all the environmental benefits of a new build. The inclusion of the green roof contributed to achieving a 'very good' BREEAM rating.
- The architects instigated the initial development of the green roof. During the design process the client requested amenity space. Subsequently the green roofs were relocated to the main roof.

Barriers Faced:

- Relocation of the original planned sedum roof from the two terraced areas was challenging as it required the layout of the roof to be re-planned to accommodate the sedum roof, resulting in two separate blocks of sedum.
- The roof area available for greening was influenced by the positioning of the plant equipment such as the cleaning cradle and the necessary access requirements.
- It was essential the inverted roof design and paving choice were compatible to ensure there was no need for additional local strengthening.

Benefits of Green Roof:

- The inclusion of green roofs has improved the roofscape for the surrounding community of office occupiers.
- The additional greened area creates the opportunity to add biodiversity value to the city.

Biodiversity Consideration:

- There has not been a specific review to assess whether the green roofs are encouraging local biodiversity, but it is hoped that the presence of the sedum blanket and planters on the terrace level will attract local wildlife to the site.

Further Information

- The sedum roof at roof level (illustrated) was provided exclusively for biodiversity, whereas the roof terrace at level 7 was created for the amenity value of the tenants.

10 Queen Street Place

Client Name:	***Blackstone Group International / SJ Berwin***
Green Roof Supplier:	***Greenscape (UK) Limited***
Architect:	***John Robertson Architects***
Landscape Architect:	***HOK & Seth Stein Architects***
Development Type:	***Office, Retail Unit & Underground Car Park***
Date Completed:	***December 2005***

Context

10 Queen Street Place is located directly east of Southwark Bridge and closely neighbouring Cannon Street Station. The strategic views of St Paul's Cathedral cut diagonally through the development. This led to a large area of lower roof on Level 4. During the retrofit of the building, the opportunity was taken to make the space on the bank of the Thames into an amenity for the clients and tenants.

Total Roof Area (m²):

- 4905

Total Green Roof Area (m²):

- Soft Landscaping - 302
- Hard landscaping – 2170
- 50% coverage of the roof

Build Cost (m²):

- £237 – excluding waterproofing and insulation

Type of Green Roof:

- Intensive roof
- Hard surfaces in timber and paving on the Level 4 terrace.
- Soft landscaping featuring grass & planters
    - Substrate Depths: Grass – 190mm, Planters – 490mm

(Source: Nick Gutteridge)

Key Drivers for the Green Roof:

- The development was affected by the St Paul's Heights restrictions; whilst this impacted the office floor space on Level 4 it did offer the opportunity to enhance the outdoor amenity for the clients and tenants. The size of the roof allowed for hard and soft landscaping and for the roof to have an amenity value.
- The roof on Level 4 is over 2000m² this would be a vast expanse of flat roof to leave bare or fill with plant equipment and would look rather unsightly for overlooking buildings. Along the River Thames, many of the buildings from Southwark Bridge to London Bridge have green roofs creating a green cluster along the river bank roofscape.

Barriers Faced:

- The depth of the roof build up and insulation of the roof garden (350 mm) versus the raised access level floor depth (150 mm) at 10 Queen Street Place posed a barrier to providing a level threshold from inside to the outside roof garden. The option to increase the height of the raised access floor was not viable as it would increase the overall height of the development and exceed the St Paul's heights restriction. The development now has a 250 mm step from inside to outside and the tenants have provided a ramp to access the roof terrace.

(Source: Hufton & Crow)

(Source: Hufton and Crow)

Benefits of Green Roof:

- The green roof at 10 Queen Street Place was designed purposely to provide an amenity for the people who work there. Research has shown having access to open green space can reduce stress and have a positive impact on human health. Green roofs may therefore be able to assist in a healthier and more productive workforce because of their interaction with the green roof.

(Source: Hufton and Crow)

Biodiversity Consideration:

- Biodiversity was not the major consideration at 10 Queen Street Place. This is because emphasis was put on the human benefits and the amenity value of the green roof.
- The green roof development does however feature a significant planted and grassed area so the green roof provides a rich and biodiverse environment.

150 Cheapside

Client Name:	***St Martins Property Corporation Limited***
Green Roof Supplier:	***Erisco Bauder***
Architect:	***Michael Aukett Architects***
Development Type:	***Office & Retail at Ground Floor***
Date Completed:	***March 2009***

Context

Located at the corner of Cheapside and St Martin's le Grand, 150 Cheapside is in the foreground of St Paul's Cathedral. The proximity to St Paul's meant the appearance of the roof is vitally important as it is overlooked from the Stone Gallery balcony. This development has a large greened sedum area with minimal plant equipment present on the roof. In addition to this photovoltaics cover the lift run off. A lower paved terrace area acts as an entertainment amenity for the clients and offers additional space for planters.

(Source: Dennis Gilbert)

(Source: Dennis Gilbert)

Total Roof Area (m^2):

- 1990

Roof Area Greened (m^2):

- Sedum Blanket on Main Roof – 1025
- Hard Landscaping with Planters on Lower Terrace Level – 556
- 79% green roof coverage

Build Cost (m^2):

- £50 - excluding waterproofing and insulation

Type of Green Roof:

- Extensive Erisco Bauder sedum blanket green roof.
    - Sedum Substrate Depth: 28 mm
- Lower paved terrace level with planters containing indigenous species.

Key Drivers for the Green Roof:

- 150 Cheapside is clearly visible from the viewing balcony of the Stone Gallery at St Paul's Cathedral meaning additional attention was paid towards the appearance of the roofscape.
- The development achieved a BREEAM rating of 'excellent'. A green roof was considered essential in boosting sustainability credentials and reaching an 'excellent' target.

Barriers Faced:

- It is a BREEAM requirement that sedum and green roofs should feature indigenous species to the area. The sedum blanket was created in Germany and failed to contain any indigenous plant species to England. To obtain additional BREEAM biodiversity credits planters containing indigenous species were positioned on the roof terrace,.
- 150 Cheapside is impacted by the St Paul's Heights restrictions, this made a sedum blanket green roof the best option because of its relatively low substrate depths.

Benefits of Green Roof:

- The appearance of the roof is improved; it encourages innovative design to make roof plant less obtrusive or to completely remove plant from the roof.
- The lower terrace level is in line with St Vedast Church allowing better visibility of the spire.
- Green roofs offer a chance for biodiversity to flourish in an area that is very densely built up.
- The extra layers of material added to the roof help to prolong the life of the roof membrane and act as thermal insulation.

Biodiversity Consideration:

- Four bird and bat boxes were placed on the roof to provide a new habitat
- The gravel paths that encompass the green roof to stop weeds protruding has been adapted to have varying size gravel stones to create mounds, coves and spaces suitable for insects and birds.

Further Information:

- The original competition design in 2005 did not feature a green roof. It became a growing priority by planners and the increased awareness of the clients to increase sustainability as much as design would allow.
- A green wall was considered in 2005, however the low success rate at this time lead green walls to be dismissed. Since then greater advances in products and technology would mean it would be a more viable proposal on new developments.

201 Bishopsgate

Client Name:	***British Land***
Green Roof Supplier:	***Hasmead***
Landscape Architect:	***EDCO Design London Ltd***
Development Type:	***Office & Retail at Ground Floor***
Date Completed:	***March 2009***

Context

201 Bishopsgate lies directly beside the Broadgate Tower in the east of the City of London. The new build development features both an extensive green roof and a vertical green wall compromised of a mixture of native ivy and Boston ivy at ground level.

Total Roof Area (m²):

- 2200

Roof Area Greened (m²):

- Soft Landscaping – 750
- 34% green roof coverage

Type of Green Roof:

- Extensive green roof reflecting a wasteland habitat.
    - Sedum substrate depth 100-150 mm
    - Brown roof substrate depth 30 -150 mm
- Three different substrates including: a fine-grade crushed brick concrete mix, a medium-grade concrete rubble mix, and a larger roof shingle mix.

(Source: British Land)

Key Drivers for the Green Roof:

- 201 Bishopsgate was designed to be a sustainable office development with a BREEAM rating of 'Excellent'. The inclusion of the green roof system plays a major part in the development achieving these sustainable credentials.

Barriers Faced:

- The original design was for a sedum roof that incorporated twelve plant species. The BREEAM Report recommended further enhancements to increase ecological value and additional BREEAM credits. As a result the design was amended late in the process. This included a further twenty typically-urban wildflower species being added.

Benefits of Green Roof:

- The roof was specifically designed to achieve high biodiversity values. Monitoring has revealed that the roof is progressing well and attracting various target urban species.
- The variety of planting and habitats creates a more aesthetically pleasing environment for the surrounding overlooking buildings.

(Source: British Land)

Biodiversity Consideration:

- Both the green roof and the green wall (100m²) present on the site were designed with biodiversity values in mind.
- The roof has proven to be attractive to wildlife. Two species of bee, butterflies and hoverfly were recorded in 2009. There have been sightings of the Black Redstart in the surrounding roof area; it is considered that this bird species uses the roof space for foraging.
- The roof also aims to provide foraging habitats for bats, House Martins, House Sparrows and Swifts. Roost boxes were not installed, limiting the potential nesting sites of larger species.
- The evaluation of the site follows the criteria set out by the UK Green Building Council (UK-GBC), the target BAP habitats (London Biodiversity Action Plan) and species for the Greater London Area. Following development two BAP habitats have been achieved in the form of the green roof and green wall. This also aligns with the City of London Biodiversity Action Plan.

Further Information:

- Consideration should be given to the provision of biodiversity features and resources from the concept design stage of each scheme, so that no late changes are required, nor subsequent costs associated with abortive work.
- Where structures such as roost and nest boxes are recommended, these need to be pragmatic, realistic and compatible with the structural limitations and architecture of the build site to ensure that these are achievable.
- Monitoring the roof progress will allow you be adaptive and develop the roof to better fit the needs of various urban species.
- If the roof is open with a sunny aspect consider the need for shade.

Barts Hospital

Client Name:	***Barts & The London NHS Trust, Skanska***
Green Roof Supplier:	***Knight Asphalte***
Landscape Architect/designer:	***HOK***
Development Type:	***Hospital***
Date Completed:	***Phase 1: March 2010, Phase 3: 2016***

Context:

St Bartholomew's Hospital is located in the West Smithfield area of the City of London. The redevelopment of the hospital was part of the largest PFI (Private Finance Initiative) in the UK between contractors Skanska and the Barts & London NHS Trust. Barts Hospital Phase 1 building runs along Little Britain and Edward Street was completed in 2010; Phase 3 completion is due in 2016. Currently Barts Hospital features two green roof areas on the FM yard and Energy Centre, with more to be developed by completion. Construction has taken place whilst the hospital is still occupied and functioning.

(Source: Skanska)

Total Roof Area (m²):

- 5500

Roof Area Greened (m²):

- Phase 1 – 150
- Completion - 20% green roof coverage, approx. 1100

Build Cost (m²):

- £106
  - £70 – roof build up
  - £36 – green roof

Type of Green Roof:

Extensive sedum blanket on the FM yard and Energy Centre
  - Sedum Substrate Depth: 300mm

Key Drivers for the Green Roof:

- The Barts and London NHS Trust wanted the development to achieve a NEAT (Healthcare BREEAM) 'excellent' rating.
- A green roof offered the opportunity to introduce some greenery into the local area, particularly as the green roof would be overlooked.
- A green roof at the Barts redevelopment was essential to gain planning consent, partly due to the high risk of surface water flooding in the area.

Barriers Faced:

- The original concept was to have the whole roof area greened. Due to the long narrow shape of the Phase 1 building there were issues with necessary access, plant equipment and space remaining for the green roof. The amount of space therefore available for the green roof would be significantly minimised and was deemed unviable for this specific roof.
- The hospital services plant had to be strategically placed but could not breach St Paul's height restrictions. The further addition of a green roof here would have led to very shallow substrate depths affecting the efficiency of the sedum growth, water attenuating qualities and being at risk of exceeding height restrictions.
- The two small areas that have green roofs do not impact the insulation of the building because of the peripheral location and size.
- The original 18th century buildings would not be structurally sound enough to cope with the associated weight of a green roof. Therefore only the new developments at Barts hospital can incorporate green roofs.

Benefits of Green Roof:

- The opportunity to improve local biodiversity. Biodiversity would not be greatly enhanced by a sedum blanket, but there are other biodiversity features in place on the development site.
- The green roofs at Barts Hospital have deep enough substrate levels to attenuate rain water reducing surface run off and flood risk in the localised area.

Biodiversity Considerations:

- Bat boxes installed.
- There has been work in conjunction with English Nature with regards to suitable locations to install Falcon roosts. Extra care must be taken to place them away from air vents.

Further Information:

- Brown roofs support more biodiversity than sedum blankets as sedum blankets usually contain limited sedum varieties and will mostly attract invertebrates. A disadvantage of having a brown roof however is that if it is overlooked it can look untidy unlike the short sedum blanket.

Cannon Place

Client Name:	***Hines UK Limited***
Green Roof Supplier:	***Icopal***
Architect:	***Foggo Associates***
Development Type:	***Office & Transport***
Date Completed:	***September 2011***

Context

Cannon Place is a new development located on Cannon Street. The development has been built over Cannon Street Station with the office entrance at ground level. Cannon Place has a large extensive sedum and wild flower roof.

(Source: Foggo Associates)

Total Roof Area (m^2):

- 5300

Roof Area Greened (m^2):

- Soft Landscaping : 3500
- 66% green roof coverage

Build Cost (m^2):

- £110

Type of Green Roof:

- Extensive sedum blanket green roof
    - Sedum Substrate Depth - 80mm
- Additional scattering of native urban wildflower seedlings put on to the sedum

Key Drivers for the Green Roof:

- The development achieved a 'Very Good' BREEAM rating and the presence of a green roof was integral to achieving this goal.
- A green roof would be beneficial for the client Hines as a marketing tool.
- Sustainability is a key driver for the architect. Cannon Place provided an opportunity to reduce the development's environmental impact by providing a sedum roof.

Barriers Faced:

- The sedum green roof was installed during the construction of Cannon Place. The paths around the perimeters were heavily trafficked and resulting in a section of Sedum being eroded by construction footfall. A new direct pathway had to be laid to deter people from walking on the sedum.
- Cannon Place is located within the St Paul's Heights restriction corridor. The restrictions impacted the choice of plants that can grow on the roof. The sedum species were chosen for their ability to grow below the St Paul's Heights datum.

Benefits of Green Roofs:

- The sedum blanket covers 66% of the roof area. The high coverage levels will enhance the insulation qualities of the development.
- Cannon Place meets the criteria set out in the GRO Green Roof Code 2011 for rainwater attenuation. The code has identified the presence of a reservoir layer and 80mm of substrate as the standard depth required for a green roof to obtain rainwater attenuating qualities which are present on this green roof development.
- The green roof's contribution towards the BREEAM rating can make the development more marketable. Buildings with sustainability measures in place can compete within the speculative City office development market.

Biodiversity Considerations:

- Bat and bird boxes will be installed on the roof. There are aspirations to later have falcon roosts.
- Native wildflower mix was added to the roof to give more variety than sedum species.
- The window cleaning cradle encompasses the roof and is surrounded by pebbles; these adittionally create a habitat for invertebrates.

(Source: Sian Warr)

Further Information:

- Initially netting was placed over the sedum blanket to avoid the sedum and wildflower seedlings being blown away in the harsh windy conditions found on high roofs. After a period of three months, the plants were well rooted and the net removed. The sedum has thrived and is establishing well.

Grange Hotel, Carter Lane

Client Name:	***Grange Hotels***
Green Roof Supplier:	***Knight Asphalte***
Architect:	***Buchanan Associates Architects***
Development Type:	***Hotel & Leisure***
Date Completed:	***January 2010***

Context

The Grange Hotel at St Paul's is located on Carter Lane, which runs parallel to Cannon Street and the southern elevation of St Paul's Cathedral. The roof of the development consists of three different components: solid roof, green sedum area and a large proportion of glass roofing over an 80 ft atrium.

(Source: Buchanan Associates Architects)

Total Roof Area (m^2):

- Total Roof Area - 3698
- Total Solid Roof Area – 2470

Roof Area Greened (m^2):

- 670
- 27% of the available solid roof

Build Cost of Green Roof:

- An additional £42,000 to lay a green roof over the build cost of gravel finished roof.
- Approx £63m^2 extra over build cost of a gravel finished roof.

Type of Green Roof:

- Extensive Sedum Roof
    - Substrate Depth: 150 mm

Key Drivers for the Green Roof:

- The roof of the Grange Hotel is visible from the Stone Gallery at St Paul's Cathedral. A conscious effort was made to make the roof aesthetically pleasing, overlooked by tourists the roofscape became an important part of the design.

- With growing global concern about climate change the architects were keen where possible to design and implement measures that would make the development more sustainable.
- A green roof can prolong the life of the roof membrane as it provides protection from human and environmental damage.

Barriers Faced:

- Limitations due to St Paul's height restrictions meant that in order to maximise indoor space only relatively shallow substrate depths were possible and therefore a sedum blanket was the only green roof system that did not breach the height restrictions.
- The sedum blanket was installed in the summer months. The hot and dry weather conditions affected the sedum's ability to grow. This led to some of the sedum dying within the first year.
- A rainwater catchment system for irrigation was not installed the first summer and exacerbated the issue of sedum failing to grow in hot and dry conditions. Since the installation of the rainwater catchment system the issue has not reoccurred.

Benefits of Green Roof:

- The presence of the green roof acts as an additional layer of protection for the roof membrane. This extends the longevity of the roof so that it could be replaced less often in the future.
- Mitigating the urban heat island effect through the natural processes of evaporation and evapotranspiration.
- Improved storm attenuation with the presence of a rainwater catchment system, excess water is drained to the system, which is reused to irrigate the green roof.

Biodiversity Consideration:

- The development does not have any specific equipment in place to increase biodiversity on the roof such as bird boxes or beehives. Instead, it is hoped that biodiversity may thrive naturally because of the presence of the sedum as a potential habitat for invertebrates and birds drawn to the roof for nesting materials and food.

Further Information:

- The roof at the Grange Hotel St Paul's was Buchanan Associates Architects first green roof. Since then they have designed intensive green roofs, it was not possible for this hotel because the roof structure was not designed to support the further weight of an intensive green roof as well as breaching St Paul's heights.
- Recommendation for deeper substrate to improve the water attention. This will help to avoid sedum drying out in the summer months offering a greater chance of survival as well as significantly reducing surface run off.

Guildhall

Client Name:	***Corporation of London***
Green Roof Supplier:	***Bailey Roofing System LTD***
Architect:	***TP Bennett LLP, Purcell Miller Tritton LLP***
Development Type:	***Office***
Date Completed:	***2010***

Context

The Guildhall has three separate green roof areas: four terraced sedum roofs on the North Wing roof, landscaped Piazza in front of the North Wing entrance and an internal courtyard; and the sedum blanket on top of the North Ambulatory roof.

(Source: TP Bennett)

Total Roof Area (m²):

- 3575 - (green roofs only)
  - North Wing – 1750
  - Piazza – 1550
  - North Ambulatory - 275

(Source: Michael Coleman)

Roof Area Greened (m²):

- 884
  - North Wing roof – 500
  - Piazza – 180
  - North Ambulatory - 204

Build cost (m²):

- North Wing roof - approximately £50

(Source: Sian Warr)

Type of Green Roof:

- Extensive sedum blanket on four terraces of the North Wing roof.
    - Sedum Substrate Depth: 35mm
- Extensive sedum blanket over the North Ambulatory roof.
    - Sedum Substrate Depth: 100mm
- Intensive hard landscaped Piazza and courtyard with planters.
    - Hedge and Tree Planter Substrate Depths: 600-1200mm

Key Driver for Green Roof:

- The improvements to Guildhall North Wing exposed the unsightly plant equipment surrounding the Lady Mayoress Corridor. The corridor was demolished and a green roof installed over the North Ambulatory roof in addition to the redevelopment of the courtyard to improve the appearance from the new North Wing glass façade.
- To improve the public realm outside the Guildhall North Wing.
- One of the key drivers for installing the green roof system was to increase biodiversity within the City. The architects felt this location had the potential to enhance the biodiversity value of the site and surrounding area.
- The system was designed to improve the roofscape and remedy the deficiency of green views within the locality.

Barriers:

- Considerate construction work within close proximity to the Grade I listed Great Hall whilst also causing minimal disruption to workers.
- Refurbishment of the existing North Wing structure meant the architect was not able to reinforce the foundations, limiting the green roof to an extensive sedum system.
- The restrictions to the weight of the system meant it was difficult to achieve a variation in substrate levels.
- The potential cost of the system was an important consideration. This was overcome by finding a high quality low cost system.

Benefits:

- The extensive system aims to improve the thermal performance of the building, impacting the energy consumption required to control the temperature of the internal spaces.
- Glass balustrade installed along the length of the green roof on the North Ambulatory roof allowed greater visibility of the Great Hall than previously.
- An improved aesthetic experience for the surrounding office community.

- A sedum roof can be made to possess the qualities the client requires. The North Wing sedum roof is comprised of alpine sedum selected for its seasonal display of colour as well as self-sufficient qualities, providing a low maintenance green roof.

Biodiversity Considerations:

- The sedum roof has attracted a variety of invertebrates and butterfly species, also it has been reported that a Black Redstart has been sighted on the terraces.
- Hornbeam, box hedges, and pin oak trees were planted in the piazza to create additional habitats for birds in the area.

Further Information:

- There are a variety of products and systems for different applications. The extensive sedum system demonstrates that there are affordable light weight green roof options for refurbished buildings. Green roofs should not automatically be excluded in the case of refurbishments.
- The type of green roof relies on whether the development involves a new build or refurbishment. In certain situations, there is the scope to be more ambitious, use the space available effectively. Do not limit yourself to delivering green roof space on conventional surfaces, show diversity in your approach to providing green roofed areas.

Merrill Lynch Financial Centre

Client Name:	***Merrill Lynch***
Architect:	***Swanke Hayden Connell Architects, Design Principal – David Walker***
Landscape Architect:	***Townshend Landscape architects***
Development Type:	***Office***
Date Completed:	***2001***

Context

The Merrill Lynch Financial Centre in the City of London is located on Newgate Street opposite the London Stock Exchange. Positioned within the strategic viewing corridor of St Paul's Cathedral resulted in the east and west sections of the building being different heights. The taller eastern section was designed to house plant equipment, allowing for a large accessible intensive green roof for the occupiers use on the western side of the main roof with views towards St Pauls Cathedral. This was one of the first green roofs within the City of London.

Total Roof Area (m²):

- 8800

Roof Area Greened (m²):

- Soft Landscaping and Planters– 500
- Hard Landscaping – 2150
- 30% coverage of available roof.

Type of Green Roof:

- Intensive roof with hard and soft landscaping.
    - Substrate Depths: 150 -500mm
    - Tree Planter Substrate Depths: 600-900mm

(Source: Sian Warr)

Key Drivers for the Green Roof:

- The building's large foot print and desired sight lines presented an opportunity to create a desirable and innovative outdoor amenity space.
- To take advantage of the location and maximise the exceptional views.
- The architects designed the interior of the building so that the main board rooms overlooked the green roof.
- Merrill Lynch was a committed partner in the creation of the green roof from the initial concept, understanding the benefits of such a space. Their desire to create a usable and stimulating amenity space was transferred to the architects.

Barriers Faced:

- There were problems with some of the original chosen plant species. The initial stages presented learning opportunities as to which plant species could successfully grow in that environment.
- The inclusion of the intensive roof threw up very few barriers, apart from the odd technical difficulty. As the idea had been an initial concept it meant it was planned for throughout the process.

Benefits of Green Roof:

- The incorporation of the roof has created a well-used and inspirational amenity space for the occupiers. It has added an additional dimension to the work environment, providing the opportunity for a better quality workspace.
- The integration of the various trees and planters improves the view for the surrounding overlooking office developments.

(Source: Sian Warr)

Biodiversity Consideration:

- Biodiversity was not an initial driver of the project. The architect noted that the combination of human and biodiversity values can create a mutually beneficial space.

Further Information:

- Plan the green roof with professionals as part of the original concept.
- A green roof is a design concept as well as a scientific feature, it should be attractive to people as well as wildlife. Each green roof should make the City a better environment. They should not be included to just 'tick the BREEAM box'.
- The Merrill Lynch building was one of the first significant green roofs within the City. The building pre-dates the technical benefits of green roof development. This meant BREEAM and various other energy initiatives were not at the forefront of the design concept. The design was driven by the aim to create a desirable amenity space.

Mint Hotel, Pepys Street

CLIENT NAME:	*MINT HOTEL*
GREEN ROOF SUPPLIER:	*FROSTS LANDSCAPE CONSTRUCTION LTD*
ARCHITECT:	*BENNETTS ASSOCIATES ARCHITECTS*
LANDSCAPE ARCHITECT:	*NONE*
DEVELOPMENT TYPE:	*HOTEL*
DATE COMPLETED:	*DECEMBER 2010*

Context

The Mint Hotel is situated in the East of the City of London close to Tower Hill and Fenchurch Street. There are two green roof areas on Levels 2 and 11, additionally the Mint Hotel contains the tallest living wall in Europe and the hotel has been designed with environmental quality in mind, of which the roof and living wall play an important part.

(Source: Bennetts Associates)

Total Roof Area (m²):

- 1195

Roof Area Greened (m²):

- Sedum – 385
- Hard Landscaping with planters - 505
- 75% green roof coverage

Build Cost (m²):

- Level 2 - £100
- Level 11 - £150

Type of Green Roof

- Extensive Sedum blanket on Level 2
    - Substrate Depth: 130mm
- Semi Intensive green roof at Level 11 with inaccessible sedum and wildflower area and accessible paved terrace with planters.
    - Substrate Depth: 130mm

Key Drivers for the Green Roof:

- Designing a feature amongst the skyline which offers panoramic views of London in a unique accessible green roof space for hotel guests and the general public.

- The clients have a strong sustainability agenda. The green roof and living wall were important elements, acting as passive sustainability features.

Barriers Faced:

- Maintenance could have been a potential barrier for such a design, but the clients were supportive of the design from the initial stages.

(Source: Bennetts Associates)

Benefits of Green Roof:

- Passive sustainability techniques such as the green roof and living wall help create a more sustainable building.
- Aesthetically pleasing for users and the surrounding building community.
- The substrate depths have rainwater attenuating qualities as well as improving thermal performance.
- The planting chosen for the green roof and living wall have thick coverage, and improve solar reflection aiding the reduction of urban heat island effect.
- Both green roof levels and the living wall require relatively low maintenance.

Biodiversity Consideration:

- The green roofs and living wall were designed to strike a balance between biodiversity benefits and aesthetic appearance.
- Level 11 contains Bee Hotels, providing habitats for bees.
- Deep substrate layers and plants were chosen to attract a vast array of wildlife species, but importantly also to be sustainable and create microhabitats.
- The living wall covers 1025m² and contains 184,000 plants chosen to tolerate varying weather conditions and to create an excellent habitat for nesting birds.

Further Information:

- Sustainable construction and involvement with contractors from the initial stages.
- Fully understand the maintenance requirements for the designed green roof as this could potentially affect its letting potential.

Museum of London

Client Name:	*Museum of London*
Green Roof Supplier:	*Bauder*
Landscape Architect/designer:	*Livingstone Eyre Associates, Dusty Gedge*
Development Type:	*Museum*
Date Completed:	*2009 - ongoing*
Contractor	*Russell trew*

Context

The Museum of London was constructed in the 1970s on the edge of the Barbican Estate. The completed green roof areas are currently on the Rotunda canopy and roof terraces, the central courtyard the original upper roof ribbon planter and main roof. The Museum of London is leading by example in innovative and diverse green roof areas. GLA Drain London and the University of East London have been working with the Museum on experimental green roof research areas on the main roof. The Museum has developed an educational 'Object in Focus' tour incorporating looking at the benefits of green roofs.

(Source: Lesley Burdock)

Total Roof Area (m^2):

- 4200

Roof Area Greened (m^2):

- 1400
- Currently 33% green roof coverage

Build Cost:

- Courtyard Areas - £51,700
- Rotunda Canopy, Garden and terrace roofs - £75,000
- Lower Courtyard - £30,000
- Upper Central Courtyard - £18000
- Upper roof planter - £16,000
- Experimental main roof area - £35,000

(Source: Lesley Burdock)

Type of Green Roof:

- Rotunda Canopy, Garden & Terrace roof and planters
  - Extensive Sedum and individual plug planting substrate depth: 80mm
- Lower Central Courtyard
  - Intensive hard landscaping Recycled plant pots, some moved from the Rotunda during refurbishment
  - Sunken bio diverse garden
- Upper Central Courtyard
  - Wildflower meadow blanket substrate depth: 100mm
- Upper roof ribbon planter filled with British wildflowers and hedges
- Experimental Main Roof Areas
  - Intensive Wildflower meadow blanket substrate depth: 100mm
- Intensive biodiverse planters

(Source: Gavin McCourt)

Key Drivers for the Green Roof:

- In 2009 the Museum roofs required replacement as they were 34 years old. A root resistant cap sheet was specified allowing the roof to be retrofitted for green roofs in the future when funds permit.

Barriers Faced:

- The Museum of London had to give consideration to the neighbouring buildings and residents. The central London location restricted access to the site and all works had to be carried out whilst the building was occupied and maintained public access.
- A business case had to be developed to obtain approval and funding for the green roofs. External funding was sourced from the GLA Drain London who contributed £5,000 towards storm water attenuation green roof research areas.
- The Museum of London had to apply for planning permission to install the green roofs proposed on the existing roofs. It is noted Green roofs on new developments are a requirement so approval does not need to be requested separately.

Benefits of Green Roof:

- Green roofs can provide additional insulation to the building, keeping spaces cooler in the summer and warmer in the winter with reduced air conditioning and heating

requirements leading to improved energy efficiency. Increased energy efficiency should cut utility bills resulting in a financial saving.

- Green roofs can combat the urban heat island effect as they do not absorb or retain heat in the same way as other flat roofs, reducing the temperature in the summer months.
- The additional layers protect the roof membrane from heat related expanding and shrinking, a common issue shortening flat roof life span.

Biodiversity Considerations:

- Within the Upper Courtyard area there is a bee hive. The courtyard features a wild flower meadow blanket and bee friendly plants. The variation provides an important foraging environment to help sustain the bee community in the urban environment.
- At the centre of the Lower Courtyard there is a sunken garden that has been left as a bio diverse area. The outcome revealed a great variety of species began to grow here. Allowing the area to develop organically resulted in a mixture of native species and more unusual plant species such as strawberries growing here. Another product of the bio diverse area was that there is evidence of lichen growing on artificial rocks.

Source: Gavin McCourt

Further Information:

- Adding a weed resistant cap sheet when replacing a roof allows a green roof to be retrofitted in the future. It is relatively inexpensive to install such a capping sheet when replacing a roof compared to adding it at a later date.
- Habitat and green walls are being proposed to cover two walls in the rear courtyard. The green wall would feature plant species that reflect London's history such as elm, fern and clematis. The habitat wall will provide a vertical habitat for invertebrates and a nesting material resource for birds.
- There are future proposals to cover the entire main roof with different, innovative, and experimental green roof areas.
- The complex roof layout of the Museum creates an array of conditions and separate microclimates with many different scenarios that can be replicated on other buildings.

- The Museum along with the City of London, GLA, the Environment Agency, UCL, Green Roof Consultancy and British Land are looking to set up a green centre of excellence. This centre has three main strands and will: enable building managers, planners, architects ,planners, developers and climate change experts to see in-situ examples of the types of eco –technology that can be retrofitted into existing designs or incorporated into new designs; serve as a hub for green infrastructure in London; provide research facilities for Universities and commercial entities to examine the performance of different planting regimes and new technologies different planting regimes, roofing systems and new technologies.

New Court, St Swithin's Lane

Client Name:	***N.M Rothschilds & Sons***
Green Roof Supplier:	***Prater & Arbor***
Architect:	***Office of Metropolitan Architecture***
Landscape Architect:	***Charles Funke Associates***
Development Type:	***Office Headquarters***
Date Completed:	***2010***

Context

Located in St Swithin Lane, New Court boasts excellent views of the neighbouring green roofs of No 1 Poultry and Cannon Place. The office development is the third Rothchild's building on the site. The latest development features two intensive roofs at Levels 4 and 11, and a further extensive green roof at Level 16.

Total Roof Area (m^2):

- 1385

Roof Area Greened (m^2):

- Sedum – 246
- Soft & Hard Landscaping – 505
- 54% green roof coverage

Build Cost of Green Roof:

- Level 4- £10,000 (excluding planting)
- Level 11- £60,000 (excluding planting)
- Level 16 - £37,500

(Source: OMA)

Type of Green Roof:

- Non-accessible intensive roof Level 4.
    - Paving and a grassed turf area.
- Accessible intensive roof Level 11.
    - Paved throughout with black planter around the edge.
- Non-accessible extensive roof Level 16.
    - Sedum mat.
- Substrate Depth 200mm.

Key Drivers for the Green Roof:

- The addition of green roofs has become a common feature incorporated in developments in the City and is a common planning condition.
- To provide an outdoor amenity space for staff.

(Source: OMA)

Barriers Faced:

- The intensive green roofs have attracted seagulls; which was deemed inappropriate for the building tenants. To resolve this issue a number of owl statues were placed throughout roof areas.
- Careful selection of the planting scheme for the Level 11 roof top need to be considered as the height created harsh wind and temperature conditions.
- There was an additional cost of installing a green roof.

(Source: OMA)

Benefits of Green Roof:

- A green roof helped to attain planning consent for the New Court development.
- The green environment of hedges and trees has created a unique area to conduct meetings during the summer months.
- Staff can readily access an outdoor area. Research suggests this may alleviate stress and improve the general wellbeing of the workforce.

Biodiversity Consideration:

- No specific consideration was given to improve local biodiversity. The landscape architects did endeavour to provide planted areas that would successfully survive in the rooftop climate.

Pocket Habitat, Exchange House,
Broadgate Estate

Client Name:	***British Land***
Green Roof Supplier:	***Arup & Sky- Gardens, Grey 2 Green***
Development Type:	***Office***
Date Completed:	***May 2011***

Roof Area Greened (m²):

- 180
    - 504 Pockets

Build Cost of Green Roof:

- £9100
    - £50m²
    - £18 per pocket

(Source: British Land)

Context:

- Pocket Habitat was developed by Arup for British Land to increase the biodiversity of their existing buildings and urban land stock after all other green roof systems were viewed inappropriate due to the environmental limitations related with retrofitted green roofs.
- The modular planting pockets can be individually personalised to promote biodiversity with varying combinations of depths, locally sourced substrate materials and seeded with native plant species. Each individual pocket emulates the natural environment by providing shade, shelter and exposure to sunlight. Pocket Habitat can therefore be a valuable tool in successfully reaching and exceeding the needs of Biodiversity Action Plans (BAPs).
- Pocket Habitat is easy to retrofit to existing roofs due to the compact and lightweight design. Installation and removal can be done manually with little specialist equipment. The flexibility of the pockets also offers an immediate temporary greening on development sites.
- When the modular pockets are joined together they make a carpet of vegetation that can be designed for visual or biodiversity features. 2.8 pockets can be installed per m² and can be installed on awkward shaped roof spaces as no cutting is required.
- The Pocket Habitat system acts as a Sustainable Drainage System (SUDS) with the pocket substrate capable of attenuating rainwater reducing the amount that enters public sewers and risk of localised flooding.

Ropemaker Place

CLIENT NAME:	*BRITISH LAND*
GREEN ROOF SUPPLIER:	*FROSTS LANDSCAPE CONSTRUCTION LTD, ALUSMASC, ZINCO*
LANDSCAPE ARCHITECT:	*TOWNSHEND LANDSCAPE ARCHITECTS*
DEVELOPMENT TYPE:	*OFFICE*
DATE COMPLETED:	*JUNE 2010*

Context

Ropemaker Place is situated close to Moorgate on the City fringe. This new build development has been designed as one of the most sustainable buildings with the City. Ropemaker place includes five accessible semi intensive terraces on Levels 6, 8, 12, 16 and 20. Ropemaker Place has a BREEAM 'Excellent' rating and won the Estates Gazette Green Award for Office Development of the Year.

(Source: British Land)

Total Roof Area (m^2):

- 4700

Roof Area Greened (m^2):

- Sedum – 875
- Soft Landscaping – 975
- Hard Landscaping – 1650
- 74% green roof coverage

Type of Green Roof:

- Semi intensive green roof terraces are present on Levels 6, 8, 12, 16 and 20.
- Extensive sedum mats - Level 6, 8, 12, 16 and 20.
- Additional planting of bulbs, shrubs, hedges, and trees – Level 8, 12, 16, 20
- Paved Areas – Blue Limestone

Key Drivers for the Green Roof:

- Ropemaker Place was designed to be one of the most sustainable office developments within the City. The inclusion of the green roof system plays a major part in the development achieving its sustainable credentials.
- To create a large outdoor amenity space for tenants.

Barriers Faced:

- Townshend Landscape Architects designed a challenging system of terraces. The primary reasons for selecting the chosen plant species were due to the aesthetics and building height. However on reflection there appears to be a slight negative relationship between the height of the terraces and excessive vegetation growth.
- Retrospectively more could have been done to combine landscaping and biodiversity with the ecologists and landscape architects.

Benefits of Green Roof:

- Prior to development there were no species identified in the London Biodiversity Action Plan (BAP) present on the site. No BAP species have yet been recorded but a number of invertebrate species have been spotted.
- The five semi intensive terraces offer a great outdoor amenity space for tenants.

(Source: British Land)

Biodiversity Consideration:

- A total of 40 trees and 28,000 shrubs were distributed throughout terraces 8, 12, 16 and 20.
- Any dead wood produced from failed tree planting will be recycled on site and relocated to roof terraces to increase the habitat diversity and encourage invertebrates.
- The roof was evaluated by criteria set out by the UK Green Building Council (UK-GBC) and the target BAP habitats and species for Greater London Area.
- At Ropemaker Place the management requirement will be reviewed regularly to assess the current biodiversity impact and identify any potential modifications that could be implemented retrospectively.

Further Information:

- It is more cost effective to install biodiversity measures at the time of construction, as apposed to retrofitting.
- Referencing guides such as 'Natural England's Gardening with Wildlife in Mind' offer guidance for the correct plant selection to complement the existing planting design.

Unilever House

Client Name:	***Unilever***
Green Roof Supplier:	***Willerby Landscapes***
Architect:	***KPF***
Landscape Architect:	***Charles Funke Associates***
Development Type:	***Office Headquarters***
Date Completed:	***2007***

Context

The roof at Unilever House was rebuilt during the refurbishment of the building creating intensive roof terraces on Levels 8 & 9 that are heavily used by the tenants. Unilever House was constructed in 1929 prior to the implementation of the St Paul's Height restrictions with some parts of the roof exceeding this.

(Source: KPF)

Total Roof Area (m²):

- 2614

Roof Area Greened (m²):

- Hard and Soft Landscaping – 1825
- 70% green roof coverage

Build Cost of Green Roof:

- £514,650

Type of Green Roof:

- Intensive terrace Levels 8 & 9
    - Planter Substrate Depth: 200mm

(Source: KPF)

Key Drivers for the Green Roof:

- The architects for the Unilever House redevelopment had previous experience of green roofs and were enthusiastic about the opportunity to create a substantial green roof as an integral part of the project.
- The previous roof had been predominantly taken over by mechanical plant and crucial to the concept for the new roof was to the desire to return the roof-scape to its original 1930's profile.
- The green roof gives the building users the access to a substantial amenity space with great views along the River Thames from Unilever House's Victoria Embankment location.
- To ensure that Unilever House maintained its importance and stature as the sustainable European Headquarters for the Unilever company.
- The green roof was integral to meeting all these objectives and influenced the planning of the project to locate staff restaurant facilities and social and meeting spaces at the top of building where they could have access to the new amenity.

Barriers Faced:

- The existing roof was not as structurally sound as originally thought. A portion of the roof had to be rebuilt to support the roof garden.
- Services where built around the roof garden plans encouraging minimal plant on the roof and innovative design techniques.
- A small structure on the roof required planning permission despite parts of the original roof being higher than current height restrictions.

Benefits of Green Roof:

- Heavy use by the tenants as a key outdoor amenity space. The roof is very accessible with three access stairs as well as opening out from the canteen and meeting rooms.
- The sloped design of the beds allows for more of the planting to be visible as well as creating shelter from the wind.

Biodiversity Consideration:

- Bio diverse plant species have been planted within the cradle cleaning zones as these zones are less likely to be disturbed than in the general roof garden.
- No specific species have been targeted for this roof garden. However it is hoped that with the variations in materials, substrate depths and plant species the roof garden does support biodiversity.

Further Information:

- Much of the plant equipment was moved to the basement to allow the maximum available space for the roof garden and to maintain a tidy roofscape. Where plant

was on the roof innovative design methods were used such as stacking cooling towers to conserve space.

Watermark Place

CLIENT NAME:	*UBS GLOBAL ASSET MANAGEMENT*
GREEN ROOF SUPPLIER:	*FROSTS LANDSCAPE CONSTRUCTION LTD*
ARCHITECT:	*FLETCHER PRIEST ARCHITECTS*
LANDSCAPE ARCHITECT:	*TOWNSHEND LANDSCAPE ARCHITECTS*
DEVELOPMENT TYPE:	*OFFICE & RETAIL AT GROUND FLOOR*
DATE COMPLETED:	*JULY 2009*
CONTRACTOR :	*SIR ROBERT MCALPINE*

Context

Watermark Place is situated along the northern bank of the River Thames. The site is within the strategic viewing corridor of St Paul's Cathedral, which had an impact on the height and the design resulting in two different levels of terrace. Watermark Place has capitalised on its strategic riverside location by providing two accessible terraces at Levels 5 and 6 and has also provided an extensive roof at Level 12. The building achieved a BREEAM 'Excellent' rating and also includes photovoltaic panels which are located on the sedum roof on level 12.

Source: Tim Soar and Fletcher Priest Architects

Total Roof Area (m²):

- 6500

Roof Area Greened (m²):

- Sedum – 2500
- Soft Landscaping – 1200
- Hard Landscaping – 1200
- 75% green roof coverage

Build Cost (m²):

- Level 12 - £350
- Level 5 & 6 - £600

Source: Tim Soar and Fletcher Priest Architects

Type of Green Roof:

- Extensive sedum matt including 800m² of photovoltaic panels.
    - Sedum Substrate Depth: 65-100mm
- Intensive terraces hard and soft landscaping in square and rectangular block design.
    - Lawn Substrate Depth: 150mm
    - Shrubbery Substrate Depth: 350 – 400mm

Source: Tim Soar and Fletcher Priest Architects

Key Drivers for the Green Roof:

- The development's riverside location and south facing position provided the impetus to develop accessible roof terraces.
- The intensive space provides space for functions and events as well as for workers needs.
- The green roof contributed towards accomplishing an 'Excellent' BREEAM rating. Critical in achieving a competitive edge in the speculative development market.

Benefits of Green Roof:

- The green roofs at levels 5 and 6 provide an accessible amenity space
- Visually attractive to the surrounding buildings.
- Green roofs positively affected the BREEAM rating and aided the ability to meet Part L of the Building Regulations for thermal performance and UV values.

Biodiversity Consideration:

- The plant species included within the intensive space had been historically sourced. Research was conducted into which species of birds had previously resided in the area. This prompted a selection of plants that would recreate existing habitats and encourage the repopulation of bird species, such as the Black Redstart.

Further Information:

- One of the key elements of the design is the contiguous design between the accessible terraces and the new public riverside and the pedestrianisation of Angel Lane. Angel Lane, that runs east of the site, was redeveloped using section 106 monies and in this way more than doubled the existing public space. The design was undertaken by the architect of the roof terraces and in this way achieved a consistency of design features.

Glossary

- BAP – Biodiversity Action Plan
- Biodiverse Roof – a roof designed to create a desirable habitat specifically to attract a particular species of plant or wildlife.
- Biodiversity - is the variety of all life on Earth. This includes all species of animals and plants, and the natural systems that support them. *(DEFRA, 2011, http://www.defra.gov.uk/environment/natural/biodiversity/)*
- BREEAM – Building Research Establishment Environmental Assessment Method for buildings. It sets the standard for best practice in sustainable design and has become the de facto measure used to describe a building's environmental performance. *(BREEAM, 2011, http://www.breeam.org/page.jsp?id=27#1)*
- Brown Roof– is a non vegetated roof containing purposely-selected growing medium, such as crushed bricks, to replicate the previous habitat, thus enabling local plant species to organically populate the roof over a natural course of time.
- Drainage Layer/Reservoir Board – allows excess water to drain away, thereby preventing the water logging of the substrate. Some drainage layers also incorporate water storage cells to retain additional water that can be diffused to the plant support layer during prolonged dry periods. *(GRO, GRO Code 2011, Pg.25)*
- Extensive Green Roof – a lightweight, low-maintenance roof system, typically with succulents or other hardy plant species (often sedum) planted into a shallow substrate (typically less than 100mm) that is low in nutrients. *(GRO, GRO Code 2011, Pg.25)*
- GLA – Greater London Authority
- Green Roof – is a roof, deck or other structure onto which vegetation is intentionally grown or habitats for wildlife are established. *(GRO,GRO Code 2011, Pg.8)*
- Green Wall - is part of a building envelope system, comprising pre-vegetated or planted on-site panels containing plants, growing medium or liquid nutrient installed in or on a frame, secured to a structural wall or it can be free standing.
- GRO – Green Roof Organisation: The industry forum for green roof development and promotion in the UK.
- Intensive Green Roof – a green roof with deeper substrate levels (typically 200mm+), capable of supporting a variety of flower, shrub and tree species, normally designed for recreational use and are often referred to as roof gardens.
- Plug Planting – rooted young plants (plugs), typically sedum species, are individually grown and planted with the opportunity to provide a greater diversity of planted species. *(GRO, GRO Code 2011, Pg.17)*

- Sedum – a genus of about 400 species of low growing, leafy succulents that are wind, frost and drought tolerant and found throughout the northern hemisphere. Not all species are suitable for roofs. *(GRO, GRO Code 2011, Pg.26)*

- Sedum Blanket/Mat – selected sedum species grown to maturity, facilitating sedum to be rolled directly on top of the substrate.

- Semi-intensive – also known as simple intensive, includes characteristics of both extensive and intensive roofs. Typically requiring a depth of substrate between 100 mm to 200 mm, a wider range of plants can be included, compared to extensive roofs, including shrubs and woody plants. Irrigation and maintenance requirements are dependent upon the plant species installed.

- St Paul's Heights – since 1938 the Corporation of London has operated a unique policy known as 'St Paul's Heights' to protect and enhance important local views of the Cathedral from the South Bank, Thames bridges, and certain points of the north, east and west. *(City of London, SPG: St Paul's and Monument Views, 2002, Pg. 5)*

- Substrate – is the growing medium for green roofs. Conventionally engineered to a ratio of organic and inorganic materials designed to support the living conditions required for green roof plant survival. Additionally aiding rainwater attenuation and the release of excess water.

- SUDS – Sustainable (Urban) Drainage Systems