

1 **Introduction**

2 Heavy industry has been in decline in the UK since the 1970's, leaving behind a legacy of
3 derelict buildings and waste ground (Rivett et al., 2002). Such 'brownfields' (i.e. "any land that
4 has previously been used or developed and is not currently fully in use and may be vacant,
5 derelict or contaminated" (Alker et al., 2000, p. ...)) are frequently associated with deprived or
6 declining neighbourhoods, high unemployment, environmental degradation and neglect (Grimski
7 and Ferber, 2001). Recognition of the loss of green fields to urban sprawl, a need to promote
8 sustainable land use and fears over human and environmental health risks at brownfield sites has
9 prompted many European governments to drive land regeneration through incentives and
10 taxation. The regeneration of brownfield land is regarded as a major tool in achieving sustainable
11 development (Grimski and Ferber, 2001)

12 The UK government has placed strong emphasis on integrated land use policies including
13 brownfield land regeneration in support of urban renaissance and quality of urban living (Anon.,
14 2005a). According to the Urban White Paper (DETR, 2000) new urban developments should
15 have greenspaces that are accessible to their communities, preferably by forms of transport other
16 than the car. This objective is expanded in the UK by Natural England's 'Access to Natural
17 Greenspace Standards (ANGst)' that recommend that people living in towns and cities should
18 have accessible natural greenspace less than 300 metres from home (English Nature, 2006). Just
19 as important as access, however, are planning, design and management. There is an ever growing
20 body of evidence to demonstrate that greenspaces offer lasting economic, social, cultural and
21 environmental benefits - if quality is maintained (NAO, 2006). Shabby, badly maintained public
22 spaces lend a sense of physical and social decline (CABE Space, undated).

23 The multi-functional role of urban greenspaces consolidates the case for their re-
24 establishment (van Leeuwen et al., 2002). The environmental and recreational functions of
25 greenspaces include the sequestration of atmospheric pollutants, energy conservation through

26 cooling and shading, storm water attenuation, habitat provision, and a place to relax, exercise and
27 socialise (Moffat and Hutchings, 2007). The economic benefits of greenspaces, though hard to
28 quantify, include improved surrounding land values leading to recognition of brownfield greening
29 as a pump-primer to regional economic revitalisation (Grinski and Ferber, 2001).

30 Good practice published in support of successful regeneration (e.g., DoE, 1996) is
31 underused, resulting in examples of greenspace establishment projects with questionable success,
32 with respect to sustainable regeneration and the functions the greenspaces were designed to fulfil
33 (Sellers et al., 2006). For example, successfully improving accessibility for local communities at
34 the expense of important species that have colonised the site equates to environmental
35 degradation and contravention of sustainability principles (Anon., 2005b). Consequently, the
36 terms ‘success’ and ‘sustainability’ in the context of brownfield greening projects are not
37 automatically interchangeable.

38 Following decades of declining investment in public open green spaces, calls have
39 emerged for increased investment, quality standards and regional strategies for urban greenspace
40 (NAO, 2006), to raise the profile and quality of greenspaces. Understanding what makes a
41 successful greenspace is important to securing revenue funding and ensuring that the space can
42 deliver the anticipated social, environmental and economic benefits (CABE Space, 2005).

43 The aims of this paper are to: A) review the literature to consider the definition of success in
44 the context of brownfield greening and elucidate principles important in success evaluation, B)
45 propose the ‘logic’ model for the evaluation of success, and C) use a case study approach to
46 demonstrate the utility of the logic model within the context of a selection of social and
47 environmental criteria.

48

49 **A Review**

50 *Definitions of success*

51 In brownfield regeneration, success has been described generically as economic benefit
52 (De Sousa, 2003), or as civil infrastructure renewal, tax-based development, economic
53 development and neighbourhood revitalisation (Amekudzi and Fomunung, 2004). In specific
54 terms, success has been described as local community involvement, job creation, or relative to
55 environmental remediation (Amekudzi and Fomunung, 2004). Reviewing the literature,
56 Silverthorne (2006) noted that definitions of success varied between countries, academic
57 disciplines and regeneration projects, recognising that different concepts of success emerged from
58 the attachment of different values. The lack of definitive criteria against which success may be
59 measured can result in a lack of motivation to improve standards (Silverthorne, 2006).

60

61 *Traditional approaches to success measurement*

62 Dictionary definitions of success emphasize it as a product, gain of a desired state,
63 achievement or conclusion. Thus, success can be thought of as attaining something sought after.
64 In the context of brownfield greening, success is often demonstrated against aims/objectives. This
65 definition is reflected in traditional developer-, funding body- and site owner/manager-centric
66 notions of success where the focus of evaluation is exclusively economic (Wedding and
67 Crawford-Brown, 2007). Three reasons explain the persistence of this definition:

- 68 i) economic factors of success justify project expense;
- 69 ii) success can be described in project management terms, which are relatively simple to
70 measure (e.g. project deliverables) and data may be collected as part of the delivery
71 programme at little or no extra cost;
- 72 iii) project inputs and outputs tend to be easy to describe quantitatively.

73 However, such measures can imply that once success is achieved, continued investment in
74 management, maintenance and development is not required; irrespective that the measures may
75 bear little relevance to local community needs or site sustainability and that an on-going revenue
76 stream is paramount to prevent disrepair and neglect (CABE Space, 2005; Sellers et al., 2006).

77 Across the UK, brownfield greening is almost exclusively undertaken by government
78 departments (such as the Forestry Commission), regional bodies (such as the Regional
79 Development Agencies) and Local Authorities, often in partnership with private companies.
80 Exceptions include mineral extraction and landfill site restorations and aftercare strategies. This
81 is primarily because regeneration costs force a financially rewarding hard-end use. However,
82 whilst the costs are relatively easy to identify and calculate, the economic benefits of greenspaces
83 are harder to quantify (Morancho, 2003; Moffat and Hutchings, 2007). Benefit versus cost
84 presents a problematic measure of success because each must be identified, described and
85 compared in order to evaluate the level of success attained.

86

87 *Sustainability appraisal of success*

88 Sustainability has been defined as the integration of social, economic and environmental
89 considerations. However, when it comes to its application, the central concept of sustainability
90 remains somewhat elusive and its relevance and application are tainted by the complexity of the
91 real world (Moffat and Hutchings, 2007). In the context of urban greenspace, sustainability has
92 been taken to include effectiveness of pollution control measures, longevity of planted vegetation
93 or public utilisation of the greenspace (Moffat and Hutchings, 2007). From an environmental
94 perspective, success may be considered with respect to the conservation of ecological interests
95 (Harrison and Davies, 2002). Relating to economic sustainability, success evaluation may
96 consider the benefits of regeneration as opposed to the cost of doing nothing; and from a socio-

97 environmental perspective, how people visit the greenspace (e.g., car, foot or bike), impacts on
98 the site's environmental sustainability.

99 Each aim and objective of a regeneration project can be ascribed to one or more stakeholder
100 groups (for a list of brownfield greening stakeholders see Alker et al. (2000) and Doick et al.
101 (2009)). A flaw of traditional funder- or developer-centric approaches to defining success is the
102 restricted representation of the stakeholders. Undoubtedly, greenspace establishment is about
103 community development. The justification may be economic regeneration and the medium of
104 change may be the environment but the vector of change is society. As Selman (1997, ...) states:
105 "sustainability, biodiversity, appearance, accessibility and environmental impact of greenspaces
106 are clearly matters of public concern". Developer-centric notions of success fail to correlate (or
107 inversely correlate) with the social and economic well-being of the surrounding communities and
108 stakeholders such as environmental bodies (Silverthorne, 2006). Although including stakeholders
109 in success evaluation may create conflicts of interest (Kitchen et al., 2002), it may also encourage
110 an integrated appraisal, with long-term perspective on regeneration.

111

112 **Logic: a model for measuring success**

113 Learning from traditional approaches, evaluation should be practical and appropriate.
114 Sustainability evaluation demands economic, environmental and social criteria and integration of
115 different stakeholders' values. Furthermore, short-, medium- and long-term monitoring
116 perspectives are required to evaluate continuing success and to respond to changes in demand. A
117 model is required that integrates traditional and sustainability principles in the evaluation of
118 brownfield greening projects.

119 The 'logic model' was developed in the 1970s by Joseph Wholey as a general framework
120 for describing work in organizations; it categorises work as inputs, processes, outputs and
121 outcomes to represent the logical flow from one step to the next (Millar et al., 2001). Logic

122 modelling has been applied to program and strategic planning, childhood development and
123 project performance evaluate in relation to different stakeholders (Millar et al., 2001). An input is
124 a resource, investment or commitment into a project; a process is a programme or activity by
125 which an output is delivered; an output is a product or service delivered directly by or through a
126 project; and, an outcome is a consequence of a project (an indirect output). Figure 1 presents a
127 logic root model diagram for brownfield greening projects and a variety of greenspace aims and
128 objectives as inputs, processes, outputs and outcomes for a number of example stakeholders.
129 Logic models highlight the synergy between difference stakeholders' project aspirations.

130

131 *Insert Fig. 1 about here*

132

133 Outputs, directly attributable to a project partnership or influence and are typically
134 straightforward to measure. On the contrary, project outcomes are susceptible to influences
135 external to a project. Thus, it can be hard to apportion with certainty the influence of a project on
136 an outcome. Outcome measurement may also be problematic as resource demand is greater than
137 for output monitoring. Moreover, there is often a lag between the project's delivery and outcome
138 realisation.

139 Regeneration project evaluations have tended to focus on inputs and outputs, not
140 outcomes (DETR, 1999; Wedding and Crawford-Brown, 2007). However, brownfield
141 regeneration and greenspace establishment project aims are frequently outcome-based (e.g.,
142 improve health and well-being in local communities). Inputs and outputs evaluate the project's
143 contribution to achieving the outcome but do not demonstrate that the desired outcome has been
144 attained. Thus, outcome evaluation becomes unavoidable in any meaningful evaluation of site
145 success and sustainability. A summary of documented impacts of greenspace establishment that

146 may be employed in the identification of ‘outcomes’ and, thus, success assessment criteria is
147 presented in Table 1.

148

149 *Insert Table 1: Impacts of greenspace establishment from regenerated brownfield land used in*
150 *the identification of evaluation criteria of a successful greenspace.*

151

152 The input-process-output-outcome categorisation within the logic model can also be used to
153 direct and facilitate monitoring (i.e. what to monitor, when and how). ‘Monitoring’ is defined
154 herein as observation and recording of a variable, either qualitatively or quantitatively, to assess
155 performance or progression to a target. ‘Evaluation’ goes further by assessing impact against a
156 scheme’s objectives and testing that those objectives remain valid.

157

158 **Application of the logic model to brownfield greening success evaluation: a case study approach**

159 The following sections provide an example of how the logic model was applied within the
160 context of six brownfield regeneration case studies to assess success with respect to outcomes and
161 quality attained.

162

163 ***Methodology***

164 Six UK case study sites were examined in order to investigate a number of brownfield
165 greening project success criteria. The sites studied were: Bow Creek Ecology Park, East London
166 (BC); Eastbrookend Country Park, London (EBE); Ibstocks, St Helens (IBS); Ingrebourne Hill
167 community woodland, Essex (IH); Russia Dock Park, London (RD) and Thames Barrier Park,
168 London (TBP). The case studies, introduced in Table 2, bear similarities in their land-use
169 histories but varied in the extent and methodology of regeneration employed. For each project,
170 relevant background information was compiled including land use and reclamation history, site
171 management plans and project aims. The sites were investigated in 2005 and included walkovers,

172 environmental media analysis and visitor surveys. Analytical data were collected using standard
173 field and laboratory protocols (Table 3).

174

175 *Insert Table 2: The six case study sites*

176 *Insert Table 3: Methods of data collection and laboratory analysis*

177

178 Each study site was divided into zones based on spatial and historical land-use
179 differences. For vegetation and soil sampling, 5 sub-sites were randomly selected within each
180 zone and the media bulked to provide a single, representative sample (unless otherwise stated,
181 Table 3). The number of zones ranged from 14 at Russia Dock to 22 at Eastbrookend.

182 Formal project documentation and reclamation specifications were not available for all sites
183 because of time lapse since restoration. Therefore, a comprehensive list of site aims and
184 objectives for each case could not be compiled. However, interviews with site managers and
185 perusal of historical documentation and management plans elucidated many of the original and
186 contemporary site aims. Aims and objectives common to all sites were:

- 187 • regenerate land to a soft-end use for public use,
- 188 • provide access to attractive setting,
- 189 • increase use of the site for sport, amenity or recreational activities,
- 190 • involve community in design and management of site,
- 191 • create new habitats,
- 192 • maintain and enhance biodiversity.

193 Each site also had context-specific aims and objectives and some examples include: providing
194 an educational resource (BC, EBE, TBP), and promoting surrounding land and house prices
195 (TBP, IBS). Applying the logic model to the case study sites presents a summary of inputs,
196 processes, outputs and outcomes related to the common objectives (Figure 1). The outcomes

197 considered by this research were establishment of trees/woodland and provision of quality
198 greenspace with social and amenity value. Analysis drew on comparisons between the case-
199 studies to evaluate to what extent outcomes and success had been achieved.

200

201 **Results**

202 *Substrate for the establishment of healthy trees/woodland*

203 Brownfield sites are exemplified by site variability and instability, soil infertility and site
204 hazards (Moffat and McNeill, 1994). Consequently, risk assessment, remediation and landscape
205 design are priority regeneration tasks. However, tasks that promote healthy vegetation
206 establishment are often de-prioritised due to cost implications. For example, recognising that
207 vegetation has both a preference and a tolerance range to growth, a variety of soil-forming
208 materials at the outer bounds of the tolerance limit are used in brownfield greening without
209 amelioration or amendment. Tolerance ranges can be used both pre-reclamation in species
210 selection and post reclamation to see how conditions are changing.

211 Soil pH at the six case study sites was typically in the range 6.8-7.8, but extremes were
212 observed (pH<3 at Ingrebourne Hill; pH>8 at Russia Dock and Bow Creek). The optimum range
213 for most tree species is pH 5.0-7.5 (Bending et al., 1999). Thus, species selection must be
214 appropriate to ensure establishment and health. In this context, species selection at each site was
215 appropriate. Species tolerant of brownfield land conditions including rowan (*Sorbus aucuparia*
216 (L.)), field maple (*Acer campestre* (L.)) and hawthorn (*Crataegus monogyna* (Jacq.)) and pioneer
217 species such as silver birch (*Betula pendula* (Roth.)) and common alder (*Alnus glutinosa* (L.)
218 Gaertn.) were used at the majority of the case study sites. Extremes in pH have the potential to
219 influence various woodland establishment success measures such as localised tree loss (as seen at
220 IH) and poor growth rate. Regarding success for woodland establishment according to species
221 suitability to soil pH, all case studies were successful.

222 Soil chemical quality was assessed using total and calcium chloride extractable
223 concentrations (CaCl₂-extractions representing the mildly extractable or 'bioavailable' fraction
224 (Landrum, 1989)) for various metals, metalloids and nutrient concentrations. Tolerance levels of
225 metal/metalloid total soil concentration vary between plant species and individuals, growing
226 medium and condition, so conservative literature values were used (Table 4). Two case study
227 sites displayed localised exceedences relative to published background concentrations for total
228 arsenic and zinc concentrations (Table 4); however, these values did not exceed the tolerance
229 values reported by Dickinson (2000) as suitable for tree planting. Total copper, nickel, cadmium,
230 chromium and cobalt soil concentrations were within background ranges (Table 4). Boron, lead
231 and barium tolerance values were exceeded at 3, 1, and 1 sites, respectively. However, these
232 exceedences were localised and mean values per site zone were less than the published tolerance
233 values and, although tolerance values are conservative to take account of species and site
234 variability, the broadly acceptable metal/metalloid total soil concentrations across the case studies
235 nevertheless represent success in terms of contamination abatement. Observed values for
236 available concentrations and uptake (recorded as leaf concentration) enable a site specific
237 prognosis of vegetation establishment success. In the following sections, available
238 metal/metalloid is discussed with respect to observed leaf concentrations and field notes to
239 elucidate causes of poor tree health and growth.

240
241 *Insert Table 4. Ranges of total soil concentrations recorded at the case study sites and the*
242 *literature values used for comparison.*

243
244 All sites displayed widespread deficiency of available potassium, phosphorus and
245 magnesium. For example, at Thames Barrier Park (TBP) all but one of the samples were deficient
246 in available potassium and phosphorus and over half were deficient in available magnesium, in

247 comparison to literature guidelines. At Russia Dock (RD) all samples were deficient in available
248 phosphorus, contained adequate magnesium, but were deficient in potassium at approximately
249 one third of the sampling locations. The least fertile site with respect to tree growth was
250 Eastbrookend (EBE) where all samples suggested a deficiency of available potassium,
251 magnesium and phosphorus. At these sites, the prognosis for healthy tree growth was poor – this
252 suggests that TBP, RD and EBE did not succeed in providing a suitable medium for sustainable
253 tree growth.

254 The successful establishment of a diverse wildflower grassland favours soil of poor
255 fertility (Agate, 2002). In contrast to nutrient availability for tree growth, soil fertility exceeded
256 wildflower's preference range with respect to available potassium and phosphorus (Table 4) at all
257 sites except TBP and Ibstocks (IBS). High fertility constrains wildflower meadows because more
258 competitive species (particularly grasses) tend to thrive in areas of bare earth required for
259 perennial seed setting (Agate, 2002). The results suggested that only TBP and IBS had a soil
260 resource appropriate to wildflower establishment; Bow Creek (BC), Ingrebourne Hill (IH), RD
261 and EBE were unlikely to be successful in the establishment of naturalistic wildflower meadows
262 without intensive management input.

263

264 *Woodland establishment: vegetation establishment and quality of trees and wildflowers*

265 A number of parameters of vegetation health and quality are useful in determining the
266 success of vegetation establishment, including survival rate, vigour, growth rate (height or
267 biomass) and visual appearance. In this study, tree vigour - expressed as crown density,
268 appearance and elemental leaf concentrations (Table 5) - was investigated. Low crown densities
269 (15-30%) occurred in areas of low nutrient availability, and leaf discoloration (browning)
270 occurred in trees growing in areas of elevated concentrations of available boron, zinc, cadmium
271 or lead. For example, at Bow Creek (BC) low crown density was observed in field maples

272 growing in soils deficient in K, Mg, and P. Low crown density and leaf discoloration could also
273 be related to poor rooting conditions (e.g., soil compaction and water availability) and tree vigour
274 may have been hindered by excessive weed growth.

275

276 *Insert Table 5. Leaf tissue concentration ranges recorded at case studies sites and literature*
277 *values used for comparison.*

278

279 Foliar concentrations of lead, zinc and cadmium were elevated in comparison to published
280 tolerance ranges at each of the case study sites, particularly in certain species. For example,
281 samples of silver birch displayed elevated concentrations of zinc in two third of samples at
282 Eastbrookend (EBE) and in all samples from BC. Similarly, eared willow (*Salix aurita* (L.))
283 displayed elevated zinc concentrations in seven out of eleven samples and elevated cadmium
284 concentrations in all samples from Ibstocks (IBS). Five of six grey willow (*Salix cinerea* (L.))
285 samples taken at Russia Dock (RD) contained elevated zinc concentrations. Elevated lead
286 concentrations were recorded in eared willow, silver birch and alder (*Alnus* spp) at IBS. For each
287 species investigated, concentrations were not correlated with soil pH. Other factors may have
288 contributed to the elevated foliar concentrations (e.g. the propensity of some species/varieties to
289 bioaccumulate, Gussarsson, 1994; Punshon and Dickinson, 1997). Furthermore, the CaCl₂-
290 extractable assessment demonstrated local elevation in the putative bioavailable fraction; e.g.,
291 CaCl₂-extractable zinc ranged 0.2-0.5 mg/l across all case study sites, with ‘hotspots’ of >2 mg/l
292 at each. Local elevations in the CaCl₂-extractable fraction were also noted for lead, boron,
293 copper, barium and cadmium at more than one site.

294 Based upon trees growing on green and brownfield sites, Dickinson (2000) and Sopper
295 (1989) suggested a boron foliar concentration tolerance level of 100 mg/kg, above which
296 decreases in growth may be expected. All sites, except IBS, had boron foliar concentrations in

297 excess of this tolerance level including eared willow and silver birch at Bow Creek (BC); eared
298 willow (all samples) and dogrose (*Rosa canina* (L.), 4/5 samples) at EBE; Eared willow (all
299 samples) and oak (*Quercus* spp, 3/5 samples) at IH; in all grey willow, maple, oak, London plane
300 (*Platanus acerifolia* (Aiton) willd.), false acacia (*Robinia pseudoacacia* (L.) and grey poplar
301 (*Populus x canescens* (Aiton) Sm.) at RD; and, finally, in more than half of the oak, Norway
302 maple (*Acer platanoides* (L.)) and hornbeam (*Carpinus betulus* (L.)) at Thames Barrier Park
303 (TBP). At each of these sites, a high percentage (10-50%) of the total soil boron was CaCl₂-
304 extractable and, therefore, may be considered available for plant uptake. However, elevated boron
305 foliar concentrations did not correlate with visual signs of poor tree health.

306 Foliar concentration measurements do not demonstrate site success or failure alone. For
307 example, many species are capable of tolerating concentrations significantly elevated in
308 comparison to background levels without adverse toxicological effect. These results support other
309 studies demonstrating accumulation of various metals/metalloids in birches (Gussarsson, 1994)
310 and willows (Punshon and Dickinson, 1997). However, long-term monitoring of tree health may
311 be necessary as accumulating species may constitute pollutant pathways to sensitive receptors
312 (e.g., food-chain transfer and leaf litter recycling).

313 The diversity of wildflower species recorded at the case study sites ranged from zero to
314 nine per quadrat and was typically 3-5 species. Some of these areas were dedicated by design to
315 wildflowers (i.e. were seeded for wildflowers, although may not have received the appropriate
316 ground preparation or on-going maintenance). Others were subject to natural regeneration by
317 grasses and wildflowers. At Bow Creek (BC), two wildflower and grassland areas recorded
318 species diversity of 9 and 6 per quadrat. At Ibstock (IBS), species desirable because of their
319 aesthetic appeal, rarity or importance to biodiversity such as yellow rattle (*Rhinanthus minor*
320 (L.)), rough hawkbit (*Leontodon hispidus* (L.)) and devilsbit scabious (*Succisa pratensis*
321 (Moench.)) competed with smothering and/or aggressive species such as common ragwort

322 (*Senecio jacobea* (L.)) and ‘mares-tail’ (*Equisetum* spp (L.)). Furthermore, a natural regeneration
323 area was predominated by bramble (*Rubus fruticosus* (agg) (L.)), creeping thistle (*Cirsium*
324 *arvense* (L.) Scop.), broadleaf dock (*Rumex obtusifolius* (L.)) and silverweed (*Argentina anserina*
325 (L.) Rydb.). At Russia Dock (RD), a wildflower area, whilst containing cow parsley (*Anthriscus*
326 *sylvestris* (L.) Hoffm.) and field rose (*Rosa arvensis* Hudson), also contained the binding cleavers
327 (*Galium aparine* (L.)), poisonous deadly nightshade (*Atropa belladonna* (L.)) and bramble –
328 plants commonly associated with compacted low nutrient soils. Predominance was also observed
329 locally for species favoured because of their ecological function – such as willowherb (*Epilobium*
330 *hirsutum* (L.)), a good provider of pollen and nectar. The diversity of species identified
331 demonstrated that wildflower meadows had not been successfully established and changes to soil
332 preparation or management regimes were required if this objective was to be met.

333 With the exception of Thames Barrier Park (TBP), each case study site displayed
334 localised patches of poor growth in grassland areas (i.e. less than 50 % surface coverage).
335 Physicochemical parameters analysed at each of these locations demonstrated that in most cases
336 the problems related to soil pH, low nutrient availability or compaction. For example, a sampling
337 location at IBS dominated by coltsfoot (*Tussilago farfara* (L.)), ragwort, creeping thistle,
338 willowherb and broadleaf dock may be explained by the low soil pH. At Eastbrookend (EBE),
339 areas of grass surface coverage of < 35 % may have been the consequence of an inappropriate
340 grass seed mix for soil pH 6.0. At IH, soil pH of 3.4 limited the presence of grasses and
341 wildflowers, although oaks, eared Willow, Corsican pine and silver birch grew in the locality. At
342 RD, an area of cow parsley, bramble and red deadnettle (*Lamium purpureum* (L.)) growth,
343 providing on average 25 % surface coverage, suffered from very compacted soil (> 5 MPa) below
344 15 cm depth. Poor quality tree growth (crown densities of 25-40 %) were also recorded for birch,
345 willow, ash, maples and poplars growing in areas with soil compaction (> 4 MPa) at depths as
346 shallow as 15-30 cm at Russia Dock (RD), Ingrebourne Hill (IH), Bow Creek (BC) and EBE. A

347 soil strength value of 2-3 MPa has been found to significantly limit root development (Greacen
348 and Sands, 1980). Non-compacted soil with soil density $< 1.5 \text{ g cm}^{-3}$ to 50 cm depth has been
349 proposed as best practice in brownfield land reclamation for tree establishment (Bending et al.,
350 1999).

351

352 *Amenity greenspace and social value: visitor survey perspectives*

353 A major social sustainability criterion for new greenspace is that it should be wanted by
354 its intended users (Moffat and Hutchings, 2007). Therefore, success criteria included the creation
355 of spaces for diverse activities, local use and the promotion of social diversity. These criteria
356 were reflected in visitor surveys for Thames Barrier Park (TBP) and Eastbrookend (EBE).

357 A comparison of questionnaires conducted at TBP and EBE showed different patterns of
358 use depending on the destination type. The formal design of TBP was intended to create a tourist
359 destination, as well as a place for locals to relax, yet the predominance of occasional and first-
360 time and early afternoon visitors suggests that TBP is a tourist destination rather than a local
361 amenity (Table 6). In comparison, use of EBE is widespread and most visitors arrive by foot or
362 bicycle, which suggests local usage. Previous visitor surveys at TBP suggested that whilst the site
363 was highly regarded by site users, it was relatively poorly used by neighbouring communities and
364 user groups did not reflect the local ethnic diversity of UK census data (Villegla et al., 2006).
365 Thus, TBP did not fully meet the stated aim of promoting social diversity.

366

367 *Insert Table 6. Summary of visitor survey questionnaire results performed at Eastbrookend*

368 *Country Park (EBE) and Thames Barrier Park (TBP)*

369

370 Visitor surveys showed that the reasons stated for visiting EBE and TBP were very
371 similar, including walking, relaxing and exercise, as well as site specific attributes such as fishing

372 at EBE and visiting the café at TBP (Table 6). Respondents pointed out potential improvements
373 for both sites, including signage, information boards and other infrastructure. Addressing these
374 site specific failures may encourage target audiences to visit but would not, in themselves,
375 constitute a measure of success.

376 The importance of wildlife as part of a visit scored very highly at both sites, with 86 and
377 71% of respondents stating it to be ‘very important’ or ‘important’ at EBE and TBP, respectively.
378 EBE respondents also stated that more trees and wildflowers and other animals would be valued
379 improvements, suggesting that existing vegetation was inadequate. The woodland establishment
380 data (soil chemical, vegetation establishment and quality) presented in previous sections raise a
381 number of questions concerning the viability and sustainability of the established habitats (e.g.,
382 because of soil fertility) and demonstrate that reclamation works must be appropriate given the
383 importance of wildlife to visitor experience. In summary, the social surveys highlighted three
384 factors (quality, design and biodiversity) as important site attributes. Quality in design, site
385 delivery and on-going management and maintenance therefore lend themselves as important
386 input and output success criteria, and biodiversity as an important outcome success criterion.

387 Surveys of visitors to urban greenspace typically quote aesthetics alongside safety as key
388 factors that would lead them to feel excluded from a site. Survey data demonstrated an array of
389 problems affecting the aesthetic appeal of the case studies including litter; water-logged paths
390 (because of ground compaction); arson damage; patchy grass growth; unauthorised construction
391 of cycle jumps; and Japanese knotweed (*Fallopia japonica* (Houtt.)) a highly invasive non-native
392 species indicative of inadequate site management. Lack of appeal and low frequency of use may
393 promote anti-social behaviour, neglect and decline, and are indicators of potential problems for
394 the future success of the greenspace.

395

396 **Discussion**

397 Delivering a brownfield greening project on time, on budget, with the ascribed habitats
398 and infrastructure is not enough to guarantee the success of a new greenspace, either in the
399 context of its aims or in the long-term (Sellers et al., 2006). Many project aims and objectives are
400 by definition outcomes and therefore cannot be measured immediately upon delivery of a
401 greenspace, nor can they always be measured directly. This research indicates that there is a gap
402 between measuring outputs as indicators of success and achieving the ‘outcome’ project aims and
403 objectives envisaged. Whilst this research focussed on greenspace projects, the findings are
404 supportive of calls in the literature to promote brownfield development sustainability in the wider
405 sense (Pediaditi, et al., 2006; De Sousa, 2008). This research also, therefore, focussed on socio-
406 environmental outcomes of brownfield regeneration, but not socio-economic.

407 The aim ‘to establish habitats’ had been only partially successful at the case studies, with
408 poor quality tree health (leaf discoloration) and growth (low crown density) recorded. Woodland
409 establishment was compromised in the long term by poor soil nutrient quality and foliar
410 accumulation of metals/metalloids. Applying the logic model demonstrates the need for
411 continuity in design, development, management and evaluation; e.g., the development phase
412 establishes the planting medium - the foundation for the successful establishment of vegetation,
413 however, site developers are typically not the site owner/manager and are unlikely to be formally
414 associated with a greenspace as it matures. Therefore, evaluation of development phase inputs
415 (e.g. monitored by the developer) and project outputs (monitored by the developer and/or site
416 owner/manager) provide a prognosis of success that can only be affirmed by monitoring and
417 medium- to long-term outcome evaluation. Ensuring continuity in evaluation through the project
418 phase and post-regeneration will help ensure successful long-term project delivery.

419 With respect to the provision of quality greenspaces with social and amenity value, the
420 success of the case study sites is also questionable. The use of the sites by age and ethnically

421 diverse groups was an outcome aim for Eastbrookend and Thames Barrier Park; yet visitor
422 surveys indicate that this aim has not yet been achieved. Managers should determine whether this
423 can be achieved by further work or if the original project aims were unrealistic (see Villeda et al.,
424 2006).

425 Improved access to 'quality' greenspace is a common aim in greenspace establishment
426 projects (whether green- or brown-field land regenerations). Successful delivery of this aim
427 requires an understanding of greenspace 'quality'. Yet, greenspace 'quality' is an emergent
428 property, complex to understand and deliver. Greenspace quality needs to consider all users of the
429 greenspace (NAO, 2006). Harshaw et al. (2007) stated that visitor satisfaction is a
430 multidimensional concept dependent upon not only resource, social and management settings but
431 also socio-economic and cultural characteristics, experience, attitudes, preferences and norms.
432 This research support claims that large capital expenditures do not guarantee visitor satisfaction,
433 quality or success, but that design and on-going management and maintenance are influential.

434 Greenspaces are dynamic places: vegetation grows, ecological succession takes place and
435 social attitudes toward the place change. Given this dynamism, a greenspace considered
436 successful relative to establishment aims may become 'unsuccessful' or 'less successful' as the
437 roles it is expected to fulfil change. Thus, in the context of greenspaces, success is more than just
438 'attaining a desired state': it has to be embedded within a process of review and re-evaluation as a
439 site matures. A site management plan typically contains sub-sections on monitoring but not all
440 sites have such a plan and the monitoring specified may not support assessment of outcomes,
441 especially where the focus is on quantitative measures. Irrespective of the history or primary
442 functionality of the greenspace, evaluation of data collected is required to assess outcomes, to
443 manage the greenspace more effectively, to identify good practice and to allow accurate reporting
444 to key stakeholders (DETR, 1999). Given the social and environmental benefits of a quality

445 greenspace, the presence and appropriate management of greenspaces should be welcomed, even
446 in light of the establishment and maintenance mentioned above.

447 Monitoring and evaluation affords many opportunities over and above assessment of
448 project delivery including:

- 449 i) supporting the site management cycle - management efficiency and effectiveness,
- 450 ii) informing funding bodies and other stakeholders,
- 451 iii) learning lessons,
- 452 iv) formulating best practice,
- 453 v) providing opportunities for community engagement.

454 Characterisation of outcomes is not always dependent on expert assessment; rather, many
455 indicators (such as bird and butterfly counts) can be captured by local residents or volunteer
456 groups, which is in itself an opportunity to deliver against social outcomes such as education,
457 volunteering and encouraging community cohesion. Problems associated with long-term
458 monitoring and evaluation should also be recognised, including cost, time, skills-base and
459 stakeholder capacity (e.g., see De Sousa, 2008). Therefore, capital regeneration funds must be
460 supported by a revenue package to manage and maintain the established greenspaces, and fund
461 monitoring.

462 This research supports the UK's National Audit Office call for increased investment and
463 quality standards for urban greenspace (NAO, 2006). Different forms of greenspace require a
464 range of appropriate benchmark standards encompassing *inter alia* recreational spaces, habitats,
465 green-infrastructure and formal planting. Such benchmark standards should be refined through
466 multidisciplinary input, peer-review and ongoing research and applied via the site management
467 plan review. The research highlights the need for sustainability objectives to be defined and
468 agreed for each site as a matter of good practice to drive delivery and success (Doick et al.,
469 2009).

470 Success for brownfield greening projects can be defined as the on-going delivery of site aims
471 and objectives. This requires developers and managers to shift their focus from project
472 completion to project outcomes and to adopt a fluid monitoring and evaluation process of
473 greenspaces. Such a process must integrate a broad range of stakeholder perspectives and be
474 designed with long-term sustainability of the greenspace in mind. This research does not
475 disregard the efforts made towards the successful regeneration of brownfield land, but rather
476 aimed to emphasise the need of a clear understanding of success, adapted to the context of
477 regeneration and evaluated in terms of its outcomes, rather than just its outputs, in order to strive
478 towards sustainable quality greenspaces.

479

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485

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Tables:

Table 1. Impacts of greenspace establishment from regenerated brownfield land used in the identification of evaluation criteria of a successful greenspace.

Economic	Social		Environmental
	Social – Community	Social – Civic	
Cost (reclamation and regeneration)	Access (accessible resource, community aware of site)	Aesthetics – site and locality	Air quality, temperature and pollutants
Economic regeneration	Amenity and facilities and public use of site	Community engagement in local political issues	Biodiversity – populations and biodiversity action plans
Employment (prosperity and affluence)	Community development, cohesion, interaction	Connectivity networks	Resilience to and mitigation of climate change
Energy efficiency (heating/cooling)	Cultural heritage conservation (built environment)	Crime reduction	Flood alleviation and mitigation
Inward investment	Education / life skills	Design (especially at the landscape scale)	Habitat (provision and delivery of BAPs)
Land value (property rental prices; revised tax base)	Health and well-being - healthier environments	Legislative and risk of potentially contaminated land	Natural heritage conservation (flora, fauna, landscape)
Regional image: tourism, commerce, industry	Neighbourhood renewal / Renewed sense of place	Planning (delivery of local strategic needs)	Soil quality conservation
Revenue for management and maintenance	Recreational asset	Sustainable communities - waste / energy	Water quality conservation

Table 2. The six case study sites

Site	UK OS Landranger map grid reference	Regeneration year	Regeneration costs £ (£/ha)	Site history
Bow Creek Ecology Park, Limmo Peninsular, East London (BC)	TQ386817	1996 (initially) and 2006	£1.2 million in 1996 (~ £460,000)	Initially marshland, the Victorians converted the site in to a coal wharf and then, in 1912, a rail marshalling yard for 68 years whence forth it lay unused until construction of the Dockland Light Railway extension. Construction exposed hitherto buried soils containing zinc, arsenic, copper and mercury hotspots. Soils were imported (200 mm depth) and grass sown. A complex 2.6 ha ecology park was built and opened in 1996 featuring patches of woodland and wetland areas fed by water sluices. By 1998, the park had severe problems including incorrectly managed wetland systems, collapsed embankments, unsafe boardwalks and was closed on safety grounds. A further £2 million was invested in re-landscaping in 2006 (one year after the data for this study was collected) and, recognising the sites limited vehicular access and vulnerability to vandalism, a new management plan was created, the site re-opened in June 2006.
Eastbrookend Country Park, Rush Green, Romford, London (EBE)	TQ507859	1995	£2.5 million (~ £31,000)	From 1920 to the 1950s this area of farmland (80 ha) was opened for gravel extraction and, subsequently, in-filled with uncontrolled waste. After closure, the area was vacant until the 1980s when it was converted to a country park with a low budget. Natural regeneration was preferred to active restoration although various waste materials, including London Clay, were brought in. The park was split into three areas with distinct management regimes: Fels field, Eastbrookend Grove and a lake, and opened in 1995.
Ibstock (the Daisyfield Landfill Site), Lea Green Road, St Helens (IBS)	SJ514917	1996	(regeneration obligated by planning; budget unknown)	Formerly agricultural land, Ibstocks (45 ha) is a mosaic of former land uses including a colliery railway site, clay pits (for brickworks) and, subsequently, landfill sites, initially for non hazardous industrial waste (from 1966) but later (1969) for general packaging waste. Contaminant risks include leachate contamination of ground and surface waters and methane production. In 1996, planning permission was obtained for further clay extraction, land-filling of the void and limited restoration of closed landfill areas to green open space with community access. Poorly executed, remedial works were subsequently required including deepening the soil resource to > 300mm. Previous surveys recorded nothing of ecological significance on site. Daisyfields - a 4 ha ex-landfill site – was the only part of the Ibstock site surveyed in this study.
Ingrebourne Hill community woodland, Rainham, Hornchurch, Essex	TQ526836	1996 (initially) and 2007	(regeneration obligated by planning; costs unknown)	Originally agricultural land, the 74 ha site was used for sand and gravel extraction between 1932 and 1960, followed by uncontrolled tipping and land-filling. Subsequently, the area was restored with inert soil forming material and soils excavated on site, the new voids being used to created lakes and wetland areas. The site is bounded to the southeast by an SSSI (Ingrebourne marshes). Restoration specifications required soil forming material to a depth of 0.5 m in open areas and to at least 1.5 m depth where trees were to be planted. A shipment of pyritic London clays used to restore some areas led to tree

(IH)				death. Subsequently, the inappropriate material was replaced with new material and replanted. In 2007, two years after the data for this study was performed, £1 million was invested to regenerate the site as community woodland with mixed grassland open space and woodland planting.
Russia Dock Park, Salter Road, Rotherhythe, London (RD)	TQ362801	1980s (initially) and 2003	(initial costs unknown) Restoration in 2003 - £350,000 (£17,500)	Initially marshland unsuitable for farming, the land including the neighbouring village of Rotherhythe, was developed in the 1600's for shipbuilding and docks. By the 19th-Century the docks were handling grain, timber, cheese, bacon, and served as a base for whaling fleets. As ships got bigger, the docks became less suitable and closed in 1969. No contamination issues were reported. Approximately 20 ha, the site was developed as an island of woodland, wetland (based upon a complex pumping system) and open grass, with adjacent sports facilities and an ecology park. Completed in the 1980's, the site was handed to Southwark council. Restoration retained historical and cultural significance such as the old wharf edges. The park declined for many years until a simpler 'sustainable' plan was implemented in 2003 by Southwark Borough Council.
Thames Barrier Park, North Woolwich Road, London (TBP)	TQ414798	2000	£12 million (£1.35 million)	This formal garden (8.9 ha) situated adjacent to the River Thames in the London Borough of Newham is a former dock and industrial chemicals factory. It was left contaminated upon closure of the docks in the 1960s. Creation of the London Docklands Development Corporation (LDDC) in 1981 saw this and surrounding areas regenerated, mainly for housing and commercial development, but also for greenspace. The park was created by clearing the derelict land of physical structures and contaminated soils, capping it with a capillary break layer and importing soils (2.5 m - trees, 1 m - wildflower meadow/ grasses). The park remains sacrificial land, in case the Thames barrier fails. Annual running costs are quoted as £700k (Villegla et al., 2006).

Table 3. Methods of data collection and laboratory analysis.

Environmental research	Soil analysis	Soil cores taken at depths of 30 cm (wildflower areas) or 60 cm (tree areas), containerised, labelled, stored (0-4 °C). Soil pH was determined in the laboratory using a 0.01 M CaCl ₂ solution according to the method of Avery and Bascomb (1982). This solution was subsequently filtered through No 42 Whatman Filters and the supernatant retained at 0-4 °C, until required for elemental analysis. Concentrations were determined for potassium (K), magnesium (Mg), phosphorus (P), boron (B), copper (Cu), zinc (Zn), nickel (Ni), cadmium (Cd), chromium (Cr), lead (Pb), cobalt (Co) and barium (Ba) by Inductively Coupled Plasma – Optical Emission Spectrometry (ICP-OES) (Spectrohm, Germany) following CaCl ₂ or aqua regia digest, using standard laboratory protocols for measurement, calibration and calculation (Kilbride et al., 2006).
	Soil compaction	Penetration resistance was recorded using a modified Bush recording cone penetrometer (Anderson et al., 1980). The penetrometer recorded soil resistance at 0.03 m depth intervals to total depth of 0.45 m (Sinnott et al., 2006).
	Foliar analysis	Grass and wildflower vegetation sampled using a 0.5 m ² quadrat. Vegetation was cut, bulked and stored in a paper bag. Conifers were sampled by collecting 5 current year shoots from 5 trees of the same species cut from the first whorl below the leader (the needles were not stripped off), between early October and mid November. Deciduous conifer and broadleaf trees were sampled by collecting a leaf area equivalent to one A4 sheet of paper of fully expanded undamaged leaves between late July and late August. Trees less than two growing seasons old were not included as they reflect nursery nutrient and contaminant conditions. Crown density was determined according to the methods outlined for each species by Innes (1990).
	Tree and wildflower identification	Tree identification was carried out in the field by qualified personal. For grasses and wildflowers, a 0.5 m ² quadrat was placed at 5 sub-sites per zone and a species count, estimate of percentage cover and species identification performed. Those plants that could not be identified in the field were sampled and returned to the laboratory for subsequent identification using Rose (1991) and Stace (1997) as primary references.
Social research	Visitor survey	Visitor surveys were carried out in Eastbrookend Country Park (EBE) and Thames Barrier Park (TBP). Surveys sought to determine who used the park (in terms of gender, age, income and ethnicity), how they travelled to and how they used the park, what they liked about the park and how it could be improved. At TBP, 103 interviews were conducted over the course of 3 days (one weekend in June and one Tuesday in August) in 2005. At EBE, 119 interviews were conducted in the third week of October, 2005.

Table 4. Ranges of total soil concentrations recorded at the case study sites and the literature values used for comparison.

(mg/kg)	Total soil concentration - literature values										Extractabl e-Mg	Extractabl e-P	Extractabl e-K	
	As	B	Cu	Zn	Ni	Cd	Cr	Pb	Co	Ba				
Mean background ^a	<20	1.1	23	97	25	0.8	42	74	11		Recommended value for tree establishment	>51 mg/l (Index 1)	>16 mg/l (Index 2)	>121 mg/l (Index 2-)
Background range ^a	0.1-50	0.4-3.1	2-250	10-300	7-70	0.01-2.4	10-121	2-300	2.3-53		Recommended value for wildflower meadows	< 10 mg/l (index 0)	<100 mg/l (Adas 0-1)	
Tolerance level ^a	80	30	600	3000	250	15	1000	2000	240		(Index value given in the parentheses refers to the Adas agricultural Index)			
Background ^b	29		36	140	35	0.8	100	85	9	160				
Intervention value ^b	55		190	720	210	12	380	530	240	625				
Ranges observed at case study sites														
	As	B	Cu	Zn	Ni	Cd	Cr	Pb	Co	Ba	pH	Extractabl e-Mg (mg/l)	Extractabl e-P (mg/l)	Extractabl e-K (mg/l)
(values in parentheses in the table are mean averages) (mg/kg) ^d														
Bow Creek Ecology Park (BC)	21-71 (38)	16-46 (26)	96-224 (157)	259-514 (404)	27-53 (34)	2-3 (3)	37-56 (43)	407-2320 (1010)	9-17 (11)	221-1809 (734)	7.2 – 7.8	29.3 – 385 (100)	0.0 – 4.1 (1.2)	22.5 – 441 (168)
Eastbrooken d Country Park (EBE)	5-17 (11)	5-22 (14)	15-55 (33)	59-247 (105)	14-25 (18)	1-2 (1)	14-45 (33)	35-321 (122)	4-9 (7)	5-22 (14)	5.9 – 7.6	0.0 – 34.9 (10.5)	0.0 – 1.6 (0.3)	0.0 – 26.1 (11.3)
Ibstocks (IBS)	5-19 (13)	32-61 (48)	19-89 (44)	46-88 (71)	45-53 (49)	3-5 (4)	80-144 (92)	39-67 (50)	13-18 (16)	299-591 (402)	3.9 – 7.4	64.4 – 321 (175)	0.0 – 2.6 (0.2)	4.9 – 133 (58.5)
Ingrebourne Hill (IH)	8-18 (13)	12-27 (19)	9-155 (49)	27-234 (125)	17-29 (23)	1-3 (2)	27-54 (41)	12-354 (160)	8-11 (10)	38-227 (130)	2.8 – 8.1	0.0 – 248 (84.9)	0.0 – 14.2 (2.7)	0.0 – 380 (106)
Russia Dock (RD)	12-26 (20)	22-53 (36)	37-212 (98)	186-1400 (462)	23-49 (38)	2-6 (5)	56-106 (85)	141-329 (247)	9-15 (12)	167-285 (214)	6.8 – 7.5	50.4 – 719 (165)	0.2 – 13.3 (5.7)	9.0 – 584 (185)
Thames Barrier Park											7.1 – 7.6	0.0 – 161 (52.2)	0.0 – 16.7 (2.5)	0.0 – 581 (96.2)

(TBP)

^a (Dickinson, 2000)

^b (Crommentujin et al., 2000)

^c (Bending et al., 1999)

^d for metal/metalloid concentrations $n = 9$; soil pH and nutrient conc. $n = 3$ per site zone

Table 5. Leaf tissue concentration ranges recorded at case studies sites and literature values used for comparison.

	Literature Values						
	Ca ²⁺ (%)	Mg ²⁺ (%)	N (%)	P (%)	K (%)	Fe (mg/kg)	Mn (mg/kg)
Tolerance level ^a							300
Deficiency and Optimum levels ^b		< 0.03 – > 0.05	< 1.2 – > 1.5	< 0.12 – > 0.16	< 0.3 – > 0.5		
Sufficiency range ^c	0.13 - 0.16					20-100	50-600
Indicative average concentration	0.06 – 0.35 (in cereals) ^e	0.09 – 0.15 (in cereals) ^e	1.7-2.8 (in trees) ^d	0.14 -0.22 (in trees) ^d	0.7 - 1.2 (in trees) ^d		
Ranges observed across all species studied at the case study sites							
	Ca ²⁺ (%)	Mg ²⁺ (%)	N (%)	P (%)	K (%)	Fe (mg/kg)	Mn (mg/kg)
(values in parentheses in the table are mean averages excluding outlier species (willow, poplar, oak) see text)							
Bow Creek Ecology Park	0.78 – 3.25 (2.07) ^j	0.2 – 1.0 (0.4)	1.3 – 4.3 (2.3)	0.12 – 0.44 (0.22)	0.8 – 3.3 (1.7)	97.3 – 457 (253)	9.6 – 66.6 (26.0)
Eastbrookend Country Park	0.75 - 4.23 (2.12)	0.2 – 0.6 (0.4)	1.0 – 3.5 (1.9)	0.11 – 0.82 (0.38)	0.7 – 4.6 (4.5)	75.1 – 267 (138)	26.5 – 211 (105)
Ibstock	0.31 – 2.99 (1.53)	0.1 – 0.6 (0.4)	1.3 – 3.7 (2.5)	0.15 – 0.40 (0.26)	0.8 – 2.0 (1.2)	79.3 – 838 (194)	44.8 – 3447 (270)
Ingrebourne Hill	0.29 – 3.16 (1.57)	0.1 – 0.6 (0.3)	0.8 – 3.5 (1.9)	0.10 – 0.93 (0.28)	0.6 – 2.7 (1.2)	108 – 742 (236)	22.5 - 6330 (123)
Russia Dock	0.49 – 4.21 (2.35)	0.1 – 0.7 (0.3)	1.1 – 3.7 (2.2)	0.09 – 0.31 (0.18)	0.4 – 4.0 (1.7)	110 – 511 (217)	9.1 – 132 (29.4)
Thames Barrier Park	0.31 – 4.30 (1.58)	0.1 – 0.5 (0.2)	1.1 – 3.1 (1.9)	0.12 – 0.52 (0.23)	0.5 – 1.9 (1.1)	116 – 670 (238)	15.4 – 480 (83.0)
Literature Values (mg/kg)							
	B	Cu	Zn	Ni	Cd	Cr	Pb
Tolerance level ^f *	100	100	900	220	200	30	300
Tolerance level ^a *	100	150	300	50	3		10
Sufficiency range ^c	3-9	2-6	20-50				
Indicative average plant concentration ^g				0.02-5	0.2-0.8	0.03-15	0.1-10
Ranges observed across all species studied at the case study sites (mg/kg)							
	B	Cu	Zn	Ni	Cd	Cr	Pb
Bow Creek Ecology Park	31.8 – 555 (150)	4.5 – 16.4 (9.0)	20.9 – 1240 (55.5)	0.4 – 2.2 (1.4)	0.0 – 2.9 (0.4)	0.3 – 1.8 (0.7)	1.0 – 7.2 (3.8)
Eastbrookend Country Park	25.2 – 176 (72.0)	3.2 – 15.5 (6.6)	10.2 – 348 (37.9)	0.4 – 11.4 (1.3)	0.0 – 2.3 (0.2)	0.3 – 1.2 (0.6)	1.0 – 3.5 (1.6)
Ibstock	23.9 – 66.0 (40.5)	3.9 – 27.7 (12.2)	20.0 – 277 (109)	0.8 – 17.8 (3.8)	0.0 – 4.0 (0.4)	0.3 – 2.5 (0.6)	1.9 – 52.7 (5.4)
Ingrebourne Hill	21.2 – 394 (77.6)	3.0 – 18.6 (6.7)	15.4 – 2771 (63.5)	0.4 – 17.0 (3.3)	0.0 – 9.8 (1.1)	0.3 – 1.6 (0.7)	1.2 – 9.0 (2.7)
Russia Dock	22.9 – 303 (93.8)	3.7 – 12.8 (8.1)	19.3 – 748 (77.4)	0.3 – 9.2 (1.4)	0.0 – 3.3 (0.5)	0.4 – 2.5 (0.8)	1.0 – 6.2 (3.0)
Thames Barrier Park	20.1 – 244 (74.9)	4.6 – 13.1 (7.7)	24.1 – 483 (59.6)	0.4 – 3.7 (1.1)	0.0 – 0.3 (0.1)	0.4 – 2.2 (0.7)	1.6 – 6.4 (3.4)

^a (Sopper, 1989)

^b (Binns et al., 1980)

^c (Brady and Weil, 1999) (for pine trees)

^d (Evans, 1984)

^e (Rowell, 1988)

^f (Dickinson, 2000)

^g (Ross, 1994)

*Tolerance levels are the total concentration in plant foliage that should be considered suitable for tree planting

Table 6. Summary of visitor survey questionnaire results performed at Eastbrookend County Park (EBE; n = 119) and Thames Barrier Park (TBP; n = 103) in Summer 2005. Surveys also sought to determine who used the park (in terms of gender, age, income), what they liked about the park and how the park could be improved.

Greenspace visit frequency		Daily	A few times a week	Once a week	A few times a month	Once a month	Not at all	First Time	Does not say
	EB E	28	28	18	10	12	4	0	0
	TB P	7	11	12	17	23	0	27	3
Time of day greenspace normally visited		Morning	Early Afternoon	Late Afternoon	Evening	Does not say			
	EB E	34	30	22	14	0			
	TB P	41	35	9	3	12			
Mode of transport to greenspace		Car	Walk	Cycle	Bus	Train/DL R	Other	Does not say	
	EB E	61	27	7	4	0	1	0	
	TB P	72	17	1	6	3	1	2	
Activities greenspace used for		Taking Children Out	Being with nature	Walking (with dog / without)	Relaxing	Exercise	Other	Does not say	
	EB E	8	19	33	16	14	10	0	
	TB P	12	3	33	10	3	4	64	
Activities greenspace used for (specified by recipients)	EB E	Sketching	Horse riding	Student education	Bird watching	Cycling	Fishing		
	TB P	Fountain	Riverside Path	Basketball court	'Green Dock'	Children's play area	Café		
Importance of wildlife to greenspace visit		Very Important	Important	Somewhat important	Not very important	Not at all	Does not say		
	EB E	56	30	7	7	0	0		

	TB P	38	33	18	5	4	2
Ethnicity		White	Mixed	Asian	Black	Chinese	Does not say
	EB E	96	0	2	1	1	0
	TB P	83	3	5	5	0	4

Figure 1. Logic root model for brownfield greening projects, including a variety of greenspace aims and objectives and examples for a number of stakeholders.

