UEL University of East London

SRI Sustainability Research Institute

Multidisciplinary urban landscape design guidelines: Barking Riverside green infrastructure opportunities

TURAS

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Cover photo: Small-scale green roof bike shelter with bug hotel habitat features at Derbyshire St Pocket Park in the London Borough of Tower Hamlets © Stuart Connop

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Table of contents

Table of Figures

Multidisciplinary landscape design guidelines:

Barking Riverside – Green infrastructure opportunities

1. Introduction

Transitioning towards Urban Resilience and Sustainability (TURAS) is a European-wide research and development programme. The "TURAS" project aims to bring together urban communities, researchers, local authorities and SMEs to research, develop, demonstrate and disseminate transition strategies and scenarios to enable European cities and their rural interfaces to build vitally-needed resilience in the face of significant sustainability challenges. To ensure maximum impact, the TURAS project has developed an innovative twinning approach bringing together decision makers in local authorities with SMEs and academics to ensure meaningful results and real change are implemented over the duration of the project. Eleven local authorities or local development agencies are involved as partners in the project and they will orient research and development from the outset towards the priority sustainability and resilience challenges facing their cities. Nine leading academic research institutions and six SMEs will work with these cities helping them to reduce their urban ecological footprint through proposing new visions, feasibility strategies, spatial scenarios and guidance tools to help cities address these challenges. The specific challenges addressed in TURAS include: climate change adaptation and mitigation; natural resource shortage and unprecedented urban growth.

Over the five year duration of the project, the feasibility of these new approaches is being tested in selected case study neighbourhoods. One of these neighbourhoods is the Barking Riverside development in the London Borough of Barking and Dagenham (http://www.turas-cities.org/case_study/10).

The following report comprises a guidance document for the masterplanning and design process for the Barking Riverside development. The document showcases a broad range of multidisciplinary approaches to landscape design that could be incorporated at Barking Riverside to enhance the environmental, social and economic value of the green infrastructure. Adopting the approaches detailed would ensure that the ecosystem service values of the pre-development state of the brownfield site would be conserved throughout development process and that resilience would be embedded at the heart of the new community.

2. Greening public and private urban infrastructure

The increasing proportion of people living in urban areas has led to a range of environmental issues and sustainability challenges. In order to ensure that urban living is sustainable and that cities have the resilience to cope with environmental change these challenges must be met. Restoration and re-creation of green infrastructure in urban areas is a potential solution to many of these challenges.

Green infrastructure in the built environment has traditionally been designed with limited consideration for biodiversity or regional context. Instead, a blend of horticultural fascination with exotic species, ease of maintenance, accessibility and an innate desire to control nature have led to aesthetic appeal and amenity value being the key drivers for urban greenspace design (Eisenberg 1998). Even selection of species suited to local climates has been limited with artificial irrigation and heavy management of urban landscapes common place.

Given the increasing recognition that the natural environment can provide goods and services of benefit to humans and the planet ('ecosystem services'), the European Commission and the UK government are now advocating well-planned green infrastructure that provides opportunities to protect and enhance biodiversity (UK National Ecosystem Assessment 2011; DEFRA 2011; HM Government 2011; Town and Country Planning Association and The Wildlife Trusts 2012; Secretariat of the Convention on Biological Diversity 2012; European Commission 2013). In response to this, there is a need to develop and monitor 'novel' biodiversity-focused designs for green infrastructure at roof, wall and ground-level that maximise biodiversity value and provide a wide range of social, economic and ecological benefits. The key first step to maximising the resilience and sustainability in such a process is ensuring that design is multifunctional and is based on regional context both in terms of being climate adaptation resilient and relevant to regional biodiversity of national and international conservation value. The 'added value' of such a biodiversity-focused climate resilient approach beyond, biodiversity and ecosystem service benefits, is that the management requirements of the urban green infrastructure become more sustainable with reduced requirements for fossil fuel use, artificial irrigation, and fertilizer and pesticide input.

In order to maximise biodiversity, and the associated ecosystem services, in urban areas it is necessary to utilise ecomimicry to incorporate local and regional environmental context into the design of urban green infrastructure. This includes the incorporation of plant diversity and habitat structure typical of regional habitat of national or international conservation value.

3. The London context

One of the key research cities for TURAS is London where the University of East London's Sustainability Research Institute is leading Work Package 2 - Greening public and private infrastructure. The aim of this Work Package is to develop state-of-the-art techniques for evaluating and enhancing the ecological 'quality' and multifunctionality of green infrastructure within urban environments. One of the ways that this is being achieved is through the design and establishment of field experiments investigating state-of-the-art technology and processes to maximise the biodiversity and economic value of urban green infrastructure.

One of the key aims behind this research is to look at how landscape design can be incorporated into new sustainable developments and retrofitted into existing developments in such a way as to promote biodiversity and the valuable ecosystem services it supports. This includes the use of ecomimicry to incorporate habitat interest features typical of regional habitat of national or international conservation value.

In a London context, one of the key conservation priority habitats that lends itself to ecomimicry in urban green infrastructure design is the exposed and arid characteristics of brownfield (post-industrial) sites. In intensively managed urban and rural environments, brownfield sites often represent some of the only remaining fragments of 'wildspace' in the landscape. This unmanaged nature of the sites lends itself to being able to support biodiversity of national and international conservation value and this value has been recognised nationally and internationally (Harvey 2000; Harabiš *et al.* 2013).

Typically comprising a blend of friable substrates and pockets of contamination, many brownfield sites represent open flower-rich resources with no management intervention that lend themselves to supporting many warmth-loving species at the edge of their range. Such is the value of the habitat in otherwise heavily managed urban and rural landscapes that, in the UK, the habitat typical of the highest quality brownfield sites has been characterised and included in the list of UK Biodiversity Action Plan (BAP) priority habitats (Riding *et al*. 2010) as Open Mosaic Habitats on Previously Developed Land.

The value of brownfield sites lies in the complexity of microhabitats within the wider mosaic, which support species throughout their lifecycles (Bodsworth *et al*. 2005). In addition to open flower-rich resources, much of the literature describing wildlife-rich brownfield sites (Bodsworth *et al*. 2005; Buglife 2009; Riding *et al*. 2010) list the essential components of the brownfield mosaic as:

- shelter belts of mid/late successional trees and bushes;
- early successional ruderal and scrub habitats;
- south facing slopes;

- bare disturbed ground that heats up rapidly;
- a variety of aggregates;
- ephemeral pools/standing water;
- seasonal wet areas or inundation communities.

This habitat mosaic is thus something that should be aspired to through ecomimicry in urban green infrastructure design.

Experiments investigating best practice for the design of biodiverse green infrastructure are already underway at Barking Riverside, on the UEL campus, in Stuttgart (Germany) and across several other sites. The systems put in place are being monitored by TURAS researchers to investigate the link between green infrastructure design, ecosystems service provision and maximising biodiversity.

4. Local focus, universal application

The ideas and principles behind the innovative design of the urban green infrastructure within the TURAS case studies are applicable to all urban sustainable development initiatives (Figure 1). It is hoped that the processes behind these case studies will act as blueprints for use throughout the TURAS partnership and beyond to promote the use of ecomimicry of regional habitat of conservation value in the design of green infrastructure to maximise the value of urban areas for biodiversity. It is hoped that the principles established within this research framework will encourage other such initiatives to develop globally. This would enable further investigation extending the limits of understanding as to how habitats and ecosystems can be replicated at ground level by taking inspiration from natural and semi-natural ecosystems and incorporating the design principles into urban landscaping. By adopting such an approach, biodiversity of regional, national and international conservation importance can be supported in urban areas.

The basic principles of the design features established within the TURAS case study research projects are equally relevant for developments globally. The specifics however need to have regional ecological context applied them to make them location specific. In relation to Barking Riverside, this means applying the ecological features typical of the East Thames Corridor many of which have been included in the examples included in this report. It is intended that the principles behind examples included will have broader benefits beyond Barking Riverside however, and that the green infrastructure design principles pioneered and promoted within TURAS will be adopted at other sites where opportunity permits.

Barking Riverside represents an excellent opportunity to incorporate multifunctional green infrastructure interventions. The following document details recommendations for landscape design at Barking Riverside based on experiments and discussions with landscape designers, ecologists and site managers.

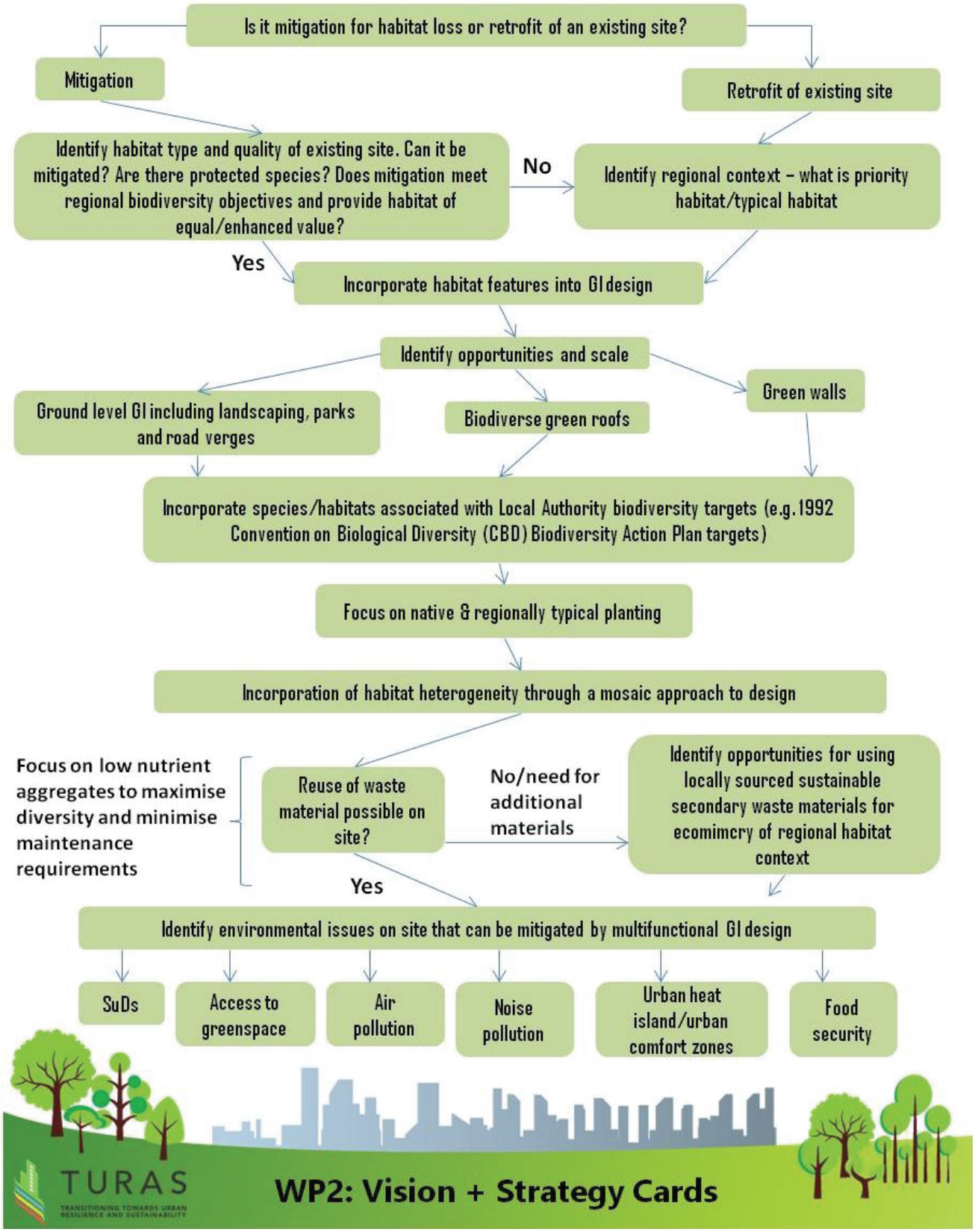

Figure 1. Decision process for achieving biodiversity-led multifunctional urban green infrastructure. Taken from TURAS Vision + Strategy Card 3. Image © Stuart Connop

5. Multifunctional biodiverse urban green infrastructure landscaping guidelines: Barking Riverside, London, UK

5.1 Wildflower meadows

Incorporation of wildflower meadow areas (Figure 2) into landscape design is a fantastic initiative if we are to return biodiversity and particularly pollinators to our urban areas. The advantages to a whole range of wildlife from pollinators through to birds and bats combined with the associated fossil fuel and cost savings associated with the reduction in management requirements mean that moving away from heavily managed amenity grass has multiple ecosystem service benefits. With respect to Barking Riverside, this should be carried out with the aim of mitigating for the loss of the original flower-rich brownfield site, and thus floral indicator species of the highest quality brownfield sites in the East Thames Corridor should be a target (Roberts *et al*. 2006). Whilst it is very encouraging to see wildflower meadow areas already being created on the development, consideration should be given to creating some of these areas on low nutrient substrates to encourage diversity, delayed succession, and to reduce the need for management interventions.

Figure 2. Wildflower meadow area of UEL's Beetle Bump brownfield nature area. Image © Stuart Connop

Once wildflower areas have been established, more intensive management of the edges of these areas can have the dual benefit of creating amenity grass areas for community use (and thus avoiding trampling wildflower meadow areas) and ensuring that the areas look managed and intentional to avoid any issues of negative perception associated with abandonment. For ideas of how this can be achieved, see the Barking Riverside brownfield landscaping trial (Connop *et al*. 2014).

Below is a list of species that should be considered for inclusion in a wildflower meadow planting lists. The species listed are particularly focused on being of regional value and/or of importance in terms of the London Borough of Barking and Dagenham Biodiversity Action Plan:

Wildflower meadow target species specific for the London Borough of Barking and Dagenham

- Agrimony (*Agrimonia eupatoria*)
- Annual mercury (Mercurialis annua)
- Autumn hawkbit (*Scorzoneroides autumnalis)*
- Birdsfoot trefoil (*Lotus corniculatus*)
- Black horehound (*Ballota nigra*)
- Black medick (*Medicago lupulina*)
- Bladder campion (*Silene vulgaris*)
- Bulbous buttercup (*Ranunculus bulbosus*)
- Clustered bellflower (*Campanula glomerata*)
- Common knapweed (*Centaurea nigra*)
- Common poppy (*Papaerva rhoeas*)
- Common toadflax *(Linaria vulgaris*)
- Common sorrel (*Rumex acetosa*)
- Common vetch (*Vicia sativa*)
- Corncockle (*Agrostemma githago*)
- Cornflower (*Centaurea cyanus*)
- Cowslip (*Primula veris*)
- Dog violet (Viola riviniana)
- Field scabious (*Knautia arvensis*)
- Greater knapweed (*Centaurea scabiosa*)
- Hoary plantain (*Plantago media*)
- Kidney vetch (*Anthyllis vulneraria*)
- Lady's bedstraw (*Galium verum*)
- Lesser stitchwort (*Stellaria graminea*)
- Meadow buttercup (*Ranunculus acris*)
- Meadow vetchling (*Lathyrus pratensis*)
- Musk mallow (*Malva moschata*)
- Narrow-leaved birdsfoot trefoil (*Lotus glaber*)
- Oxeye daisy (*Leucanthemum vulgare*)
- Perforate St John's-wort (*Hypericum perforatum*)
- Red bartsia (*Odontites verna*)
- Red deadnettle (*Lamium purpureum)*
- Rough hawkbit (*Leontodon hispidus*)
- Salad burnet (*Sanguisorba minor*)
- Scarlet pimpernel (*Anagallis arvensis*)
- Self-heal (*Prunella vulgaris*)
- Small scabious (*Scabiosa columbaria*)
- Tufted vetch (*Vicia cracca*)
- Vipers bugloss (*Echium vulgare*)
- Weld (*Reseda luteola*)
- White clover (*Trifolium repens*)
- White deadnettle (*Lamium album*)
- Wild basil (*Clinopodium vulgare*)
- Wild carrot (Daucus carrota)
- Wild marjoram (*Origanum vulgare*)
- Wild mignonette (*Reseda lutea*)
- Wild pansy (*Viola tricolor*)
- Wild red clover (*Trifolium pratense*)
- Wild thyme (*Thymus polytrichus*)
- Yarrow (*Achillea millefolium*)
- Yellow rattle (*Rhinanthus minor*)

** A more comprehensive list of species of local provenance can be found in LBBD (2010) . This can be cross-referenced against Thames Corridor brownfield indicator species (Roberts et al. 2006) to identify the most appropriate brownfield species.*

5.2 SuDS

Incorporation of green infrastructure Sustainable Drainage System (SuDS) components such as rain gardens, tree pits and planters to manage stormwater can have additional benefits such as supporting biodiversity and improving runoff water quality. In addition, they offer a great opportunity for community engagement through initiatives such as green street wardens, whilst providing sites for educational activities and environmental research. Figures 3, 4 and 5 show some of the innovative ways that SuDS can be incorporated into high density urban areas and how biodiversity can be incorporated into SuDS designs.

Where possible, native planting should be favoured in rain gardens. Species suitable for drier areas include:

- Autumn crocus (*Colchium autumnale*)
- Bellflower (*Campanula glomerata*)
- British bluebell (*Hyacinthiodes non-scripta*)
- Broad buckler fern (*Dryopteris dilatata*)
- Bugle (*Ajuga reptans*)
- Dogwood (*Cornus sanguine*)
- Geulder rose (*Viburnum opulus*)
- Hemp agrimony (*Eupatorium cannabinum*)
- Male fern (*Dryopteris felix-mas*)
- Pendulous sedge (*Carex pendula*)
- Royal fern (*Osmunda regalis*)
- Silverweed (*Potentilla anserina*)
- Soft rush (*Juncus effusus*)
- Stinking hellebore (*Helleborus foetidus*)
- Wild daffodil (*Narcissus pseudonarcissus*)
- Wild tulip (*Tulipa sylvestris*)

Wetter central areas should incorporate species suitable for the draw down zone or shallow water of ponds, especially sedges (*Carex sp.*) and rushes (*Juncus sp.*).

Figure 3. Rain garden fed by downpipes from neighbouring building. Image ©Stuart Connop

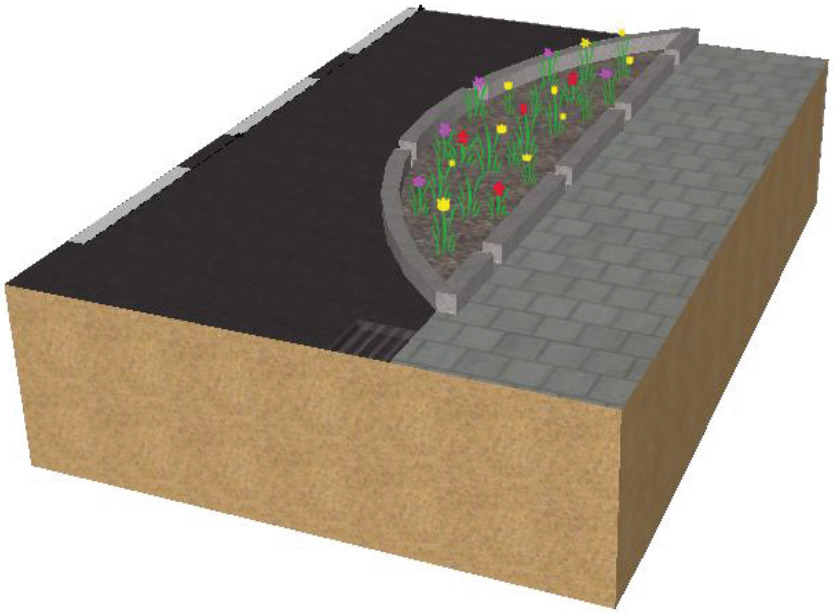

Figure 4. Road calming rain garden. Rain fed from pavement and road. The rain garden attenuates stormwater, improves water quality and calms traffic. Image © University of East London.

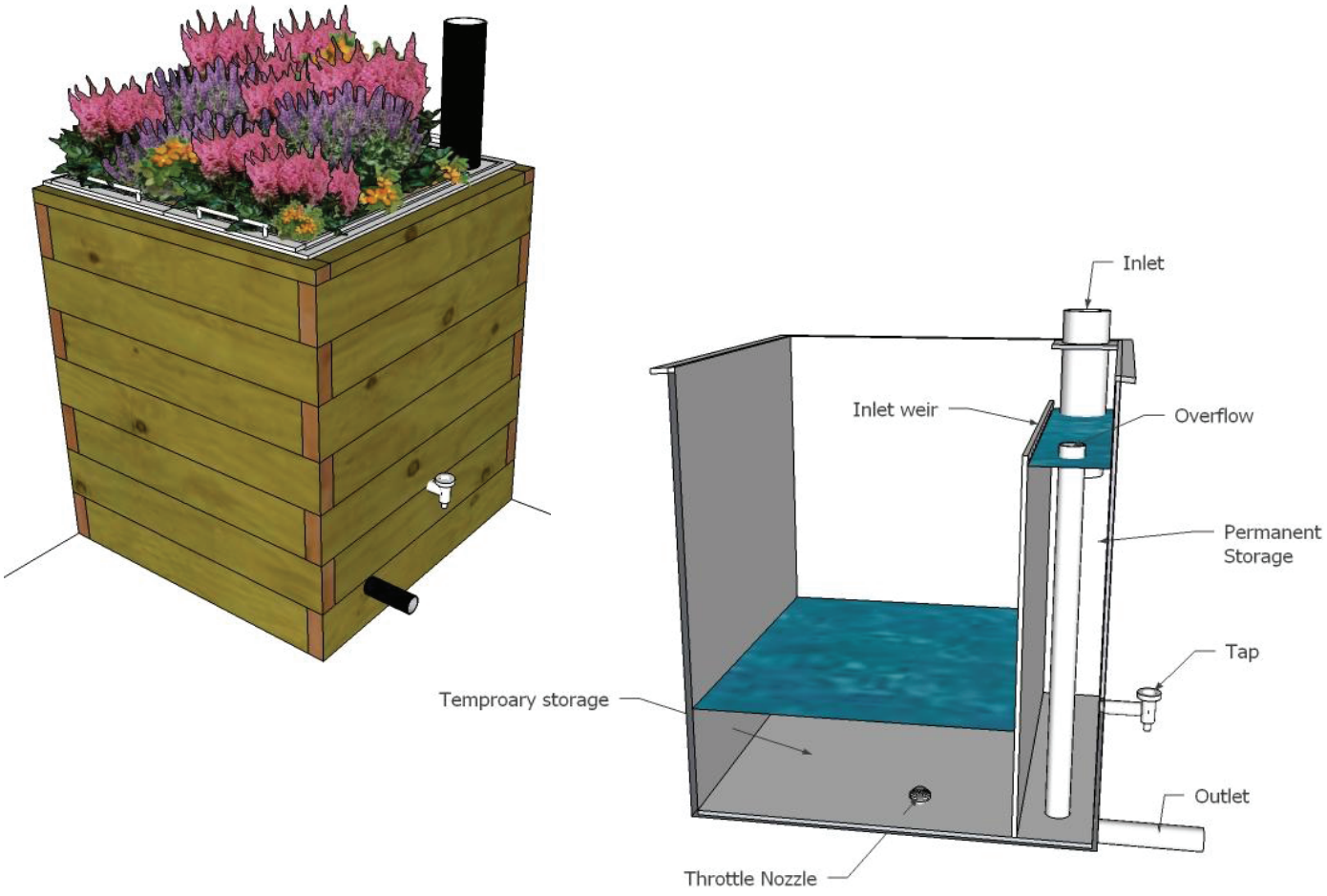

Figure 5. Downpipe-fed stormwater attenuating planter. Image © Thames Water

5.3 Native planting

Substantial new planting of trees and shrubs has already been initiated at Barking Riverside. Where feasible native planting should be a targeted. Often when design and planting takes place, it predominantly focuses on horticultural rather than biodiversity value. This is generally done due to a perception that they require less maintenance than native alternatives, but this is not necessarily the case and biodiversity benefits can be missed by not selecting native species. There is an increasing body of evidence to suggest that the greatest biodiversity value is added by planting with native/naturalised species. A number of studies comparing gardens planted with native species compared with more conventional gardens (with exotic species) found that bird and butterfly diversity was greater in 'native gardens' (French *et al*. 2005; Daniels & Kirkpatrick 2006; Burghardt *et al*. 2009). Corbet *et al*. (2001) found that native insects rarely make use of exotic species when compared with natives. There are a number of British native species that can be planted in a conventional gardening manner to provide a wonderful show throughout the summer (Baines, 2000). For hedgerow planting hawthorn (*Crataegus monogyna*), blackthorn (*Prunus spinosa*) and dog rose (*Rosa canina*) create huge interest in a small amount of space that can be further enhanced with climbers such as old man's beard (*Clematis vitalba*), honeysuckle (*Lonicera periclymenum*) and hop (*Humulus lupulus*). This would help provide habitat for many species of invertebrates and birds and perhaps even small mammals.

If deciduous species are not suitable, native evergreen species such as holly (*Ilex aquifolium*), wild privet (*Ligustrum vulgare*) or yew (*Taxus baccata*) make a good and beneficial alternative to exotic ornamental equivalents. If not managed too intensively (and this applies to exotic species also), these shrubs can provide a crop of flowers and berries, which provide the majority of the biodiversity interest (Thomas 2010).

The following is a list of potential trees, including those suitable for SuDs tree pits:

- Ash (*Fraxinus excelsior*)
- Aspen (*Populus tremula*)
- Beech (*Fagus sylvatica*)
- Black poplar (*Populus nigra subsp. Betulifolia*)
- Common alder (*Alnus glutinosa*)
- Commono oak (*Quercus robur*)
- English elm (*Ulmus procera*)
- Hawthorn (*Crataegus monogyna*)
- Horse-chestnut (*Aesculus hippocastanum*)
- Large-leaved lime (*Tilia platyphyllos*)
- London plane (*Platanus occidentalis x orientalis)*
- Scots pine (*Pinus sylvestris*)
- Sessile oak (*Quercus petraea*)
- Silver birch (*Betula pendula*)
- Small-leaved lime (*Tilia cordata*)
- Sweet chestnut (*Castanea sativa*)
- Sycamore (*acer pseudoplantanus*)
- Walnut (*Juglans regia*)
- White willow (*Salix alba*)
- Wych elm (*Ulmus glabra*)

Fruit trees should also be considered where appropriate. In addition to the urban comfort, greenspace and pollinator benefits, they can contribute to local food security and

community engagement with nature through 'grow your own' projects. It should be noted, however, that choice of trees should be subject to consultation with an arboriculturalist, soil conditions and anticipated pollution conditions.

5.4 Nesting habitat

In addition to providing nectar and forage sources, it is important to provide other habitat requirements such as nesting habitat. This could include more typical features like bird and bat boxes but could also include more innovative features such as bug hotels. Innovative bug hotel design offers an opportunity to not only enhance biodiversity but also introduce an element of artistic design and community engagement into landscape architecture. Features at Barking Riverside such as expanses of walls represent ideal locations for inclusion of these habitat walls. Figures 6 and 7 show the opportunities for including art and creativity into the design of these features.

Figure 6. Bee wall at Lend Lease offices, Central London. Image and wall design © Gary Grant/ Green Roof Consultancy Ltd.

Figure 7. Trellick bee tower at Roots and Shoots, Kennington, London. A bee hotel designed to look like a local landmark, the Trellick Tower .Image © London Permaculture on www.flickr.com.

5.5 Brownfield-inspired landscaping

Brownfield sites in the Thames Gateway represent the last remnant pockets of wildspace in urban areas and thus some of the last sites to support a true diversity of ecosystem services. Key to ecosystem service provision is the biodiversity that can be found on these sites. A network of brownfield sites in the East Thames Corridor have been recorded supporting invertebrate populations of national importance (Harvey 2000; 2007) along with a host of other key conservation priority groups including birds (e.g. black redstart, linnet), reptiles (adders, grass snakes) and amphibians (great crested newts). The importance of brownfield habitat was officially recognised recently when Open Mosaic Habitat (OMH) on Previously Developed Land was added to the UK Biodiversity Action Plan as a Priority Habitat. It is also listed as a priority habitat within the Barking & Dagenham Biodiversity Action Plan (listed as wastelands).

Brownfield sites are under greatest pressure from Thames Gateway development (Harvey 2000) and the highest quality sites are being lost to development at an alarming and unsustainable rate (Robins & Henshall 2012). For development to be environmentally sustainable, nationally important invertebrate populations in the region must be protected. Redevelopment of urban space represents an opportunity to achieve this. By incorporating the floral diversity and diversity of habitat features typical of brownfield sites into urban landscape design it is possible to make our urban landscapes more permeable to biodiversity and create connectivity between key brownfield sites in the region.

Opportunities include providing vegetation of a variety of heights from taller herbs and grasses to sparser more stressed lower vegetation and finally to bare areas of sand and/or shingle. These areas are particularly important for thermophilic invertebrates (e.g. solitary bees and wasps) as they warm up quickly when exposed to the sun and provide basking areas. Ideally sand should be incorporated as banks with a sunny southerly aspect. Other key features include deadwood, particularly standing deadwood and areas of rubble and fixed metal sheeting blended with ornamental planting. Figures 8 to 10 can give an idea of how this kind of habitat can be incorporated into urban landscape design. For further details see the Barking Riverside landscaping report (Connop *et al*. 2014).

It is important to note that mature trees are generally not a key feature of brownfield sites and, if included in the landscaping, should be managed to ensure that they do not dominate the site shading out all other habitat features mentioned previously.

Figure 8. Rubble, metal sheeting and ornamental planting landscape design at Barking Riverside (BR)

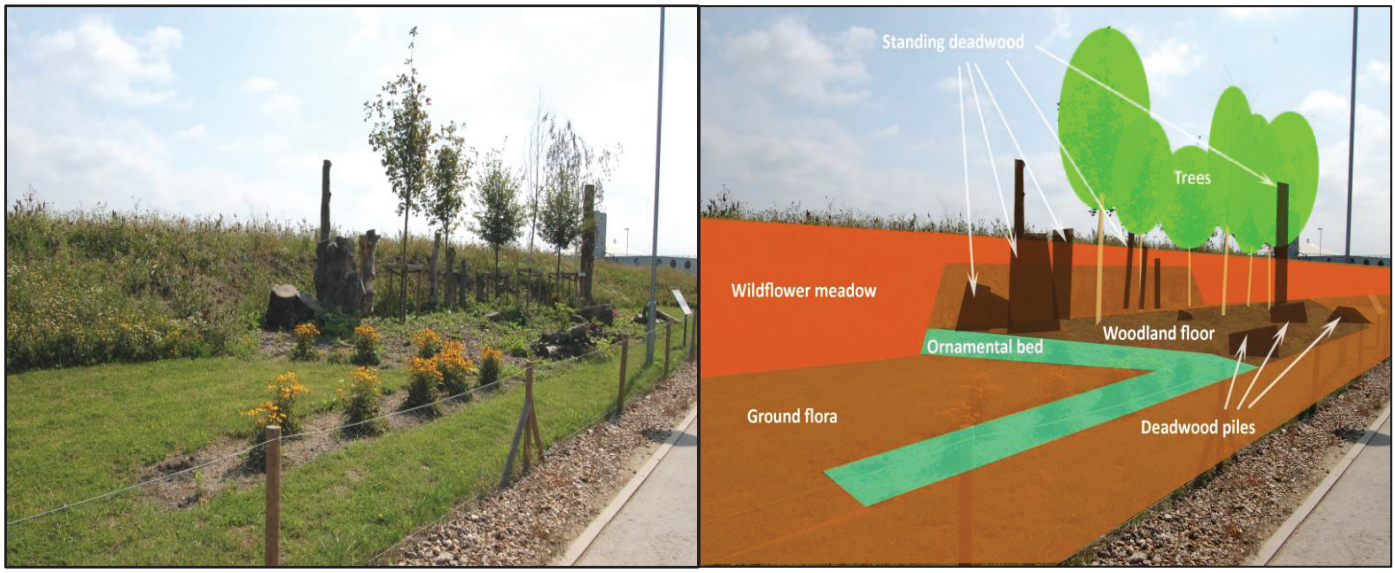

Figure 9. Woodland pocket with standing deadwood and deadwood piles landscape design at BR

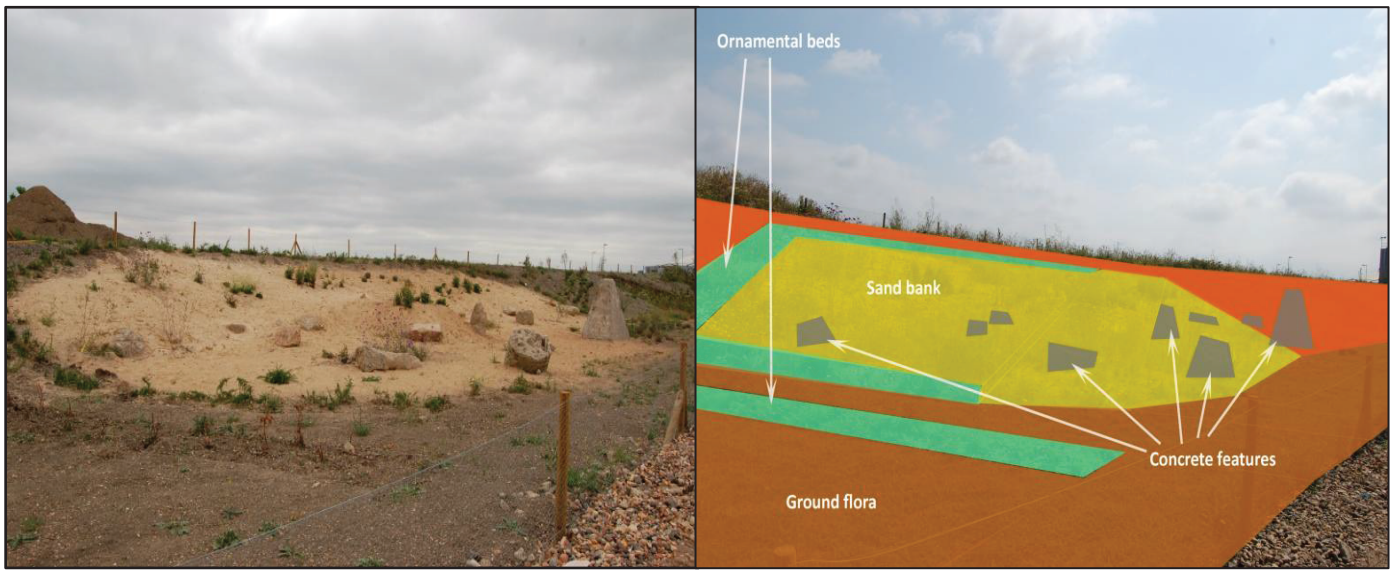

Figure 10. South facing sand bank with concrete features landscape design at BR. Images© UEL

5.6 Small-scale green roofs

Green roofs offer enormous opportunity to restore biodiverse green infrastructure to urban areas and a range of associated ecosystem services including:

- Thermal insulation of buildings;
- Stormwater attenuation;
- Improved water quality;
- Improved air quality;
- Reduction of the urban heat island effect;
- Habitat for biodiversity (including pollinators, pest controllers);
- Human contact with wildlife and greenspace.

Green roofs are currently being rolled out across many of the new buildings on the Barking Riverside development. Nevertheless, additional opportunities exist for the incorporation of small scale green roof systems as part of the landscape design (Figures 11 and 12). Innovation in thought and design means that green roofs are being incorporated in more and more locations in high density urban environments. This includes locations such as bike shelters, bus shelters and bin covers. Including small-scale green roofs within urban areas provides habitat to support biodiversity, breaks up and converts impermeable surfaces to permeable SuDS areas to alleviate stormwater problems, reduces urban heat island effects and adds additional greenspace for community health and well-being. In fact, their value as SuDS features in urban areas has been recognised to such an extent that they are now being included in the London Borough of Tower Hamlets SuDS planning guidance (Bastock *et al*. 2014).

Figure 11. Pre-fabricated green roof bin store ©Green Roof Shelters

Figure 12. Green roof bike shelter. © Green Roof Shelters

5.7 Green walls

Green walls represent another opportunity for multiple ecosystem service benefits. If designed correctly, green walls can provide space for biodiversity, a more pleasant visual environment for residents, create urban comfort zones, improve air quality and reduce noise pollution. As part of the TURAS green infrastructure research programme a novel free-standing 3D green wall system (the green Living Room) has been installed and trialled in Ludwigsburg (Figure 13), Germany, to investigate its effect on air pollution, noise pollution and urban comfort zones. Several areas bordering roads or in community spaces at Barking Riverside would make ideal locations for installations mirroring that in Stuttgart. The Green Living Room walls use modular wire cages and a novel 'baubotanik' technology to combine the engineering strength of trees within a modular green wall system to create instant shade (Figure 14). For more information see the award winning Green Living Room video: https://www.youtube.com/watch?v=nxSooNdE8Fs.

Figure 13. The Ludwigsburg Baubotanik green wall. Image © Helix Pflanzen

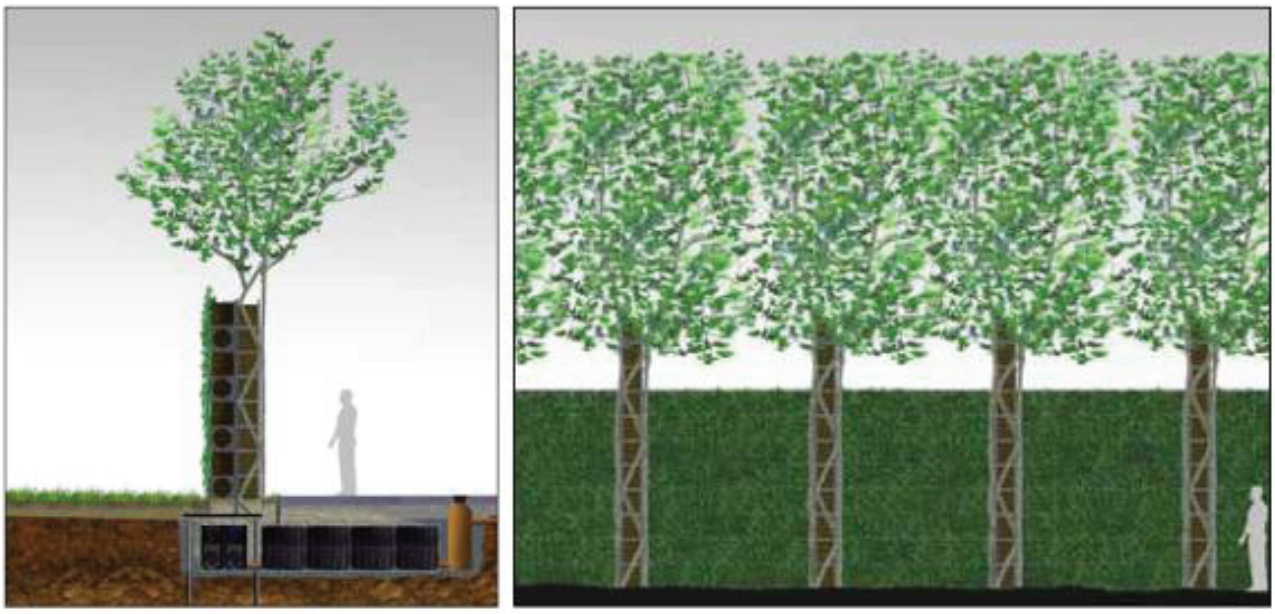

Figure 14. Baubotanik green wall. Image © Helix Pflanzen

Such is the strength and flexibility of modular design that these systems can also be combined with seating structures, biodiverse planting, bug hotels and even bee hives (Figures 15 and 16).

Figure 15. Nectar-rich plants for pollinators on a Baubotanik green wall. Image © Helix Pflanzen

Figure 16. Prototype of the Ludwigsburg Baubotanik green wall. Image © Helix Pflanzen

Alternatives to the more traditional irrigation dependent green wall systems have also been trialled as part of a TURAS case study. Researchers from the University of East London's Sustainability Research Institute (SRI) established a novel urban greening trial investigating the potential for creating passive green wall systems with low-to-no irrigation requirements. Researchers experimented by retrofitting plug plants to gabion walls on their Docklands Campus in East London, UK (Figure 17).

Four species of plant were selected that are considered to be typical of dry stone walls in the UK based on Natural England guidance (NE 2009). Plants selected were biting stonecrop (*Sedum acre*), wild thyme (*Thymus serpyllum*), red valerian (*Centranthus ruber*) and wild wallflower (*Cheiranthus cheiri*). Plugs were irrigated initially following installation but were then left irrigation free. Some plugs were installed using AquaSAF© super absorbent fibres for enhanced drought resistance.

Initial results for the low irrigation 'passive' green wall system have been very promising, with *Sedum acre* in particular thriving in the irrigation free environment. The predominance of gabion walls and opportunities for gabion wall creation at Barking Riverside mean that this is a technique that could be incorporated.

Figure 17. Plug planted gabion wall.

For further information on the gabion green wall trial see http://aquaten.co.uk/aquaten-aquasaf-enhanced-the-survivability-of-plug-plants-in-a-university-of-east/

5.8 Ponds and ephemeral wet areas

Wetland areas are typical habitat features of brownfield sites that are rarely incorporated into urban landscape design. Permanently wet ponds and ephemeral wet areas are key habitat features for supporting biodiversity and lack of available standing water is considered to be a significant limiting factor for urban biodiversity. Continued roll out of wetland features (Figure 18) at Barking Riverside, either as part of a SuDS system or even as a habitat feature within ecology/education areas could have substantial benefits to the landscape design both for biodiversity and for community engagement and educational activities such as pond dipping.

Figure 18. SUDS pond. Image © Susdrain/CIRIA

Pond planting list suitable for Barking Riverside planting include:

Submerged and floating:

- Broad-leaved pondweed *(Potamogeton natans)*
- White water-lily *(Nymphaea alba)*
- Yellow water-lily *(Nuphar lutea)*

Emergent Plants for the draw down zone or shallow water:

- Branched bur-reed *(Sparganium erectum)*
- Bulrush *(Typha latifolia)*
- Common reed *(Phragmites australis)*
- Gipsywort *(Lycopus europaeus)*

- Greater Pond-*sedge (Carex riparia)*
- Greater Water-dock *(Rumex hydrolapathum)*
- Marsh woundwort *(Stachys palustris)*
- Purple-loosestrife *(Lythrum salicaria)*
- Reed canary-grass *(Phalaris arundinacea)*
- Reed sweet-grass *(Glyceria maxima)*
- Rush *(Juncus sp.)*
- Yellow iris *(Iris pseudacorus)*

Marginal plants for <u>base rich soils</u>:

- Amphibious bistort *(Persicaria amphibia)*
- Common spike-rush *(Eleocharis palustris)*
- Common water-plantain *(Alisma plantago-aquatica)*
- Creeping bent *(Agrostis stolonifera)*
- Fools water-cress *(Apium nodiflorum)*
- Marsh foxtail *(Alopecurus geniculatus)*
- Marsh marigold (*Caltha palustris)*
- Marsh pennywort *(Hydrocotyle vulgaris)*
- Sweet-grass sp. *(Glyceria sp.)*
- Water forget-me-not *(Myosotis scorpioides)*
- Water mint *(Mentha aquatic)*
- Watercress *(Nasturtium officinale)*

Marginal plants for <u>acid rich</u> soils:

- Articulated rush *(Juncus articulatus)*
- Bog stitchwort *(Stellaria uliginosa)*
- Bog-myrtle *(Myrica gale)*
- Bottle sedge *(Carex rostrata)*
- Bulbous Rush *(Juncus bulbosus)*
- Common sedge *(Carex nigra)*
- Common spike-rush *(Eleocharis palustris)*
- Creeping forget-me-not *(Myosotis secunda)*
- Deergrass *(Trichophorum caespitosum)*
- Floating sweet-grass *(Glyceria fluitans)*
- Flowering rush *(Butomus umbellatus)*
- Hard rush *(Juncus inflexus)*
- Lesser spearwort *(Ranunculus flammula)*
- Marsh speedwell *(Veronica scutellata)*
- Marsh thistle *(Cirsium palustre)*
- Marsh violet *(Viola palustris)*
- Marsh willowherb *(Epilobium palustre)*
- Ragged-robin *(Lychnis flos-cuculi)*
- Sharp-flowered rush *(Juncus acutiflorus)*
- Soft rush *(Juncus effusus)*
- Star sedge *(Carex echinata)*
- Tormentil (*Potentilla erecta)*
- Tufted hair-grass *(Deschampsia caespitosa)*
- Yellow iris (*Iris pseudacorus*)

*Plants to <u>**avoid**</u>:*

Care should be taken not to use non-native plants, particularly vigorous alien plants that can take over ponds and exclude native species such as:

- Canadian Pondweed (*Elodea canadensis*)
- Water Fern (*Azolla filiculoides*)
- Nuttalls Pondweed (*Elodea nuttallii*)
- New Zealand Swamp-stonecrop (*Crassula helmsii*)
- Curly Waterweed (*Lagarosiphon major*)
- Floating Pennywort (*Hydrocotyle ranunculoides*)
- Parrots-feather (*Myriophyllum aquaticum*)

5.9 Incorporating art into landscape design

Aesthetics is a key consideration when trying to include biodiverse habitat features into urban landscape design as there is a danger that areas could be perceived as derelict or neglected if management is not obvious. However, over management of areas designed for biodiversity can lead to significant impacts on the biodiversity they are designed to support. Indeed, one of the key reasons why brownfield sites can be so important for biodiversity is the typical lack of intervention on them in terms of intensive management.

Key to avoiding such issues is a combination of community engagement and incorporation of artistic design into the green infrastructure. Such input can comprise a variety of methods all of which should be planned to maximise the multifunctionality of the green space. Examples include utilising sculpted aggregates at ground level to add to the aesthetics of the landscape design and increase the niches available for exploitation by biodiversity (Figure 19). Using recycled aggregates, whether from an on-site redevelopment, or sourced locally, can add to the sustainability of the development by reducing waste and the carbon footprint.

Incorporating art and sculpture installations into green infrastructure landscaping can also provide a host of multidisciplinary benefits (Figure 20). Primarily this adds to the aesthetics of a site and ensures that the site appears managed and intentional. However, if planned carefully, artistic involvement can also extend to community engagement if local artists are used or by including opportunities for local school engagement. This can also open up opportunities for education on the importance of biodiverse green infrastructure in urban areas. Moreover, if an element of ecomimicry is used in the creation of organic art pieces, as was done for the creation of the green man statue that was displayed at UEL's Beetle Bump (Figure 20), the art itself can act to increase the usable niches for biodiversity.

A further tool to support this design for aesthetics and to reduce issues of public perception is to use interpretation boards with images of the target habitat and species and a description of the site (Figure 21). Including details of species that the design of the biodiverse green infrastructure was targeted to attract, and an explanation of the nature and value of sites in the region, can increase understanding and engagement with the design.

Urban landscape design using biodiverse habitat features provides an ideal platform for incorporating art, creativity and regional habitat characteristics to maximise the biodiversity value of urban green infrastructure.

Figure 19. Using aggregates to create ground sculptures and biodiverse habitat at UEL's Beetle Bump. Image © Stuart Connop

Figure 20. Green man statue constructed from driftwood that was installed as the first exhibition at on the plinth of UEL's Beetle Bump. Image © Stuart Connop

Figure 21. Interpretation board on brownfield landscaping. Image © Jamie Robins (Buglife – the Invertebrate Conservation Trust)

5.10 'Grow your own' urban agriculture

With escalating food costs and an increasing recognition of the need to provide localised food security in urban areas (Secretariat of the Convention on Biological Diversity, 2012), 'grow your own' pocket community urban agriculture projects should play an integral role in multifunctional urban green infrastructure design. The broad array of benefits that are possible if multifunctional design is incorporated include:

- Cheap and local food source (Twiss *et al*. 2003)
- Social capital (Midmore & Jansen 2003)
- Community ownership of green spaces and social interaction (Ferris *et al*. 2001; Shinew et al. 2004)
- Biodiversity benefits (Matteson & Langellotto 2009)
- Urban comfort zone benefits (Deelstra & Giradet 2000)
- Health & well-being benefits (Smardon 1988; Alaimo *et al*. 2008; Parmer *et al*. 2009)

Due to the unsuitable nature of the soil in many urban areas (due to soil quality or contamination), the typical and simple solution to providing space for community grow your own projects is the provision of raised bend planters in communal green space or hard standing areas. Design and layout can vary but for increased sustainability, use of recycled materials should be considered (Figure 22). 'Meanwhile' spaces can be used during the prolonged development of the site, but permanent areas should be provisioned for in site masterplanning.

Figure 22. Community grow your own project, Brownfield Estate, Poplar, East London. Image © Stuart Connop

Substantial guidance exists on the governance involved in establishing such projects, and key to planning such areas is consideration of the long-term tenure of the land and ownership/management of the allotment areas. From an environmental sustainability perspective consideration should also be given to a water source for irrigation. Grow your own projects can be relatively water intensive. As such, if possible, rainwater harvesting systems such as water butts or underground storage that collect rainwater from hard surfaces such as roof areas should be included within landscape plans (Figure 23). With careful planning, it is possible to link this in with the SuDS design of any development or renovation project.

Figure 23. Rainwater harvesting water butt. Fitted as standard within the Barking Riverside development. Image © Stuart Connop

Also critical for the sustainability of urban agriculture is the need to take into consideration the importance of the biodiversity and associated ecosystem services necessary for urban agriculture to be successful. When planning urban agriculture design it is necessary take lessons from traditional rural agricultural systems, in particular in relation to adopting a biodiversity-friendly approach. In urban pop-up agriculture projects, in addition to raised bed planters, particular focus should be placed on the provision of habitat suitable for the biodiversity that provides the ecosystem services that make urban agriculture possible and increase crop productivity and yield. This includes key pollinator groups such as honey bees,

bumblebees, solitary bees and wasps, butterflies, moths, hoverflies, beetles, as well as groups such as nutrient cyclers, decomposers, pest controllers. These groups tend have complicated life cycles requiring a diversity of habitats. By including a mosaic of habitats within urban landscape design, that can support the broad range of life cycle requirements of these organisms, it is possible to ensure that they are conserved within urban landscape design. Habitat creation for these groups comprises increasing the number of niches available for supporting nesting, hibernation and feeding behaviour. This can be as simple as ensuring there is a year round supply of nectar and pollen sources, and leaving areas uncut to allow overwintering in dead seed heads. Additional simple measures that can be incorporated into urban landscape design include:

- the provision of compost areas;
- bug hotels and bug walls (Figure 24);
- south facing sandy banks;
- over turned plant pots for nesting/hibernating;
- log/woodchip piles (Figure 25);
- brick/rubble/gravel piles (Figure 25).

Figure 24. Bug hotel at the Brownfield Estate community allotment, Poplar, East London. Image © Stuart Connop

Figure 25. Gravel and deadwood habitat pile at the London Wildlife Trust Community Garden, Barking Riverside. Image © Stuart Connop

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