Assessing and improving the efficacy of BREEAM in relation to ecology

By

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Certificate of originality

I, Jon Kirkpatrick, declare that this PhD thesis entitled “Assessing and improving the efficacy of BREEAM in relation to ecology” is, except where indicated, my own work and has not been submitted previously in whole or part for the award or any other academic degree or diploma.

Abstract

The loss of ecological integrity as a result of urban spread and construction threatens the overall biodiversity of urban areas and prompts us to consider means of better including ecological biodiversity within development projects. The UK's best practice tool for ensuring the integration of ecology into such projects is the Building Research Establishments Environmental Assessment Method (BREEAM). This thesis seeks to identify the efficacy of the current approach to ecological integration within BREEAM, and enable development to foster biodiversity and ecology more positively in the urban environment. Qualitative and quantitative research techniques were used to develop a new approach to the integration of ecology within an existing and nationally recognised model. This began by exploring the efficacy of and the main flaws in the present system by a survey of ecologists with experience of the BREEAM process. This led to a new approach to establishing the ecological value of urban ecology utilising a new calculation methodology, adapting the current scheme to focus on land use change as a result of urban land use planning and development. This new approach utilises habitat changes at its core to measure positive and negative change and indicate potential design solutions in land use planning within a development. The innovative methodology was tested using an in depth case study to review and discuss its effective application. The outcome was a new way to address the important variables of habitat integration and linkages maintaining ecological integrity and provision of ecosystem services. It is considered that the outlined approach of the new Land Use and Ecology section of BREEAM is suitable for integration into the next iteration in 2010, which will enable development to positively foster biodiversity and ecology in the urban environment.

Acknowledgements

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Also worthy of appreciation are my family and friends too numerous to mention who have been both kind and incredibly patient with me in the long process of finishing a PhD.

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Acronyms used in the text

AWTC	Association of Wildlife Trust Consultancies
BAP	Biodiversity Action Plan
BRE	The Building Research Establishment
BREEAM	The Building Research Establishment Environmental Assessment Methodology (UK based Sustainability Assessment System)
BS	British Standard
CASBEE	Comprehensive Assessment System for Building Environmental Efficiency (Japanese based Sustainability Assessment System)
CIWEM	Chartered Institution of Water and Environmental Management
DREAM	Defence Related Environmental Assessment Method
DS	Design Stage (BREEAM process)
EcIA	Ecological Impact Assessment
EIA	Environmental Impact Assessment
ESP	Ecosystem Service Provider
EV	Ecological Value
GBC	Green Building Council
GBCA	Green Building Council of Australia
GIS	Geographical Information System
GREEN STAR	(Australian based Sustainability Assessment System)
HCR	Habitat Context Rarity
HK-BEAM	Hong Kong Building Environmental Assessment Methodology (Hong Kong based Sustainability Assessment System)
HQE	Haute Qualite Environnemental
IEEM	Institute of Environmental Management and Assessment
IEMA	Institute of Environmental and Assessment
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
JSBC	Japan Sustainable Building Consortium
LBAP	Local Biodiversity Action Plan
LEED	Leadership in Energy and Environmental Design (American based Sustainability Assessment System)
LI	Landscape Institute
MLF	Multifunction Landscape Factor

MOD	Ministry of Defence (UK)
NEAT	NHS Environmental Assessment Tool
NHS	National Health Service
PCS	Post Construction Stage (BREEAM Process)
PV	Plot Value
RF	Replication Factor
SAC	Special Area for Conservation
SPL	Species Population Level
SQE	Suitably Qualified Ecologist
SV	Species Value
TPO	Tree Preservation Order
UKBAP	United Kingdom Biodiversity Action Plan
UN	The United Nations
USGBC	United States Green Building Council
WHO	World Health Organisation
WSSD	World Summit on Sustainable Development

Glossary

Agenda 21	A commitment entered into at the Rio (Earth) Summit (1992) to introduce specific policies to move towards sustainable development at governmental and local level
Biodiversity	Biodiversity is the term given to the diversity at the different scales of ecosystem, habitat and species, including the genetic variation within them
Brownfield Sites	Land in urban areas which has already seen development and is lying vacant. In the UK about 20 per cent of urban land falls into this category
Environmental Cost	A measure of the cost in resource or financial terms of environmental damage or degradation
Environmental Impact Assessment (EIA)	The assessment and evaluation of the impact of development upon a specific site or location. It usually consists of three analytical stages; impact identification, evaluation and comparison. Environmental Impact Assessment and Environmental Assessment are synonymous terms
Environmental Impact Statement	A quantitative and qualitative statement of a broad range of impacts (from ecological to social), whether direct, indirect or cumulative. It is usually a publicly available document prepared by a developer as part of an EIA
Environmental Value	The value attached to an environmental resource in social, economic or cultural terms
Green Field Sites	Land in rural areas which is primarily in agricultural or forestry use
Greenhouse Effect (of a building)	The warming of a building due to the absorption, usually through glass, of short wave solar energy which is stored as heat by elements of construction and prevented from being re-emitted as long wave radiation by the glass
Greenhouse Effect (of the planet)	The warming of the planet due to the increase in density of trace greenhouse gases in the atmosphere. They have the effect of increasing the absorption of sunlight by preventing the outward radiation of heat from the Earth
Hazardous Waste	Particular types of waste which pose direct risks to personal or environmental health
Micro-Climate	The modified climate close to a building usually due to man's intervention
Phenomenon	Occurrence of notable fact, example of situation, issue or concern
Pollution	The contamination of natural resources (water, air, land) or eco-systems by man-made actions and a human reaction to that physical effect
Precautionary Principle	Where doubts exist one should err on the side of caution rather than risk. This implies an anticipatory and preventative approach
Recycled Materials	Products which are manufactured from the resources previously existing in waste

Recycling	The reuse of the resource potential locked within a waste product , including a redundant building
Sample Group	Selected number of representative individuals from a larger body
Sustainability Assessment System	A term used by companies to measure and understand the environmental implications of their operations/ built developments, particularly with regard to pollution
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their needs and aspirations (Brundtland Commission definition). Alternatively, Sustainable Development is based upon development which: "Utilises renewable resources at rates less than the natural rate at which they regenerate, and optimises the efficiency with which non-renewable resources are used"
Thematic Coding	The linking of similar items, objects or concepts using a common theme
Waste Management	The management of waste to reduce the amount generated and to recycle the resources that exist within it

1 Chapter 1 – Introduction to the research

1.1 Introduction

The focus of this research study is split across two fields, firstly the rise of the concept of sustainable development within the urban context which has led to the creation of indicators to demonstrate measurable compliance of the concept itself. Secondly the relationship between these indicators of sustainability and the environment in terms of ecology. Within the UK the most recognised and widely used system used to rate sustainable development within construction projects is the Building Research Establishment Assessment Methodology (BREEAM) (Roderick et al., 2009). The developers and current custodians of the BREEAM rating system the Building Research Establishment (BRE) have orchestrated a growth in significant application from its inception in 1990 used solely on office buildings to a system of international renown (Mistry, 2007). The system is capable of rating the sustainability on any building type, making the urban form comparable in terms of sustainable development and growth. BREEAM utilises set criteria across a number of fields to measure both the potential sustainable benefits (at the design stage), but also the actual impacts on the environment (at the post construction phase).

BREEAM currently represents the benchmark approach to measure the impact of construction projects in relation to their levels of sustainability within the UK. In the arena of urban development and sustainable design, ecology is often an element which receives little forethought and integration. This research represents an opportunity to understand the barriers that are in place to prevent this integration within BREEAM, a nationally (and growing internationally) recognised standard for sustainable development. By proving that ecology within BREEAM can be improved it becomes possible to maximise efforts to benefit ecological connectivity and progress the potential of urban design to integrate with the environment using BREEAM. With BREEAM becoming the de facto standard for government and publicly funded projects within the UK, the system will be applied to a significant number of development projects. This will only expand as the United Kingdom looks to minimise its environmental impacts and meet rising statutory requirements.

The BREEAM process is not only well established but effective as a system overall. It is well understood and forms a simple approach to measuring a complex concept, sustainability. As such BREEAM is the perfect vehicle for expressing sustainability to the uninitiated and therefore is a process to be worked with, not derailed. The research methods undertaken here have been carefully chosen to complement the BREEAM process, and are appropriate to both the way BREEAM has been created but also how it operates. The investigative process utilised looks to improve BREEAM's Land Use & Ecology section from the ground up. Utilising the information available from those individuals using BREEAM in the field (the ecologists) minimises the chance that changes will have a negative effect on the system as the needs of the end users ultimately will be met. Equally it makes the elements introduced into the scheme defensible as they have been introduced on the basis of investigation into issues identified through both experience and professional judgment on the part of the ecologists.

1.2 Background

The background of this research lies in the emergence of sustainable development and how this concept has influenced the construction industry to measure its impact on ecology. At the beginning of the twenty-first century the concept of sustainability as a global concern is widely recognised by world leaders (Adams, 2006) and has been wildly reported and discussed in the media. This recognition at the start of the century was encapsulated within the World Summit on Sustainable Development (WSSD, 2002), whose focus outlined how the first decade of the new century would be one of reflection in relation to sustainability, and in particular about the demands placed on the biosphere by humankind. Sustainability as a modern cultural concept dates back more than 30 years and formed a key theme of the United Nations Conference on the Human Environment in Stockholm in 1972 (McCormick, 1992).

The concept itself was described at the conference in order to propose that it was possible to achieve solid economic growth and industrialisation without significant environmental damage. In the years that followed this concept has been progressively developed into mainstream thinking in particular through the Brundtland Report (1987), and the United Nations Conference on Environment and Development in Rio (1992). This led to significant national and international discussion and wider engagement from governmental organisations and business leaders. As the concept was discussed the definition of sustainable development evolved. The most recognised definition is that found within the Brundtland Report which defined sustainability as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. To many this definition was vague (Lélé, 1991), nothing more than a 'buzzword' (Marshall et al., 2005) and open to significant interpretation (Holling, 2000), but it did capture two crucial elements, namely the concern of environmental degradation that typically follows economic growth, and the need of this economic growth as a catalyst to help alleviate poverty.

As a result the core of sustainable thinking became a concept with three dimensions, environmental, social and economic sustainability. Over the past decades these three concepts have been developed into three models which describe the overall concept of sustainability and have been represented as three pillars, three interlocking rings and concentric circles (Figure 1.1)

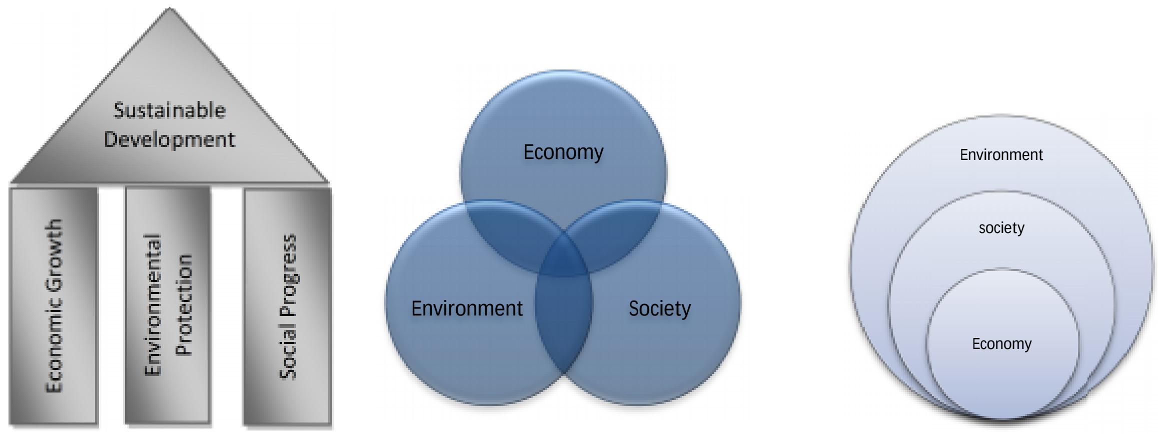

Figure 1.1: The three Models of sustainability - pillars of sustainability, interlocking rings & Concentric Circles (Adams, 2006)

This first model of three pillars is flawed as it implies that trade-offs can always be made between the three dimensions (Adams, 2006). Typically in response to this a distinction is often drawn to allow for elements that cannot be traded (often referred to as 'strong' sustainability) and those elements where trade is permissible ('weak' sustainability). Decisions by governments and businesses allow trade-offs and often put great emphasis on the economic elements above the other dimensions of sustainability. This has led to the second model of interlocking rings to demonstrate that the elements are not in competition but need to work in relation to each other to achieve a central goal, sustainable growth.

This model is also flawed as the assumptive position is that all three elements can work in unison and compliment each other. However the largest flaw is in the fact that the three elements cannot be considered equal. Not only do they contain different drivers but the model does not allow for growth in any element. In response the concentric ring model has developed which best describes sustainability, at the centre is economy as it is a function that emerges from society. Created by society as a means of exchange of economic goods or value it can shrink or grow, but can never exceed the size of society, because all parts of the human economy require interaction among people. Equally society is greater than the economic element as there is much more to society e.g. music and art, friends and families, ethics and religion, all of which vital elements of society, but are not primarily reliant on the exchange of goods and services.

Equally society grows and shrinks in stature dependant on the availability of the economy to support it; however it exists entirely within the environment. The basic requirements to support life (air, food and water) all come from the environment, as do the resources relied upon by society such as energy and raw materials. The environment however is different; it is a fixed system not created by society and has no potential for further growth. The environment underpins both society and economy and the resources it provides present a finite limit on human activity. In early human history, the environment was responsible for shaping society, however today the reverse is true, the activity of human kind is reshaping the environment and the velocity of environmental change is both fast, and increasing. According to Vitousek (1997), 'we are changing the earth more rapidly than we are understanding it'.

The parts of the environment unaffected by human activity are getting increasingly smaller and as urbanisation grows as a phenomena, resources are needed in ever increasing rates. Society however can never be larger than the environment, and so maintaining the environment is the crucial factor in true sustainable growth. BREEAM has been developed along this paradigm and represents one area where sustainability is becoming ever present, the construction industry.

BREEAM as a system to measure and improve sustainability in the urban realm follows the observable fact that sustainable thinking and design are rapidly becoming mainstream practice within the construction profession. The need to measure and benchmark sustainability has followed the rise of sustainability within the construction sector to prove green credentials of buildings. Organisations who's sole focus is the progression and promotion of sustainability such as BRE and the national Green Building

Councils (GBCs) across the world have made significant effort to promote sustainable assessment systems as tools to be utilised by organisations to meet sustainable goals.

The real benefit of the sustainable assessment system is the creation of criteria that create common ground between projects thus allowing comparison. These benchmarks create not only an award for those who attain them, but form education tools on environmental issues for those involved in the process. The use of a sustainability rating system such as BREEAM provides a measure of sustainability and creates an effective industry accepted stamp of approval of a well designed and constructed project.

Given the significance of the environment within the sustainability paradigm, and the rate of urbanisation, how well does a sustainability assessment system work at integrating buildings into the environment and how well does it help to protect the vital ecological resources that growing society needs? Prior to attempting to address these questions it is crucial to understand the importance of ecology in terms of the systems and services it provides, what opportunities exist for integration into urban forms as well as the potential damage that can be done through an unregulated system or a potentially ineffectual system. This research therefore assesses this problem and what can be achieved for the benefit of ecology within a sustainability rating system.

1.3 Research Problem

Given that there is a lack of evidence in literature and therefore recorded knowledge surrounding the implications of BREEAM's use on ecology at the outset of this project, the focus of this research is on the use of BREEAM as a sustainability assessment system to determine whether it delivers as a suitable ecological indicator within a UK context. More specifically the role it plays in the integration of developing urban realm and the protection of the precious ecosystem services that are required to maintain a sustainable development balance. Given that the essence of sustainable development is to protect key natural resources and reduce pressures on the environment, does BREEAM protect ecology as part of its application? As it and other systems spread in popularity are they enhancing the ecological environment through their use? Or creating a potential problem for future generations, precisely what the Brundtland report suggested to be a significant risk.

The extent of ecology within the BREEAM system, its specifically effects and efficacy have not been to date investigated and reported in the literature. Although change has occurred on each section of BREEAM in the past, little work has been undertaken in updating or evaluating the Land Use & Ecology section. As the efficacy is unknown the potential benefits or impacts are also not understood. At the start of this research project there was little understanding of how effective BREEAM currently is at improving ecological quality. Understanding where BREEAM succeeds and fails in affecting ecological quality from developments is crucial if it is to grow and develop as a methodology for gauging sustainable development. As the urban population grows, so too will the efforts of the construction industry to meet increasing demand for buildings and urban spaces. People utilise buildings in a range of ways, and for the first time in history, 2008 saw more of the planets population living in an urban context rather than a rural one (UNFPA, 2008).

Cities are becoming more and more important as populations grow, and the development of the urban realm is only going to intensify over the coming decades. At one point shelter was the prime concern. But as time has progressed specialist buildings have been created to perform key roles with in society. Buildings are used to live in, to learn in, to recuperate when we are ill, to distribute goods and services and buildings are needed to maintain cultural cohesion. But buildings also occupy space in an environment effectively blocking the natural succession of vegetation and habitat. It is this integration of buildings into a landscape which is the focus of the Land Use & Ecology section of BREEAM, and it is at this border where the efficacy of the system needs to be established.

1.3.1 Research objectives and hypothesis

The following presents the leading questions for this:

1. Given that the environment is a key component of sustainability (and therefore so is ecology), does BREEAM as a sustainability assessment system address ecological issues?
2. Could BREEAM be harming ecology?
3. Is the format of the UK's leading Sustainability Assessment System (BREEAM) capable of improving ecology?

4. Is the system fit for purpose in its current structure and format?
5. Assuming its efficacy is not 100%, can it be improved?
6. What are the risks to ecology and the environment?

Answering these questions will help determine if the following hypothesis is correct:

Ecology does not have to exist outside the urban realm, it can be integrated into the urban form and through the use of a nationally recognised sustainability assessment vehicle such as BREEAM, the boundary between human development and nature can be blended for the benefit of both

1.3.2 Contribution of the research

This research makes a number of contributions to knowledge and in particular the field of urban ecology; firstly this study investigates the efficacy of BREEAM in relation to Ecology to determine if the UK's leading sustainability assessment system is effective. To date no investigation has been undertaken into the ecological effects of BREEAM's use. Secondly this research has developed an approach to integrate ecology into sustainability in an effort to bridge a gap between science and practical application within building design, demonstrating a possible solution to the problem and proving that it is possible to utilise an existing platform to positive effect. Lastly an innovative calculation approach is proposed to allow the change in ecological value for projects to be measured. This new methodology allows the integration of ecology and sustainable building design through the application of core ecological principles. In addition it also incorporates elements required to maintain complex ecosystem processes.

1.4 Method and thesis outline

This research study has been underpinned using a range of both quantitative and qualitative research techniques including:

- Quantitative data gathering and assessment
    - Ecological habitat surveys, assessment and interpretation

- Qualitative data gathering and assessments
    - Interviews with ecologists
    - Workshops
    - Thematic coding and analysis of phenomena
    - Subjective risk coding and prediction
    - Case study analysis

This thesis does not follow the typical research structure of Introduction, methods, research analysis and discussion. This is due to the subject matter and the lack of knowledge surrounding ecology within BREEAM. It has become necessary to undertake a two phase approach where analysis of the first phase (investigating the efficacy of BREEAM) is required to inform the second phase (improving the ecology component) as a result methods will be identified for each phase and results will be analysed accordingly as identified in Figure 1.2. This approach to research is not without precedent and has been adopted elsewhere in other research efforts (Hickie, 1998).

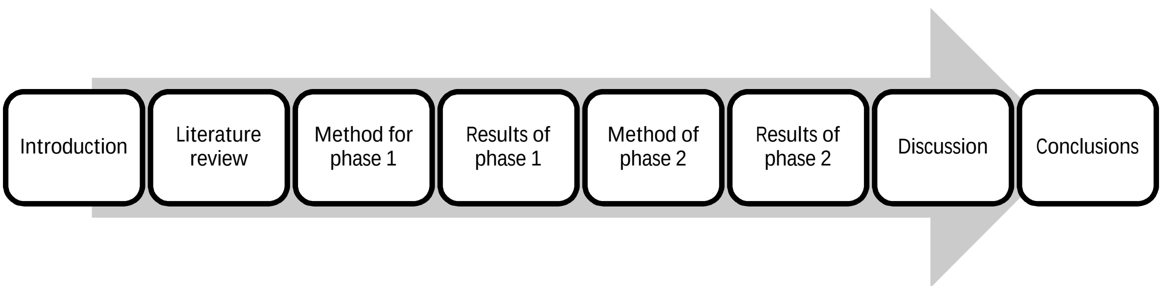

Figure 1.2 Research approach to the thesis

The first phase of investigating the efficacy of BREEAM is contained within chapters three and four of this thesis, with the second phase which aims to improve the ecology component, forming chapters five and six. Figure 1.3 outlines the complete thesis in terms of chapters and represents the iterative and logical progression of this research study.

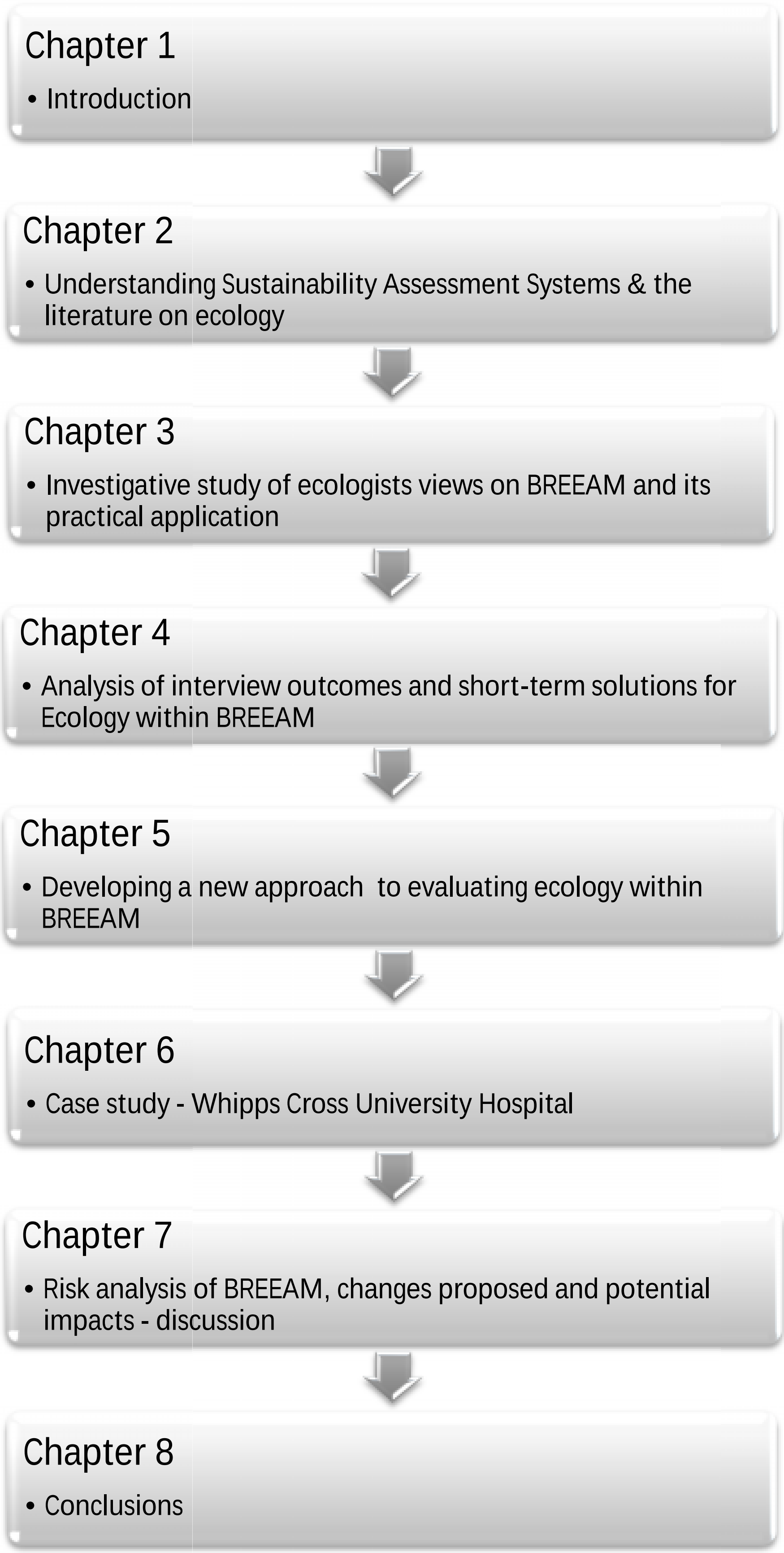

Figure 1.3: The outline of this research thesis

1.5 Scope of this research

In order for effective research in this area to be conducted, limits have to be applied and a scope defined. The following represent limiting factors which help to define the scope of this work:

- Although other sustainability assessment systems are available, the work here centres on the UK's leading system, BREEAM. Other systems are reviewed and comparisons made, however the focus of this project is to establish the efficacy of BREEAM in relation to ecology and improve it wherever possible. It does not extend to the other systems used throughout the world and no effort has been made to improve these and their relationship with ecology.
- In a similar manner no effort has been made to assess and improve the efficacy of the UK's code for sustainable homes. Although effort to improve the code naturally follow changes in BREEAM, BRE are not in ownership of the code so changes here would not directly affect it, (though by changing BREEAM, the code may be influence in the future).
- BREEAM encompasses many aspects of environmental impacts and sustainability, including water and energy use and the material choice in building construction. Each have their own section within the system and are vital to the overall sustainability picture, however the function if this research project is to concentrate on one section alone, that of Land Use & Ecology.
- The key aim is to understand the mechanics of the section, how it works and more importantly how well it works. New knowledge will be demonstrated in the analysis of the efficacy as well as utilising a new solution to the problem. Further new knowledge is demonstrated in a new approach to calculating environmental value designed to integrate into the proposed changes to BREEAM.
- The outcomes of this research project represent an effective blue print to change the BREEAM system in relation to ecology. It has been conducted with the knowledge and consent of BRE but has been done so independently of BRE. BREEAM is a commercial entity and as such the changes recommended here represent an opportunity for BRE not an expectation. Further work will have to occur to ensure the changes are conducive to any planned amendments to other sections as part of the next revision of BREEAM, the nature of which are outside the scope of this work.

1.6 Summary

The aim of this research is to investigate the efficacy of BREEAM as the UK's leading assessment tool in relationship to one of the fields within BREEAM, ecology. In addition it will establish a methodology to strengthen it into a scientifically defensible mechanism to improve the quality of ecology within the UK's construction programme. This research project has developed in an iterative manner through the investigation of how BREEAM works as an assessment tool, its relationship to ecology and its global position in relation to other systems (Chapter two). As well as the experience of those tasked with its implementation (Chapter three), understanding how the efficacy of the system can be improved (Chapter four) before developing a new approach for projects to better interact with their environments and improve the quality of ecology on development sites (Chapter five). This new approach has been tested on a large scale construction scheme utilising a case study approach (Chapter six) before being discussed and critically reviewed itself in terms of risk to both the environment and the incumbent system (Chapter seven). The new approach, its development and the process itself is summarised in Chapter eight to make clear the new contribution to research on the topic and to provide a conclusion of the outcomes of this project including a vision of the future of ecology within BREEAM.

2 Chapter 2 - Understanding BREEAM, how it works and its relationship to ecology.

2.1 Introduction and aims

In order to understand the efficacy and potential development for ecology within BREEAM, it is important to understand BREEAM's relationship with sustainability and how it works as a system. It is also important to understand its current position and relationship with other comparable systems currently in use. However by far the most crucial element is in understanding how ecology as a science relates to BREEAM. This chapter aims to investigate the main assessment methodologies in relation to ecology and in particular focus on the main UK methodology of BREEAM. Reviewing in particular the ecological components and approaches, it will assess the drivers behind these tools and their mechanics in order to understand how assessment tools work within a UK context. Finally the chapter will review the current relevant literature on ecology and conservation biology in relation to urbanisation in a bid to identify what is addressed and what has yet to be addressed within the BREEAM approach.

2.2 The development of BREEAM – Paralleling sustainability

To understand the current context of BREEAM, it is important to understand how the concept of sustainability has developed over time and how BREEAM has developed within it. Although the concept of living in a sustainable way can be traced back to the ancient Greeks (Lovelock, 1987) the modern concept as initially stated in the last chapter began in the late 20th century in the 1970s. 1972 saw the issuing of an important document, the 'Limits of Growth' commissioned by the Club of Rome and produced by the Massachusetts Institute of Technology (Meadows, 1972). This along with the Stockholm Conference on the Human Environment not only introduced the environment to government (creating a wave of regulation), but also cemented it the general public's mind. Table 2.1 charts the growth of the environmental awareness from 1972 to the next global environmental milestone in 1987 with the release of a report by the Brundtland commission entitled ‘Our Common Future’.

1972	- "The Limits to Growth" Report - Stockholm Conference on the Human Environment UN
1979	- Berne Convention on Habitat Protection (Council of Europe) - Geneva Convention on Air Pollution
1980	- World Conservation Strategy (IUCN) - Global 2000 Report (USA)
1983	- Helsinki Protocol on Air Quality (UN) - World Commission on Environment and Development (UN)
1987	- Montreal Protocol on Substances that deplete the Ozone Layer (UN) - Our Common Future (Brundtland Commission on behalf of the UN)

Table 2.1: Sustainability milestones in the 1970s and 80s

The release of the report ‘our common future’ by the Brundtland commission is a significant milestone in the history of sustainability as it is the point where the concept of environmentalism became the goal of sustainability. The report identified that the degradation of the environment along with the use of resources by the general public could not be sustained and that the protection of the environment was the duty of society as a whole. The focus of the report was to safeguard social wellbeing through the prudent use of resources thereby raising the quality of life for future generations. The report was the first to give a meaning for the term sustainable development and defined it as:

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987).

This definition has been widely accepted but not by all (Kates et al., 2005). Equally for many environmentalists the idea of sustainable development is an oxymoron as development and growth entails resource use and therefore environmental degradation (Redclift 2005). Despite the mixed views on the definition, following the release of the Brundtland commissions report, the 1990’s saw an increase in both public and governmental knowledge as well as interest in the environment by the European community. These milestones are identified within Table 2.2.

1990	Green Paper on the Urban Environment (EC)
1992	Rio Summit Agreements (UN) Our Common Inheritance (UK)
1994	European Environment Agency Established (EU)
1997	Kyoto Conference on Global Warming

Table 2.2: Significant sustainability milestones in the 1990s

The production of the European Commission's Green Paper on the Urban Environment (1990) was another significant milestone in the sustainability timeline as it was this document that helped to establish the framework for widespread change at the community level, effectively utilising the Brundtland approach of society as a whole to make changes for the betterment of the environment. The green paper looked to initiate effective change on a number of environmental issues ranging from energy use and noise abatement to the pollution of waterways and the effects of increased levels of man-made gases such as carbon dioxide (the beginnings of the concept now referred to globally as climate change). The most significant outcome of the green paper, however, was that it prompted national governments, authorities and organisations to react to the declining quality of urban life that had developed across Europe. As a result key European governments such as the UK moved the emphasis of policy towards environmental quality and identifying benchmarks for sustainability.

In 1990 in response to the changing attitude to environmental awareness, a government think tank the Building Research Establishment (BRE) developed a system to score the sustainable elements of new offices. Entitled BREEAM 1/90 the Building Research Establishment Environmental Assessment Methodology took the form of a checklist designed to promote the design and construction of buildings which are friendlier to the environment (Prior, 1991). This first form of BREEAM had 25 credits available to be scored across 19 issues and represented a certificated process with buildings being rated out of 25. The assessment had three key areas dividing the issues into those that were Global in effect, those that were on a neighbourhood level, and those that affected the building internally. By 1991, 50 major buildings had been put forward for voluntary assessment, and with further interest from organisations looking to assess other types of buildings (such as supermarkets) further development began.

The uptake of this system in 1991 however remained slow, as although the concept of sustainability had been defined in 1987, the European Union did not make a commitment to it until 1992. This was embodied within the Maastricht Treaty, which defined two key concepts namely futurity and resource conservation:

- Futurity – the duty on the current population to consider the potential needs of future generations through focusing on the continuation of the planet being in a healthy and fit state.
- Resource conservation – the duty of care bound to the current population to respect resources that are non renewable in nature such as land, minerals, water, energy and biodiversity.

It was the Maastrict treaty that adopted "sustainable and non-inflationary growth respecting the environment" as a core principle which became a foundation of the European Union approach to the environment (Wilkinson, 1992). 1992 also saw the UN Conference on Environment and Development (The Rio Earth Summit) held in Rio de Janeiro. The significant outcome of this conference saw 160 world governments including Britain commit to its recommendations resulting in the adoption of four aspects or elements of sustainable development namely:

- Agenda 21
  - A programme of action that set out to achieve a greater sustainable model of development
- The Climate Change Convention
  - An agreement between countries which established a framework for action to limit the emissions of so called "greenhouse gases" and thereby reduce the risks of global warming.
- The Biodiversity Convention
  - An agreement between countries which identified approaches to protect species and habitats on a global level and their diversity.
- Treaty on Forest Principles: A Statement of Principles
  - Set out for the management, conservation and sustainable development of all the forests across the world.

This boost in efforts to promote sustainable development was evident by 1993 when a new BREEAM for newly built and existing offices as well as a system for rating industrial units had been produced, utilising an improved number of criteria for scoring (with over 40 credits now being available). Achieving certification had become much harder for organisations to achieve and far more desirable.

Architects and developers began using BREEAM as a tool to certify the environmental credentials of their buildings.

2.2.1 Need for sustainable development

A rise in interest for sustainable development in the early 1990s led to more scientific evidence and greater understanding of environmental impacts from industrial processes and the operation of buildings (Shrivastava, 1995). A growing list of stressors formed in the consciousness of the public and the scientific community and impacts generated higher profiles from media attention, key impacts included:

- Ozone Depletion
- Global Warming
- Toxic Wastes (production and disposal)
- Natural Resource Scarcity
- Loss of Biodiversity
- Industrial Accidents (including chemical and oil spills)
- Air Pollution
- Acid Rain

The UK government met this rising challenge with the production of the policy document Sustainable Development: The UK Strategy (HMSO, 1994a). This report fortified the guiding principles of the Bruntland report (1987) looking to strike a balance between environmental protection and development. It also developed key guiding principles to include in future policy and legislation:

- Decisions need to take account of the best possible scientific information and be based on the analysis of risks.
- Where there is uncertainty and potentially serious risks are present, a precautionary approach should be taken.
- Ecological impacts must be considered, particularly in case where resources are non-renewable or effects may cause irreversible damage.
- Cost implications should be brought home directly to the people responsible; therefore policy should adopt the polluter pays principle.

In addition to the four key principles outlined above, within this strategy there is greater emphasis by the government to protect environmental resources, wildlife sites and ecosystems. As well as a new definition of sustainable development:

"Sustainable development is the balancing of urban development with conservation of environmental resources - land, air, water, forests and energy" (HMSO, 1994a)

The production of such a strategy brought in a renewed effort to conserve energy, protect resources and highlight ecological issues and in particular conservation issues. It also led to a new paradigm in sustainable design. Design of products, fashions, processes, vehicles and the way we construct buildings became more sustainable. This expanding environmental awareness in the mid 1990s became evident in ethical positions as well as new regulations and policies by designers. Sustainability had become fashionable and desirable and as a result new conceptual models of sustainability began to emerge.

In 1998 in response to this new growth area of sustainability in addition to its now clearer position on resource management (with key elements being recognised), BRE updated the BREEAM standard with its largest overhaul yet. The 1998 format (which is still currently in use) saw the growth of the criteria of the assessment methodology to 9 categories, 110 credits, a score weighting system and minimum standards. With this new approach BREEAM had grown into a world leading sustainable assessment system. The most crucial addition however was the inclusion of thresholds for scores, turning the assessment system from its origins as a certification process with a pass and fail approach to fully fledged rating scheme to demonstrate levels of compliance. This advancement in the system meant that for the first time 'sustainable development' could be measured in the built form, not just a comparison to sustainability principles.

2.3 Understanding sustainability assessment systems in relation to construction

Increasing public awareness of environmental issues during the late 1980s and 1990s has led to the creation of a wide range of environmental labelling schemes (Chau et al., 2000). The most important in relation to the urban built form are the sustainability assessment systems used to rate construction projects, and form the focus of this chapter. This is because sustainable development is unattainable without sustainable buildings and construction (Lai and Yik, 2005). Sustainable construction and the creation of sustainable buildings are the keys to continued and manageable growth. The definition of the term sustainable building is not widely accepted, even though there are many suggested descriptions (Burnett, 2005; Shafii 2005). Although there are many elements and aspects of a buildings construction that will inevitably impact in some manner on sustainable development, those that are of commonly perceived to be essential include: consumption of resources, energy use and efficiency, water, materials, waste, indoor environmental quality (OECD, 2002, 2003). The sustainability assessment systems concerned with construction projects look to include all of these key elements and link them together to assess and showcase high sustainable performance. These systems often cover aspects of the entire construction project from design and construction to operational use and potential demolition.

According to the literature, assessment systems designed to provide an indication of sustainability and sustainable development have three main functions: simplification, quantification and communication (Bossel 1996; Moldan et al., 1997). They distil what it essentially a complex and diversely functioning system into quantifiable or tangible indicators and communicate performance in simplistic terms through recognisable certifications or labels. Therefore these systems at their core are empirical model's of reality (Hammond et al., 1995)

2.3.1 The UK's Leading sustainability assessment system – BREEAM

Although the original BREEAM came into being in 1990 there have been many revisions to the standards. These revisions have fallen in line with progressive changes of UK building regulations and aim to keep BREEAM as a standard set well above that which is legislatively required (Mistry, 2007). Within this section information about BREEAM (including data for tables and figures) has been taken from the BREEAM offices technical guidance (2008a) unless otherwise stated. It utilises generic information to demonstrate how BREEAM works and how scores are established. The BREEAM system is a rating tool that has specific formats for a range of buildings allowing it to be capable of meeting the different functions of key building types. These standards include (BRE, 2008a):

- Offices
- Retail
- Prisons
- Education
- Industrial
- Multi-residential

- Healthcare buildings
- Court buildings
- Existing housing stock
- New Housing

Additional tools include (BRE, 2008a):

- BREEAM Communities (for masterplanning)
- BREEAM Bespoke (for individual projects that do not fit within one of the existing standards)
- BREEAM International (for use in countries outside the UK, presently BREEAM Gulf and BREEAM Europe are under production)

The tools underwent significant changes on the 1st of October 2008 when the standards were released as BREEAM2008. The most significant elements arising from the 2008 update are:

- A new two stage certification process. Previously projects were scored and assessed on the design stage of their development only. This new approach added a post-construction review to ensure plans are followed through into construction.
- Mandatory credits were introduced. In order to achieve the higher certifications minimum scores are now applicable in certain areas to differing extents. This prevented developer's concentrating on some areas, ignoring others and still scoring well overall.
- A new rating level was introduced – BREEAM Outstanding. Up until 2008, 'excellent' represented the highest achievement under the scheme. However this presented recognition for those projects which strive to be as sustainable as possible, it also prevented developers doing 'just enough' to obtain the highest tier of BREEAM certification. The outstanding certification is under the scheme a very difficult achievement and signifies considerable sustainable credentials within a project.

BREEAM is a credit building process with point's available over nine differing areas for meeting set criteria in each, these key areas are:

- Management
- Health & Wellbeing
- Waste
- Energy
- Transport
- Land Use & Ecology
- Water
- Materials
- Pollution

To achieve an award, the criteria are scored, and a weighting process is applied. Table 2.3 shows the weightings applied across the nine sections for both new construction projects and refurbishments. It can be seen that the scheme is heavily biased (in terms of weighting) towards energy with health and wellbeing and materials following closely behind. Water is given the least weight of all sections. This coupled with its low number of credits makes it the weakest of the sections in relation to point scoring. Land Use & Ecology's weighting of 10 makes its overall weight neutral given the number of credits within the section. The overall total of weighted points awarded lead to specific certification awards based on key thresholds and outlined in Table 2.4.

BREEAM SECTION	Weighting (%)	
	New Builds	Building fit out only
Management	12	13
Health & Wellbeing	15	17
Energy	19	21
Transport	8	9
Water	6	7
Materials	12.5	14
Waste	7.5	8
Land Use & Ecology	10	NA
Pollution	10	11

Table 2.3: Weightings applied to BREEAM categories (BRE, 2008a)

BREEAM rating	% score
Unclassified	<30
Pass	≥30
Good	≥45
Very Good	≥55
Excellent	≥70
Outstanding	≥85

Table 2.4: Score thresholds for BREEAM awards (BRE, 2008a)

<u>Minimum standards</u>

In order to achieve an overall BREEAM rating not only must a threshold be scored (over 70% to be awarded excellent for example) but a series of minimum standards must also be met (i.e. a certain number of credits being achieved in each section). The severity of credits needed increases with the level of award. Table 2.5 shows the minimum credits needed in certain sections to score and overall award (BRE, 2008a).

BREEAM Issue	BREEAM Rating/ Minimum number of credits				
	Pass	Good	Very Good	Excellent	Outstanding
Man 1 – Commissioning	1	1	1	1	2
Man 2 – Considerate Constructors				1	2
Man 4 – Building User Guide				1	1
Man 9 – Publication of building information (BREEAM Education only)					1
Man 10 – Development of Learning resource (BREEAM Education only)					1
Hea 4 –High Frequency lighting	1	1	1	1	1
Hea 12 – Microbial Contamination	1	1	1	1	1
Ene 1 – Reduction of CO_2 emissions				6	10
Ene 2 – Sub metering of substantial energy uses			1	1	1
Ene 5 – Low or zero carbon technologies				1	1
Wat 1 – Water consumption		1	1	1	2
Wat 2 – Water meter		1	1	1	1
Wst 3 – Storage of recyclable waste				1	1
Le 4 – Mitigating Ecological Impact			1	1	1

Table 2.5: Minimum standards set within BREEAM for each level of award taken form the BREEAM technical guidance (BRE, 2008a)

In addition extra credits are available for innovation within a scheme that demonstrates excellence in its sustainable performance. Recognition and subsequent award is only applied to innovations that exceed the levels set by BREEAM. Each credit is worth 1% overall to the scheme, and the maximum number of credits per scheme is 10. These credits can boost a score regardless of the level being obtained and can be gained through one of two routes, firstly by meeting the exemplary performance requirements attached to other credits within each section. The second is through application by a BREEAM assessor to BRE Global for recognition of the innovation, be it for a particular design idea, technology or system, approval gains the credit (BRE, 2008a). Once a weighted score is established for each section, the minimum standards met, and any innovation credits sought out, the score is then totalled. Depending on this score's relevance to certain percentage thresholds a certification is awarded (Pass, Good, Very Good, Excellent, Outstanding).

Below is an example taken from the BREEAM technical guidance (BRE, 2008a) represented by Table 2.6, that demonstrates the BREEAM scoring process in brief and general terms. Table 2.7 follows and identifies that the minimum standards have been met within this worked example to meet a 'very good' award threshold.

BREEAM Section	Credits Achieved	Credits Available	% of Credits Achieved	Section Weighting	Section Score
Management	7	10	70%	0.12	8.40%
Health & Wellbeing	11	14	79%	0.15	11.79%
Energy	10	21	48%	0.19	9.05%
Transport	5	10	50%	0.08	4.00%
Water	4	6	67%	0.06	4.00%
Materials	6	12	50%	0.125	6.25%
Waste	3	7	43%	0.075	3.21%
Land Use & Ecology	4	10	40%	0.10	4.00%
Pollution	5	12	42%	0.10	4.17%
Total Score					54.87%
Innovation Credits Achieved					1
Final BREEAM Score					55.87%
BREEAM Rating					Very Good

Table 2.6: A worked example of the BREEAM scoring process (BRE, 2008a)

Minimum standards for BREEAM very good	Achieved?
Man 1 - Commissioning	✓
Hea 4 – High frequency lighting	✓
Hea 12 – Microbial contamination	✓
Ene 2 – Sub metering of substantial energy uses	✓
Wat 1 – Water consumption	✓
Wat 2 – Water meter	✓
LE 4- Mitigating ecological impact	✓

Table 2.7: Minimum standards met within worked example to meet a 'very good' award threshold (BRE, 2008a)

2.3.2 Structure of sections

Table 2.6 also highlights the number of credits available in each of the 9 categories. It is crucial to understand the weighting process as clearly when undertaking a BREEAM assessment understanding which credits are more valuable will enable a development to strategise for a given award i.e. when achieving 'Very Good'. Using this approach is used then it becomes evident that the schemes energy usage is the first priority (to gain an award under BREEAM) as not only is it the section with the most credits available, but due to the weighting, they are worth the most too. In addition understanding how the scoring works allows for manipulation of sections to improve efficacy over all.

As each section varies in the number of credits available as well as the criteria needed to achieve them (i.e. the ease of obtaining them), careful thought will inevitably need to be applied as to the best approach. Equally as the criteria need to be applied to a specific design, the scheme itself will play a role as some credits will be easier to achieve on particular schemes as a result of building design, location and budget along with many other factors. Each credit requires demonstrative evidence of compliance in order to be included in the total. This evidence will have to be demonstrated to the assessor in charge of the assessment and the nature and level of evidence is defined within the section notes in the technical guidance for each category (BRE, 2008a).

2.3.3 The BREEAM process

The process and approach of how a BREEAM assessment is scored has been demonstrated in 2.3.1. However this only explains the assessment methodology, it does not explain its relationship within a project, nor does it explain the stages required to undertake an assessment. The following sections outline the assessment procedure in relation to the construction process to better understand the key mile stones in the scheme. BREEAM (following the last process revision in 2008) is a two stage process. Both stages must be completed in order to achieve a final accreditation. The two key stages are:

- The Design Stage (DS) – which upon completion of an (interim) assessment, leads to an 'Interim' BREEAM Certificate
- And the Post-Construction Stage (PCS) – which upon completion leads to a Final BREEAM Certificate.

The DS assessment is used to measure the potential of the scheduled design in relation to sustainability and is typically conducted before the project begins construction. Although the building is 'certified' at this stage it is only an indication of the potential award and does not represent the final 'as built' award. When this initial assessment process is undertaken it is completely down to the project in question as it will need to be sufficiently developed to be capable of supplying key information to the BREEAM Assessor. The technical guidance is used for scoring as it will be in the second phase of the process and is treated as a formal assessment. Typically this assessment will be undertaken at the scheme design or detailed design stage.

The PCS assessment is the crucial element in achieving a BREEAM certification and converts the interim assessment into an 'as built' performance rating. In order for this part of the process to be carried out it is necessary to wait until practical completion of the building works but before there is a hand over or occupation of the project. The approach of the PCS is through two distinct routes, in projects that have undertaken Design Stage assessment, the PCS serves as a review process to ensure all elements remain accurate in the translation from design to construction. For those projects which do not have a DS, the PCS can be used as a full assessment to gain certification.

2.3.4 Ecology within BREEAM

The 'Land Use & Ecology' section of BREEAM represents 10% of the overall credits available, and due to the weighting, has a direct link to the overall score with each credit being worth 1% of the final total. The following sections briefly outline the credits for Land Use and Ecology and indicate the range of issues covered by the assessment system. Information quoted is in reference to BREEAM offices technical guidance (BRE, 2008a), however the same information is utilised across the range of standards, with only two exception outlined in 2.3.4.7. In relation to the ecologist's role, technically it only extends to gathering data and offer design advice, typically however assessors rely on ecologists to undertake reporting for ecology, often the entire section (Including land use). The following sections also outline the roles for ecologists and specialists within each credit.

2.3.4.1 LE1 – Previously developed land

"Where evidence is provided to demonstrate that the majority of the footprint of the proposed development falls within the boundary of previously developed land" (BRE, 2008a)

LE1 is typically addressed by the BREEAM assessor as this does not need specialist knowledge. However in some cases ecologists are asked to complete this section if asked to undertake the entire section of behalf of the developer.

2.3.4.2 LE2 – Contaminated land

"Where evidence is provided to demonstrate that the land used for the new development has, prior to development, been defined as contaminated and adequate remedial steps have been taken to decontaminate the site prior to construction" (BRE, 2008a)

LE2 is another credit that is unlikely to be undertaken by an ecologist (unless the ecologist is also a specialist contaminated land consultant). The only exception to this is the ecologist role in identifying invasive plant species. Under BREEAM 2008 Japanese Knotweed (Fallopia japonica) and giant hogweed (Heracleum mantegazzianum) constitute land contamination, although easily recognisable, the ecologist may have a role in identification and advice.

2.3.4.3 LE3- Ecological value of the land and Protection of ecological features

"Where evidence provided demonstrates that the site's construction zone is defined as land of ecological value and all existing features of ecological value will be fully protected from damage during site preparation and construction works." (BRE, 2008a)

The value of the land can be determined with a checklist as part of the BREEAM assessment guidance (using Form A4 within the guidance, a dedicated BREEAM reporting form created by BRE) or on the judgment of a Suitably Qualified Ecologist. The use of an ecologist will generally result in a more accurate determination. The ecologist will also have a role in identifying the ecological features (if any) on site in need of protection.

2.3.4.4 LE4 – Change in ecological value

"Where evidence provided demonstrates that the change in the site's ecological value, as a result of development, is minimal or positive."

The ecologist has a role here to survey and identify the ecological value of the site using the calculation methods set out in the credits criteria and establish what the overall change in species number (i.e. plants) is. The ecologist may have a role in offering advice or guidance in design to ensure the overall effect of change is positive (or minimal). However this is not the case in every project.

2.3.4.5 LE5 – Enhancing Site ecology

"To recognise and encourage actions taken to maintain and enhance the ecological value of the site as a result of development"

The ecologist has a role under this credit in determining the difference between 'enhancement' and 'mitigation'. In order to gain the credit, the ecologist should have a role in advising the projects designer in features that will enhance the site such as the introduction of key habitat types for locally rare species, the introduction of nesting equipment for birds, bats, and other wildlife, or introduction of refuge habitat for reptiles and amphibians. The enhancements are limited only to an ecologist's suggestions and the developer's budget. Enhancements will of course need to be ecologically sound and appropriate.

2.3.4.6 LE6 – Long-term impact on biodiversity

"To minimise the long-term impact of the development on the site and surrounding area's biodiversity"

The ecologist will have a role in the production of a management plan for the site in conjunction with the recommendations set out for enhancement under LE5. It is unlikely that the ecologist will be involved on the project in the long term; however this is not always the case. If it is, however the management plan is the only real opportunity for an ecologist to help shape the direction of the project.

2.3.4.7 Variations – Schools and Prisons

Under the revised BREEAM standards introduced in 2008, there are two significant variations from the land use and ecology credits highlighted above (which apply to all the other BREEAM standards) and those variations are within BREEAM education and prisons. Within education there are an additional two credits:

LE7 – Consultations with Students and Staff – which requires the involvement of the students and staff in the design process and,

LE8 – Local Wildlife Partnerships – which looks to build links between the educational institution and local wildlife groups

The ecologist may have a role dependant on their brief, to either create of facilitate these links. Within prisons the credits are rearranged to remove one credit from LE5 (site enhancement) and add it to LE6 (long term impact to biodiversity) for achieving 2, 3, or 4 of the additional requirements. Finally in theory a Bespoke BREEAM may have a variation in credits that affect ecology; however these would be project specific and not relevant in the wider context.

2.4 Alternative systems to BREEAM

The following sections provide background information on the leading systems currently in use throughout the world, outlining the different approaches and focuses of the countries in which they originate. The global construction industry can demonstrate a history of approach to rating sustainability stemming back in some case to the early global sustainability movements in the 1980s and 1990s. Systems such as BREEAM in the UK and the Leadership in Energy and Environmental Design (LEED) in the USA scheme have developed global profiles and footholds in growing markets both in their respective countries of origin but also international markets. This embedding of sustainability assessment in these growing sectors is leading to the wide spread introduction of benchmarking and rating in the construction sector. Following the brief description of each system is a closer look at the ecological elements and or components within each (These can be found in 2.4.3.)

2.4.1.1 LEED

The LEED assessment system was created in 1998 by the US Green Building Council (USGBC). It forms the American benchmark of sustainability in construction (USGBC, 2008). Stemming from the initial system (New Construction) six versions have since been created namely:

- LEED for New Construction: New construction and major renovations (the most commonly applied-for LEED certification
- LEED for Existing Buildings: Existing buildings seeking LEED certification
- LEED for Commercial Interiors: Interior fit outs by tenants
- LEED for Core and Shell: Total building (minus tenant fit outs)

- LEED for Homes: House construction
- LEED for Neighbourhood Development: at a street or neighbourhood level
- LEED for Schools: Recognises the unique nature of the design and construction of primary and secondary education (referred to K-12 schools in the US)
- LEED for Retail: Consists of two rating systems. One is based on New Construction and Major Renovations version 2.2. The other route is based on LEED for Commercial Interiors version 2.0.

Each version is based on the original system (new construction) in approach and design and has grown to meet the needs of the American construction market. This can be seen in the work undertaken by the USGBC in developing LEED for specific applications such as homes, schools and master planning elements within their new standard Neighbourhood Development. At its core, LEED is similar to BREEAM in that it is a scoring system based on obtaining a set number of points (the LEED equivalent of BREEAM's credits) across a number of focused areas, namely:

- Sustainable sites,
- Water efficiency,
- Energy and atmosphere,
- Materials and resources,
- Indoor environmental quality,
- Innovation.

Within each category there are specific design requirements, each worth credits. Some are mandatory in order to achieve further credits or obtaining the overall award. There are 100 credits available. The grand sum of these credits earns an award dependant on the final tally of points namely, Certified (40-49 Points), Silver (50-59 Points), Gold (60-79 Points) or Platinum (80 Points and above) awards.

LEED is a voluntary programme in the United States and is reliant on developers already being committed to sustainable development and being 'environmentally aware'. Although a voluntary programme, some government authorities are adopting LEED as 'best guidance' on their construction projects. LEED has been produced to meet certain aims and goals and has a central focus on:

- Creating a standard for green buildings in the United States
- To promote the concept of integration and whole building design

- Create a mark that represents environmental leadership within the building industry
- Develop a vehicle for sustainable competition
- Increase awareness in consumers and developers
- Create a change in the construction industry towards sustainable construction

2.4.1.2 Green Star

The Green Star assessment methodology is a voluntary system designed and operated in Australia (GBCA, 2008). Launched in 2003 by the Green Building Council of Australia (GBCA), Green Star draws heavily from other systems already in place, primarily LEED (USA) and BREEAM (UK). The tool is tailored to an Australian market and reflects the antipodean construction approaches as well as a key environmental focus relative to the region. This is managed by different weighting factors, which vary across the states and territories. This weighting creates effectively a different rating system for the vast range of climatic issues and concerns across the continent. Green star has been created to rate commercial buildings, primarily office design, (both in construction and as built) however variations are currently in production to assess other sectors including retail, residential, health and education. The scheme is based around 9 categories namely:

- Energy,
- Management,
- Water,
- Indoor environmental quality,
- Transport,
- Ecology and land use,
- Emissions,
- Materials,
- Innovation

The rating system is 'stars' arranged in six levels with one star being the lowest, and 6 the highest, however only the top three are considers to be eligible for certification. A building with 1, 2 or 3 stars is considered a 'rated building'; however the following certifications are available:

- 4 stars – (Score 45 -59 points) signifies (according to the GBCA) 'best practice'
- 5 stars – (Score 60-74 points) signifies 'Australian Excellence'
- 6 stars – (Score 75 – 100 points) signifies 'World Leadership'

2.4.1.3 Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)

CASBEE is an assessment system developed by the Japan Sustainable Building Consortium (JSBC). Introduced in 2002 as a tool for new buildings it has since been developed into versions capable of assessing existing buildings, renovations and a tool for assessing pre construction designs (JSBC 2008). The system also has the capacity to be tailored to individual requirements and project specifics as such, examples include the capacity to assess, detached housing, temporary structures, regional scale development and urban heat island effects caused by large scale projects. The scheme uses three assessment phases split across the building life cycle (Pre design, Design, Post design) and the assessment covers four categories:

- energy efficiency,
- resource efficiency
- local environment,
- Indoor environment.

CASBEE is unique in the sense that it is not a credit or point building system, but weights building environmental quality and performance as a positive impact against the buildings loading, as a negative impact. The final ranking is demonstrated graphically and then rated as either C (poor) B-, B+, A or S (Excellent), the steeper the line on the graph (or the higher the ratio of positive impacts to negative ones) determines the final score of the building.

The design of the system followed the following base principles (CASBEE technical Manual 2008):

- The system should be structured to award high assessments to superior buildings, thereby enhancing incentives to designers and others.
- The assessment system should be as simple as possible.
- The system should be applicable to buildings in a wide range of applications.
- The system should take into consideration issues and problems peculiar to Japan and Asia

2.4.1.4 Hong Kong Building Environmental Assessment Method (HK-BEAM)

The Hong Kong Building Environmental Assessment Method is an assessment tool which originated as a tailored version of BREEAM (UK). HK-BEAM is a completely voluntary programme that can be used on existing buildings as well as new constructions, and has been designed to certify residential, commercial, and mixed use complexes (HK-BEAM, 2005). HK-BEAM differs from BREEAM through its increased focus on environmental issues as a result of it being adapted to take account of Hong Kong's Planning Standards and Guidelines and the Environmental Impact Assessment Ordinance. Its focus is on improving the performance of the planning, design, construction, commissioning, operation and management of the building with certification only being undertaken at the post occupation stage. Originally established in 1996 it has undergone several revisions and in 1999 a new version was established to assess high rise buildings. In a similar approach to other schemes, the HK-BEAM system aims to promote sustainable construction as well as benchmarking performance for comparison. The overall scoring of the system is point based as with other systems resulting in a percentage score overall. Points are awarded across 6 core areas namely:

- Site Aspects
- Material Aspects
- Energy Use
- Water Use
- Indoor Environmental Quality
- Innovations and Additions

However each core area has a number of sub topics resulting in some 100 best practice criteria needing to be scored against. Different percentage thresholds result in one of four certifications (as with LEED) Bronze, Silver, Gold and Platinum. One significant deviation from other systems is the use a mandatory percentage score for one key aspect. Within HK-BEAM, Indoor Environmental Quality is ranked above all others and regardless of the final overall score, a minimum percentage score for IEQ must first be achieved in order to be certified.

Certification	Overall Score	IEQ Score	Ranking
Bronze	40%	45%	Above Average
Silver	55%	50%	Good
Gold	65%	55%	Very Good
Platinum	75%	65%	Excellent

Table 2.8: Percentage thresholds for awards within HK-BEAM (HK-BEAM, 2005)

2.4.1.5 Haute Qualité Environnementale (HQE)

The 'Haute Qualité Environnementale' or High Quality Environmental standard is the French sustainable assessment methodology for rating construction projects (HQE, 2008). Based on the sustainable development principles set out as part of the 1992 earth summit, the scheme was designed by the Agence de l'Environnement et de la Maîtrise de l'Energie (the French Environment and Energy Management Agency) in 1997 and is currently controlled by the Association pour la Haute Qualité Environnementale. The standard focuses on key themes such as the reduction of natural resource consumption, pollution discharges as well as focusing on the interior of the construction project to improve the overall comfort and health of building occupiers. The scheme is designed to be used on both refurbishments and new builds.

The key themes are split into two parts (internal and external environments) with 7 core elements in each:

<u>Creating a pleasant interior environment</u>

- Hydrothermal control measures
- Visual attractiveness
- Hygiene and cleanliness of the interior spaces
- Acoustic control measures
- Air quality controls
- Measures to control smells
- Water quality controls

<u>Managing the impacts on the external environment</u>

- Integrated choice of construction methods and materials

- The avoidance of nuisance by the construction site
- relationship between buildings and their immediate environment
- Minimising energy use
- Minimising water use
- Minimising construction waste
- Minimising building maintenance and repair

Each core element is independently scored then combined to reach an overall score, the certification results in one of four grades, pass, good, very good and Excellent. According to Bidou (2002) the benefits of implementation of the HQE methodology extend beyond the environment and into the social and economic fields, and these form a significant focus of the system. This is represented through the identification within the scheme of health and internal environment issues, as well as costs and the development of new sustainable materials.

2.4.2 Variations of UK systems – Specialist systems

Although BREEAM is the country's most widespread and recognised sustainability assessment, there are three variations worth noting and in particular their relationship with BREEAM and this research. These are the Code for Sustainable Homes, the NHS Environmental Assessment Tool (NEAT) and the Defence Related Environmental Assessment Methodology (DREAM).

2.4.2.1 The code for sustainable homes

As indicated in chapter one, the code for sustainable homes is now the standard used to rate new homes being constructed in England (CLG, 2009). The Code is an environmental assessment method for new homes based upon BRE's Ecohomes assessment methodology (a specialist BREEAM system for housing) and is capable of rating building on a scale of one to six, with level six representing the highest standard in terms of sustainability. In April 2007, the Code replaced Ecohomes and at that time formed a voluntary scheme to rate housing. On the 1st of May 2008 it became mandatory for each newly built housing to be rated, and a minimum code level of 3 was set. The aim is by 2016 all new housing will meet the codes level six requirements and help meet the government's tight carbon dioxide targets. As of the 1st of May 2008 and the 2nd of June the code applied to Welsh housing, and social housing in Northern Ireland respectively. The code does not apply to Scottish housing. Like BREEAM it contains mandatory performance levels in 9 key areas (CLG, 2009):

- Energy efficiency/CO_2
- Water efficiency
- Use of materials
- Surface water management
- Waste
- Pollution
- Health and well being
- Management
- Ecology

Assessments are carried out in two phases:

a) An initial assessment and interim certification is carried out at the design stage. This is based on design drawings, specifications and commitments which results in interim certificate of compliance.

b) Final assessment and certification is carried out after construction. Based on the design stage review, this includes a confirmation of compliance including site records and visual inspection.

Although the code was developed by BRE and follows a similar structure and process to BREEAM, ownership of the scheme lies with the office of Communities and local Government, and as such is not subject to the review process set out by BRE for BREEAM. Recommendations made for BREEAM however typically are reviewed and incorporated into the Code and as such any changes as a result of this research to BREEAM will be capable of incorporation at a later stage into the Code.

2.4.2.2 NHS Environmental Assessment Tool

The NHS Environmental Assessment Tool (NEAT) was a bespoke BREEAM assessment designed for NHS Estates and the Dti by BRE (2002). Designed to be utilised on existing buildings currently in operation as well as new buildings or refurbishments it was designed to evaluate the impact of NHS facilities on the environment and raise awareness with both staff and patients. Based on the existing BREEAM approach it was introduced in 2002 as a mandatory requirement in order to achieve business case approvals for capital development schemes (it remained voluntary for existing operational facilities). As an assessment methodology NEAT had many benefits, particularly for the NHS as an organisation. It not only increased recognition of environmental impacts but also improved awareness of the developing environmental agenda within the NHS. The holistic approach of NEAT was a first in 2002 for the NHS which up until this point had no central system for assessing environmental performance. Utilisation of the scheme helped to improves NHS building stock through resource efficiency creating a cost effective pleasant environment for staff and patients.

Being a bespoke BREEAM process however the system had several weaknesses inherent in its status as a standalone process. The system was not designed to react to changes in building regulations or improving standards set by the department of health/ industry. This led to NEAT rapidly being out of date and no longer representing best practice. In addition the lack of any third party verification within the scheme reduces the importance of the scheme. For these reasons the NEAT system evolved into a recognised member of the BREEAM family of tools by becoming BREEAM Healthcare in 2008. By forming a dedicated BREEAM standard along side other BREEAM standards, the NHS can ensure the latest requirements and best practice are included in their developments. Reporting and assessment now follows the same process as other standards and will evolve along side them as part of BRE's BREEAM update/ revision process.

2.4.2.3 The Defence Related Environmental Assessment Methodology

The Defence Related Environmental Assessment Methodology (DREAM) is a sustainability assessment system designed by the Ministry of Defence (MOD) for use on military bases and estate to recognise the specific environmental impacts related to the military. The approach is similar to BREEAM in that it is a credit building process; however it differs in several key areas:

- The system scores over four phases the total of which are used to determine an overall final score. The phases are initial survey, design, construction, and operation; with the final score being awarded a year after the building has been occupied.
- The process is automated and exists solely online to allow the MOD central access, minimise paper copies of the assessments and minimise user error as options are limited and controlled centrally.
- Buildings are scored then awarded based on the thresholds of Pass (25%), Good (40%), Very Good (55%) and Excellent (70%).
- DREAM utilises the following categories:

  - Biodiversity and Environmental Protection
  - External Environmental Quality
  - Energy
  - Internal Environmental Quality
  - Procurement
  - Travel
  - Water
  - Waste
- The MOD utilise DREAM on almost all of their building types, however some are not covered within the scheme and in such cases, BREEAM bespoke is used to rate unusual building types such as leisure centres or laboratories.

2.4.3 To what extent do these global and UK alternatives to BREEAM include ecology?

All these systems include either a methodology to address ecology as part of the construction process or have within their design, dedicated credits available for reduction of ecological impacts. None have ecology as a key driver of the system, with most focusing on energy use and material choice as the key components. Only two schemes (BREEAM and Green Star) have dedicated sections which include ecology, the rest distribute the theme of ecology across the scoring process.

Both BREEAM and Green Star link land use and ecology with each other and combine the credits available across both elements. Within Green star, eight credits are available for the section, four related to land use and four associated to ecology. Within Green Star as a whole 100 credits are available. Ecology within BREEAM fairs slightly better within the section, with two credits available to land use the remaining eight are available for ecology. In comparison BREEAM has 102 credits in total split across 9 sections. Of all the alternative sustainability systems BREEAM has the most notable dedication to land use and ecology in terms of credits available and effort required to gain those credits. Green Star as its closest competitor relies on a simplistic calculator process to determine land use change and thus change in ecological value. This calculator is a spreadsheet based tool and is reliant on fixed national data thereby not reflecting regional deviation or local factors.

2.5 Ecological Principles – what's missing from BREEAM?

Section 2.3.4 outlined the six aims within BREEAM's land use and ecology section from which credits can be obtained. These aims represent the criteria to be measured against and as such demonstrate the ecological principles built into the system. Table 2.9 highlights the principles inherent within the aims of each credit within BREEAM's ecology section, the credit themselves have been reproduced from the BREEAM technical guidance (BRE, 2008a), the principles have been deduced as part of this research investigation.

Credit	Credit aims	Ecological principle
LE1 – Previously developed land	"Where evidence is provided to demonstrate that the majority of the footprint of the proposed development falls within the boundary of previously developed land"	Minimisation of land disturbance and land take in development
LE2 – Contaminated land	Where evidence is provided to demonstrate that the land used for the new development has prior to development, been defined as contaminated and adequate remedial steps have been taken to decontaminate the site prior to construction"	Reclamation of polluted land, and minimising use of virgin or unpolluted land
LE3- Ecological value of the land and Protection of ecological features	"Where evidence provided demonstrates that the site's construction Zone is defined as land of ecological value and all existing features of ecological value will be fully protected from damage during site preparation and construction works."	Focus of development within a site to the areas of lower value (protecting ecological features)
LE4 – Change in ecological value	"Where evidence provided demonstrates that the change in the site's ecological value, as a result of development is minimal or positive."	Minimising impacts from construction
LE5 – Enhancing Site ecology	"To recognise and encourage actions taken to maintain and enhance the ecological value of the site as a result of development"	Utilising the development to add ecological value
LE6 – Long term impact on biodiversity	"To minimise the long term impact of the development on the site's, and surrounding area's biodiversity"	Utilising the development to add ecological features that will maintain ecological value and prevent degradation of habitat

Table 2.9: Ecological principles embedded within the land use and ecology credits of BREEAM 2008 (Taken in Part from BRE, 2008a).

The logic of approach of the principles embedded in BREEAM appears initially sound from an ecological perspective, but are they comprehensive? The following sections outline key elements that would appear to be missing from the land use and ecology approach of BREEAM and set out from the literature key principles which indicate sound ecological management. Through a better understanding of conservation biology and ecological management it becomes possible to begin to build a picture of the efficacy of BREEAM. This can only be achieved by understanding the relationship between the core ecological principles set out within BREEAM and comparing them to the literature surrounding conservation biology, and ecological management. The following sections therefore identify through the relevant literature how important these principles are.

2.5.1 Conservation biology – the role BREEAM should be playing

Conservation biology has been described as the scientific study of the nature and status of biodiversity on earth, with the aim being to protect species, the habitats they use and the ecosystem they form from excessive rates of extinction (Soulé and Wilcox, 1980). Originating as a concept created to combat tropical deforestation at a conference held in California in 1978 (Douglas, 1978), it has grown as a science to study disappearing species and eroding diversity within species. According to Soulé (1986), it is best described as a multidisciplinary field drawing its insights and methodology mostly from population ecology, community ecology, sociobiology, population genetics and reproductive biology.

This wide ranging approach is crucial to ecologists as its study helps to better understand the dispersal, migration, demographics, effective population size, inbreeding depression, and minimum population viability of rare or endangered species (Wilson, 2002). The most crucial and fundamental concept within conservation biology is biodiversity, be it the maintenance, loss or restoration of it to maintain ecosystem stability (Hunter, 1996; Groom et al., 2006; Van Dyke 2008). Humans represent the most significant risk to biodiversity with the impacts that are created through changes in our environment, making themselves apparent across vast areas of the globe (Bouma et al., 1998; Jongman et al., 2004).

According to Fry and Gustavsson (1996) the most significant implications on the continuation of biodiversity can be categorised into two broad patterns; land use intensification and land abandonment. Although land abandonment is not a common practice in the UK, (Laiolo et al., 2004; Suárez-Seoanea et al., 2002), the other pattern, land use intensification is becoming more and more common. Land use intensification has been linked to both the loss and fragmentation of semi-natural habitat (Jongman, 2004) in particular from the spread and intensification of urban development.

This issue of fragmentation has become so important that some authors have stated that it is the most significant threat to the conservation of biodiversity on a global scale (Bennet, 2003). There has been a continual loss of semi-natural habitat over the last 65 years (Adams 2003). This united with environmental impacts on a large scale such as climate change and the nutrient loading of the river networks cause the conservation at the local scale to become problematic. Concentrating on small localised areas to create real change is ineffectual, the environment is larger than any one construction project and changes need to be addressed in a more coordinated and bigger picture approach. The UN Millennium Ecosystem Assessment (Sarukhán and Whyte, 2005) has established the five most significant drivers for biodiversity loss world wide: habitat change, eutrophication, invasive species, climate change and over exploitation. The continued development of the urban settlement can lead to all of these and as such should form a consideration in any effort to measure environmental benefits through ecological change. The interlinked nature of ecology, the interconnectedness of living systems, the importance of global natural systems and the passage of energy through trophic levels of living systems are crucial to the overall concept of sustainability (Worster, 1994). It is clear that the current land use patterns seen here in the UK along with associated conservation activities to mitigate impacts are failing to maintain biodiversity, humans must live within its measurable biophysical constraints (Costanza, 2000). Urban ecology can achieve significant gains in biodiversity (Smith, 2006), and nature conservation efforts should concentrate on urban and densely populated area to help protect biodiversity (Knapp et al., 2009). Cities can provide a wide range of habitats for plants and animals which can occur in seemingly unlikely recombinant communities (Angold et al., 2006.) Domestic gardens have as significant a role as conservation areas (Loram et al., 2008) especially through the interaction of native and non-native species creating unique ecological value and habitat types (Maskell et al., 2006). However by understanding the habitat potential of certain plant species it becomes possible to provide a suitable environment for a wide range of animal species, e.g. understanding insect dependencies and use of certain species of trees (Kennedy & Southwood, 1984). Understanding how species use habitat in an urban environment is a key element of urban ecology, however so is understanding how urbanisation affects habitat, e.g. wetlands and brownfield sites are less sensitive to urbanisation than habitats with longer maturity cycles such as woodland (Sadler et al., 2006; Small et al., 2006).

2.5.2 Determining the 'value' of ecology- understanding ecosystem services

The change in ecological value is a measurement that concerns humans because as a species, we benefit from the vast range of processes and resources that ecosystems provide, from clean drinking water, and the removal of wastes through decomposition, to food production and temperature regulation (Kremen, 2005). Humans have a vested interest in maintaining the current support networks created by ecology and as such the services it provides must be considered as the most important measure of 'value' in anthropological terms. It is biodiversity that is crucial in maintaining these services in the long term and therefore the maintenance of biodiversity is a key component of sustainable development not just for individuals but entire communities. The services provided have fundamentally been defined as 'functions', the use of which allow a society to meet its future "goals and aspirations" (Rapport and Moll, 2000) and can be divided into 5 distinct groups: provisioning such as the regulation of water and production of food; regulating, i.e. those that control disease or climate; supporting, those services inherent in pollination and nutrient cycles; cultural, those that create spiritual environments and recreational benefits; and preserving, which includes creating a bank of genetic material, and ensuring maintenance of diversity (Daily, 2000). These key factors not only represent the ability of society to reach it goals and aspirations but also they affect our quality of life and the degree of social experiences (Troyer, 2002).

Measuring the value of ecosystem goods and services is difficult due to two major factors; 1) the value of any resource is highly subjective, and 2) the complex nature of ecology and the interwoven relationships or behaviours between organisms, their surroundings and the processes inherent within habitat types. The first is typically measured in financial terms as either what a service or good is worth if it is sold or its value if it had to be undertaken by artificial means. However there is a significant disparity between what a service costs and what it is perceived to cost. Society as a whole generally sees the services provided by nature as free and although the level of environmental awareness is currently rising, the concept of ecosystem capital (the value imbedded in nature) and its flows must be seen as poorly understood by society as a whole.

The methodology used to value services for decision makers centres around the translation of ecological science into economic terms, in order to determine the consequences of human interactions as economic variables. In essence if certain elements were lost, understanding the impact on human health and well being and therefore the cost of replacing that service (Daily, 2000). This is further complicated by the fact that measurements or assigned values are often taken or made in limited timeframes and applied generically and often flawed. It is important to understand the ecological processes and the importance of those processes relative to ecosystem services to truly inform economic decisions (DeFries et al., 2004).

In understanding the importance of a given process, utilising a weighting factor such as the irreplaceability of a service can help allocate economic value. According to Farber et al. (2002) there are six major methods for valuing ecosystem services:

- Avoided Cost
  - These services allow society to avoid costs that would have been incurred if they were not present (e.g. waste treatment by wetland habitats avoids health costs)
- Replacement Cost
  - Services could be replaced with man-made systems (e.g. restoration of reed beds and natural water treatment processes will cost less than the construction of a new water purification facility).
- Factor Income
  - Services provide for the enhancement of incomes (e.g. improved water quality can increase the viability and commercial effectiveness of fisheries thereby improving the income of an entire employment sector.
- Travel Cost
  - Service demand may require travel, whose costs can reflect the implied value of the service (e.g. the rising value of ecotourism, the very experience of which is sufficient that a visitor is willing to pay additional costs to get there).
- Hedonic Pricing
  - Service demand may be reflected in the prices people will pay for associated goods (e.g. housing with coastal or open views will exceed that of homes without such amenities).
- Contingent Valuation
  - Service demand may be created by posing hypothetical scenarios that involve some applied valuation to alternatives (e.g. the possibility of visitors willing to pay for use of amenities such as increased access to national parks).

Therefore if economics is the language used to determine a measurable unit of value, how are the services determined in the first instance? According to Kremen (2005) the methodology for determining the goods and services in relation to human ecology is a four step process:

1. Step one involves the identification of ecosystem service providers (ESPs) – firstly identifying the species or populations that provide specific ecosystem services then characterisation of their relationships and functional roles.
2. Step two is the determination of the various aspects of community structure that have an influence on how ESPs function within their natural landscape, such as compensatory responses that allow functional stabilisation and the non-random extinction sequences which can erode it.
3. Step three is the assessment of key environmental (abiotic) factors influencing the provision of services.
4. Step four is the measurement of the spatial and temporal scales that ESPs and their services operate on.

Additional work by Balvanera et al. (2005) has shown that this process can be further improved and strengthened by creating a standardised evaluation process to evaluate ESP's functionality. This can be achieved through the quantification of the relative importance of the different species and ranking them in terms of efficiency and abundance. This allows an indication of how effective a species is at responding to changes in its environment such as predation levels, availability of resources and climate fluctuations. This will indicate those species that are disproportionately important in relation to the provision of ecosystem services, i.e. the key functional species capable of maintaining services. The approach is not without its flaws however as it fails to account for interactions between species, a crucial element in maintaining an ecosystem. This is especially important as some 'priority species' may in some way rely on another 'non priority species' for its survival. Regardless of this flaw however, the approach of estimating a functional structure within an ecosystem and adding information on specific species traits can help in determining the resilience of the ecosystem as a whole. No approach will be perfect as the complex nature and constant evolution of ecology ensures that any efforts to completely categorise the functionality will fail.

It is a fair assumption given the redundancy implicit in nature (following an extinction another species will take its place) that some goods and services will continue to be provided with a reduction in biodiversity (Purvis and Hector, 2000), however it is essential to maintain as many species as possible for two distinct reason: Firstly as previously stated, the complex nature of ecology will mean that we will always have a somewhat limited knowledge of ecosystem functionality and thus we will never be able to safely predict which species we can afford to loose. Secondly a diverse ecosystem will provide insurance in relation to future environmental change (Noss, 1995). In fact Hooper et al. (2005) have stated that there is a broad scientific consensus that the continued provision ecosystem services and goods can only be delivered in the event that biodiversity is maintained.

In a similar manner to determining whether priority species will discount or miss other important species, it is highly probable that in ascertaining ecosystem services, it is possible to miss other services that may only become apparent in the event of an ecosystem collapse. As a result a stance that is fundamentally precautionary which looks to maintain biodiversity as it currently stands would prove in the longer term to be a sound policy to implement.

From the above it is clear to see that not only is the maintenance of ecosystems important but also:

- We are reliant on many obvious (and some not so obvious) ecosystem services for our survival
- Ecosystem services are hard to map and value, but not impossible
- Priority species can be identified to maintain or introduce to a habitat in order to keep or create goods and services
- Economics is currently the language of choice in expressing value but it is not without its problems
- The understanding of the importance of processes and the use of weightings on irreplaceability are key elements in determining value of ecology
- And the use of a precautionary approach is prudent, as it maybe that once a species is lost and subsequently so too is a service it provides, it may be difficult, costly or even impossible to replace.

2.5.3 Understanding the key ecological principle of movement

If ecosystems services are created by biodiversity and as such are crucial to human long-term survival, then from an ecological view, the concept of movement is the most crucial element to maintaining biodiversity. It is essential on a series of organisational levels, genetically speaking movement helps prevent the effects on non-random mating and ensures the best opportunity for evolution of a species through the integration of new genetic material (Hedrick, 2000). In a limited area such as a fragmented semi-natural habitat the number of individuals within a given population present a greater degree of relatedness than one would expect if left to chance. This will result in the expression of detrimental recessive genes and an overall loss of genetic variation for the population. This will result in an unfit population and as a result the chances of a local extinction will rise dramatically.

Therefore movement is crucial, it is this genetic variation created by species being able to move that creates the possibility of a population to change and adapt to environmental pressures. However within landscapes shaped by humans any which have intensely over exploited uses, populations often form subdivisions called metapopulations (Levins, 1969). These are populations limited by habitats size capable of utilising limited resources through movement. Although the concept of metapopulations is subject to debate, and even the very existence in some cases (Harrison, 1994), work undertaken more recently has established that “innumerable species” can and often exist as metapopulations (Hanski and Gaggiotti, 2004). The establishment of metapopulations create a group of species which (often due to loss and fragmentation of habitat) undergo an ongoing process of local extinction and re-colonisation across a series of patches of habitat. As such many species ‘survive’ using a series of often small individual patches. However the functional area of the habitat available to support species numbers is increased due to the possibility of movement. Therefore when it is possible for species to move between patches of habitat, it is possible for a species to persist in a wide area even though no significant large areas of habitat are available. In essence connected areas of suitable habitat make it possible for species to thrive as movement is the key factor which keeps a population viable even when suitable habitat is not available in large areas.

2.5.4 Allowing for climate change – adaptive and multifunctional landscapes

Many authors now recognise the inevitability of climate change at the large scale. Significant changes are predicted to occur to the bioclimatic environment of several habitats (Harrison et al., 2001) and for many species (Pearson, 1993). This predicted impact only intensifies in small sites that suffer from isolation in terms of connectivity. This will have a significant impact on any populations present unless spatially consistent adaptation strategies are put into place. Although it still remains impossible to predict exactly what the impacts will be in every case and to what extent it will affect ecology, precautionary approaches (and ones that allow the re-assortment of species) will prove to be the most sound approach (Miller, 1994). It may be possible to maintain viable populations of ecological units by simply providing a wider range of topographic variation in a smaller area, or careful monitoring of the thermal properties of materials and prevention of heat island effect will create significant benefits for many species of plant and animal. A variation in the structure and height of vegetation along with the composition of species types can also be beneficial, to invertebrate species in particular, Miller (1994).

As space becomes more and more restricted, and with an ever increasing population, creating a landscape that maximises its outputs is crucial. This is particularly important in the built form that creates our urban settlements, where land is at a premium. The concept of green infrastructure originated in the United States in the mid 1990s and at its core is the philosophy that the environment is an important factor at the heart of land use planning (Benedict & McMahon, 2006). The core aim of a green infrastructure approach is to make the most of inherent functions within the environment including the physical processes such as water purification, soil conditioning and the creation of networks of natural ecosystems to promote sustainability. In addition however more social or anthropocentric functions are also considered such as recreational space or potential food generation can be included within landscape design. In this way, according to Benedict and McMahon (2006) landscaped areas in towns and cities can be used to control storm run off, act as recreation space for a local community as well house the ecology needed to undertaken significant biological processes, like air purification and pollination. The concept of applying ecological thinking and creating multifunctional spaces has become more and more common place within a UK context over recent years (Environment Agency, 2009). The use of a green infrastructure approach is slowly becoming best practice as a spatial planning tool, and can now be found in one form or another within planning policy and strategy documents on a local, regional and national level. Within the Regional Spatial Strategy (RSS) of the North West of England for example, green infrastructure has its own specific policy (EM3 Green Infrastructure) (Natural England, 2009), in turn this policy is further supported by strong guidance and documentation in the form of the North West Green Infrastructure Guide. It is being used as a strong approach to managing flood risk, a concern growing in magnitude within the UK following serious floods in recent years, and with the growing pace of climate change, the risk is only set to rise. Reducing hard surfaces, slowing down run off and utilising natural processes therefore is not only sound practice but also common sense. If this can be achieved in conjunction with other land uses, it is likely to increase the success rate especially in areas with limited expansion capacity.

2.5.5 Factoring in fauna to the system

The base principle within BREEAM is to measure ecological change through numbers of plant species, and although it is fair to say there have been declines in flora in recent years, most noticeably woodland plants (Kirkby et al., 2005), vascular plants (Cheffings et al., 2005) and infertile grassland plants (Bunce et al., 1999), plants form only part of the role of indicator of good ecosystem health. The other indicator within ecology is fauna, which is typically seen as a strong indicator of ecosystem health. The decline in types of species as well as species number can be seen as an obvious indication of an unsustainable system. Over recent years, significant declines have been noted in bumblebees (Kells & Goulson, 2003; Goulson et al., 2006) and other pollinators (Biesmeijer et al., 2006). Invertebrates are often considered the most sensitive to declining ecosystem health and the loss of butterflies for example is a solid indicator of unsustainable land management (Bergman, 2001; Fox et al., 2001; Swaay et al., 2006). The loss of such species can often be indicative of greater risks to come. For example the significant declines noted in woodland birds in the UK (Eaton et al., 2005) demonstrate how concerns can migrate up the food chain, less insects means less predators. Fauna therefore is an important aspect of ecosystem viability both in a practical sense providing services such as pollination as well as helping to indicate the stability and strength of the system as a whole. It is impossible to measure the value of ecology and not therefore include an aspect of fauna. To do so will only indicate part of the ecological story.

2.5.6 Fragmentation of habitat - the need to reconnect

Fragmentation of habitat is a key concern for many ecologists. Changes in habitat can clearly occur as a result of construction projects and the fact that there are no drivers for developers to consider the effects of the landscaping design will have on fragmentation of key habitat is a concern for many. As more and more land is developed and undergoes a change in usage, the risk of habitat isolation and fragmentation increases. Ecologists feel that the loss of semi-natural habitat will perpetuate the functional isolation of these areas. However reduced patch size is only one of the causes of increased functional isolation (Mennechez et al., 2003). Several recent studies have shown that patch quality is just as pertinent as size (Verbeylen et al., 2003) as is the context of the patch of habitat (Riffel et al., 2003). It is therefore essential that in an effort to reconnect fragmented habitats, quality and context are also considered along with the initial efforts to increase habitat area. For example it may be pertinent when undertaking efforts to connect habitat to prioritise habitat with a lower final area if it has better quality and a more suitable context. Efforts should be made to encourage native habitat types and local history to provide context is incredibly valuable in establishing which habitats to prioritise in efforts to reduce fragmentation. Equally given that more than just size of habitat is important in preventing fragmentation, it is possible to assume that the most vulnerable of habitat sites are those that are small in size, of poor quality and have a hostile land use context. In such cases taking all these factors into account can help identify priority habitat types on which to focus conservation efforts.

When the need to prevent fragmentation of habitat and therefore help stabilise ecological populations, is combined with an understanding of movement, it becomes clear that assessing the connectivity of existing resources must become a significant management priority. According to With et al. (1997), connectivity can be defined as:

"The functional relationship among habitat patches, owing to the spatial contagion of the habitat and the movement responses of organisms to landscape structure"

Therefore the level of connectivity cannot be determined simply by the spatial arrangement of patches of habitat; the level of connectivity can only be determined by the responses and behaviours of the individuals within the habitat to its landscape structure. In essence linking similar habitat types may not be incredibly effectual, as its success is determined by the species inhabiting the patch and their ability to move within it. This limiting factor of a species ability to utilise the habitat around it is termed 'functional connectivity' (With, 2002) and can be summarised as total sum of the behaviours and responses that decide the extent a species may be able to move within a landscape. It is therefore this 'functional connectivity' that needs to take a priority when establishing management of landscape design, along with efforts in de-fragmentation. Efforts that simply evaluate the structural connectivity set by a given habitat type will not take into account the complex interactions and will result in significant lack of ecological realism; such efforts therefore will fail to create viable long-term habitat. Understanding not only habitat but the species that utilise it therefore is a key principle in landscape ecology and sound landscape design/management.

2.6 Chapter outcomes

As a result of this chapter it can be concluded that there are many types of sustainability assessment methodology in use throughout the world to measure and rate the sustainability performance of many forms of product and service. BREEAM and LEED have developed global profiles and footholds in growing markets both in their respective countries of origin but also international markets. This leads to a responsibility for sustainability assessment systems to maintain a cutting edge position in the market to maintain a constant level of quality and dependability. Equally their use and adoption by organisations and governments form a strong case for being the most effective methodology to benchmark sustainable development. They are also growing not only in popularity and use as measuring tools, but also as key elements of marketing and funding strategies of development projects. BREEAM has become a global leader with many alternatives actually sharing a homogeny in their design approach. Equally in reviewing the alternative systems in use, it has become clear that although ecology makes up only a small part of BREEAM, it is in terms of ecological provision, one of the strongest systems in use making it potentially the current standard for integration of ecology into developments through the use of building rating systems.

As a result of this chapter it is also now clear how BREEAM as a system works, which is key to both understanding what's missing but also how it can be manipulated to be improved. It would appear in relation to the literature to be missing key elements in terms of ecological principles and as such its efficacy at protecting the ecological value of a development site is in doubt. As there is no literature on the aspects of ecology within BREEAM itself, it is impossible to understand the practical implications of BREEAM to ecology. the literature, public opinion and perception is that these systems as a whole work, and are valid for the purpose of measuring sustainable design and construction, but this is not the case in relation to ecology. Therefore the next chapter aims to investigate if this is indeed the case by building data not only of what is missing within the system ecologically speaking, but also if the system practically is flawed, by polling the people tasked with carrying out the assessments, the ecologist themselves.

3 Investigating the reality of practical application of ecology within BREEAM

3.1 Introduction and aims

So what is the effect on ecology of utilising the BREEAM assessment approach? Are there flaws in the system? Are there key ecological principles missing from the BREEAM system? This chapter examines the real effects of ecology within BREEAM by investigating real experiences of those undertaking the assessments in the field, the ecologists themselves. This chapter has a number of key aims which are:

In reaction to the findings of the previous chapter, design a methodology to gather real life experiences of BREEAM in its use for biodiversity.

- To ensure that this methodology is a robust process which will lead to solid accounts of BREEAM in action.
- To establish ecologically speaking, if BREEAM as a whole is as effective as public opinion would seem to suggest.
- Understand the realities of the system in practice and establish if any issues arising are rare incidents or a common occurrence.
- Understand the nature of ecology and BREEAM and highlight positive and negative elements of the scheme on the basis of those who are applying BREEAM.

The methodology and results can be found within this chapter

3.2 Establishing a methodology to research experience of ‘land use and ecology’ in practice

In order to research real experiences of a member of any group or organisation (in this case the ecologist) it is essential to build a robust replicable process to ensure both the integrity of the study as well as the validity of the end result (Clonts, 1992). The following sections outline the process of thought in determining the approach and design of the study as well as the selection process for candidates to take part in the research. Some terms utilised here form common terminology used within social science and social research practices. As such definitions for terms such as 'Sample Group', 'Thematic Coding' and 'Phenomenon' can be found in the glossary at the beginning of this work (taken from Miles & Huberman, 1994). This is not intended as a comprehensive discussion of social and behavioural scientific study techniques, but it does highlight background to those aspects of research design that are not only relevant but also practicable in relation to this efficacy investigation.

3.2.1 Qualitative vs. quantitative studies

Undertaking an investigation into the effectiveness of the Land Use and Ecology section of BREEAM requires a decision on the overall research methodology, e.g. establishing whether a quantitative or qualitative approach is more appropriate. There has been much debate on the value of both qualitative and quantitative methods in the gathering of data, with some researchers being of the opinion that research is quantitative as expressed by Kerlinger (cited in Miles & Huberman, 1994):

'There's no such thing as qualitative data. Everything is either 1 or 0'

However alternative views are expressed and exemplified in Campbell's views (cited in Miles & Huberman, 1994):

'All research ultimately has a qualitative grounding'.

Regardless of these opinions, many researchers believe that the debate does little to rectify the position. According to Miles and Huberman, (1994) the constant argument is 'essentially unproductive'. They and many other researchers agree that:

'These two research methods need each other more often than not'.

The debate often revolves around which is the more 'scientific' approach, often quantitative is considered more 'scientific' as it involves the gathering of numerical data compared to the typically word orientated qualitative approach.

The second significant difference is that qualitative is considered to be inductive where as quantitative is regarded as deductive. In essence all quantitative research needs a hypothesis to test, however this is not the case with qualitative approaches. Often qualitative data will lead to hypothesis generation (Newman, 1998).

Much is made around the distinctions between qualitative and quantitative research especially in relation to the design of research studies and the enquiry process (Lloyd-Jones, 2003). The 'scientific ' element of quantitative studies usually concerns logical experimentation and correlations made through a methodology that adheres to agreed formulas and rules in data gathering, regardless of the outcome of the process. The results do not impact on the study's approach. Conversely qualitative designed studies often have emerging characters allowing the study to grow as more and more information is gathered (Hammersley & Atkinson, 1995; Maxwell, 1996; Becker, 1996)

Regardless of the debate however it can be argued that quantitative survey techniques typically require qualitative analysis, as numerical values require judgments and interpretations to obtain results (Issac & Michael, 1995). This supports the view that one cannot exist without the other. As such the interlinked nature of both approaches to study will therefore require the use of both on some level. The real debate in relation to this study therefore is not on the overall approach but on the starting position (Hathaway, 1995).

This is demonstrated by the fact that qualitative data can be converted into quantitative results through the use of thematic coding analysis (assigning categories or themes to answers and analysing them in context) as outlined by Flick & Vvon Kardoff (2004). The reverse however is not true, answers such as 'Yes' & 'No', or "on a scale of 1 to 10 what is…" will lead to hard numerical data that cannot be expanded at a later date (Miles & Huberman, 1994).

The end result is that both quantitative and qualitative data are at some level virtually inseparable due to these many interrelations (Salomon, 1991). One cannot exist without the other and in most cases both rely on each other at some point in order for studies to be conducted. Both are connected and in order to maximise the results of an investigative study, both the qualitative and the quantitative need to be used. However the debate does increase the importance of the actual design of the study, as poor decisions at the design stage will lead to poor responses and poor end results (Marshall & Rossman, 1999).

3.2.2 Designing the study

By understanding how the subject matter is used (in this case how BREEAM assessments work and are undertaken) it becomes clear how to engage with the participants of the study. Utilising the information outlined in chapter two on the BREEAM structure and its implementation, it can be determined that although BREEAM is primarily a quantitative process, the Land Use and Ecology section of BREEAM can be best described as iterative, relying on the experience and knowledge of the ecologist to enact the best result for the project. As such utilising a qualitative approach in the first instance would seem to complement the Land Use & Ecology section of BREEAM and is likely to gain more meaningful results. Therefore the use of a qualitative approach with its definable reasoning and logic inbuilt in the data is better in this instance than a quantitative one.

3.2.3 Qualitative approaches

Although the term qualitative outlines the style of research in the broadest terms, it does not fully explain the purpose of the qualitative research, what role the researcher plays in the process, what stages there may be or the method of data gathering/analysis. There are many approaches to qualitative assessment and a number of these are prevalent in many research fields, primarily the social sciences (Kerlinger, 1992). Each is briefly outlined here in an effort to determine the most appropriate for this investigation into BREEAM.

Ethnography

Although generally dedicated to the field of anthropology, the emphasis of ethnography lies in the study of entire cultures or organisations (Agar, 1986). The most common methodology within this approach is participant observation typically through field research. This requires the observer to become immersed within a 'culture' recording their experiences extensively. Fundamentally this approach could be utilised in this investigation as it is the ecologists themselves and their views on the effectiveness of BREEAM that represent the culture at the centre of this investigation. However, the function of ethnography would be to assess the culture of ecologists as a whole; not just the elements associated with the undertaking of BREEAM assessments, which is the key focus of this study. Equally the process of working alongside ecologists in the field would take a considerable amount of time. In addition to the main focus of this investigation is to understand ecologists' experiences and understanding of BREEAM, not to follow the process alongside them, therefore it is an inappropriate approach.

Phenomenology

Phenomenology has a strong presence in social research disciplines particularly psychology and sociology (Bogdan & Tailor, 1975). Phenomenology focuses on an individual's subjective experiences and interpretations, with the intent that the researcher is focused on ascertaining how the world is perceived by others (Denzin & Lincoln, 1994). This is partially suitable to this investigation through the focus on the experience of the ecologists; however the 'phenomenon' being researched is unknown, and will not become apparent until the research is underway. Therefore using a solely phenomenological approach is also an inappropriate methodology.

Field research

Field research is essentially the overarching approach to methods such as participant observation, and is reliant on the researcher heading out 'into the field' to observe the phenomena in situ. Essentially seeing it for themselves, researchers then typically record through extensive notes to be analysed later (Babbie, 1979). This would require significant cognitive abilities on behalf of the researcher to ascertain all the elements and intricacies of the application of the BREEAM process for ecology. In addition this would take considerable time as a significant number of assessments would have to be observed by the researcher. Therefore this approach is also inappropriate.

Grounded Theory

Originally developed by Glaser and Strauss (1967), the purpose of grounded theory is to develop theory about phenomena of interest through observation (Strauss & Corbin, 1990). That is, as more and more information becomes apparent, the more clearly defined the phenomenon becomes. Grounded theory is an iterative process, beginning with generative questions to help guide the research but are not designed to be leading. As data is gathered, core theoretical concepts become apparent. As more and more data is established, these core theoretical concepts become more solid and as such are 'grounded' in observation. This process often is time consuming due to repetition. However as there is the possibility of gaining new insights to the phenomena as more data is gathered, it is a very valuable process. In relation to this investigation where the topic area is known, but the exact phenomena is borne of experience by the participants, this would seem to be the best approach to investigating the effectiveness of BREEAM in relation to Ecology.

3.2.4 Qualitative methods

The decision to utilise a Grounded Theory approach will determine the structure and the overall path that the investigative process will take as well as the most appropriate qualitative methodology for gathering data needing to be determined. Within grounded theory the methodologies are seemingly endless as any data gathered may lead to the generation of core theoretical concepts. As such methods will vary greatly from study to study in both form and extent and to a degree how appropriate they maybe to the study in question (Miles & Huberman, 1994). Below are those approaches considered to be the most relevant methodologies for gathering qualitative data:

Participant observation

Participant observation requires the immersion of a researcher within the cultural context he or she is studying. It is one of the most demanding approaches taking significant time and effort to return results. In relation to BREEAM the 'cultural context' in question (e.g. the ecologists and their use of BREEAM), are nationwide and many undertake assessments sporadically, therefore this approach holds little merit.

Direct observation

Direct observation follows a similar path as participant observation when studying a culture, organisation or group; however despite the name there is no 'direct' involvement by the researcher. Rather than participating they watch (often remotely) so as to not impact on the subjects of the research (Loftland, 1971). Typically this methodology is more complex and circuitous than participant observations. The nature of BREEAM and the approach to assessment with its site visits and report writing does not lend itself well to this method of data gathering.

Case studies

Case studies are typically a series of intensive studies on an individual or context, in effect a showcase to describe the phenomenon in action (Hamel et al., 1993). Such studies often utilise several different methods and represent a good (or bad) example to demonstrate the phenomena being researched. Such an approach is useful in demonstrating a known phenomenon. However part of the process of investigating the effectiveness of ecology within BREEAM is to determine the phenomenon associated with undertaking assessments. Therefore given that, by definition, the phenomenon is unknown at the outset, case studies cannot be utilised here to gather useful data.

Interviewing (structured and unstructured)

The purpose of the interview is to probe the ideas of the interviewees about a phenomenon of interest. These can be conducted in two distinct ways (structured and unstructured) to either an individual or a group (Houtkoop-Steenstra, 2000). Structured interviews often have preformed questions designed to elicit simple measurable responses. A survey with 'yes', 'no' & 'maybe' as available responses (typically conducted in person), would be a good example of a structured interview. An unstructured interview is similar; however the questions are designed to elicit a free flowing response, giving more information. This form is harder to analyse as the responses are often very different from participant to participant, and the length of response will be different also. There is a danger that unstructured interviews can become non-comparable as the deviation of topics throughout the interview can be dramatic across a sample group. According to Houtkoop-Steenstra (2000) this can be overcome through the use of a semi-structured approach, utilising a series of topic questions to guide the interview but not eliminating the possibility of free flowing thought. Careful determination of questions and wording are crucial in this approach. On reflection given the approach of BREEAM it would appear that this is the best approach to gather data, using semi-structured interviews and a series of guiding questions to elicit helpful responses on experiences from ecologists.

3.2.5 Gathering qualitative data

It would seem that on closer examination the best approach would be to utilise that of grounded theory to understand the phenomena to be observed, and semi-structured interviews to gather data, as this would seem to best complement the BREEAM assessment process and the ecologists role within it. In this way the approach set out here is similar to testing within Yin's (1994) model of multiple case study design, with each interview forming a discrete unit for comparison of phenomena. By treating each interview as a form of mini case study and as a separate entity, replication and comparison is permissible.

It is possible to undertake these interviews on a one on one basis in person. However given the nationwide application of the BREEAM assessment programme and the likely subsequent geographical spread of ecologists, travelling to each area would be a highly inefficient approach. A better approach would be to undertake a series of short telephone interviews with participants, recording the responses via digital audio equipment where permitted and extensive written note taking where not. The recordings/notes would then be transcribed, analysed and summarised.

3.2.6 Preventing threats to validity of the outcome

In the design of this interview process several factors will have to be addressed in the approach and several assumptions made. This section addresses how potential issues with the final data can be addressed in the planning of the interviews. These threats to validity are present in the outcome of any experimental research, and are highlighted here to strengthen the outcomes. In all research, omissions pose potential threats to validity similar to misinterpretations, or measurement error (Popper, 1963). In relation to qualitative research one of the most significant threats comes from generalisation and the application of a study to the greater population. Given that not every ecologist in the UK will participate in this study, a measure of generalisation is required to extrapolate results and this is a potential threat to any study undertaken. Although it is fair to say a select group cannot truly represent an entire population, careful selection and a robust process will help give statistical validity to the outcome (Firestone, 1993).

Within social research the term validity refers to 'The best available approximation to the truth or falsity of propositions' (Cook & Campbell, 1979) and the term external validity refers to the approximate truths of conclusions that involve generalisations. In essence the measure of external validity is the degree to which the conclusions in the study hold for other persons in other places and at other times. In order to maximise external validity of this study, the assessment of validity will occur in two stages. Within this chapter measures will be put in place to ensure the study itself is designed and carried out in such a manner so as to minimise threats to validity. The next chapter will look at the external validity of the responses using thematic coding to determine if the experiences are unique or common occurrences and risk assessed accordingly. Gomm et al. (2000) have pointed to the lack of attention paid by researchers to generalisation within qualitative study. This can be combated through rigorous attention to sampling of respondents and the use of a well designed survey approach but the issue remains a potential threat to validity.

With this in mind and to ensure external validity of this study it is crucial therefore to determine the correct sampling model and approach. It is important to first identify the population required to generalise to (in this case ecologists), then draw a fair sample from that population and conduct the research on this sample group. Then assuming the sample group is robust, conclusions and generalisations can then be drawn from the sample group. There are a number of threats to the validity of this approach and these will need to be addressed. They are namely:

- At the time of the study the population that is to be generalised may be unknown. This however is not the case in this research as the population (ecologists operating within the UK) is a known element.
- It may not be easy to draw a fair or representative sample. Within this study however, those qualified to undertake ecological assessments for BREEAM form a fixed element. Therefore although obtaining a potential representative sample group is relatively straight forward, it does not guarantee participation. It is expected that a percentage of this group will not be willing to take part and this should be factored in to the numbers of participants approached.
- It may not be possible to undertake study at variant times of the year to determine seasonal variations. However the aim of this investigation is to ascertain historical information and given that BREEAM assessments are undertaken at any point in the year, such information and experience will cover seasonal variations.

3.3 Improving external validity

Given that external validity is so crucial to the investigation it is essential that opportunities to strengthen the process in this regard be not only explored but also incorporated into the study's design. Given that the goal is to maximise generalisation, the first step would be ensure the sample group is robust (Hernon, 1994). Therefore the sample group chosen for investigation should be determined using a randomising process. Equally information will be collected in order to assess bias utilising a number of key factors. This will be used to ensure no one single element within the sample group has a significant influence on the outcome, and thereby affecting validity.

In addition, by understanding the nature of the ecologist's role within project work it is possible to maximise participation. Ecologists typically undertake seasonal work, in direct correlation with the nature they are studying. As such ecologists will typically be in the field during the spring, summer and autumn months, undertaking survey work and site visits. Therefore by timing this research investigation during the winter it is possible to maximise exposure of this study to ecologists who are often in offices writing reports. This should help improve response numbers and reduce dropout rates associated with the study.

3.3.1 Interview design and approach

The design of the interview process covers five key themes

- Overall knowledge of BREEAM
- Experiences working with BREEAM
- Experiences working with other systems (nationally and internationally)
- Personal opinion of BREEAM as it stands
- Recommendations or suggestions to improve BREEAM

These key themes have been determined as part of an analysis exercise resulting from chapter two, where key aspects of the literature and more importantly what is missing from the literature have been determined. Each theme has been established to provide insight to appropriate experiences and knowledge of the system and help fill these gaps in knowledge ecology within BREEAM. The resulting information should therefore give a solid account of the effectiveness of BREEAM in all areas of its application from planning and client contact to methodologies for improving any faults the assessment scheme may have.

3.3.2 Question design, and logic of approach

Given the approach of semi-structured interviews, the questions found in each section highlight open-ended statements designed to elicit an open response. This will allow participants the opportunity to identify examples, give opinions and utilise their experiences of using the scheme to generate ideas of best practice or potential benefits to the process. The questions are generally qualitative in nature however in some cases, quantitative questions (with typically 'yes' or 'no' answers) are used for screening purposes to streamline the interview process. The interview has been designed to be engaging allowing the participant to be guided but free to expand on answers wherever they feel they need to do so. Each set of guide questions are used for each interview giving similarity between interviews for purposes of comparison and analysis.

The approach to interviews undertaken as part of this study adhere to the following process:

- Participants are selected randomly and set into phased groupings to monitor and control the process,
- Participants are contacted and invited to take part in the study,
- Following a positive response further communications to occur to determine a suitable time for interview,
- Information is issued to each candidate outlining the study in principle highlighting the format of the interview, the topic areas (but not the questions), as well as inform them of the policies in place for ethics, data protection and anonymity,
- Telephone interviews are then undertaken at the arranged time,
- The contents of the interviews are transcribed,
- Analysis of the responses is undertaken.

3.3.3 Determining the sample group

In order to determine a sample group and undertake the study some information needs to be identified in relation to the population from which that sample group is drawn. Given that the aim is to allow generalisation of the whole population from the sample group, understanding the study population is essential (Naizer 1992). Therefore given that the group with which we want to generalise is the population of this study, this is the pool from which a sample is taken. In this case the population of this study is all ecologists, as they all have the potential to undertake BREEAM assessments once certain criteria are met. This is termed the theoretical population, however it is unlikely that all members of this population can be accounted for (nor are they all qualified to undertake assessments at the point of this research) and as such a smaller group within this population is created, this is the group who can be reached and form the 'accessible population'. The next stage is to take the accessible population and determine a database of information (typically names and contact details). By listing the accessible population in this way a 'sample frame' can be drawn (Beyea & Nicoll, 1997). It is from this sample frame that a suitable list of interviewees is drawn at random to create a sample group. This process is identified in the Figure 3.1.

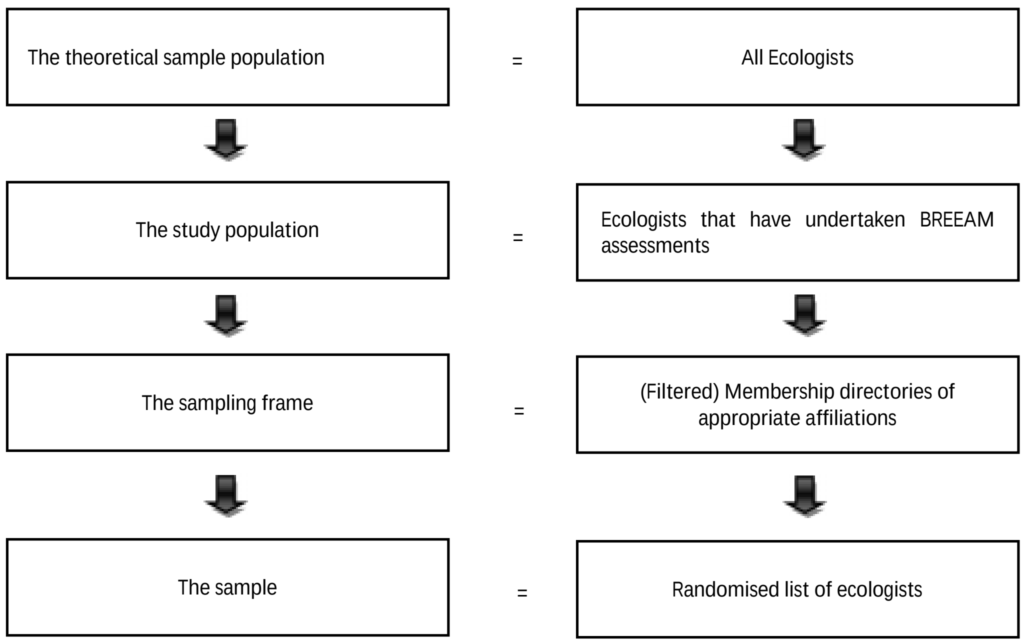

Figure 3.1: Determining the sample group for the study

3.3.4 Determining who are Suitably Qualified Ecologists (SQEs)

Given the aim of this exercise is to build a realistic picture of what is actually happening in the field, the selection process of interviewees is crucial. If the responses are to yield valid and useful results, then a sample group must not only be appropriate but also experienced. Therefore it is crucial to determine the correct sample frame. To ensure accurate results and to understand the potential pool of interviewees, it is essential to understand the process and benchmarks required of an ecologist to undertake BREEAM assessments and apply them to the selection criteria for this interview process. Any ecologist wishing to undertake a BREEAM assessment must be considered a 'suitably qualified ecologist' (SQE) by BRE. Therefore it is important that of the thousands of ecologists working in the UK at present only SQEs are considered to be part of the interview process. Therefore only SQEs will make up the sampling frame.

Using the BREEAM 2008 Office assessor's manual as a reference guide (BRE, 2008a), an SQE for the purposes of a BREEAM assessment is considered to be an individual who achieves all of the following items:

1. Holds a degree or equivalent qualification (e.g. N/SVQ level 5) in ecology or a related subject.
2. Is a practising ecologist, with a minimum of three years relevant experience (within the last five years). Such experience must clearly demonstrate a practical understanding of factors affecting ecology in relation to construction and the built environment; including, acting in an advisory capacity to provide recommendations for ecological protection, enhancement and mitigation measures. Examples of relevant experience are: ecological impact assessments: Phase 1 and 2 Habitat surveys and habitat restoration.
3. Is covered by a professional code of conduct and subject to peer review.

Peer review is defined as the process employed by a professional body to demonstrate that potential or current full members maintain a standard of knowledge and experience required to ensure compliance with a code of conduct and professional ethics.

Full members of the following organisations, who meet the above requirements, are deemed SQEs for the purposes of BREEAM:

- Association of Wildlife Trust Consultancies (AWTC)
- Chartered Institution of Water and Environmental Management (CIWEM)
- Institute of Ecology and Environmental Management (IEEM)
- Institute of Environmental Management and Assessment (IEMA)

- Landscape Institute (LI)

3.3.5 Establishing the sample frame

Using directories and membership lists of professional bodies at a starting point it is possible to create a database of potential participants. However this will include many ‘non-suitably qualified ecologists’ and as such the database must be reduced in order to ascertain the sample frame. The database is filtered to remove:

- Non ecologists (who are members of the aforementioned professional bodies)
- Members of professional bodies that do not qualify e.g. student or affiliate members or those with less than three years experience.
- Those who have indicated that they have no experience in undertaking BREEAM assessments. Although they may technically be SQEs and therefore could theoretically undertake a BREEAM assessment: with no experience they will have little benefit to the study, given that the aim is to assess BREEAM’s effectiveness. This point is given further weight in relation to validity as each name generated for participation has had to have undertaken a set number of assessments to qualify for the study.

3.3.6 Statistical validity of the sample (randomisation)

The final sample frame database consists of 3,572 entries (eligible participants) therefore to ensure the validity of any sample group the names of the participants drawn are done so through random selection. Each entry in the database is given a number and then a fixed number of entries are chosen using a random generation algorithm formula within the database spreadsheet. These ‘lots’ of potential participants were approached to take part and form the various phases of the study (which is further outlined in section 3.3.8)

3.3.7 Gathering pre-interview bias information

After establishing that the sample group is appropriate and experienced enough, it becomes essential to ensure they are representative of the larger group. To allow a random selection process, and to ensure a reduction in bias towards any one particular population factor, five key pieces of information are compiled for everyone approached to participate or through membership listings with the appropriate professional body. This information consists of:

- Number of years experience
- Number of assessments undertaken.
- Gender
- Size of company
- Geographical location

The first two pieces of information are used to ensure validity of the study, as those with little or no experience will not be in a position to offer issues or concerns (phenomena) experienced, equally those with too few assessments are also less likely to be in a position to benefit the study. The remaining three pieces of information forms an addition to the sample frame data base and is used after the interviews have been undertaken to establish if there is any potential bias within the study sample group. This information has no bearing on the individuals approached to partake in the study.

3.3.8 Determining the end point

The purpose of any experimental research study is to develop theory through repeated testing of related hypothesis (Lloyd-Jones 2003). In reality however much replication is needed using similar conditions before a theory (or theories) is upheld, rejected or modified, and the point at which this occurs is subject to the researcher's judgement (Campbell & Stanley, 1963). This is especially the case within grounded theory, as effectively the study can go on forever. In relation to this study taking into account the significant number of candidates within the accessible population the interview process could potentially go on ad infinitum. However, this is neither practicable nor beneficial to the study.

Given that the BREEAM process is fixed and the only variable is the candidates relationship to an interpretation of the process, this becomes the determining factor in halting the research. By applying thematic coding to responses and subsequent analysis into core concepts, an end point can be reached. Essentially there will be a tipping point within the answers given where a significant level of the sample group will return similar or almost identical answers. At this point the value of continuing will decrease as the level of new information will also decrease accordingly. In order to undertake this approach, and reach a point of diminished returns, the process will be phased. At the end of each phase coding will occur and analysis undertaken to determine whether the next phase should occur and at what point the study should finish.

3.3.9 Pre-interview testing

In order to assure the best possible outcome for the interview process, a series of four pilot interviews were undertaken with eligible ecologists. Originally five ecologists were approached, and one declined to be involved due to time constraints. Each of the ecologists in the pilot tests had experience of BREEAM, and the outcomes of the four pilot interviews were not included in the overall results so as to not taint the overall study results. The pilot helped to improve or determine several factors of the interview process, namely:

- The questions – it is imperative that in an interview the questions asked, not only make sense but also yield valuable information. In addition it is crucial that the wording of questions is not ambiguous or creates 'closed off' short responses. Leaving opportunity for the interviewee's to express their concerns but also guiding them along with the wording of the questions is a cornerstone of this type of semi-structured approach. The pilot interviews therefore are a valuable tool to help shape the questions for the actual interview process.
- The interview technique – experienced interviewers practice techniques to ensure the interviewee is comfortable and happy to express their opinions. This is especially important when telephone interviews are conducted as valuable visual communication clues are lost. This pilot allowed an opportunity to develop a comfort with the process and the subject matter so as to be consistent in the real interview process.

- Over all process – by running through the pilot interviews it allowed a better understanding of the interview process itself thereby allowing more information being imparted to the interviewee, information on how long the process should take for example, or how many questions were in each section helps the interviewee understand the process and gives context to what their level of participation maybe.

A topic guide was prepared and sent to the ecologists taking part, to give background on the interview process this can be found in Appendix 1.

3.4 The results

Utilising the above interview process a total of 43 ecologists volunteered to be part of the effectiveness study, the interviews were conducted between September 2008 and January 2009. The following sections outline a summary of findings of the interviews, with minimal interpretation and observation. Detailed analysis of both actual answers and validity will be undertaken in the next chapter. The following sections summarise responses in a format which mirrors the structure of the interview, e.g. a number of questions spread over 5 sections.

3.4.1 Section 1 – Overall knowledge of BREEAM

Within this section, interviewees were asked questions designed to establish three main facts:

- If Ecologists understood what BREEAM is and how it works,
- If it is significant whether they need to know or not,
- If they understood the process and their role within it.

3.4.1.1 Question 1

When asked “Can you describe what BREEAM is? What it does? And how it works?” Most (91%) gave a relatively accurate and concise account of BREEAM, examples included:

"It's a sustainability assessment in order to provide mainly a marketing tool for new developments and also integrate more sustainable features into a building or site. Covering different areas such as retail, industrial, schools bespoke, multi resi, further education depending on what year you're going for..."

"It's basically a scheme where people get awarded points for their environmental viability of their structure, be it an old people's home or a warehouse or a railway station etc... Points are awarded for various things like using Brownfield sites, cleaning up contaminated sites and by using sustainable heating and lighting etc... Also the part that I deal with is the ecology whereby they are scored on their impact, or lack of, to the environment and how well they mitigate or enhance for whatever it is that they are doing..."

Only 9% could not describe what BREEAM is and all of those who could not stated that they only worked with the Land Use & Ecology section and had knowledge of that section alone. The work they undertook formed a discrete piece of work for a separate BREEAM assessor with no links on the part of the ecologist to the client or project (and therefore no links to the rest of the BREEAM process.) Although uncommon, this form of contractual approach on the part of the developer to only employ an ecologist for a recommendation report as opposed to more detailed involvement in decision making and design, does sometimes occur. In general almost all of those interviewed displayed a strong awareness of what BREEAM is and the context of its use. Many (84%) suggested that it was important to understand the context of BREEAM (and the other elements) so as to better understand not only the relevance of the Land Use and Ecology Section but also how credits were awarded.

3.4.1.2 Question 2

When asked "How well would you say you know or understand the mechanics of the BREEAM rating system?" almost all (93%) of respondents replied with variations on a theme, such as 'not very well' or 'only a little'. This shows that although a significant proportion of the sample population could describe to an effective standard what BREEAM is, few (7%) could describe how it worked as a system. Of those that could explain how it worked, half could describe the mechanics of the system in terms of credits and overall scores, but only one respondent mentioned weighting of the units as well as score thresholds for particular awards.

3.4.1.3 Question 3

"In your opinion and from an ecologist's point of view is there a need to understand the system as a whole?"

Only one response suggested that it was useful to understand how ecology fitted into the wider aspects of BREEAM the remainder stated that there was no significant benefit to either the ecologist professionally speaking or to the process as the recommendations would remain the same regardless as they are independent of other work streams.

3.4.1.4 Question 4

"At what point do you think an ecologist should get involved in the process?"

The overwhelming response to this question was "at the very beginning". Every interviewee mentioned that to be truly effective this was possibly the most essential element of the process. Several interviewees (28%) highlighted the differences between ecology and other elements of BREEAM and in particular the need for real study and benchmarking. Survey work is crucial to ascertaining the initial ecological value of the site before construction begins, and therefore establishing real effects on ecology brought about by the development. Alternative processes are in place if this is not possible (and the BREEAM process/ construction has already begun) namely the use of standardised value tables for given habitat types however a significant amount of assumption is required to utilise this approach. Actual site vegetation based on witness accounts or using historical information is required. Many (74%) ecologists chose this point to raise concerns around not being involved early enough in the process, and being forced to use post construction methods to 'assess' ecology which in their opinion was pointless. Equally within the same group, a third expressed concerns that developers are utilising ecologists to gain vital points late in the construction to push through thresholds, and not integrating it in the projects designs.

3.4.2 Section 2 – Experiences working with BREEAM

The questions set out in this section aim to establish the range of assessments that have been undertaken by the sample group, their overall opinion of the scheme and in their own views on the strengths and the weaknesses of the process as it currently stands.

3.4.2.1 Question 5

"What types of development have you undertaken a BREEAM assessment for?"

As described in the previous chapter there are several variations of BREEAM based on the differing types of construction project being undertaken. Of the 12 main BREEAM standards, the most common type of BREEAM assessments undertaken by ecologists in this study were housing projects, especially utilising the EcoHomes assessment methodology, as well as multi residential and to a lesser extent under the new code for sustainable homes (the successor to EcoHomes, in England). In the non-residential category, the most common assessment type undertaken by the sample group of ecologists was Education followed by Offices then Industrial. This would seem to track the growth of the various sectors of the construction industry in the UK as outlined in chapter one.

3.4.2.2 Question 6

When asked "On the whole how would you rate the effectiveness of BREEAM for the benefit of Ecology, on a scale of:"

Excellent	Very good	Good	Average	Poor	Very Poor	Not at all

Figure 3.2 represents the interviewees answers as a percentage of the overall sample group.

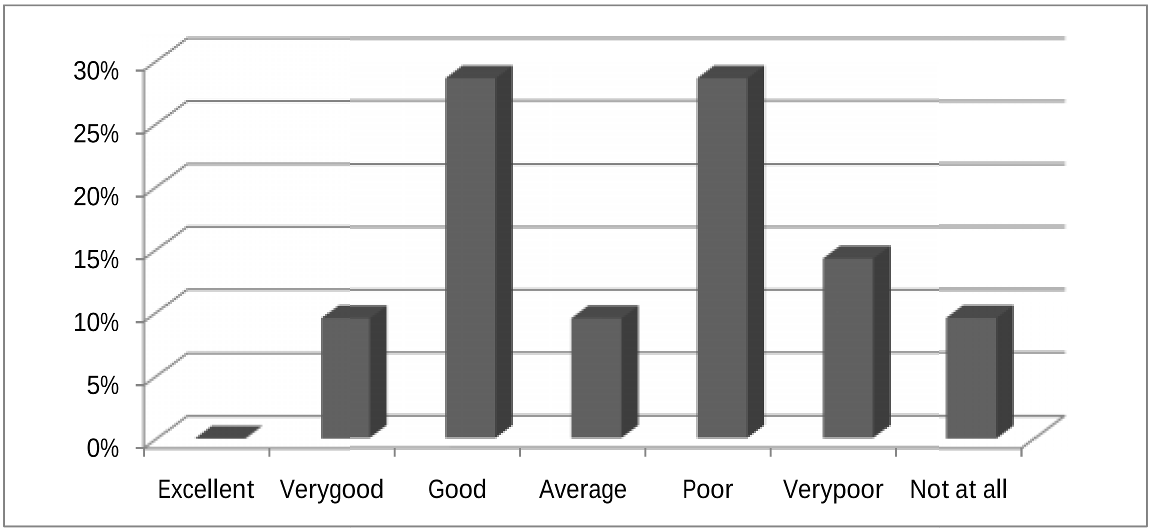

Figure 3.2: A graph detailing ecologists' opinions on the effectiveness of BREEAM for ecology (N=43)

Essentially the two most significant answers were 'Good' and 'Poor' with the overall trend towards the negative end of the questions option spectrum. On the whole the interviewee's felt BREEAM did not represent a benefit to ecology, with no one considering the benefits to ecology to be excellent. It would be expected that with such a range of possible answers a more normal distribution or Gaussian curve would be exhibited in Figure 3.2, and with the exception of the response of 'Average' this is indeed the case. It is hypothesised here that the design of this study itself may be the cause of this low average, as those interviewed were chosen (although randomly) from a sample population with strong opinions. Simply put it stands to reason that those ecologists who were willing to take part and volunteer their time to input into the study would have an opinion on the subject of BREEAM (either positive or negative) and as so a bimodal distribution forms within the graph.

3.4.2.3 Question 7

"Can you give an example in your opinion of the benefits of the scheme for ecology?"

The question generated a number of responses from the sample group, and the following are representative of the responses received:

"There's an opportunity to get ecology/ an ecologist involved in a development that may not have been there before"

Several ecologists (37%) felt that the use of an assessment scheme such as BREEAM generated an opportunity for advice on a range of ecological issues that may not have existed if the scheme were not used on projects. Typical opportunities included species and habitat protection, construction design advice, landscaping design and inclusion of ecological features.

"It makes developers think"

A common remark from the ecologists with 44% of respondents highlighting that they thought the use of BREEAM (and in particular the introduction of ecology) raised awareness with developers than would not normally be evident. Equally by undertaking an assessment, developers become more aware of the process and introduce ecologists in to future schemes at a more appropriate time, resulting in better end results.

"It educates developers on ecology"

14% of those interviewed felt that developers were keen in many cases to work 'alongside' ecology on site, or include it further in the construction process but had little knowledge on how to do so. The use of a fixed process like BREEAM can help receptive developers understand ecological issues to a greater degree and prevent significant loss of habitat in future projects.

"Opportunity to affect design stage from ecologies perspective"

23% of those polled felt they had in the past been employed to simply undertake surveys on which to base recommendations for the site. In many cases however (81% of those polled), ecologists are often incorporated into a scheme at a design level, giving them an opportunity to join design teams and comment on plans and approaches to better affect the inclusion of ecological design into a scheme.

"Opportunity for developers to demonstrate environmental responsibility"

12% of ecologists felt that the use of BREEAM and therefore the inclusion of ecology resulted in the best way to show case a developer's commitment to environmental responsibility, something which is growing in significance with suppliers, clients, customers and investors.

"Can go beyond 'cosmetic' ecology"

All too often ecological input in a site can result in 'token gestures' for the benefit of ecology, typically in discrete ecological features such as artificial habitats (nesting boxes etc…) or distinct areas (ponds, 'wildlife areas'). Often these are poorly designed and provide little ecological benefit compared to the potential that they could generate if designed appropriately. The use of an ecologist as part of the BREEAM process can ensure that these potential benefits are realised, and this opinion was expressed by over half of those polled (53%).

"Appropriate development of low biodiversity sites"

23% of ecologists commented that sites with low or virtually no ecological value at all are often at risk of being over developed in relation to construction and never having their ecological potential realised. Some ecologists (14%) felt that it was primarily schemes that did not warrant landscaping for aesthetic reasons, or where there is a benefit to maximising developed space (industrial plots for example) that suffered the most from this phenomenon. The use of BREEAM however encourages the appropriate development of land and introduces ecological value where it may have not been present before.

3.4.2.4 Question 8

The question "Can you give an example of any flaws you see with BREEAM in relation to ecology, either from your experience or your understanding of the system?" seemingly raised the most significant number of varied responses. The following are representative of these responses, with many being repeated throughout the sample group.

"It's too 'Plant-centric', it doesn't make sense"

This was raised by nearly 74% of those interviewed. The central crux of the issue in the view of the ecologists is that BREEAM's calculations are based solely on the number of plant species and the change of number between pre and post construction of the scheme. There is no taking into account either numbers of animal species, or the differing types of animal species.

"More species doesn't equal better ecology!"

A point which naturally follows and was raised by a significant number of the sample group (63%) was that the concentration of species numbers over quality of species types does not reflect ecology. Diversity is a key element of ecology, and a fundamental principle in ecological science. However it only applies if the diverse nature of the ecology introduced is appropriate to the current habitat. The prevention of introduction of alien species is another significant tenet of sound ecological management and is not really addressed according to the sample group.

"The calculator is all wrong…wrong approach, wrong data…it's just a mathematical exercise…"

A view held by 84% of those polled is that the standard data found within table 3.0 within the Land Use and Ecology section of the BREEAM technical guidance manual (BRE, 2008a), which is used in the calculations of ecological change is inaccurate. Several ecologists suggested that in their experience it is easy to establish more species per set area through basic survey techniques. Equally breaking down ecology into a simplified mathematical equation fails to take into account the realities of ecological management. Nature is complicated; as identified in chapter two, ecology is a continual interaction of species within a space. A simple calculation of change in species of plant pre and post construction cannot take this into consideration. BRE's BREEAM Table 3.0 can be found in appendix 2.

"It doesn't really protect or prioritise protected species in the development"

This 'flaw' was highlighted by several ecologists (16% of those responding), given the emphasis inherent in BREEAM to increasing the number of plant species, the requirements of many often sensitive and protected species are not taken into consideration. In addition planting schedules are not prioritised to create habitat for key protected species, as the species listed for planting often revolve around numbers of differing species, not overall ecological value.

"It doesn't take into account the context of the site and what's neighbouring it"

BREEAM has been designed to be applied to a development and more importantly a building within that development. Therefore it concentrates on the site boundary as a context for the development. However ecology is transient in nature, it spreads, moves and grows. Working within a fixed boundary and failing to take into account what lies beyond it results in a poor ecological landscape. 42 % of those polled felt that opportunities are easily missed and no credits awarded for the improvement of connectivity (a tenet of ecological management) into and out of the site. Equally creating a viable habitat on site for a target species currently inhabiting a location on the edge of the site is not a priority within the BREEAM standard.

“Doesn’t take into account the value of ‘local’ ecology and knowledge”

BREEAM is a national standard and applies national factors to its calculations in assessing the ecological value of the site. In doing so however it fails to take into account specific local knowledge, which may affect the overall importance of the habitat type. A nationally common habitat type for example may be locally scarce and therefore have more ecological value in a localised context. Equally a particular habitat type may well produce more species per metre squared but be highly inappropriate to the local or regional context. Therefore, although of great significance in relation to the assessment report it maybe of little ecological value in practice.

“The way it’s set out, it’s limited on what can be achieved, we can only make recommendations and we don’t even have to be involved for much of it anyway”

The Land Use & Ecology section of BREEAM utilises passive language according to 28% of the ecologists, with terminology like ‘should’ and ‘it is recommended’ throughout. 63% felt that the section was week, as it doesn’t have any real minimum standards or approaches like other sections of the BREEAM methodology. Equally a significant proportion of the group (47%) thought that the ability to use standardised tables and only the ‘recommendation’ to employ a suitably qualified ecologist often leads to assessors or developers to undertake much of the unit by themselves and thereby embedding problems later on in the development by not involving an ecologist early enough in the process.

“It can be applied retrospectively on what ‘might have been there’, so it’s easy for <u>some</u> ecologists to cheat”

Throughout the interview process several accounts (from 25 % of those polled) noted that ecologists were being brought into a scheme late in the construction process to ‘get extra points’ once initial draft BREEAM scores have been assessed and have proven to be unfavourable. As a result there had often been significant ground disturbance and the current site no longer reflected the original nature of the ecology found before the development had begun. Ecologists recounted examples where they have had to utilise old reports, conversations with neighbours, aerial photography, and with the expansion of internet resources, free satellite imagery in order to make assumptions on what habitat types may have been on site. Clearly this approach is open to significant amounts of interpretation, as well as being subject to the quality of reports or media used in assessing previous habitat types. Several ecologists stated that as a result it is a loophole open to abuse by unscrupulous ecologists and developers. It is worth noting that every ecologist who raised the point mentioned the code of conduct that they are bound to under their professional membership and those who cheat were other unscrupulous ecologists. No one interviewed admitted to 'cheating' or fixing the results.

"It doesn't give enough weight to the ecologist's opinion"

There was a general opinion expressed by many (58% polled) that in a number of places throughout the Land Use & Ecology section of BREEAM that the approach was not only prescriptive but very restrictive in what should be done on the site in terms of enhancements (particularly in relation to increased species numbers), and not enough weight is given to the ecologists opinion based on detailed accounts of the site and its native ecology. Given the requirements set within the assessment methodology to ensure an ecologist is suitable and of an appropriate level to make recommendations, those who expressed the opinion felt it would seem prudent to extend a degree of freedom to ecologists about what is or is not appropriate on site. Often as the opinion leads to recommendations which are not enforceable, ecologists believe their opinion carries no real weight when offering recommendations to clients and developers. Typically financial restrictions are cited as the main reason for ignoring an ecologist's opinion.

"The flaw in the Land Use and Ecology section is there's no ecology in it!"

Similar responses to this one ranged from "I'm an ecologist, not a contaminated land expert" and "half the credits have no ecology in them". Many ecologists (67% of those polled) felt that they had no control over LE1 and the reuse of land as typically the land had either already been purchased or they were no part of the decision making process. Equally many are being asked to undertake work outside their expertise (typically as a result of LE2 contaminated land). This in conjunction with several other credits being a "mathematical exercise" over half of the credits can be gained without any real ecological work being undertaken.

"We don't get involved, we just write a report"

Although some ecologists stated that they would not undertake BREEAM assessments unless they were part of the overall design process (7% of those interviewed), many (53%) complained of a feeling of disassociation with the project, having been asked to simply "do a quick survey and write a report". As a result the overall recommendations, even though based on sound ecology could not take into account the site constraints and the actual design. 67% of the ecologists interviewed felt that a high level of involvement in the design process however was beneficial and could therefore tailor the report accordingly.

"The developer didn't like the last report, so we've been asked to do another one"

Several members (37%) of the sample group indicated that they either found themselves "finishing off" another ecologists work, verifying reports that were not their own or in some cases being asked to re-write assessment reports as the developer simply did not like the outcome and wanted a new report to get more points. As there is no requirement within BREEAM to utilise the same ecologist for each credit it may be possible for a developer to use a range of ecologists to ensure a preferred result or outcome.

"We can only use native flora to boost the number of species…but what does BRE consider native?"

Under LE5 there is a requirement to use 'only native flora/plant species and those with a known attraction or benefit to local fauna can be considered for the purpose of increasing the number of species on site, as well as general enhancement' (BRE, 2008a). As a result there comes a discrepancy amongst ecologists on what constitutes native? Over half (53%) commented that guidance or a ruling from BRE would be of significant benefit or at the very least a better description/wording of the assessment guidance, 12% of those polled even question the benefits of using only native species in relation to ecology.

"The species boundaries are too low, 6 is easy"

In a related point, the minimum credit boundaries for LE5 is undertaking a report by a suitably qualified ecologist, with the intention of implementing the general recommendations (one credit.) After achieving this if the implementation of the recommendations results in an increase of plant species (less than 6 in number) two credits are awarded. If in the previous statement the number of species grows by 6 or more, then three credits will be awarded. Over a quarter of those interviewed (26%) felt this was the position, and as a result, many ecologists feel that this boundary of 6 species is simply too low and too easily achieved. Therefore with a few simple changes to the landscaping species palette 33% of the points available for the Land Use & Ecology section can be awarded with minimal effort for the developer and with minimal benefit to ecology. Another ecologist pointed out that the solution was simple, and developers had experience of it; simply specify wild seed mix within the landscaping schedule. The ecologist went on to suggest that although the solution meets the requirements of BREEAM, it misses the spirit somewhat of applying sound ecological principles in a planned effort to increase biodiversity.

"There's no monitoring or follow thorough, our recommendations are not enforceable"

In one form or another, a number of ecologist (23%) expressed concerns that credits were being awarded on the assumption that the recommendations identified through the reporting process were actually being implemented, or even in situations where they have been, there were no guarantees that recommendations for long-term management and therefore biodiversity gain being implemented. As a result even a well-designed scheme earning three credits for enhancing site ecology (LE5) may only generate a short-term enhancement of biodiversity. One example identified trees being planted to gain credits for a housing development, only to be removed post construction (to be used on another scheme) with the developer citing that "the new owners wouldn't want the trees, they never do, we often get called back to take them out."

"Habitat descriptions are a bit simplistic…"

A few interviewees (19%) felt that the category descriptions utilised in the ecological calculations are somewhat simplistic. Equally by labelling each habitat type found nationally into one of five landscape types and vegetation into nine plot types many sites are being poorly categorised or forced to use inappropriate labels in order to establish an ecological value using the calculator methodology. Equally as several key habitat types are not included such as wetlands for example, technically it would be more beneficial to create inappropriate landscapes such as infertile grasslands rather than extending existing wetlands to achieve more credits.

"The calculations don't allow for ecologically intense features like ponds or hedgerows"

Although LE3 (Ecological value of site and protection of ecological features) requires the protection of ecological features, e.g. existing ponds, water courses, hedgerows and wetlands, it does not allow within the calculations for the introduction of new features according to the sample group. Ponds for example are not considered a habitat type and as such are not included in the calculations for ecological gain. In fact one ecologist felt forced to keep ponds from her reports as "given that the calculations are based on area and on net growth of plant species, ponds act in a similar way to the building footprint, decreasing the area available for the introduction of new species" and "even though ponds are considered a significantly valuable habitat feature for ecology, they effectively 'reduce' the ecology of the site within the calculation". Equally even though ecologically intense habitat types and features such as hedgerows provide a range of services for ecology such as food production, shelter and connectivity in varying degrees, there is no incentive to include them. Under the calculation methodology they do not score better than the most basic of habitat types as "the area weighting of the calculation means linear features like hedgerows are pointless."

"BREEAM doesn't allow for off-site mitigation."

In some cases there is not enough space to protect or include new habitat to any significant degree, but there is no scope to undertake off-site mitigation to compensate or (although not ideal) the translocation of species either for the duration of the construction project or to a more suitable habitat nearby. This according to at least two interviewees is a common occurrence on small sites or very urban projects, where they felt the assessment methodology is too restrictive. However BREEAM is not designed as a mitigation tool, its primary role is to demonstrate excellence in approach to a development within the boundaries of the site. As such the inclusion of off site mitigation within the scheme to score credits within BREEAM is not appropriate.

"There's an encouragement to introduce inappropriate habitats or species just to get the numbers up"

There is suggestion that ecologists are pressured in some cases to obtain as many credits as possible and therefore introduce inappropriate habitat types to the local context or utilise particular species because they are different in nature and therefore count as an increase in biodiversity, even if this is inappropriate for sensitive sites, or contexts 12% of those interviewed mentioned having experience of this occurring.

"There's no real guidance or training overall"

Around half (53%) mentioned that they felt they had little training in BREEAM and there was a serious lack of guidance for ecologists undertaking BREEAM assessments. In addition, 37% of those polled commented that assessors received formal training however it was insufficient in relation to ecology, e.g. assessors could not adequately instruct or guide ecologists and many are left to understand the requirements themselves. Three ecologists interviewed found that although it was relatively straightforward to undertake an assessment. There were cases where certain elements were open to interpretation and guidance or informal workshops to discuss such issues would be helpful.

"Talking to BRE is impossible."

In a related concern, ecologists commented that when they did have a question or were in need of clarification on a particular point, they found that talking to BRE was very difficult, with no real central point of communication and a host of unreturned phone calls. 23% of those interviewed recounted instances of giving up after being 'bounced' around the switchboard from department to department. Having a dedicated communication route was felt to be a major step for BRE to take.

"There's no guidance on what a suitable level of enhancement is"

Under enhancing site ecology (LE5), there is a requirement to include 'general recommendations' made by the ecologist. However the definitions as outlined in the technical guidance manual were felt to be vague. Ecologists can determine the likelihood of suitability in recommending bird and bat boxes for example as well as appropriate design elements to be included such as sustainable urban drainage, or green roof installation (all are suggested within the manual). However all three have varying degrees of complexity, cost and significant time implications. 37% of the studies participants argued that developers will logically opt for bird and bat boxes over an extensive green roof design, based on the implications of each and there is no real guidance on what would be required or suitable as a level of enhancement.

"Certain wording is unclear"

21% of the sample group cited that some wording was unclear, especially in relation to the calculator, with switching units and area's of measurement. In addition whether species increase is measured over the whole site, or per metre squared.

"BREEAM has no real links to the planning process, with BAP's and local planning Guidance or Action plans. It talks about them but it doesn't link in with them"

The technical manuals suggest that a local ecologist who is aware of any Local Biodiversity Action Plans being in place should comment on the designs as part of the LE6 credits (long-term impact on biodiversity). 12% of those ecologists interviewed however suggested that these (and other elements of planning policy) are locally important and should have a higher profile within BREEAM, to ensure it is aligned with national and regional planning policy and guidance and to ensure they are considered as part of the design process.

"The developer is my client, he's paying for the report, I need to keep him happy"

A key component raised 23% of interviewees is the cost process of BREEAM. By having the developer employ the ecologist there is a risk that the final report will be stacked heavily in their favour, meeting the requirements of BREEAM but at the minimal financial cost. In this sense developers are often 'buying credits, not ecology'. Half of those ecologists raising this issue mentioned that they would feel happier if the requirements were stricter so that they would have a stronger position in recommending ecological enhancements when talking with developers/clients.

"Developers just use ecology to score points at the last minute"

A significantly common 'flaw' raised in response to this question (by 81% of the sample group) was the phenomenon of developers bringing ecologists on board near the end of the scheme in order to find 'extra points' to raise their overall score. 44% of those polled felt that this was not only common place and a fundamental flaw in the process, but reflective of what many developers feel in relation to ecology, that it is only an added element and it can be dealt with at a later date in the scheme. Although all ecologists felt that it was crucial to get involved in a scheme at the very beginning, the likelihood was very much dependant on the developer. Equally some (28%) felt that once they had worked with a given developer, and gone through the process, then should they work with that developer again, the process was easier as they were more aware of the implications of the BREEAM process.

"Ecology points are cheap and are worth more… a good report can get you ten credits for 1.5K; an expensive technological heating solution may only get you 1 point and cost 10K!"

There was feeling that when a developer is nearing the end of the scheme and is looking for points to reach a given award requirement, Ecology credits are a good choice as the relatively high weighting of points and the low cost to achieve them make them good value for money. This response has been given by over half of those interviewed (53%) as a likely justification for bringing ecologists in late in the process.

3.4.2.5 Question 9

"Can you give any specific examples of where BREEAM has not worked as well as it could/should in regard to ecology, but still scored well overall?" 44% of those polled gave examples to answer this question, typical examples include:

"There's been quite a few schemes certainly around Newcastle way and generally on Brownfield sites because I've discovered that the county Durham Biodiversity Action Plan habitat includes Brownfield sites with 6 of their target species. The sites where I've found that it is a BAP habitat they've ended up scoring virtually zero on the ecology side but because they have a well-designed building with environmentally friendly technology they've still scored quite a few points without the need for the ecology."

"Frequently they'll not get many credits or they'll not bother doing the ecology if they think they won't score well, we've done proposals before where we've worked with a client a number of times and we can give them an idea of the number of credits they might get, but as soon as they start to develop in a non-urban context they start to loose so many credits, which is part of the point they can gain some credits for developing on a green field site but they loose so many credits that they often don't even bother, but the building still scores well… "

"Because the projects are lead by architects or engineers, most of the attention is focused on the building. So it often scores well even if the approach to landscaping and ecology is bad."

"The landscaping budget, and therefore the ecology is often the first to get cut, often the money gets spent on the high-tech stuff which gets points but the landscaping is left for 'another phase' which may or may not happen".

Clearly the feeling is that ecology has little bearing on the scoring strategy for BREEAM at the outset of a development and as such the focus is on the other elements that make up the overall score. To a degree this is understandable as ecology is only one part of the sustainability equation; however the weight of that part is in question. 23% of those polled felt that ecology should play a greater role in the early strategy for a BREEAM assessment however the lack of any significant mandatory elements within Land Use & Ecology means that it can still be an afterthought for a developer.

3.4.2.6 Question 10

When asked that "given that there are differing assessment tools for offices, hospitals, schools etc. In your experience is ecology treated equally across all these differing BREEAM standards?" On the whole almost all interviewees (91%) felt there was no real difference between the different assessment tools. The only real distinction came in the comparison of domestic standards such as EcoHomes and the new Code for Sustainable Homes, against non-domestic applications e.g. BREEAM Offices, Education or Industrial.

3.4.3 Section 3 – Experiences of other systems

This section aims to establish if the non BREEAM systems highlighted in the last chapter in use elsewhere in the world are noteworthy according to the sample group; and if so what specific elements or benefits are particularly of interest to UK ecologists. The first two questions were used to determine whether the remaining questions needed to follow, if not the interview proceeded onto the next section.

3.4.3.1 Question 11

"Have you heard of other systems like BREEAM used elsewhere in the world for rating buildings?"

The responses to this question were unequivocally negative. Only one interviewee said she knew there were others, but could not name any of them. The remainder of the sample group did not know of the existence of any others.

3.4.3.2 Question 12

"Have you worked with other UK systems such as the MOD's DREAM system?"

Only one interviewee had any experience with a BREEAM alternative and that was the Defence Related Environmental Assessment Method (DREAM). In that individual's view, the DREAM system had limitations but the approach was sound and the significance given to ecology (as highlighted in chapter 2) was both 'refreshing and welcome' in comparison to BREEAM. Expanding on his comment, he said the inclusion of ecology as a required element added weight and made his role easier to perform.

3.4.3.3 Questions 13, 14 & 15

The remaining questions found within section 3 included:

"Have you worked with any of the other recognised international systems such as LEED, GREENSTAR, CASBEE etc…?"

"If yes to above how did you find the systems in relation to ecology?"

And "Would you like to see any element of these approaches brought into use in the UK?"

However based on the responses to the first two questions by all interviewees, these remaining questions were omitted from the interview and questions continued with section 4.

3.4.4 Section 4 – Opinion of the current BREEAM standard

Questions were asked around BREEAM and its focus, centring on ecology and the perception of its role within the assessment methodology. Interviewees were asked to recount their experiences based on prompter questions to establish if they felt the methodology worked in given scenarios.

3.4.4.1 Question 16

When asked "In your opinion where is the overall aim or focus of the BREEAM standard?" The answers split into two main groups either a) (23%) they did not know enough about the remaining elements to comments as so far they had concentrated solely on the Land Use & Ecology elements with minimal exposure to the rest of the assessment. Or b) (77%) they felt it centred on the building fabric and operational components, with energy being the top answer followed by materials and then waste.

3.4.4.2 Question 17

The sample group were all asked "Where do you feel Ecology sits in relation to the other elements in terms of importance ranking on a scale on 1 to 9 (1 being the highest 9 the lowest)?" the other elements include (in this example BREEAM offices 2008 is used as a representative list of core themes):

Management	Health & Wellbeing	Energy
Transport	Water	Materials
Waste	Land use & Ecology	Pollution

Figure 3.3 shows the polled responses for the sample group. The trend saw almost all of the respondents viewing Land Use & Ecology low on the list in terms of relevant importance when compared to other assessment elements. A significant number of the group (33%) saw Ecology at the bottom of the list in their opinion with only minor support for it being higher on the list

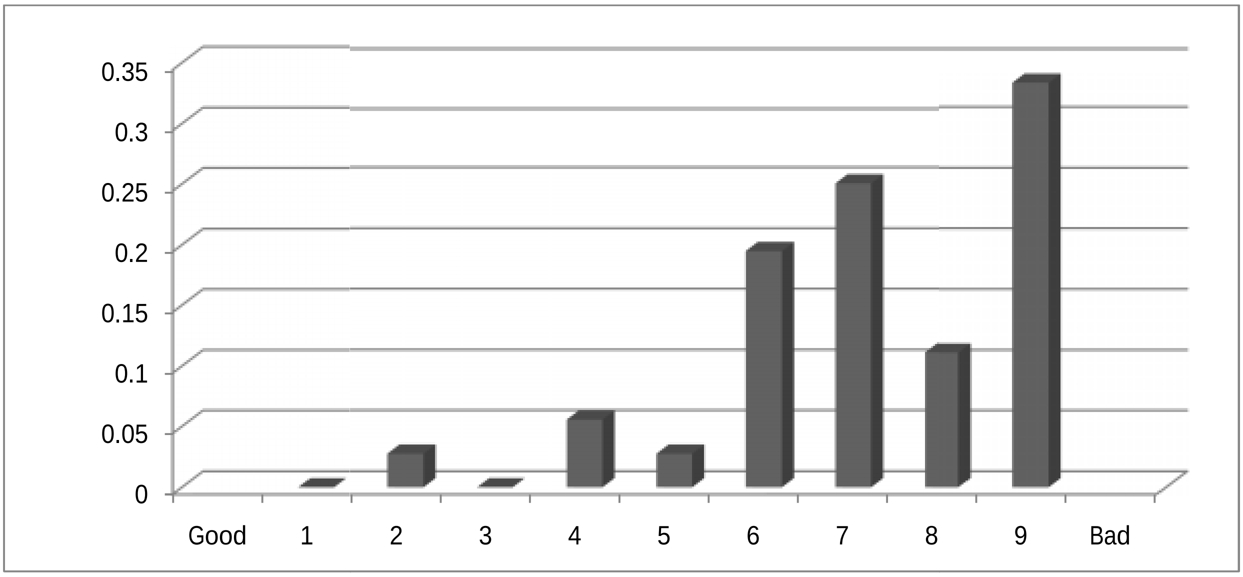

Figure 3.3 Ranking the opinion of Ecologists on ecology within BREEAM

3.4.4.3 Question 18

"Looking at BREEAM as it currently stands, does it achieve its stated aims and objectives?"

When asked this question firstly in relation to BREEAM overall (i.e. the aim to promote sustainable development) the response proved wholly positive, with 88% responding favourably. However when asked if it achieves its aims and objectives in relation to Ecology, the response was markedly inverse with 79% of respondents feeling it did little to improve ecology as it currently stands.

3.4.4.4 Question 19

"Does it encourage the developer to make the most out of their site?"

Although the responses were mixed in theme, the overall opinion was that there are positive points such as raising awareness with developers, and encouraging them to introduce elements that they may not normally consider. However many opinions were negative in nature. The most common responses being that it was often seen as a 'hoop to jump through' or a method to gain a few extra points to aid in meeting or passing an award threshold.

3.4.4.5 Question 20

"Are you aware of the changes in the 2008 revision? If so have these past changes to BREEAM made or will make a difference to the importance ecology has been given within the system?"

The key focus of this question was aimed at ascertaining the ecologist's awareness of BREEAM's evolution, if any changes had occurred to the Land Use & Ecology elements to their knowledge, or if there was an awareness of the review procedure BRE undertake as part of the ongoing development of BREEAM. The responses fell into three categories:

a) Yes and no. Yes they were aware that there were changes, but not exactly what they were as they had yet to conduct an assessment using the new versions and therefore had yet to read up on any changes.

b) The ecologists either didn't know of any changes, or if they did they felt they were minor and only in words or phrasing.

c) That 'BRE didn't advertise the changes well enough' and 'are not doing enough to support ecologists undertaking assessments'. BRE appeared to be 'concentrating on the BREEAM Assessors' in terms of updating and dissemination of knowledge.

3.4.4.6 Question 21

When asked "As an ecologist do you find the required approach of BREEAM restrictive or the best approach to enhancing ecology within a scheme?" The response was almost equally divided between 'its restrictive and limiting' (44%) and 'its pretty flexible, it lets us make recommendations and seems like a logical process' (56%). Regardless of whether the response was positive or negative however almost all added that the system could do more to be more effective.

3.4.4.7 Question 22

"Is the system better suited to a particular size of scheme in your opinion?"

Responses were equally divided, for both large and small schemes with the common reason for efficacy on large projects being that space was available, on smaller schemes it was the relative importance of ecology. Given that the calculator is area based, and dramatically affected by habitat loss through building footprint, over half the group (58%) favoured large schemes to be more effective as the larger area made it easier to improve species numbers. However proponents of BREEAM being better suited to the smaller schemes felt that within a smaller area ecology grew in importance and so it was easier to introduce ecological design with key features e.g. green roofs, living walls or ponds, and in general create more ecologically intensive spaces such as gardens focusing on wildlife. Although these approaches were no doubt harder to achieve BREEAM ratings the system lent itself well to justifying the importance of Ecology in the development.

3.4.4.8 Question 23

"Is it as effective in both rural and urban schemes?"

Nearly three quarters of responses (72%) felt that it was more effective in urban schemes, of the remaining 28% respondents, 26% stated that they were 'not sure and it is probably about the same'. Only one response (2%) favoured rural on the basis that there was more potential for integration into established ecology surrounding the site and the natural progression of habitats meant faster growth of biodiversity. Most favoured the urban schemes to be more effective as there was 'typically greater room for ecological improvement'. However several answered that this is not always the case, as an undisturbed brownfield site in a city centre can develop quite a strong ecological value. Most admitted that a significant proportion of the projects they had assessed were however urban or semi-urban schemes, and only five interviewees had experience with projects in more rural locations.

3.4.4.9 Question 24

When asked "In your opinion how effective is BREEAM in sites with either low or high initial biodiversity?" Almost all (98% of those polled) commented that it suited low biodiversity sites more as there are greater opportunities for improvements on these sites and that establishing a species increase or even combating a net loss of habitat on high biodiversity sites is inherently problematic. There was however one proponent of high biodiversity sites stating that if managed well, the high biodiversity and rich species numbers present created a positive long-term gain. In such situations, significant changes on a site could recover more quickly due to natural succession of neighbouring ecology. However significant amounts of work is needed to score credits for such a scheme.

3.4.5 Section 5 – Recommendations to improve BREEAM

Although many of the answers to previous questions would indicate that change in the system is either needed or possible, the purpose of this section is three fold: to confirm if improvements are needed, to what extent the approach may have to change and to give another opportunity to raise any issues or concerns with the system, and thereby confirming where improvements could be made or efforts best placed.

3.4.5.1 Question 25

“In your opinion could BREEAM be improved in regard to ecology in the next system review by BRE? And if so should it be improved?”

Every response to this question from the ecologists interviewed was ‘yes, it could be improved’ and ‘yes, it should be’. Not one member of the sample group felt it worked as it currently stands without improvement.

3.4.5.2 Question 26

Following the significant response of the last question, when ecologists were asked “Assuming therefore that change is needed, do you feel that there is room for improvement within the boundaries set by the current system or would it have to change radically to be more effective?” The responses were more divided. Over half (67%) felt that the system worked but it needed strengthening either with better weightings and emphasis or in the approach and process. Some felt (9% of those polled) that the scheme as it is currently presented is too flawed and needs a radical overhaul in both approach to ecology and stance on mandatory requirements for it to be effective.

3.4.5.3 Question 27

“Are all assessments equal or uniform? Is it possible to apply the same criteria to every site?” None of the ecologists questioned had experienced problems associated with this scenario, suggesting that the criteria set under the current scheme is general enough to be transferred from scheme to scheme and site to site. This is a probable key factor for BREEAM's success to date and a key element for consideration in relation to any changes that need to be made to strengthen BREEAM's Ecology elements. BREEAM must ensure its universal applicability to differing scenarios in order to maintain its usefulness as a national standard.

3.4.5.4 Question 28

Finally ecologists were asked the open ended question of "If you had free reign on changing the system, how would you like to see it improved?" in order to either pick up on any suggested issues or positive elements introduced earlier on, or to recap and expand on any major weaknesses/ positive benefits mentioned as part of the interview process. Many interviewees restated issues (many of which were initially highlighted as a result of question 8) that 'needed to be addressed' as part of the revision process. Equally many introduced new concerns which may have been previously mentioned by other interviewees and therefore captured in the responses to question 8. It was noticeable that as the number of interviews increased so did the frequency of certain responses and concerns, most notably:

- The lack of a relationship between ecological principles and BREEAM
- The problematic calculations required
- And being brought in at the last minute to conjure credits from an almost complete scheme.

This signifies through independent corroboration that certain issues with BREEAM are felt by a major proportion of the ecological community. Equally that the interview process had worked as intended in reaching a plateau point of similar responses and thereby a consensus position of the key issues facing Ecology within BREEAM. Of the responses (many of which are detailed out within the responses to question 8) fall into the following generalised categories:

- Communication with BRE
- Issues with text and wording
- SQEs and qualification issues
- Training levels
- Available guidance issues

- Relationships to core ecological principles such as connectivity
- Issues around key ecological features
- Weighting and credits
- Geographical issues and lack of context
- Lack of inclusion of fauna in entire process
- Inconsistency of ecologists approach to BREEAM
- Calculations and scoring issues
- Relationship of ecologists other work types (Phase 1 Habitat surveys, etc…) & BREEAM
- Relationships with other elements of the BREEAM process.
- Timing of Ecologists involvement and role

3.5 Initial result analysis – thematic coding

The above comments and summary information associated with each question are represented here as opinions of the interviewees and associated solely with the questions specifically asked. The validity and accuracy of the responses have not been assessed here. Analysis and interpretation will form a core element of the next chapter, as will the outcomes of concerns raised throughout the interview process overall. The process and purpose of thematic coding is for both categorising qualitative data and for describing the implications and details of these categories. Utilisation of thematic coding allows analysis of a wide range of responses, and begins with 'open coding' going through large amounts of data and establishing general key themes (this process can be seen in previous sections). Following this is 'selective coding' where themes are systematically coded into core concepts. The next chapter will continue this coding process to develop these themes into the core concepts and as a result the key areas most in need of being focused on. In addition the next chapter will focus on three key areas: are the issues and concerns real effects or misinterpretations by the ecologists of BREEAM? If they are real, are they significant and what solutions are there to improve the weaknesses they create within the system.

3.6 Interview process analysis -Number of interviews

As outlined in Figure 3.4 through the use of thematic coding and the application of a simple repetition analysis, the appropriate number of interviews was determined. From this we can see that after 33 interviews, the repetition of answers significantly reduced the value of continued investigation. To ensure this 'tipping' point in the frequency of new information was reached another phase of 10 interviewees were approached raising the total of completed interviews being undertaken to 43 (across 5 phases.) No new information was gathered from these additional interviews.

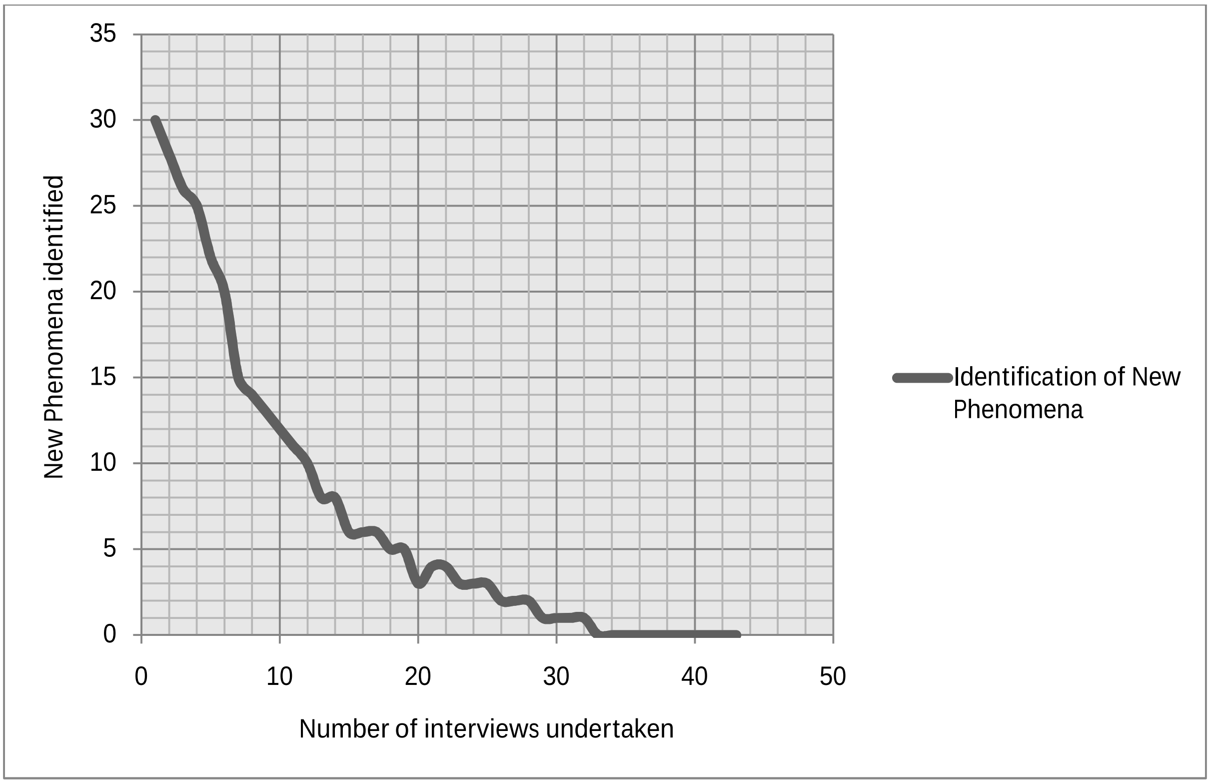

Figure 3.4 Plotting new information from interviews against number of interviews undertaken

3.7 Post interview bias analysis

Given that not every ecologist in the country was approached it becomes necessary to identify any bias in the sample group in order to allow generalisation of the data and improve external validity as highlighted in 3.2.6. In order to achieve this, the information gathered at the beginning of each interview has been utilised in order to look for key trends that may affect the data and therefore external validity.

3.7.1 Bias – location

Figure 3.5 identifies the geographical spread of interviewees taking part in this effectiveness study and represents their business addresses plotted across the UK. As the participants were chosen at random it is anticipated that not all areas across the UK will be represented equally nor will there be a completely even representation, the purpose of this bias analysis is to ensure that no one region has unfair representation, i.e. not all participants were in London or the south west. It is expected that the bulk of representation will fall inside the borders of England as this will mirror the distribution of ecologist in the uk. This in turn will strengthen the random element of selection as it should show indifference to location giving a fair spread across the country. From Figure 3.5, it can be seen that although the sample number is not vast, the spread is fair across the country with every region (with the exception of Northern Ireland) having at least one representative. The core of interviews would appear to be located within a central north-south corridor of England with minimal incidents to the north east of England, Wales or Scotland. In addition to the spread of interviewees the frequency of responses from any one region never rises above four interviews within a 20 km radius, therefore no one area is significantly 'overly represented' through the interview process. The use of a random selection approach would appear to have been effective in polling ecologist's views nationally.

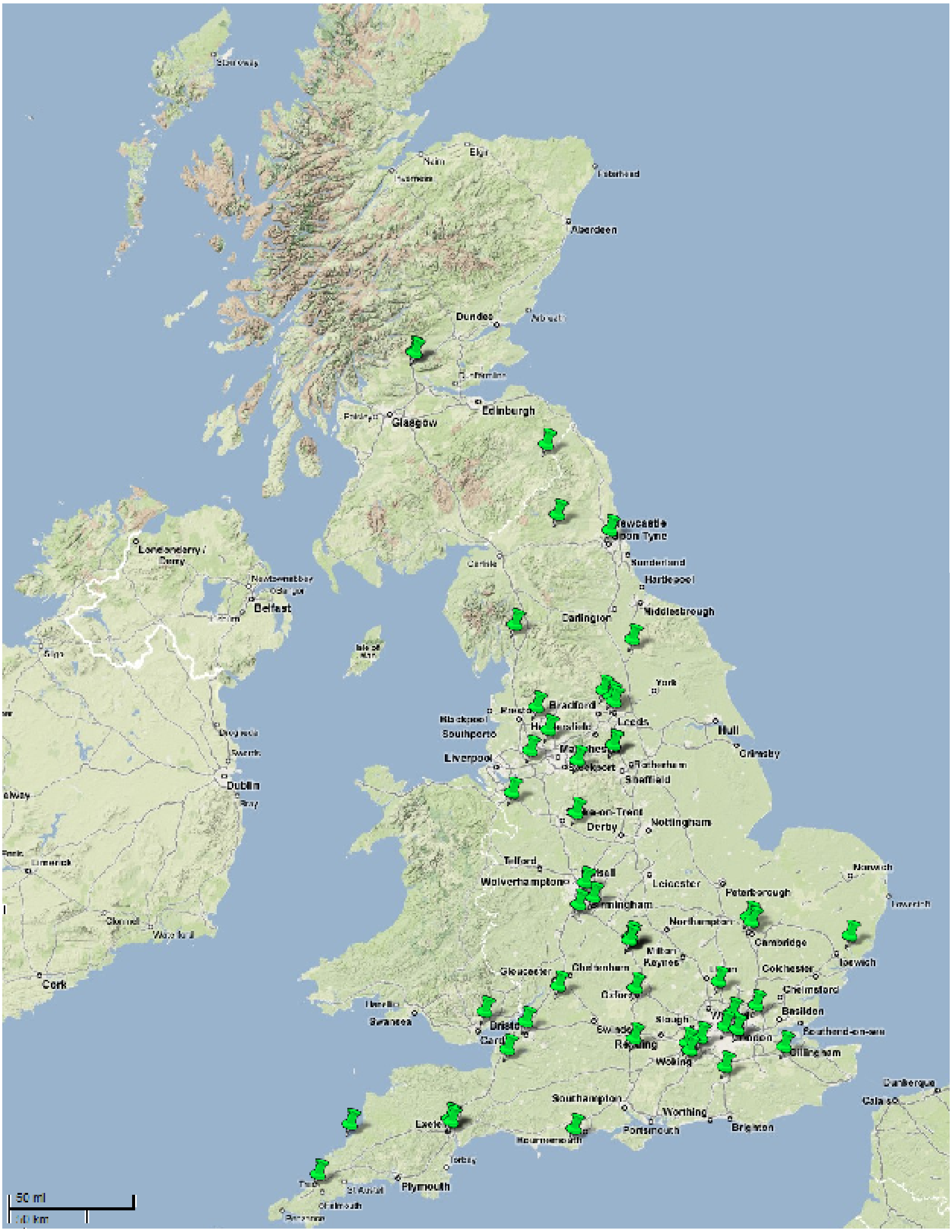

Figure 3.5 Geographical plots of interviewees

3.7.2 Bias - size of company

The second piece of information obtained from each participant was the size of the company. Respondents were asked if they worked for a small (less than 20 employees), medium (21 to 100 employees) and large (101+) company, thereby allowing the data to map the spread of companies so as to ensure each range is represented. This prevents bias from both ends of the spectrum, from large multinationals down to specialist or niche consultancies. Of the total respondents the size of each company breaks down relatively evenly as follows:

- Small = 35%
- Medium = 37%
- Large = 28%

3.7.3 Bias – Gender

The gender of the random participants sample has been recorded and analysed for bias with the split of gender as follows:

- Male = 43%
- Female = 57%

There is a slight bias towards female ecologists as part of the study. However not alarmingly so as some deviation for an even split is to be expected from a randomised sample, moreover the overall split within the population of ecologists available is Male 46%, Female 54%, as such the randomised sample is very close to the expected.

3.8 Corroboration of phenomena – workshops

In relation, to but not linked to, this research three workshops on BREEAM and ecology were held by the Institute of Ecology and Environmental Management (IEEM) in London during this research period. Given that IEEM is one of the professional membership bodies which can lead to SQE status, this presented an excellent opportunity to further test the results of this investigative study. Spread across three different dates, the purpose of the workshops was to educate ecologists in BREEAM, how it works and how it should be applied. In addition it gave the organisers a chance to 'poll' the three groups and view experiences and opinions of BREEAM as it currently stands. Through attendance of all three days it became clear that the experiences of the 43 ecologists interviewed through this research study mirrored the 78 ecologists attending the workshops, with only two ecologists in common between the interview and workshop process. This adds weight to the outcomes of this investigation and strengthens further the particular concerns of ecologists using BREEAM.

3.9 Chapter outcomes

The investigative study outlined here has led to four distinct outcomes, many ecologists from the sample group feel that the BREEAM assessment as an approach is a good starting point, has many good qualities and it is the right tool for assessing the sustainability of a building, but not ecology as evidences by the significant responses to key interview questions. Equally it provides an opportunity for ecologists to get involved in the design process often where such an opportunity may not normally exist.

There are problems however reported by ecologists in the application of the Land Use and Ecology section of BREEAM. It would appear that many of these cross the varying BREEAM versions (offices, healthcare, housing etc…) and as such may have significant effects on the efficacy of BREEAM in relation to ecology across all applicable projects. It must be noted however that the accounts stated here represent views and opinions of those polled and will require review and analysis to understand both the accuracy and validity of the phenomena encountered. It is possible that the issues arising from this investigation maybe simply due to a lack of understanding of the process or a misunderstanding of the technical guidance. This analysis and comparison of issues and real effects will form a core component of the next chapter.

Regardless of the application issues of the section, many ecologists are of the opinion that even in situations where the process is correctly applied, the overall effect does little to benefit ecology. In effect the BREEAM assessment process is just that, a process, with little benefit seen in introducing ecology. This issue is a fundamental problem, and must be addressed. Therefore the relationship of BREEAM and ecology, how this can be improved, and how it can be introduced into the process will also form a key component of the next chapter.

There were several concerns raised by the ecologists around the mechanics of the process, especially concerning, communication with BRE, training and guidance and the relationships between the ecologist and the assessor as well as interactions with the design team on projects. These issues are outside of this research into the efficacy of the land use and ecology section itself and will be collated and analysed in the next chapter but not dealt with as until the conclusion of this work when overall recommendations on improving BREEAM will be made.

It would appear from the initial responses given by the ecologists interviewed (and further corroborated throughout the workshop process), that the more frequent concerns identified here are shared among a number of ecologists (in terms of common experience) and not limited to single examples. This would imply that these phenomena are common across BREEAM assessments and not limited to individual projects. However more importantly the indications identified within chapter two that ecological principles would appear to be missing from BREEAM have been strengthened based on the opinion of ecologists spread across the UK taking part in this research study.

4 Analysis of the effectiveness of BREEAM on ecology

4.1 Introduction and aims

This chapter continues the preliminary investigation outlined in the last chapter and focuses on a number of elements in order to ascertain if the concerns identified by the ecologists are valid issues, but also to identify if these issues can be readily addressed.

The aims of this chapter focus on the progression of Chapter three, through critical review, qualitative investigation and statistical frequency analysis. This chapter will assess if the faults identified in Chapter three are in fact real phenomena, and if so give an indication of the potential impact of the phenomena. In addition the phenomena identified will be ranked and prioritised to ensure that the most pressing concerns are addressed first. In essence the first part of this chapter will identify the key phenomena to be focused upon and determine if they do indeed need to be dealt with as a real concern. The second part of this chapter will see if there are simple solutions to these problems identified within the literature and other assessment methodologies from around the world utilising the base information gathered as part of chapter 2. If this is not the case then the final element of this chapter will be to concentrate on these issues and identify if a new methodology to ecology within BREEAM can be proposed.

4.2 Thematic coding analysis

Thematic coding has been used in the last chapter to identify groupings of phenomena within the application of BREEAM. This process has helped identify in broad terms the types of concerns the ecologists have with the system as it currently stands. This process will be continued here to further categorise the phenomena into three distinct groups, each requiring different solutions or approaches and to understand which fall under the scope of this research. Broadly the phenomena identified in the last chapter fall into the following categories:

- Those concerning the practical application of BREEAM,
- Those concerning how effective the process is (BREEAM's fundamental approach to ecology) and,
- Those relating to the administration of the process and ecologists relationship with BRE.

The scope of this research is concerned with the problems associated in applying the BREEAM process as well as the efficacy of the process itself; therefore the following chapters will be concerned with addressing the first two categories of phenomena. Commentary and suggestive solutions for the third category will be made but they will be addressed at part of the conclusions of this work in the final chapter. Direct quotes and within this chapter are views expressed by the ecologists undertaking the interview process outlined in the last chapter (unless stated), the commentary and analysis however are key element of this research study and represent new findings.

4.2.1 Groups of phenomena

Analysis of the phenomena arising from the interview process has shown that before the point of diminished returns determined through the repetition analysis was reached, a total of 76 distinct phenomena had been identified. These have been catalogued and are presented in Table 4.1. Each issue has been assigned a phenomenon specific reference code and throughout this chapter this code will be used for brevity in discussing the concern itself. Each code has a letter prefix determining which of the three groups the phenomenon belongs, as follows:

- A, issues concerning the practical application of ecology within BREEAM
- B, issues concerning the fundamental approach of BREEAM
- C, issues concerning the interaction with BRE regarding ecology and BREEAM

The number following the prefix represents the order in which each were analysed and catalogued and does not denote either frequency or a ranking at this juncture. Understandably the 43 interviewees did not all utilise the same language in expressing their views, so each statement of concern or phenomenon has been carefully assessed to understand the intended meaning of the account (clarifying where necessary) and then aggregated under a common statement to represent the phenomenon. The statements are therefore generalisations across a number of instances to create an interval that can be tallied. Codes at this point have been attributed in a linar order and do not represent frequency.

Section A – Issues concerning the practical application of ecology within BREEAM	
Issue	Reference Code
The species list is confusing	A01
There is no prescription on when the survey work needs to be carried out	A02
The section is often used to bolster points missed in other sections, needs to become a priority	A03
It is a tick box exercise, ecology doesn't work like that, it needs to be more intuitive	A04
There is little control over to what degree the guidance provided by ecologists is implemented	A05
Interpretation issues differ between consultants, makes it easier for clients to cherry pick ecologists that will offer potential credits with minimal effort needed	A06
We need a fully worked example to understand the calculation process	A07
The species/area terminology is misleading and confusing	A08
There's no outline of what the client needs to supply for a comprehensive assessment, means different assessments are not comparable in terms of baseline data	A09
Ecology needs to be introduced at the outset of a project to be able to provide advice on ecological enhancements and master planning	A10
We need clearer guidance or a field manual/ examples of best practice	A11
The ecology component needs standardisation, its different between BREEAM types	A12
The manual needs to be clearer to reduce any ambiguities, especially so that the ecologist, the clients and the BREEAM assessor all read the same interpretation	A13
The guidance needs to be clearer on the inclusion of protected species, either currently on site or after the development	A14
Define ecologically valuable sites, to reduce the client determining the site has no value	A15
Greater weighting of points given under each section, scoring could be out of 50 rather than the current 10	A16
The difference between using total spp. Number or species density for calculations needs clarification	A17
Assessors need to be aware that a SQE is required to look at proposed planting lists and determine if the species are ecologically valuable and only include these in the calculations	A18
There needs to be mitigation for the displacement of legally protected species	A19
There needs to be clarity on habitat creation and quantity, how much is needed to achieve the credit	A20
The overlap between LE4 and LE5 is pointless and should be removed. The 2 credits awarded in LE5 are automatic if LE4 is achieved	A21
Clarification is needed between the terms 'development site' and 'construction site'	A22
There needs to be a better consistency of 'non native' species with wildlife benefit, and what is acceptable	A23
There needs to be a set format as each consultant is different, producing differing reports and levels of information	A24
Section B – Issues concerning the fundamental approach of BREEAM	
Issue	Reference Code
A weighted system of scoring should be considered to record 'Change in ecological value', so that semi natural habitats score more highly than recent or man-made ones	B01
There should be a systematic approach to valuing or protecting habitats or sites with UKBAP or LBAP designations	B02
There needs to be a clearer definition of species value	B03
Inclusion of ecologist's involvement as part of the post construction review.	B04
The calculation methodology is flawed and needs a complete overhaul	B05
There is conclusion over use of only native species and the use of non native species as long as they have wildlife benefit, clarification is needed	B06
There needs to be better links with ecosystem functions	B07
There needs to be reward for efficient use of spaces, ecological as well as practical use of space	B08
Look at possibly splitting urban and rural development as they are different in approach	B09
The approach should be to maximise ecological opportunities not just meeting criteria.	B10
The inclusion of an ecological management plan will ensure long term success, clarity is needed on ownership	B11

The species list for calculation is irrelevant to ecological value and should be removed.	B12
The approach needs to be less open to manipulation, i.e. putting habitat of low ecological value in categories with high levels because they are most appropriate, i.e. a mown fertile, homogenous lawn qualifies under 'fertile grassland plot type' and therefore 11.6 species	B13
The ecology component needs to be strengthened to prevent 'last ditched efforts' to make up a shortfall in credits from other areas	B14
The section on species change isn't ecologically relevant enough	B15
There should be a weighting towards native/ appropriate species	B16
Biodiversity through BAP's should be better included within the process	B17
Fauna needs to be included within the calculation process	B18
Recognition of specialist habitats such as dead wood	B19
There needs to be identification of likely species for a site, and provisions introduced accordingly	B20
There should be a different weighting for certain priority species in the calculation process	B21
Clarification is needed on determining what ecological value is and therefore whether a site has any or not	B22
There needs to be a sliding scale for points on lost features	B23
The focus of species number after the development is pointless as this is immeasurable in practice, there should be more emphasis on biodiversity and enhancement	B24
Important species that are not endangered or priority species need to be recognised and included currently the system is unable to focus on particular species	B25
The strategic value of a site in the wider context or landscape scale is important and needs to be recognised such as corridor links or migratory routes	B26
There are no ecological principles within the current credit system, there needs to be a more holistic approach	B27
Stronger use of legislation throughout credits	B28
Clarification of the evaluation criteria is needed for assessing ecological feature significance, i.e. what is significant	B29
Green roof is not adequately dealt with and should be scored differently	B30
The concept of a net loss in habitat still being awarded a credit is flawed	B31
Ecologists need to be given freedom to create appropriate enhancements	B32
Recognition of natural colonisation of ecology after the construction should be included	B33
Monitoring post development to obtain feedback as to how many recommendations have been undertaken & general success of any mitigation/enhancement strategies is needed	B34
It is hard to categorise habitats using the BREEAM system, they aren't broad enough	B35
Focus of planting schedules should be on wildlife and ecological benefit, not aesthetic appeal	B36
A more sophisticated way of calculating ecological value is needed, the current system doesn't consider there to be a difference between trees and weeds	B37
More guidance is needed on what 'low ecological value' means as if there is any planting there then there is a 'some' value	B38
Sense the approach to be based more accepted ecological principles , its currently appears the methodology was not written by ecologist at all	B39
Build start up meeting into the credits	B40
Ought to get credit for contributing to BAP targets	B41
There is no weighting of ecological enhancements, Creation of a wetland/species rich grassland should have more value that the addition of a couple of nest boxes	B42
<u>Section C – issues concerning the interaction with BRE & the communication of ecology within BREEAM</u>	
<u>Issue</u>	<u>Reference Code</u>
There should be a BREEAM /Code users' forum available online to help solve problems	C01
Do I need to do a report, some assessors say no, some say yes, and BRE have not helped in solving the issue	C02
There needs to be better clarity within the ecology component, it would benefit greatly from an improved layout, and use of plain English	C03
There needs to be some guidance on best practice	C04
BRE has a poor track record in enquiries, from ecologists, it seems they only talk to registered assessors	C05
There should be a more informative website in connection with ecology and the codes, as well as access to documents/reference material.	C06
There should be a clear and concise email service highlighting changes and updates to system	C07

BRE needs to provide a point of contact that can provide support on ecological issues	C08
Integrate all sections of the assessments so that for example ecology has links to Transport/lighting pollution sections	C09
The relationship between the assessor and the ecologist needs clarification, they are not experts in Ecology, but they control the process...	C10

Table 4.1: Listing of the 76 different concerns voiced by the ecologists throughout the research's interview process

4.3 Establishing which phenomena are of significance

The data has been analysed statistically in terms of frequency through the creation of class intervals based on reference codes. These class intervals have been then populated based on the number of responses throughout the interview process, the outcome of which is demonstrated in the frequency polygon of Figure 4.1. A frequency polygon has been favoured here over the use of a frequency histogram as a result of the number of class intervals created by the interview process.

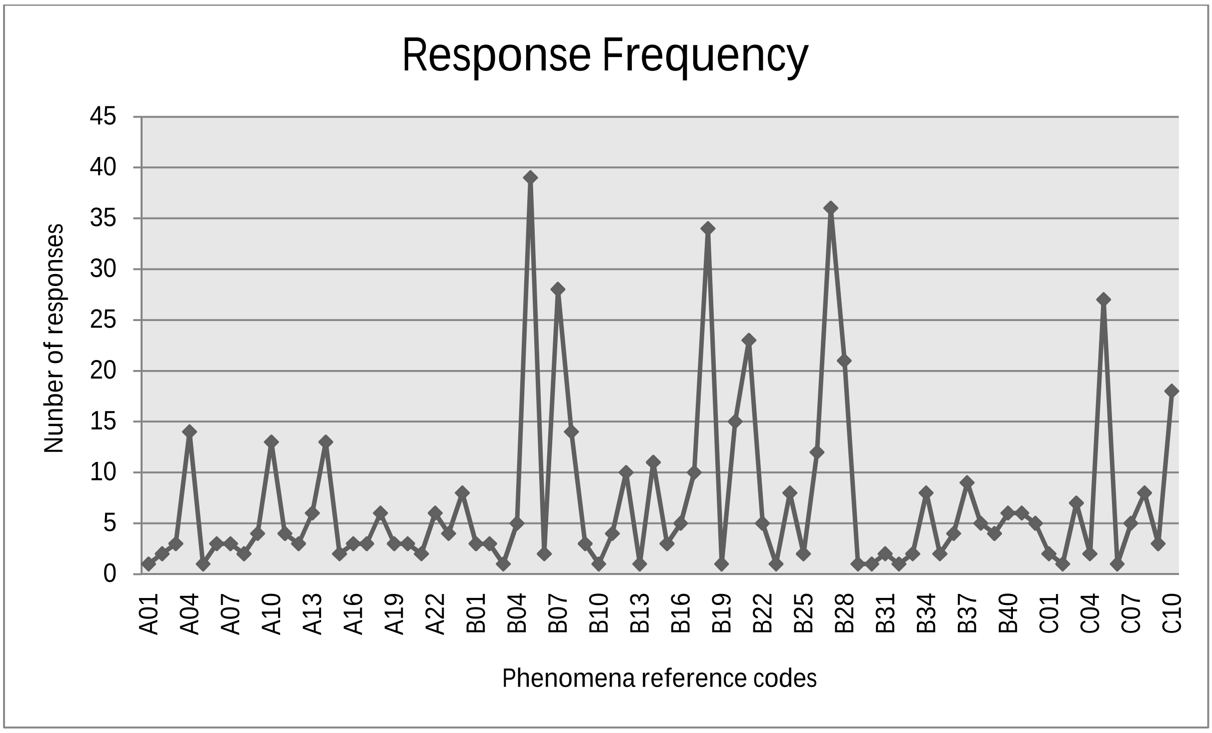

Figure 4.1: Frequency polygon for ecologist's responses to interview questions

Clearly from Figure 4.1, it is evident that not every aspect of the Land Use and Ecology section works in practical terms (as each response represents an issue or concern with some aspect of the process. Every interviewee volunteered at least one issue or concern (phenomenon) with the process resulting in a total of 76 distinct phenomena. Concerns with certain aspects were more frequent than others as demonstrated by the peaks within Figure 4.1. and across these 76 phenomena a total of 543 concerns were raised These will become the focus of the next section in terms of identifying these specific phenomena and analysing why they form the key issues in the opinion of the ecologist involved.

As a result the following sections represent the key areas where the efficacy of the assessment process is most affected, and where the focus of immediate attention should be aimed. Given that certain phenomena occurred more frequently, coupled with the fact that those raising the issues were ecological professionals and capable of applying professional judgement to their responses, it can be surmised that those phenomena that occurred more frequently are those in need of addressing first. The remainder will be logged and form a future path for this research to take. Therefore rather than identifying each response the next sections identify the 10 highest ranked phenomena for each of the three groups set out in 4.2.1. (e.g. Figure 4.2) This stepped approach is consistent with the approach taken by BRE to improve BREEAM, as incremental change is a key tenet of their revision programme. Any changes to BREEAM in relation to ecology would represent a major undertaking for BRE and staggering changes with the most common issues first is a logical approach to undertake if the outcomes of this research are to integrate with changes in BREEAM. It is also worth noting here that the percentages associated with each phenomenon will not be directly comparable to those set out in chapter 3, as these are attributable to responses to specific questions not the phenomena themselves. Question 28 performed a catchall function thereby creating another opportunity for ecologists to introduce concerns or examples of phenomena. This has therefore affected the overall frequency and subsequently percentages derived from these answers.

4.3.1 Phenomena focusing on the practical application of Land Use and Ecology (Section A)

Within this category there are essentially 24 core phenomena affecting the ability of ecologists to use BREEAM. Figure 4.2 identifies for this group the priority issues set by the ecologist opinion across the sample population. Using the figure it becomes possible to identify the highest ranked concerns to be addressed and the focus of this section (the section of most interest is marked above the dotted line). Each of these ranked issues will be analysed, identifying if it is indeed a real phenomenon or a misinterpretation of the guidance by ecologists in the field as well as the frequency of responses will be considered in this process in relation to scale of the problem.

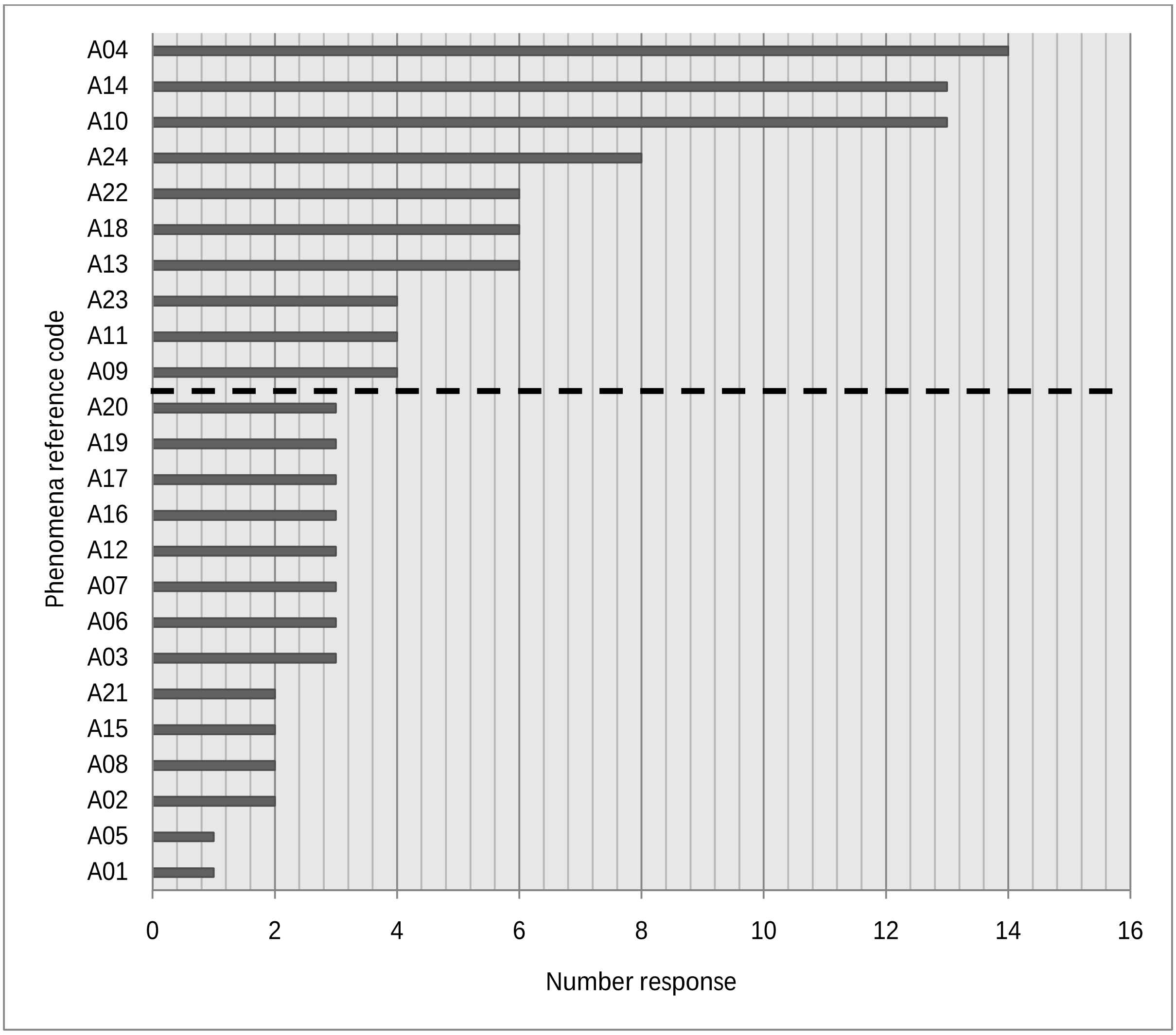

Figure 4.2: Frequency of ecologist's responses within section 'A'

4.3.1.1 A04

Phenomena A04 represents the most significant concern for ecologist in this grouping with 12.5% of all issues raised (the phenomenon was cited 14 times out of the 112 responses in this grouping). The following statement best represents the phenomena:

"It's a tick box exercise, ecology doesn't work like that; the process needs to be more intuitive."

This view point is arguably true given that the BREEAM system is such that it utilises quantifiable criteria within its design in order to rate more qualitative events. As such ecology is unlike water or energy usage which can be easily monitored and controlled, and it will develop independently of the building occupants or designed use if left alone. However, the purpose of the BREEAM system is to present a rating system for sustainability and as such there will always be some element of criteria setting by definition. The goal of addressing this phenomenon however is to strike a balance between creating an accountable system that can rate ecology, but to also make it ecologically relevant to ensure it is effective.

4.3.1.2 A14

A14 represents 11.6% of all issues raised within group 'A' phenomena, and centres around:

"The guidance needs to be clearer on the inclusion of protected species, either currently on site or after the development."

Using the current BREEAM Offices Technical guidance (BRE, 2008a) as an example, the Land Use & Ecology component of BREEAM only has one reference to protected species and that is as a general recommendation within section LE5 - Enhancing site ecology:

"General recommendations for enhancing and protecting the ecological value of the site are to include, and go beyond, compliance requirements for all current EU and UK legislation relating to protected species and habitats."

The next most appropriate reference to protected species is to identify species of local importance under section LE6 –Long term impact on biodiversity of the same technical guidance:

"Local biodiversity expertise should be sought at, or before, the design stage to help identify species of local biodiversity importance on site. It is likely that their recommendations will draw on the Local Biodiversity Action Plan (LBAP) where one exists."

In fact there are more references throughout the rest of the BREEAM manual on ecologically protected species than there are within the Land Use and Ecology section itself (found within material choice, appropriate management and environmental awareness of the constructor on site sections, BRE, 2008a). Few of those ecologists interviewed had little knowledge of the rest of the manual and therefore were unaware of these provisions so as a result it is unfair to say that BREEAM does not include the provision for protected species. However it is very true to say that the current distribution of text makes it unclear and as a result it is easily feasible to improve this element within the BREEAM Assessment system.

4.3.1.3 A10

In terms of responses, A10 is a joint second within section 'A' with 11.6% of all issues raised. The focus of which is:

"Ecology needs to be introduced at the outset of a project to be able to provide advice on ecological enhancements and master planning"

A significant point raised throughout the interview process and strongly supported throughout the series of following workshops is the issue of timing of the ecologist's involvement. Many commented that they were introduced into the design process too late and they therefore had little or no opportunity to influence the design. The late involvement of an ecologist also had the effect of not being able to identify the ecological features worth protecting before construction begins, or help influence the practicalities of construction giving advice on site protection or protocols for protected species. Several ecologists highlighted the inclusion of ecologist's time in construction meetings. However this may be seen as financially prohibitive to the project. Nevertheless the idea of a project start-up meeting which can be incorporated into the scoring system may work, and would represent an opportunity for an ecologist to present potential risks or concepts which may influence the design process.

4.3.1.4 A24

A24 represents 7.1% of the responses for the group 'A' phenomena and centres on the output of the system:

"There needs to be a set format as each consultant is different, producing differing reports and levels of information"

Following discussions with ecologists both through the interview and workshop process (as well as additional discussions with ecologists) this phenomenon is indeed true, as there is no set format of information which would constitute a BREEAM ecology report. Each ecology consultancy questioned on the topic identified a proprietary approach which they have developed 'in house' to address this problem and for commercial reasons have not shared with other bodies. The outcome is that each report is different in terms of layout and to a degree the level of information presented to the client. This makes it hard for some consultancies to remain competitive in terms of winning BREEAM work, but it also makes it difficult for clients to appoint consultants based on incomparable tenders. Finally it means that the BREEAM assessors filling in their scoring sheets will have difficulty unless the ecologist has included within their report a completed BREEAM ecology checklist (A6 within the BREEAM 2008 technical manual, BRE, 2008a). Equally it means that BRE themselves have no consistency (other than the completed checklist) should they want to utilise the ecological data to improve BREEAM in the future. BRE however has no control over the output of ecology consultancies work, either in terms of layout or content. Equally a prescriptive approach by BRE would be problematic as different quantities of input will be required on differing schemes. As a result the current approach of ensuring minimum information is presented in the form of a check list would logically be the best approach. This method allows assessors to see which criterion has or has not been met, whilst allowing the flexibility on the part of the ecologist to offer additional levels of service should they wish to.

4.3.1.5 A22

A22 represents 5.4% of the total issues raised by the ecologists in relation to the practical implications of BREEAM in relation to ecology and can be defined as:

"Clarification is needed between the terms 'development site' and 'construction site'"

Although this was a common complaint throughout the interview process and following workshops the technical guidance (BRE, 2008a) makes it very clear under LE3 - Ecological value of site and protection of ecological features, what the definition of a 'construction zone' is. There is no mention of a development site (or zone). Within BREEAM however, the use of the term development is often used to denote the design or project elements and so it could conceivably be confused with construction. As a result the site ownership boundary and the actual area designated for construction may be different on certain projects. This means that ecologists will benefit from additional definitions especially as defined areas are required in order to carry out the change in ecological value calculation and thus they may be more important here than in other sections of BREEAM.

4.3.1.6 A18

A18 forms 5.4% of the responses for group ‘A’ phenomena and follows that:

“Assessors need to be aware that a SQE is required to look at proposed planting lists and determine if the species are ecologically valuable and only include these in the calculations”

Arguments such as that above stem from the relationship between ecologist and assessor and the distribution of work between the two. This distribution is unclear for many ecologists, and as such there is great variance in both roles. Evidence from the interview process identifies cases where there is minimal involvement on the part of the assessor, leaving the ecologist free reign to establish the credits awarded. Equally the evidence also shows that other cases the reverse is true, with the assessor dominating the ecological process only looking to the ecologist to provide simple survey data. The Interview data shows that most ecologists find themselves somewhere in the middle, often having to support assessors in concluding which credits are to be awarded. There does however need to be some clarity over what is in the purview of the suitable qualified ecologist (SQE) and therefore what is left for the assessor to undertake. This may help to reduce in some cases the friction which can arise between the two.

4.3.1.7 A13

5.4% of all responses from the ecologists in regard to concerns about the application of BREEAM focused on phenomenon A13:

“The manual needs to be clearer to reduce any ambiguities. Especially so that the ecologist, the clients and the BREEAM assessor all read the same interpretation”

The reality of this phenomenon results from perspective. It is the opinion of many ecologists questioned that clients were only interested in the financial implications of the ecology section, whilst they themselves were more focused on the outcomes for ecology. Similarly many stated that the assessors simply wanted the bare minimum information in order to determine which credits were to be awarded. This is a logical outcome as each of the three roles is different within the process. However the main aim of the Land Use & Ecology component of BREEAM is to efficiently and beneficially use the site for a positive change in relation to ecology. Therefore, regardless of the starting point of those involved, the section should be changed to ensure that the greater purpose of the section is not lost.

4.3.1.8 A23

A23 represents 3.6% of the total issues raised on practical application:

"There needs to be a better consistency of 'non-native' species with wildlife benefit, and what is acceptable."

Within BREEAM, there is a requirement that:

"Only native floral/plant species and those with a known attraction or benefit to local fauna can be considered for the purpose of increasing the number of species on site, as well as general enhancement." (BREEAM 2008 –Offices - LE5 –Enhancing site ecology, BRE 2008a)

This causes significant problems as the determination of what is either a native species or a species of wildlife benefit is down to the ecologist involved. This can prove problematic on heavily developed or urban sites as it is difficult to tell what is locally native, or give the intensification of the vegetation in such areas if native species would be most appropriate given the context (residential gardens rarely consist of solely native species). Equally the term of 'attraction or benefit to local fauna' is highly subjective as any ecologist will state that all flora will have some benefit to wildlife. This issue is a significant one and one that should be addressed either through prescription (identifying a checklist of appropriate species for ecologists to use, or those banned from use, e.g. non native species) or by reducing barriers and allowing ecologists freedom to influence the design for the benefit of local fauna. If the former is the case then long-term maintenance of a list would be required by BRE to ensure that it reflects the most appropriate data.

4.3.1.9 A11

A11 is representative of 3.6% of the total issues raised in terms of practical application of ecology within BREEAM:

"We need clearer guidance or a field manual/ examples of best practice"

A common request from the ecologists interviewed, a significant number feel that the component of ecology within BREEAM is important enough that additional guidance would improve the section dramatically. For many ecologists the undertaking of BREEAM assessments forms only a small part of their jobs and the process is significantly removed enough from their core work that they find it difficult to relate to the requirements set out within the system. As such a guide for ecologists in undertaking BREEAM assessments or clear and concise examples of how to address issues on site may be significant in creating consistency in assessments.

4.3.1.10 A09

A09 also correlates to 3.6% of the total responses within group ‘A’ and relates to an issue concerning the starting position for ecologists:

“There’s no outline of what the client needs to supply for a comprehensive assessment. It means different assessments are not comparable in terms of baseline data.”

BREEAM makes no provision for specific documentation to be issued to ecologists to undertake assessments. From site plans and construction programmes to design drawings, a significant amount of information can be issued to the ecologist which will help determine the best course of action in relation to improving the ecology of the site. As a result the ecological report for each project is different and incomparable. Also there may well be significant opportunities lost as a result of an ecologist not knowing the plans of the client. Issuing site plans and drawings may also speed up the process for the ecologist saving their client money in the longer term.

4.3.2 Phenomena focusing on BREEAM’s efficacy, what is missing from BREEAM’s Land Use and Ecology section? (Section B)

This group solicited the most responses within the sample population, with the ecologists highlighting 42 separate core phenomena affecting the overall efficacy of ecology within BREEAM. In addition to the numbers of phenomena identified the frequency of responses is also the highest within this grouping which suggests that this is the core area of concern for the ecologists interviewed. Figure 4.3 identifies for this group the priority issues set by the ecologist opinion across the sample population, using the figure it becomes possible to identify the highest ranked concerns to be addressed in a consistent approach to Group A, The top ten will be reviewed and addressed forming the focus of this section.

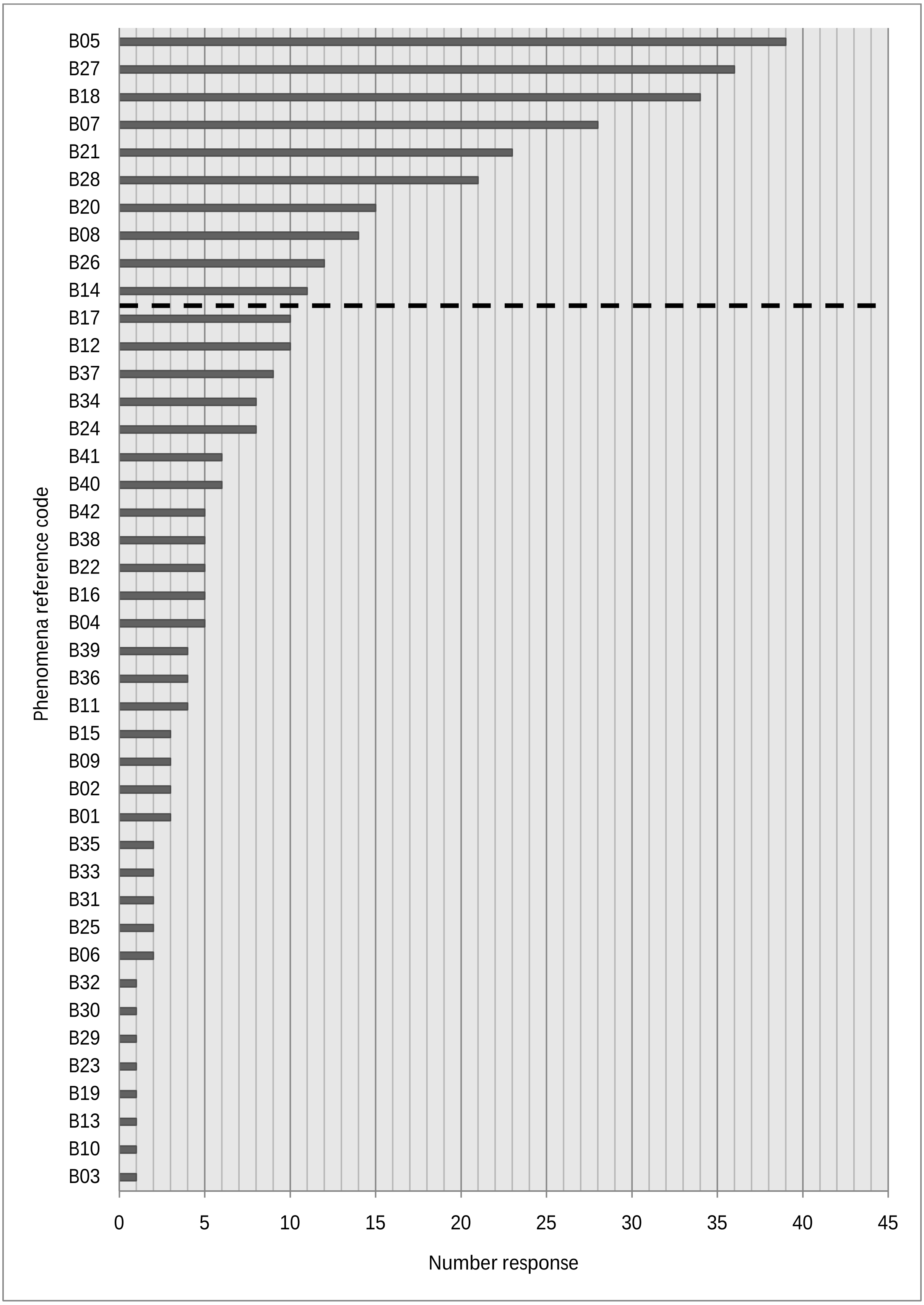

Figure 4.3: Frequency of responses from ecologists within section 'B'

4.3.2.1 B05

B05 is by far the most important phenomenon to arise from the interview process with 10.9% of all points raised in section B:

"The calculation methodology is flawed and needs a complete overhaul"

The process for calculating the change in ecological value is the most commented subject by the ecologists throughout the interview and workshop process. No single member of the sample population thought the methodology worked and many saw it as the largest stumbling block in improving the ecology on site. Flaws included not only the application of the process itself, but more importantly the essence of how change is calculated is flawed. Essentially the ecologists commented on the calculation as being a purely botanical exercise in terms of species numbers with no reference to the value of specific species, essentially as one ecologist put it, 'under the current system, oak trees have the same value as weeds'. In addition the boundaries for species change were wrong as it was far too easy to achieve a positive change by introducing only a few new plant species with little design or thought needed.

The reality of the situation is that it is not so easy to score credits as the methodology is area weighted and there is a need to establish species densities not numbers. This is a significant flaw as many ecologists interviewed did not recognise this fact, nor did the assessors who in many cases accepted calculations based on species numbers and not area weighted figures. Given that the calculation process affects a number of sections and the outcome of which represents at present 40% of the credits available for the section, introducing a new calculation methodology is a significant undertaking but a valuable one with sizable benefits to the scheme.

4.3.2.2 B27

The phenomenon described within B27 is the second most common element raised under section 'B' with 10.1% of all issues raised in this section:

"There are no ecological principles within the current credit system. There needs to be a more holistic approach"

This is arguably the most crucial element in need of addressing within the BREEAM system. Nearly all the ecologists questioned opined that the level of ecological science was seriously lacking with no single credit being attributable to recognised ecological principles. Principles such as species movement, biodiversity species composition, community stability, population dynamics and habitat fragmentation, are not clearly identified within the process and many felt as a result this inevitably led to further issues arising such as A04 (the system becoming a tick box exercise).

4.3.2.3 B18

B18 represents 9.5% of the issues raised by ecologists under section 'B'

"Fauna needs to be included within the calculation process"

The calculation process is currently undertaken using only botanical data. Other than minor references to the protection of endangered species and the inclusion of provisions for nesting boxes there is little set out to monitor, protect and encourage fauna on site within the system as it currently stands. By not including fauna in the process a significant element of biodiversity is lost which should form a central purpose of the Land Use & Ecology component of BREEAM. In addition as it is not a key element of the calculation process, changes in value for fauna are lost or not recorded. This is a crucial concern as biodiversity relies on the combination of fauna and flora in order to be viable. Fauna also has significant roles to play in the provision of ecosystem services.

4.3.2.4 B07

7.8% of all responses within section 'B' generated the issue B07:

"There needs to be better links with ecosystem functions"

Possibly the most important of benefits from improving the ecology is the level of localised ecosystem services it could potential provide. As outlined in Chapter two, Ecology is responsible for a range of services required to maintain life, from oxygen generation, pollution filtering, pollination, production of food and materials through to water purification, the roles of ecology are diverse and planting/ encouragement of key species can help secure and integrate such services (Kremen, 2005; Daily, 1997; Ehrlich & Ehrlich, 1981). Ecosystem functionality is a key principle within ecological science and should be a significant focus for BREEAM.

4.3.2.5 B21

B21 represents 6.4% of all issues raised within section 'B':

"There should be a different weighting for certain priority species in the calculation process"

Within the current embodiment of BREEAM there is no recognition of species value, as outlined in 4.3.2.1 even though trees have significantly more ecological value than low level perennial planting, they are scored in the same way. Equally there is no priority set for locally identified species as set out in biodiversity action plans (BAPs). Although they are encouraged within the BREEAM technical guidance, they carry no additional weight within the scheme.

4.3.2.6 B28

5.9% of all responses within section 'B' highlighted a need to address B28:

"Stronger use of legislation throughout credits"

Significant numbers of ecologists felt that there was a poor use of legislation as a tool within the scheme to encourage clients to improve ecology. With many feeling that BREEAM made little reference to legislation appropriate to developing a site. BREEAM is not a legislative tool, and is in essence a voluntary scheme to demonstrate excellence in design and planning. Legislation will need to be met in order for the project to progress and as such will form the basis of planning consents and various permissions throughout the construction process, the use of BREEAM should be seen as 'above and beyond' the requirements set out by UK legislation. The section LE5, enhancing site ecology, does set a provision for legislation under its general recommendations:

"'General recommendations for enhancing and protecting the ecological value of the site are to include, and go beyond, compliance requirements for all current EU and UK legislation relating to protected species and habitats" BREEAM Offices Technical guidance (BRE, 2008a)

Equally within the same guidance under LE6, long-term impact on biodiversity, there is a provision requiring that:

"The suitably qualified ecologist (SQE) confirms that all relevant UK and EU legislation relating to protection and enhancement of ecology has been complied with during the design and construction process."

Therefore it is arguable that given its role within the development process, BREEAM does set out the requirements of relevant legislation. The onus however is put on the ecologist to know the relevant regulations and ensure that the client has been made aware of them.

4.3.2.7 B20

4.2% of the total responses for group 'B' centre on one issue, B20:

"There needs to be identification of likely species for a site and provisions introduced accordingly"

The technical guidance sets out provisions for protecting and enhancing current wildlife on site. However there is no scope for predicting likely species introduction and subsequent planning for such (or at least there is no credit incentive to do so). In many projects is a relatively simple exercise to review surrounding flora and fauna and make a determination as to what will inevitably migrate onto the site and thus plan habitat accordingly. Many ecologists do this as a matter of course and this represents good practice in offering advice to clients. However this is not set out as a requirement within BREEAM and subsequently it is not rewarded (in terms of credits available). By ensuring this is undertaken (and that there is incentive on the part of the client to do so) this will result in a more stable habitat in the longer term and improve the speed of colonisation of the developed site.

4.3.2.8 B08

B08 represents 3.9% of the total concerns identified within this section, and is represented as:

"There needs to be reward for efficient use of spaces, ecological as well as practical use of space."

The BREEAM section is titled Land Use & Ecology, however the concept of efficient land use is reduced to only one criteria (LE1 – reuse of land) which focuses solely on the foot print of the building. Equally within this section the 'land use' part is seen as a distinct area by ecologists many of whom feel that it has little to do with them, as this is more an issue for the building and landscape architects. However these sections should have a better integration into the ecological aspect as the efficient use of space can easily integrate with ecological function. Multifunctional landscapes can provide several services at once such as recreational space, flood control, connectivity to support long-term viable biodiversity, water purification, improves soil condition, as well as shade, shelter and food production. There is a real opportunity to integrate the structure of the building with the design and planning of the landscape which is currently missed within the BREEAM process. This needs to be integrated into the BREEAM system to join the two areas and maximise potential opportunities.

4.3.2.9 B26

3.4% of the total responses within section 'B' pertained to B26:

"The strategic value of a site in the wider context or landscape scale is important and needs to be recognised such as corridor links or migratory routes"

The site boundary is considered the limit of interest within the BREEAM assessment system; however ecology is an organic entity which will extend beyond the site boundary. The site in question in terms of habitat is one small component within a greater habitat context. It is crucial that the development of the site and its ecology keeps this factor in mind throughout the design process and as such the ecologist has a role to play in demonstrating the strategic value of the site within an extensive environment, identifying how wildlife corridors, ecological features and habitat refuges within the development can play a wider role.

4.3.2.10 B14

Finally within this section 3.1% of the responses are attributable to phenomenon B14 which focuses on:

"The ecology component needs to be strengthened to prevent 'last ditched efforts' to make up a shortfall in credits from other areas."

This was a common complaint throughout the interview process as well as the workshop sessions. Ecologists feel that they are often brought in at the latter stages of a BREEAM assessment in order to gain 'extra credits' often in order to achieve a minimum set by an award boundary. These are seen as 'cheap' credits and can be obtained at the end if need be. This would seem to be the experience of a significant amount of those involved in this research and many would like to see an improvement in the system to ensure that the appropriate level of time and financial investment is included to benefit both ecology and the scheme in the longer term. The ability to use retrospective assessments utilising satellite imagery and photographic evidence does little but help perpetuate this problem.

4.3.3 Phenomena focusing on ecologist's relationships with BRE and communication issues (Section C)

Finally the third broad group of phenomena raised as a result of the interview process contain those issues not directly linked with the application of the process or the process. They firstly relate to the relationship with the creators and administrators of the scheme the Building Research Establishment (BRE). Secondly they contain those issues around the communication of ecology within BREEAM. Figure 4.4 shows how these issues relate to one another in terms of frequency of response and therefore importance to the sample population questioned. There are only ten phenomena identified within this category of responses and so each of these have been analysed. Although not directly linked to the following chapters (and the investigation of the efficacy of BREEAM in the direct sense), the issues outlined below are serious concerns and will make the application of the process easier in the longer term. As a result the outcomes of this grouping will be addressed in the final chapter of this work as part of the overall conclusions and recommendations to BRE.

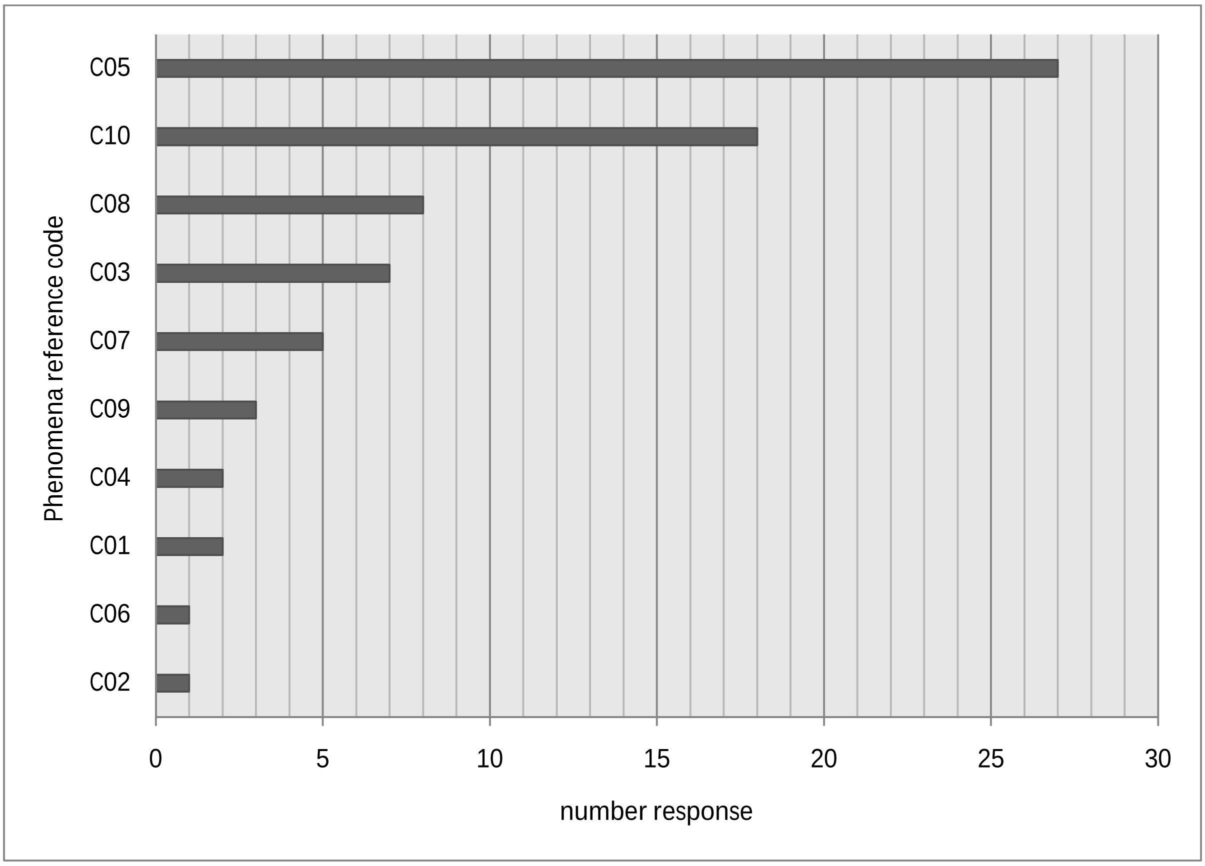

Figure 4.4: Frequency of ecologist's responses within section 'C'

4.3.3.1 C05

The most raised concern (36.5%) within section 'C' is C05:

"BRE has a poor track record in enquiries from ecologists; it seems they only talk to registered assessors"

In the opinion of the ecologists involved in the interviews for this research, BRE were unhelpful in resolving issues with ecology and BREEAM. Many failed to achieve contact with BRE or when they did, BRE failed to respond. The most significant element is the advice from BRE to 'talk to the projects assessor' whom when questioned would respond that the ecologist would need to 'talk to BRE'. This lack of communication has led to ecologists having to undertake assessments without sufficient guidance and potentially reduce the efficacy of BREEAM as a result.

4.3.3.2 C10

The second most common issue (24.3% of all concerns in this section) also involves assessors, C10:

"The relationship between the assessor and the ecologist needs clarification. They are not experts in ecology, but they control the process"

The ecologists interviewed had mixed feelings in relation to the assessors they worked with on individual projects. Many felt that a good working relationship with an assessor is essential to achieving a good assessment. This allows the ecologist to utilise their expert knowledge with the assessor helping from a procedural point of view in relation to completing the assessment process. In examples given where the relationship broke down the main cause identified within the interview process was in situations where assessors interceded not on procedural matters but ecological ones and made decisions often based on previous assessments. The relationship should be clarified as the assessor should defer to an ecologist on ecological issues.

4.3.3.3 C08

C08 represents 10.8% of all issues raised by the ecologists within section 'C'

"BRE needs to provide a point of contact that can provide support on ecological issues"

A significant number of ecologists felt that they needed support from BRE in order to correctly implement the BREEAM process. However it is the experience that if they do manage to receive a response from BRE (in contravention to C05) there is no continuity in guidance as often the response comes from a number of different people within BRE. A few ecologists cited examples of contradicting advice on the same issue. Typically errors enter the system from ecologists which may misinterpret the technical guidance, or are looking for support to bolster an argument for introducing ecological elements with a difficult client. The ecologists involved in this research felt isolated by BRE and a single point of contact with a process for dealing with enquiries would be highly beneficial.

4.3.3.4 C03

C03 represents 9.5% of the total responses for this section by those interviewed:

"There needs to be better clarity within the ecology component. It would benefit greatly from an improved layout, and use of plain English".

The ecologist responses suggest that a significant number of concerns arise from the layout of text and confusing language. Whilst there is a need for the system to outline detailed definitions in order to meet criteria it is often unclear on what the criteria is trying to achieve and how it relates to ecology as a scientific discipline. Within each credit, its aims are set out. However this fails to address in most cases any relationship to recognised ecological principles. This can be easily addressed with the addition of text to each aim, and it should be possible to reorganise the layout to make the objectives of the criteria and methodology for achieving it clearer.

4.3.3.5 C07

C07 represents 6.8% of all issues raised by the ecologists within section 'C':

"There should be a clear and concise email service highlighting changes and updates to system"

Within the sample group of ecologists interviewed the concern for being out of date was raised. Many believed that the BREEAM process was being constantly updated and they either had no access to the new information or were unaware of the changes. The review process currently set by BRE is that updates are passed out through the registered assessors and as such this forms a route to ecologists on a project by project basis. Many ecologists however found that this was not the case and had on occasion found that they were using out of date criteria, or in one case the incorrect technical manual as the information was issued in error by the assessor. A system for updating all ecologists on changes as well as other relevant information such as an emailed news letter which can be subscribed to has been tabled by some ecologists. This approach could dramatically increase the efficacy of BREEAM's ecology component if introduced, through the reduction (and in most cases elimination) of simple errors. If a more passive approach were preferred an up-to-date website could be created to achieve the same goal in giving ecologists access to current and accurate information on updates to the system.

4.3.3.6 C09

4.1% of the total responses within section 'C' pertained to C09:

"Integrate all sections of the assessments so that for example ecology has links to Transport/Lighting pollution sections"

This is a key issue as site ecology has interaction with other credits throughout the assessment system. Ecology already has a partial role within other credits such as within water use (WAT 6 - Irrigation systems) where credits are achieved for drought tolerant planting, equally light pollution, covered under POL 7 - Reduction of night time light pollution will have ecological effects (though they are not listed within the pollution credit). There are potentially significant effects that ecology can have on other areas, just as other sections may impact on the land use (energy systems such as ground source heat pumps will have land use implications for example). A review should be conducted to establish where such crossovers occur and ensure that they are coherently interlinked.

4.3.3.7 C04

2.7% of all responses within section 'C' highlighted a need to address C04:

"There needs to be some guidance on best practice."

All the ecologists who raised this concern agree that they would benefit from guidance on best practice within the BREEAM system. Whether it is in the form of a manual or a collection of case studies, the ecologists believe that given the wide interpretations that are created within the scheme and given the vast array of projects that they are applied to, past examples of what is appropriate would be very beneficial.

4.3.3.8 C01

2.7% of all responses from the ecologists in regard to concerns about communicating with BRE focused on phenomenon C01:

"There should be a BREEAM users' forum available online to help solve problems"

Another suggested approach to issues concerned with sharing information is the concept of a users forum, either as a web-based service or a network of ecologists who undertake BREEAM assessments that failing BRE's involvement, can help support each other in best practice and guidance. Although the concept of shared experiences is a no doubt a useful tool and the ability to learn from others should be commended, it must be recognised that there is inherent risk if BRE are not involved in the process that there may be a perpetuation of poor guidance or incorrect approaches. As such if this solution could be proven to be of benefit, BRE should take a guiding role in setting up and running such a forum.

4.3.3.9 C06

C06 represents 1.4% of the total issues raised by the ecologists in relation to communicating with BRE and can be defined as:

"There should be a more informative website in connection with ecology and the codes, as well as access to documents/reference material."

As a continuation of issue C07, many ecologists are of the opinion that they have little access to relevant information as well as technical guidance for differing BREEAM assessments. Again a significant body of individuals believe that they are heavily dependant on assessors to issue the correct documentation. While this is true and assessors should be in a position to issue the correct technical guidance as well as additional documentation, BRE have made the technical guidance documents available on its website (www.bre.breeam.org.uk). Any ecologist who wishes to download the technical guidance is free to do so. The assessor however is still the authority on which BREEAM assessment methodology is to be used on any particular scheme and it is from he or she that the ecologist should look to, to inform which BREEAM assessment variant is being scored against. It is worth noting that although the technical guidance is available for the BREEAM standards, the tools utilised to calculate the changes in ecology are not, which leads to ecologists developing their own spreadsheets or similar approach to complete BREEAM assessments. This obviously presents the risk of errors being introduced into the assessment methodology.

4.3.3.10 C02

Finally within this section 1.4% of the responses are attributable to phenomena C02 which focuses on the need for reporting:

"Do I need to do a report, some assessors say no, some say yes, and BRE have not helped in solving the issue."

Although the type of information needed to demonstrate compliance may well be best expressed as a report, as far as the assessment is required, there is only a need to demonstrate compliance in meeting the criteria. This can be a series of plans, documents or statements which meet the required standards. Often ecologists are required by assessors to complete checklist A6 within the BREEAM technical guidance to show compliance, and this is the level that needs to be met in order to achieve credits under BREEAM. However given the costs involved, a report is often completed for the client to explain the process for achieving certain credits. If however the client only wants sufficient information to complete checklist A6, a report is not required.

4.4 Praising what does work

Of course not all the aspects of the BREEAM methodology should be considered negative in relation to the Land Use & Ecology component of BREEAM. In fact many comments were made by ecologists in the field that were affirmative in nature and BREEAM should be commended. As such it will be essential to maintain these positive elements in any changes made to the system in relation to ecology. The following represent key elements that should be recognised as positive aspects of the BREEAM process and approach:

- It gives the ecologist an opportunity to get involved in a scheme which they might not ordinarily get involved with.
- It can help raise environmental awareness with clients and contractors.
- Given that the objective is to go beyond the requirements set out within legislation, it means that the quality of the environment should be considerably higher than that of a comparable project not utilising the BREEAM scheme.
- If done correctly the project can create habitat for key species locally and create a resource which can help support wildlife into the future.
- By reusing land and concentrating the footprint of the building, it helps to preserve well established areas, or pristine habitat.

It is essential that these key elements already in place within BREEAM, remain so throughout any changes that are made to the system. As such this list will form part of a check list process in the conclusions of this work to ensure that any changes made have not had a detrimental effect to the current efficacy of BREEAM.

4.5 Core issue review

Through the review process undertaken in 4.3 it is possible to develop an understanding of the core issues which ecologists feel are significant in relation to the ecology component of BREEAM. By eliminating the phenomena that represent misunderstandings of the application process or rare occurrences (that are project specific for example) it becomes possible to better understand where the key issues in efficacy lie.

Figure 4.5 shows in diagrammatic form the process undertaken so far within this chapter to analyse the phenomena discovered in relation to the ecology section of BREEAM. The two groupings of interest at this stage (as outlined in 4.2) are group A and group B. Within Figure 4.5 these have been separated into three sections, 'short-term solutions', 'long-term stewardship' and 'not real phenomena'. The first of these (Short-term solutions for BREEAM) represent the bulk of the phenomena analysed here and essentially become the key areas that can be addressed quickly and in line with BRE's current revision programme (in time for the next BREEAM revision in 2010). The long-term stewardship phenomena represent areas where BRE will have to maintain a key interest if BREEAM is to maintain a level of quality in relation to ecology. In addition the remaining phenomena identified in Table 4.1 that was not analysed as part of this research is added here to ensure they form part of the review process for future revision of BREEAM. The final section 'not real phenomena' highlights those phenomena which were analysed and determined to be either untrue or misinterpretations of the technical guidance. Of the twenty phenomena analysed within group A and B, only three were catalogued in this section. Some phenomena are logged in multiple sections as appropriate following analysis and as such may have short term solutions but require long-term monitoring for example. Only one phenomenon is present in all three and that is related to the calculation methodology B05.

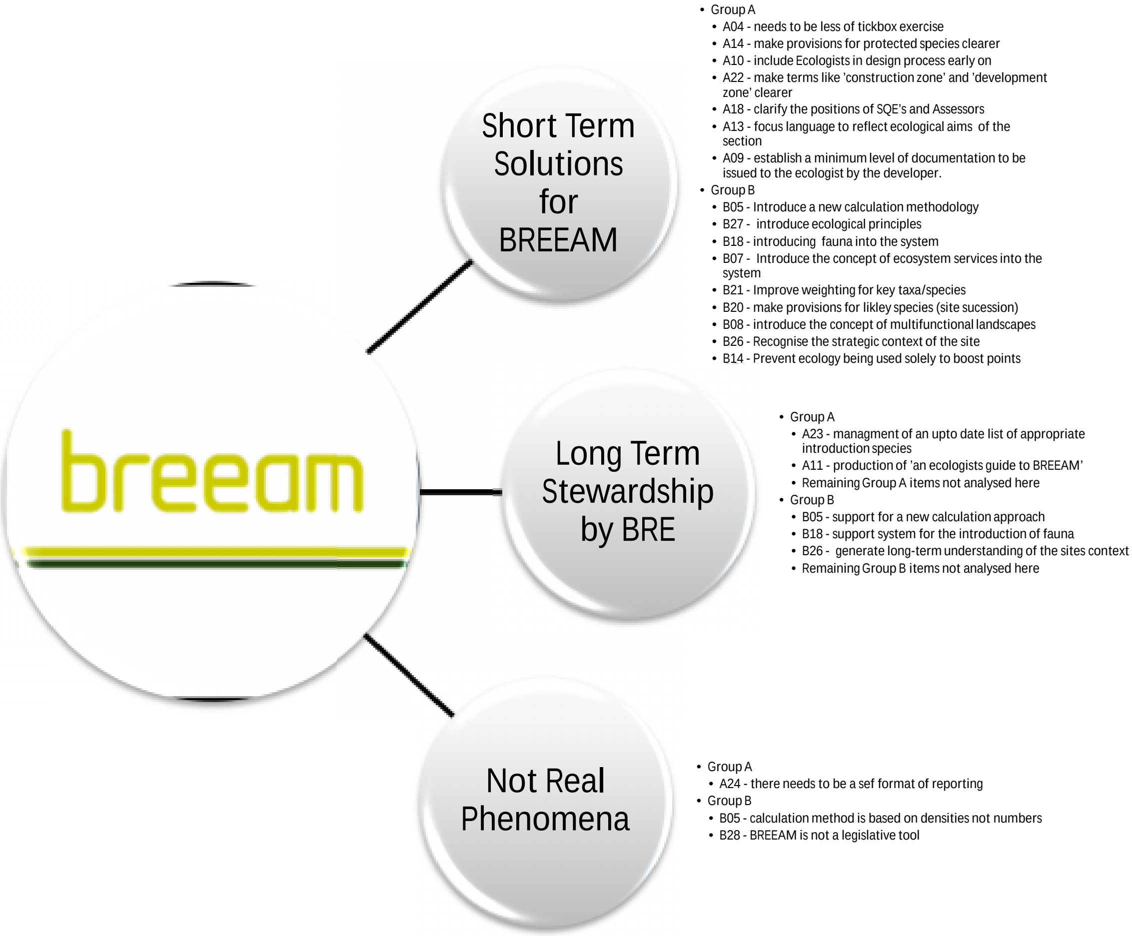

Figure 4.5: Thematic coding of phenomena into short-term and long-term elements

In reviewing these two groups of phenomena and from the number of responses and the nature of responses themselves it is evident that the central concerns of the ecologist focus on the correlation between the scheme and the scientific validity of what it is trying to achieve. The lack of core ecological principles within the current approach will lead to a final result which may achieve the credits through meeting the criteria set, but actually achieving little in terms of ecological benefit in the long term. If this continues then the concern set out in A04, of the scheme becoming a ‘tick box exercise’, is likely to become a stronger reality.

4.5.1 Are there solutions from other assessment methodologies?

Following a review of other methodologies from around the world as outlined in chapter two the question must be asked if there are so many issues with the ecology component of BREEAM do the alternative schemes such as LEED, CASBEE, Green Star or HK-BEAM have similar problems? And if so have they been solved? As has been demonstrated in chapter two the various methodologies in use around the world have within their systems ecology to some degree. Some such as Australia's Green Star have very simple components amounting to a small credit award for meeting low levels of ecological criteria. Others such as CASBEE have a more holistic approach and concentrate heavily on the interaction between the building and its immediate environment. However none of the alternative schemes has a section on ecology as well defined as that found within the BREEAM System. Equally many of the schemes have similar origins, systems such as LEED and HK-BEAM can trace their earlier versions back to early BREEAM incarnations and as such any problems inherent within early versions of BREEAM could arguably be embedded within these systems too. On closer inspection the alternative schemes seem to have reduced the number of ecological problems within their assessment processes by simply reducing the ecological components. This means that in a similar way to BREEAM being at the beginning of the sustainability assessment movement in the early 1990s, it could be argued that it once again falls to BRE to set a new benchmark for other benchmarking associations by successfully addressing ecology and incorporating it both coherently and effectively into its well established current system.

4.5.2 Addressing the priorities –what can be addressed immediately

This chapter has identified a number of key elements that need to be addressed if ecology is to become more effective and reach its potential within the BREEAM assessment system. Many of these represent changes to the system with minimal time implications and can be achieved through the rewording of text and undertaking a process of refocusing the priorities of the Land Use & Ecology section. These changes can be easily put into place to meet the next 'minor' review programmed by BRE in 2010. Table 4.2 outlines the phenomena that have been recognised as having potential solutions in the shorter term, and indicates those that can be changed with minimal effort by BRE (highlighted as minor level changes), others require a change in structure or philosophy and are therefore not as simple to change within the current format of BREEAM (major level changes).

Code	Description	Solution possible within the BREEAM 2008 format	Level of Change
A04	It's a tick box exercise, ecology doesn't work like that, it needs to be more intuitive	No solution, change of the 2008 format is needed to move away from this issue. However a foundation of this phenomenon will always be present as the use of criteria to judge success will always create a potential 'tick box approach'.	Major
A14	The guidance needs to be clearer on the inclusion of protected species, either currently on site or after the development	Simple text changes can be made to clarify this position and make it clear to ecologists and developers the responsibilities required of the project in relation to protected species.	Minor
A10	Ecology needs to be introduced at the outset of a project to be able to provide advice on ecological enhancements and master planning	A redistribution of credits and a ruling of retrospective assessments will solve this issue, allowing ecologists more opportunity to integrate ecology into the design.	Minor
A22	Clarification is needed between the terms 'development site' and 'construction site'	Clarification of definitions within text will address this issue.	Minor
A18	Assessors need to be aware that a SQE is required to look at proposed planting lists and determine if the species are ecologically valuable and only include these in the calculations	Additional text within the technical guidance as well as better training of assessors on the process and the ecologist's role will meet the needs of this concern with minimal impact on the current format of BREEAM.	Minor
A13	The manual needs to be clearer to reduce any ambiguities, especially so that the ecologist, the clients and the BREEAM assessor all read the same interpretation	Again simple review and clarification of text can achieve a solution to this issue.	Minor
A09	There's no outline of what the client needs to supply for a comprehensive assessment, means different assessments are not comparable in terms of baseline data	New text within the technical guidance setting out the minimum level of information to be provided by the developer will address this issue. It is envisioned that a standardised pack of information can be established including site information, proposed plans, planning permissions and landscaping drawings/strategies (if available) be issued. If they are not available then the opportunity for the ecologist to be involved in their generation will be outlined.	Minor
A23	There needs to be a better consistency of 'non native' species with wildlife benefit, and what is acceptable.	As outlined in chapter two the use of native planting over non natives is (from and ecological standpoint) counterproductive. Efforts would be better spent on determining which species should not be introduced rather than those that can be used. An initial list will be identified and should be updated annually by BRE to reflect current best practice.	Minor
A11	We need clearer guidance or a field manual/ examples of best practice	This can be easily produced by BRE with the help of ecologists in the field and can happen independently of any changes that are suggested to BREEAM's 2008 format.	Minor

B05	The calculation methodology is flawed and needs a complete overhaul	No immediate solution. The calculation process currently in place cannot be adapted without significant change, and as a result a restructure of BREEAM 2008 would be required.	Major
B27	There are no ecological principles within the current credit system, there needs to be a more holistic approach	No immediate solution. Although some elements exist in the current format of BREEAM, the credit criteria and the low number of credits available mean it is not feasible to introduce the number of elements required to meet this concern without significant change.	Major
B18	Fauna needs to be included within the calculation process	No immediate solution. The current calculation process has no capacity to include fauna in the calculations and would need to change to make this possible.	Major
B07	There needs to be better links with ecosystem functions	In a similar approach to B27, there simply is not enough scope in terms of criteria or credits to introduce new key themes such as ecosystem services or functions with the current format. Restructuring would be required to generate capacity to create new criteria.	Major
B21	There should be a different weighting for certain priority species in the calculation process	The current calculation methodology is not complex enough to allow for weighting of species and as such would need to be completely restructured.	Major
B20	There needs to be identification of likely species for a site, and provisions introduced accordingly	The research identifies that this is a common practice for ecologists currently undertaking BREEAM assessments using BREEAM 2008. Introducing new text to ensure this is done would be a simple undertaking and feasible within the current format of BREEAM.	Minor
B08	There needs to be reward for efficient use of spaces, ecological as well as practical use of space.	Text could be rewritten within the criteria of LE1 (reuse of land), to include more efficient use of space; however this would make it harder to achieve the one credit available. As such it would be more beneficial if a new credit were to be introduced however this would require a deviation from the 2008 format.	Minor
B26	The strategic value of a site in the wider context or landscape scale is important and needs to be recognised such as corridor links or migratory routes	Similarly to B20, the research identifies that this is a common practice for ecologists currently undertaking BREEAM assessments using BREEAM 2008. Introducing new text to ensure this is done would be a simple undertaking and feasible within the current format of BREEAM, however to encourage this key ecological element additional credits would have to be added to give weight to this significant ecological principle	Minor
B14	The ecology component needs to be strengthened to prevent 'last ditched efforts' to make up a shortfall in credits from other areas	This is a significant flaw in the format of the current BREEAM standard, retrospective surveys are in reality impractical and yield little benefit. Unlike other sections ecology cannot be engineered post construction or retrofitted into the scheme. The format of ecology within BREEAM would have to change significantly to address this concern.	Major

Table 4.2: Phenomena that can be addressed whilst keeping the current format of BREEAM's ecology section

4.5.3 Addressing the priorities – changing the format of BREEAM

It can be seen from Table 4.2 that there are in many cases simple solutions to address the problems inherent in the BREEAM system for ecology. Group A phenomena are easily addressed (as would be expected seeing as many of the problems encountered here are procedural or linked to the application of the process itself). However as can be seen in the ratio of major to minor level changes, few group B phenomena can be easily addressed within the 2008 section format. To tackle all of those outlined here, a change of structure is needed, as several points can only be met through a fundamental shift in approach to ecology within BREEAM. The most significant of which is a complete revision of the calculation process used to determine the change in ecological value of a site. The new calculation process will be a complex effort in order to address a significant number of factors, most notably the inclusion of fauna into the process.

Given the difficulties inherent in surveying for fauna as opposed to the relative ease of flora-based surveys, this will be a significant undertaking. Equally there will need to be a mechanism to allow for species movement, viability and other ecological principles which are needed to strengthen the calculation process. Given the scale of work needed and the implications to the process (the calculation methodology represents 40% of the overall credits available within the current system) the next chapter will identify a potential process which will meet this challenge and provide a potential route to solving the related calculation problems outlined here in the long term.

4.6 Introducing new elements – upsetting the balance

It must be recognised that BREEAM is a system which is already embedded, understood and in use on a significant number of projects, and (as a sustainability assessment tool) it is very effective. Care must be taken to improve the problem sections of BREEAM (in this case Land Use & Ecology) without upsetting the balance of the overall system and therefore impacting on the other sections of BREEAM. It is therefore important to recognise that the introduction of any new elements or approaches may have the capacity to unbalance the system and as such a review must be undertaken to ensure this does not occur. The issues raised at the beginning of this chapter have been numerous and have ranged in severity from simple concerns on the practical application of the process to key fundamental flaws within the current approach. It has already been determined that several key ecological principles are missing from the scheme. But is there a greater flaw inherent in the subdivisions of the Land Use & Ecology section of BREEAM? Are all the fields used to set the criteria for the credits appropriate or are there elements missing? The following sections outline the proposed changes to the ecological criteria fields within BREEAM as a result of this research which are required to meet all of the solutions outlined in Table 4.2 and identify the approach this research has undertaken to improve BREEAM's efficacy in relation to ecology.

4.6.1 LE1 – reuse of land

This is a key component of the current approach representing the 'land use' element of the section. However it could be better integrated into the developments function, removing the two distinct divisions of 'the building' and its 'surroundings' and merging them to give the building context. Equally it is here that the efficient use of the space and inclusion of green infrastructure or multifunctional landscapes is best placed. As such a re-labelling is suggested from 'reuse of land' to 'efficient use of land' with new criteria set and credits to be awarded for best practice.

4.6.2 LE2 – contaminated land

There is a sensible argument for the removal of this credit from within the Land Use & Ecology section and repositioning it within the pollution section. Typically ecologists should defer this credit to the client and recommend that it be addressed by a contaminated land specialist. Of the entire group of ecologists interviewed, not one individual suggested that they were comfortable in setting out proof of compliance for this credit. Therefore within the suggested changes as part of this research, it should be removed and the credit redistributed to another element. The only factor which could be argued in favour of keeping it within this section is the inclusion of invasive plant species as 'contaminates'. However these are well defined in the technical guidance and as a specialist contractor is likely to be used to remove the risk, again there is little benefit to keeping it within the ecology section over the pollution section.

4.6.3 LE3 – ecological value of site and protection of ecological features

The concept that calculating the ecological value of a site as well as protecting the ecological features of the site within one section is impractical, as too much is trying to be achieved within a small number of credits. This section needs to be more intuitive and arguably split into two sections. The role of the first is to establish not only the current ecological value of the site but also its potential. It is here that a newly devised calculation approach will be proposed to measure a baseline of ecological value at present, as well as identifying how the ecology can interact with the development. Input into the design and early indications of risks and potential benefits inherent within the site should also be addressed. The second section will see better planning for protection in a realistic manner to encourage developers to protect what ecology there is on site and design in the preservation of features wherever possible. A sliding scale should be introduced to allow for realistic development of a site as a significant issue raised by ecologists in the workshop process highlighted that developers who lost individual trees as part of the construction process would be more inclined to remove others as they had already lost the available credits. This scheme of 'all or nothing' is impractical and should be addressed accordingly.

4.6.4 LE4 – mitigating ecological impact

At present there are credits available for overall negative scores for ecology. Any developer who reduces the ecological value of the site, but makes efforts to ensure that it is not completely eradicated, would benefit from the scheme. This is counterproductive as the purpose of BREEAM is to go beyond the minimum required and demonstrate excellence in sustainable construction. Whilst it is inevitable that ecology will be impacted upon throughout the construction process it should be minimised whereever possible and processes put into place to ensure this occurs. As a result this efforts set out in this section will be updated to create a new stance of 'equal to or better' and spread across a new range of credits. Buildings should integrate with the landscape not replace it. The focus of this section therefore will move away from 'minimising the damage' to 'maintaining quality'. Credits will be available for:

- Carrying out planned protection as outlined in previous sections,
- Introducing management plans for the construction phase,
- Undertaking impact reduction measures,
- Creating temporary habitat refuges on site,
- Early introduction of permanent habitat to encourage wildlife to stay on site as well as,
- The education of contractors during the construction phase of the works.

4.6.5 LE5 – enhancing site ecology

The current system outlines possible routes to improve ecology on site. However it is unclear on the levels of cost and value in relation to potential awards within BREEAM. A client faced with the options to introduce a number of bird boxes for a minimal cost or to specify a green roof at a cost of thousands, would be hard pressed to justify the cost in terms of gaining points. Therfore new credits will be introduced to allow different degrees of enhancement to be rated and credits awarded for effort and potential ecological gain. These will be rated from simple solutions such as small wildlife ponds or nesting boxes up to significant habitat creation such as wildlife areas/reserves and the specification of vegetated roofs for wildlife. Equally credits will only be awarded if they are appropriate, introducing bird nesting boxes in poor locations, making provision for inappropriate species or blocking access to features introduced to generate ecological gain will not achieve credits.

4.6.6 LE6 – long-term impact on biodiversity

Under the banner of long-term impact this section will be expanded to create new credits that will be made available for plans and provisions undertaken within the development ensuring that developers follow through on their designs and intentions. As a result the second part of a new calculation process will be introduced under this heading to measure the changes brought about by ecologically sensitive design. Credits will also be awarded where key species have been identified and provision introduced to encourage their development either on site if already present or as a potential introduction to the site. This will give the opportunity to give special attention to locally endangered or protected species, or provide support for 'flagship' or 'foundation' species, which will help to improve ecology on site and create long term biodiversity stability.

In summary the fields used to set criteria for ecology within BREEAM can be maintained in one form or another to meet some of the issues identified within this research. However to introduce key ecological concepts into the system, it becomes needed to create new fields in which to set new criteria. Therefore the current 'issues' list (LE1 to LE6) will inevitably increase as each one will set criteria for credits that will be distinct, and different from the current structure and layout.

4.7 Establishing a new system within the current system

By keeping and working within the boundaries of the current system it becomes possible to make significant changes to the Land Use & Ecology section. This is one of the best features of the current BREEAM standard, as its cell-like structure allows changes to be made with minimal impacts on the system as a whole but allowing individual sections to be strengthened. The most important elements that makes this possible within the BREEAM framework is credit distribution and the concept of score weighting.

The current Land Use & Ecology section within BREEAM currently has 10 credits spread over 6 subdivisions. These 10 credits when combined with other credits gained in other sections such as water or pollution create an overall score and therefore an award depending on that total. Any changes in the number of credits will imbalance BREEAM as a system impacting these other areas. However given that the scheme is weighted, the number of credits is irrelevant providing the weighting remains the same. At present the Land Use & Ecology section has an overall weighting of 10, which when compared to the number of credits available (10) gives an effective credit worth of 1 overall. By changing the number of credits but keeping the same weighting the ecology component can grow and be more representative of ecological science by redistributing credits. For example the number of credits could double to 20 giving the client more scope to include ecological features or elements into the development. By keeping the same weighting of 10 the overall maximum score available within the ecology section remains the same even though each credits effective worth would now be 0.5 overall due to the weighting. This fact makes it possible to expand the ecology section to allow the inclusion of much needed ecological principles and to bring it in line with other sections throughout BREEAM in terms of opportunity to gain credits.

By doubling the amount of credits but keeping the weighting the same the overall balance of BREEAM is maintained. Although it may well be easier for clients to effectively score more credits as a result of a better range of credit options on offer, the overall score remains unaffected. Equally there should be the potential for the client to score more ecology credits if they are willing to put in the effort into the development. The risk therefore to unbalancing the system becomes minimal, nonetheless the weighting does fluctuate over time from updates of BREEAM versions. As a result care will need to be taken by BRE at the next update as even a slight change in weighting will have significant effects on the overall outcome, as the number of available ecology credits could skew the final score.

Finally the overall approach would need to be addressed to ensure key concerns are addressed (such as A10 & B14). Determining when an ecologist gets involved in the scheme will have a significant impact on the potential for the design of the development to impact or harmonise within existing ecology. Timing and level of involvement therefore are key concerns for ecologists using the BREEAM system. Under the current format involvement is feasible at anytime throughout the projects development. As a result ecologists are often required to conduct retrospective surveys surmising what might have been present prior to construction. This process from an ecological view is inappropriate and open to misuse.

It is proposed here that within the suggested changes to the land use and ecology section, that a new approach for ecological involvement be utilised. Given that a project is often phased from early scoping and design right through to post construction and occupancy, the level of ecology can also be phased in parallel. Developers can introduce the ecologist to their scheme at any point in the development but certain credits will be associated with the different phases, and only available during those phases. To maximise available credits a developer will have to include the ecologists input at the outset and maintain their input at key points in the development process. This is a radical change for the BREEAM standard, and on the surface seem highly prescriptive and inflexible. However it is reflective of the fragility of biodiversity and allows protection at both early and key stages of the development. It is far easier (and far more beneficial in terms of biodiversity) to maintain and enhance ecology and habitat rather than replace it post construction. A complete set of the proposed section criteria can be found in part within Appendix three.

4.8 Chapter outcomes

The framework of changes outlined here will be combined with the significant changes outlined in the next chapter (remodelling the calculation approach) to form the suggested changes to BREEAM's Land Use & Ecology section. The new model will be tested in chapter six as part of the case study approach to demonstrate the effectiveness of these proposed changes against the current system. There are risks associated with changing a well establish system such as BREEAM, and analysis is required to establish the risk to benefit ratio of doing so. Equally there are risks to not changing the system and these too will need to be identified and assessed. This section of this research can be found in chapter seven

This chapter has achieved a number of outcomes, firstly it has established from the data gathered as part of the interview process that there are a number of issues with the ecology component of BREEAM, and some are highly significant based on frequency identified by the ecologists interviewed. The level and quality of ecological benefits within the system needs to be improved. Secondly as a result of thematic coding and issue analysis recommendations to improve BREEAMs ecology section and changes that need to be made have been established. These represent the short-term changes that can be made within the system and are capable of being included within the timescale for the next minor review in 2010.

The long-term issues identified (and the most significant ones) centre on the calculation methodology which will be addressed separately in the next chapter. It has been demonstrated here that this is a core problem within the process and given the weight of the credits involved it requires significant amounts of effort to ensure the best possible outcome is achieved.

In essence therefore the most important outcome of this chapter has been to show which areas can be changed and improved quickly (several of which can be improved without restructuring BREEAM at all). However to realise the real benefits of this research, change is needed in the overall structure of the land use and ecology section, but this can be achieved without destabilising the remaining BREEAM system elements.

5 Establishing a new approach to evaluating ecology within BREEAM

5.1 Introduction and aims

As outlined in chapter four, when interviews were analysed the issues that were forthcoming were primarily about both the ecological content of BREEAM as well as system as a whole. However by far the most frequent issues were arising from the ecologists use of the system; centred around the calculation methodology used to establish a change in ecological value of a site. The methodology to evaluate the change in ecological value represents a relatively small number of credits (four split across two sections) within the system. However ecologically speaking it represents a significant part of the section as it encompasses some of the most important and critical ecological principles. In particular the opportunity to conserve biodiversity and 'mend' ecological degradation within the environment.

There is much that can be achieved in the short term to immediately add value to ecology within the next update of BREEAM (Chapter four), this chapter therefore is focused the longer term through the review of the calculation methodology, its flaws (as established from the ecologist interview process) and what can be done to improve the system in the future. This chapter has a number of key aims:

- To establish what is wrong with the ecological calculator within BREEAM and whether the concerns are valid or simply misunderstandings on the part of the users in its use and interpretation.
- To understand the process and understand what is missing in relation to ecological principles and practice.
- To establish a set of key ecological principles that can be used to create a new methodology in calculating ecological value.
- To establish a new and sensible approach that can be tested in the field and threfore its practical application, but also to test its suitability within the BREEAM process.

- To understand the risks and the limitations of the suggested process and to establish what would be needed to integrate the approach into BREEAM in the longer term.

5.2 Establishing the problem

It is clear both from the initial responses given by ecologists undertaking BREEAM assessments and the analysis of the concerns in the last chapter that there are flaws with the approach used by BREEAM to ascertain a change in ecological value and promote a positive impact on the overall design. The following sections outline the concerns registered as part of the data gathering exercises in chapter three (interviews and workshops) and looks thereby to establish a list of priorities needing to be addressed within any efforts to improve the calculation methodology.

Following analysis of the responses given in the ecologist interviews in chapter three and additional further discussions with ecologists, a significant number of negative opinions were voiced in relation to the calculation methodology for determining ecological value change. Below are examples of the most common responses:

'There's a serious lack of scientific rigor, it just isn't based in ecological science at all!'

'There's no relationship with the wider context, we look at the changes to the site within the ownership boundary, ecology doesn't work that way, invertebrates and birds don't recognise redlines on maps".

'The calculation's confusing, do I use the tables or use survey data, I just don't get it'.

'It's about the numbers not ecological principles more species doesn't equal better ecology!'

'There's no room for professional judgement the client hires me as a professional ecologist not for data inputting'.

'The really important aspects of ecological features are largely ignored, putting in a nature pond or taking out hedgerows doesn't seem to matter to the end result, which is crazy'.

'There's no drivers to create habitat networks, connecting the site beyond its boundaries is important but the calculator doesn't help me do that'.

'You can fiddle the results, so what's the point?'

'Where's the fauna, the calculator uses plant species as the unit for change… what about the animals?'

'The calculation is wrong, it's got out of date data and works on national averages, I'm a local ecologist with good local knowledge, doesn't that count for anything?'

5.2.1 Why is the current calculation methodology important?

From the responses to the interview process it is obvious that the ecologists feel the system is flawed; but is this element crucial to ecology? And does it impact the overall efficacy of BREEAM? The weighting alone of the calculator itself in relation to the credits available is evidence of its importance. The current calculation methodology is used to calculate the change in ecological value pre and post construction and is in place within BREEAM to meet the needs of credits LE4 and LE5. The calculation method is designed to generate a figure representative of species change for the entire site with the relationship of this figure to a positive or negative score determining the amount of credits gained.

The calculator is used in both sections which are split with LE4 representing the 'Mitigation of Ecological Impact' (negative effects) and LE5 concerned with 'Enhancing Site Ecology' (positive effects). These two sections have a combined score of 5 available credits as part of the assessment process, representing 50% of all the Land Use and Ecology credits, 4 of which are directly associated with the calculation methodology. Given that there are only ten credits available for the whole Land Use and Ecology section, the calculator alone can therefore affect 40% of the overall available credits. Table 5.1 demonstrates the criteria needed to be met in order to obtain the available credits for LE4 and LE5 (BREEAM offices, BRE, 2008a).

Credits available	Obtained by
LE4 credit number 1	Demonstrating that the change in the site's existing ecological value, as a result of development, is minimal.
LE4 credit number 2	Demonstrating that there is no negative change in the site's existing ecological value as a result of development
LE5 Credit number 1	A design team (or client) appointing a suitably qualified ecologist to advise and report on enhancing and protecting the ecological value of the site; and implemented the professional's recommendations for general enhancement and protection of site ecology
LE5 Credit number 2	Demonstrating there is a positive increase in the ecological value of the site of up to (but not including) 6 species
LE5 Credit number 3	Demonstrating there is a positive increase in the ecological value of the site of 6 species or greater

Table 5.1: Demonstrating the criteria required in order to obtain credits with the 2008 calculator methodology.

5.2.2 How the current calculation is undertaken.

Within the land use and ecology section of BREEAM 2008, there are currently two official routes available to determine the overall value of ecological change within the calculation methodology.

Option one

The plot type(s) and areas (m^2) that define the landscape of the assessed site are determined, in its existing pre-developed state and proposed state. This is then entered into a spreadsheet based calculator developed by BRE which utilises fixed ecological data taken from the national countryside survey. This method need not be undertaken by a suitably qualified ecologist.

Option two

Where a suitably qualified ecologist has been appointed and, based on a site survey, they confirm the following:

- Actual plot/habitat types that define the landscape of the assessed site in its existing pre-developed state and proposed state
- Area (m^2) of each plot/habitat type, and
- Number of plant species found within each plot type

Then the BREEAM assessor or ecologist inputs this data in to the Ecology calculator 2 (a second spreadsheet-based tool developed by BRE). There is technically a third option where ecologists undertaking a survey and gathering the associated data can choose to undertake the calculation themselves (rather than use the issued spreadsheet calculation tool). This is made possible as BRE has issued as part of the technical guidance the calculation needed to score a change in ecological value. The interview process highlighted that many ecologists take it upon themselves to develop their own spreadsheets to determine value change. This is helpful as it allows the ecologist to manipulate the area data and ascertain the species numbers needed to obtain more credits. They are then in a position to advise the landscape designers on their planting schedules accordingly. This does however create the risk of inaccurate calculations based on poor understanding of the calculation itself and introduces significant potential impacts on the efficacy of the ecological change process. Throughout the interview process to gain insight to this problem, few ecologists realised that the calculation methodology was given as a demonstration of how the spreadsheet worked, not an expectation on them to undertake the calculation.

5.2.3 How the calculation assesses change

The ecology calculation within BREEAM calculates the change in ecological value by comparing the diversity (expressed as the number and area) of plant species on the site both pre and post construction. This 'ecological value' for the entire site is expressed as an area-weighted average of plant species for the site's landscape type. This figure is then compared to figure boundaries or thresholds in order to ascertain an indication of the proposed developments impact on the sites' existing ecology. As a result a certain number of credits are then awarded. Table 5.2 details the thresholds and associated credits and is taken from the BREEAM technical guidance notes for offices (BRE, 2008a).

Change in value	Credits awarded (cumulative, up to four available)
Where the change in ecological value of the site is less than zero and equal to or greater than minus nine plant species	Under LE4 – A minimal change (1st credit).
Where the change in ecological value of the site is equal to or greater than zero plant species	Under LE4 – No negative change (2nd credit).
Where there is a positive increase in the ecological value of the site of up to (but not including) 6 species	Under LE5 – A slight positive change (1st credit)
Where there is a positive increase in the ecological value of the site of 6 species or greater	Under LE5 – A significant positive change (2nd credit)

Table 5.2: Credit criteria for LE4 & LE5

5.2.4 An example of the calculation in practice

Below is a simple example of the calculation utilising a site with only two plot types utilising material from the BRE technical guidance BREEAM for offices (BRE, 2008a).

Calculate the ecological value of a previously developed existing site:

- A 2065 m^2 existing site consists of the following types of land:
- 1865 m^2 hard landscaping = 0 species
- 200 m^2 urban mosaic - infertile grassland = 17.6 species (taken from BREEAM's Table 3.0).

The ecological value of the existing site is calculated as follows, for each plot type;

Number of species on plot type x plot type area as % of total area.

Therefore, for this example site:

- Hard landscaping: {(0 species x (1865 m^2/2065 m^2)} = 0 species
- urban mosaic-infertile grassland: {(17.6 species x (200 m^2/2065 m^2)} = 1.70 species
- Ecological value of the existing site = 0 + 1.70 = 1.70 species

Calculate the ecological value of the proposed site:

- The 2065 m^2 post-construction site consists of the following types of land:
- 1375 m^2 of building = 0 species.
- 550 m^2 of hard landscaping = 0 species
- 140 m^2 has remained as urban mosaic-infertile grassland = 17.6 species
- The ecological value of the proposed site is as follows:
- Building: {(0 species x (1375 m^2/2065 m^2)} = 0 species
- Hard landscaping: {(0 species x (550 m^2/2065 m^2)} = 0 species
- Urban mosaic-infertile grassland: {(17.6 species x (140 m^2/2065 m^2)} = 1.19 species
- Ecological value of the proposed site = 0 + 0 + 1.19 = 1.19 species
- The ecological impact is the difference between the two ecological values:
- Change in ecological value: 1.19 – 1.70 = - 0.51 species

Therefore, for this example 1 credit is achieved although, there is a minimal change in value.

5.2.5 The need for a new approach to calculating ecological value

In the review of the calculation methodology the first position should be the calculator itself. If it is indeed flawed then it is important to ask two significant questions, is it necessary at all? And if so, is there an alternative to the using a calculation methodology?

The change in ecological value is an important element of BREEAM. Its purpose is to measure impacts and assess how the new development has affected the landscape it is now in. Therefore the change in ecological value is at the very heart of the building/landscape boundary, it is a measure of interaction and how well the environment can cope with this change. If a building's design is to demonstrate 'beyond excellence' in its approach (the guiding purpose of undertaking a BREEAM assessment), then the design will need to demonstrate that it incorporates the environment into that design. Some method of proving a change has occurred (and is conscious of the potential impacts) is therefore required. Arguably given that the function of BREEAM is to demonstrate excellence in its approach and to go beyond statutory requirements, a positive demonstration should be required. Demonstrating minimal impacts and protection of certain habitats or species is a requirement of planning restrictions and permissions which occur outside of the BREEAM process. The demonstration of excellence in design should aim to show how the development not only integrates but helps improve ecological stability. Given that the recognition of ecological change and therefore a valuation is therefore needed within the system, is a calculation the only option? The following section identifies an alternative to the calculation methodology and evaluates its worth in relation to BREEAM.

5.2.6 An alternative to a calculation approach

The Land Use & Ecology section of BREEAM is on the whole a qualitative assessment process, with the calculation of ecological change being the only quantitative element involved. Can the changes in ecological value be dealt with qualitatively? The use of qualitative statements as a measure of ecological change represents a potential alternative to the calculation methodology, through the setting of fixed criteria based on ecological principles. This is a simplistic approach that can help to introduce ecological benefits into the scheme but at the expense of any coordinated efforts to improve existing ecology on site. The criteria could be set in a list format and if met credits could be awarded, the indicators of which would have to be a series of well crafted questions designed to establish a positive ecological improvement on a site. Such an approach would have to rely of simple responses to function and would resemble a dichotomous key similar to those used by ecologists for identification of species in field research. This dichotomous decision making tree approach would lead to a map of questions an ecologist could follow to establish change. Figure 5.1 demonstrates a schematic approach of the dichotomous map concept:

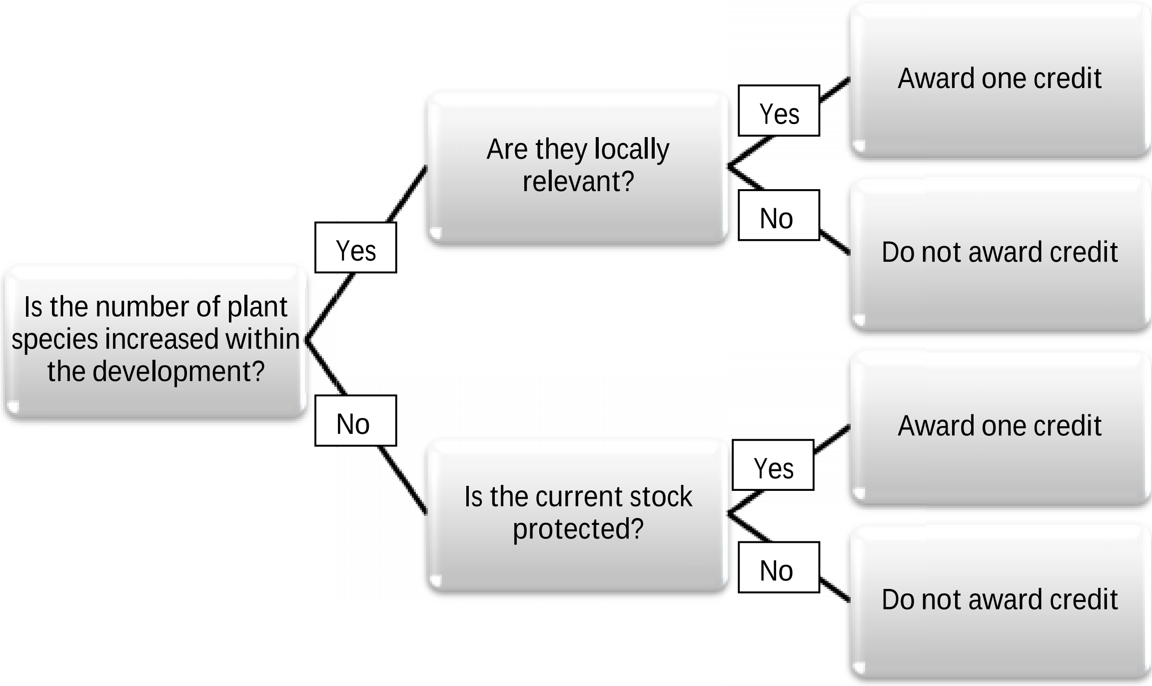

Figure 5.1: An alternative methodology approach to assess ecological change

Such an approach has positive elements in that it is formulaic and easy to follow and presents an opportunity to create a non-technical approach to the system. This approach however has several drawbacks; the positive element of the formulaic design does not lend itself well to different sites and scenarios. The only way such an approach can work is to utilise a structure that allows for every possible permutation for a type of development. Clearly this would be a significantly time consuming task and would result in an unwieldy and expensive exercise for developers. Equally such an approach takes no account of habitat types and although preferences can be written into the design, it cannot take into account the habitat currently on site. Finally given the various branches within the question map required to answer each element of ecological change, the points awarded would represent fractions of credits overall. This would result if the current credit boundaries were kept. As a total of hundreds of points from an equal number of questions would need to be gained from the answered questions in order to achieve only a few credits in the overall BREEAM scheme. As a result such an approach would be cumbersome and overly simplistic. This when compared to the use of a calculation methodology which allows flexibility would seem to make this approach inappropriate. Given that the current approach is better than the qualitative criteria based approach, establishing why it does not work in the opinion of the ecologists interviewed becomes an important point to establish.

It could be viewed that the current calculation methodology is fundamentally flawed due to one key error, which is: in attempting to make the process simple, the end result is too simplistic. Therefore the results have no real value as the foundations of the methodology are wrong. The core of the methodology equates ecological value with numbers of plant species, the more the better. This has no foundation in ecological science and therefore the core starting principle is incorrect.

5.2.7 What is ecological value?

Chapter two has established that in terms of ecological value, the concept of value is relative. The core 'value' of ecology inherent within BREEAM is never fully described however it can be deduced from the aim of LE3 – Ecological value of site and Protection of ecological features within BREEAMs technical guidance notes (BRE, 2008a):

"To encourage development on land that already has limited value to wildlife and to protect existing ecological features from substantial damage during site preparation and completion of construction works."

It is clear that the ecological value of a development is the value to 'wildlife' on site. Essentially the ecological value of BREEAM currently is in essence the potential for wildlife gain. This starting point fails to recognise the value that ecology offers especially from an anthropocentric stand point. Chapter two has identified the importance of the concept of ecosystem services and that the value of ecology to human beings is both diverse and vital. Understanding ecological value within BREEAM therefore needs to incorporate these services as well as the engine which drives them and stabilises them, biodiversity.

The current system fails therefore to create a bio-diverse approach and as such the use of random plant species in increasing numbers fails to develop integrity and strength in ecology as a system. In order to reverse this trend we need to look not at plant species numbers to assess ecological value, but at the capacity of stability within ecology, found at the habitat level. It is here we can assess change in integrity and identify a value to human beings from the services that are provided, not looking at ecology for ecologies sake as is the current approach.

5.3 Addressing the key issues

Chapter four identified 76 separate concerns with the efficacy and application of BREEAM. Several were directly associated with the calculation process, the most significant of which are:

- Lack of any real science underpinning the process – no links to basic ecological principles
- The use of plant species as an indicator of ecological value
- The calculation process causes confusion
- The process can be manipulated to give the developer what he wants
- Credits are awarded for even poor practice, i.e. even doing damage, down to – 9 species still gains a credit.

In addition chapters three and four have confirmed that which was identified in chapter two, that key ecological principles are missing, Using this information it becomes possible to identify key themes which need to be integrated into the BREEAM calculation process if it is to have real value. Achieving these will build a better relationship between the calculation methodology and the subject matter creating a more ecologically sound process. The key themes to include in the new approach to calculating ecological value are:

- The need to include an ecosystem services approach
- Understanding the key ecological principle of movement
- Allowing for climate change – adaptive and multifunctional landscapes
- The need to account for fauna as part of biodiversity
- Fragmentation of habitat - the need to reconnect habitat patches

These themes are based on ecological science, conservation biology and landscape ecology addressing these themes in the calculation process can help bridge this gap between current experience and scientific foundation. Giving the calculation methodology validity in relation to the promotion of biodiversity and therefore ecological value.

5.3.1 The role BREEAM can play in ecological design

Figure 5.2, Figure 5.3 and Figure 5.4 identify the role that BREEAM can play in preventing fragmentation of habitat and explain how landscape design can improve or hinder connectivity and thus biodiversity. In this example the same site and the same area of new habitat is used across three scenarios. In option one (Figure 5.2) three areas of habitat (A, B and C) have been designed into the landscape of a development site boundary. Within this option value is added as new habitat is created, however movement of species is limited by the boundaries of each habitat area (as demonstrated by the arrows within each area of habitat).

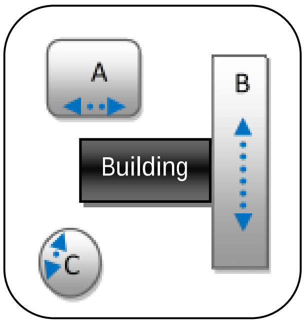

Figure 5.2: Context scenario (1 of 3) for ecology on a development site

Option two (Figure 5.3) looks at the same development but moves the areas of habitat to reflect a review of what is outside the site boundary, ascertaining the context for the site In this option the same area of habitat allows more movement for species and adds to the area of habitat already existing outside the boundaries. By simply looking at the site in context and moving the areas designed to juxtapose the existing, an opportunity for stability is created.

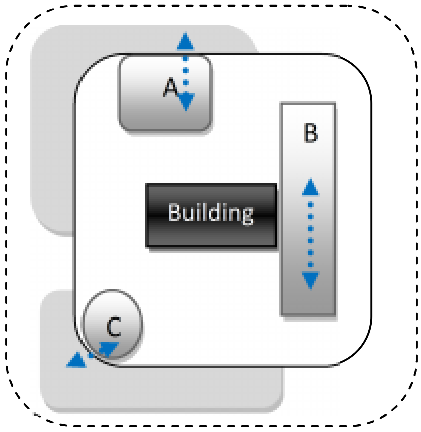

Figure 5.3: Context scenario (2 of 3) for ecology on a development site

Option three (Figure 5.4) takes this step one stage further and represents the best scenario for habitat on site. By moving area ‘B’ it becomes possible to link the habitats and create total movement across the site. This allows increased biodiversity and ecological integrity. Equally by changing the shape of area ‘C’ it becomes possible to create a better fit with other habitat areas and increase permeability into the area.

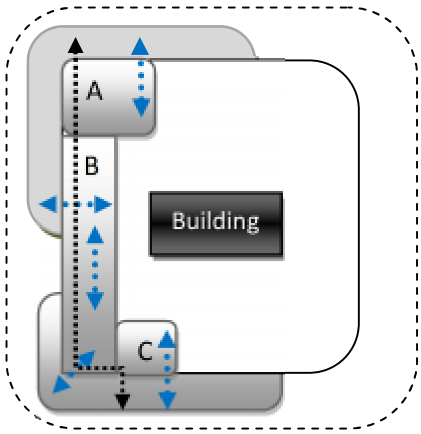

Figure 5.4: Context scenario (3 of 3) for ecology on a development site

In this basic example it becomes obvious the importance ecological input can have on the landscape design. Through the placement and shape of habitat forms within boundaries and context, biodiversity is strengthened and fragmentation reduced. The total area of landscaping has not increased with each scenario (from the point of the developer). However the total area available to species to move and occupy has increased dramatically. From this example the role the calculation can play in measuring connectivity is known as well as how it can be calculated. Simply putting habitat types in terms of boundaries together will increase movement and prevent fragmentation. In addition how important the ecologist input can be into landscape design, not only in the initial design phase but also throughout the project design phase as seemingly minor changes made by the design team can typically have major consequences in terms of ecological impact.

5.3.2 The role BREEAM can play in delivery of ecological planning policy and obligations

BREEAM can help in the development of nature networks, the concept and requirement of which have been set out in various international conventions and agreements. Agreements such as the:

- Pan-European Biological and Landscape Diversity Strategy (1995)
- The World Summit on Sustainable Development (Johannesburg, 2002),
- Objective 4, EU Biodiversity Stakeholders Conference (Malahide, 2004);
- The Ministerial Conference (Kyiv, 2003)
- And even Article 10, of the Habitats Directive (1992).

On a more national level the relevant policies, guidance and legislation which promotes the need for habitat networks can be found in:

- Planning Policy Statement 9: Biodiversity and Geological Conservation (Office of the Deputy Prime Minister, 2005),
- As well as Regulation 37, Conservation (Natural Habitats) Regulations (1994).

Although it can be argued that it is the role of planning authorities to enforce such regulation, there is also an argument for undertaking such work at a grass root level pre-empting the need for enforcement. The system could help developers be on the positive side of change rather than the negative approach of enforcement and obligations. Equally in a position of having a client with no driver other than the bottom line, having a system that requires positive change built in to support national legislation and conservation initiatives will help ecologists in persuading clients of the best course of action for the ecology on their site.

Equally there is an opportunity to tie in developments with other nationally and locally recognised conservation measures such as the UK Biodiversity Action Plan (BAP).

The UK BAP is a direct governmental response to the signing of the convention on biological diversity in 1992 and describes the biological resources found within the UK. The BAP identifies actions designed to protect these resources through a listing of priority habitats and species. The opportunity for BREEAM to utilise data from this system and integrate priority habitats and species should not be ignored.

5.4 Moving to a new approach, the logic of change

If the above elements are the scientific and political drivers that need to be behind the new calculation methodology, what is the practical reasoning for the new approach? What are the non-scientific drivers which will inform the new calculation methodology?

ecological realism

It is impossible to calculate in a simple model ecological value based on a rapid survey of a site at two distinct points (pre and post construction) to a significantly meaningful level. Such an effort could take years in itself to map out all the ecological pathways, but that is not the driver behind this calculation. What is needed is an ‘indication of value’, not a definitive figure, Therefore the approach taken here needs to have an element of ‘ecological realism’. Any ecologist using the calculator needs to be assured that the outcome has some basis in ecological science that is ‘representative’ of maintaining ecological diversity, and that the use of habitat as a measure and not plant numbers is a sound approach to achieve within this calculation.

Data gathering

BREEAM assessments occur in isolation, that is to say the outcome of any given BREEAM assessment bears little relation to another, as each assessment obtains a significant amount of data, which goes no further than the assessor or on occasion a quality control check by BRE. The ecology section of BREEAM has an opportunity to gather significant amounts of ecological data that can give real insight into habitat designation, growth of urban areas and intensification of land use. Therefore the new approach has been suggested with the intention of creating a database system of ecological and habitat associated information. This would be derived from projects on a national scale which could act as a significant resource for urban ecology.

Centralised system

By creating a uniform centralised system the data gathered can be accessed with organisations partnering with BRE, this could be research establishments, universities and educational institutions or government and policy setting organisations such as the Joint Nature Conservation Council, Natural England, and the Environment Agency among others. The data could be used by such parties to help inform policy, guidance and legislation. Similarly the reverse could be true, as policy and guidance can be added to the data set to identifying key areas of habitat for preservation, or reintroduction of species. This will integrate BREEAM developments further into local ecology.

Ease of use for ecologists

One of the fundamental principles set out for a new methodology is ease of use, by simplifying the process not the science, ecologists can spend more time on the data gathering, and survey work rather than data entry and report writing. By streamlining the process of calculation the new method will reduce confusion and generate more meaningful results for the ecological development of construction projects.

Consistency

The use of a consistent data entry system such as a web based interface will aid in overall consistency making data more meaningful. Ecologists will have a frame of reference from project to project, thus preventing different report styles dependant on the client. Equally in the case of one ecologist picking up work for another ecologist for what ever reason, the calculation methodology will not have changed (they will not have to comb through reports to find the information needed).

Quality control and up to date data

With BRE being in control of a centralised database it becomes much easier to quality control ecological survey work as well as keep track of projects as they progress. However one of the most important drivers for BRE in using such a system would be the ability to update the data sets used for the calculations. If a habitat is recognised as being in need of prioritisation in a given location the data used to inform the calculation can be updated for that area centrally making it automatically a localised priority. This means that the system can be can be kept up to date without changing format or the system for the end user, reducing the need to issue variations of calculator spread sheets and reducing the risk that users are working with out of data calculators.

Interest groups, planning authorities and bodies can establish a joined up approach

Using a central database of information can help foster a joined up approach with other aspects of the projects scope. Inputting data into a centralised database could flag local interest groups keen to partner with the project which could be a significant step towards achieving BREEAM assessments which require partnering (such as schools) in order to achieve some of the credits. Equally the system could be used by planning authorities to help build an ecological picture to inform future decisions, as well as keep track of recommendations as part of the planning process.

5.5 Outlining a new approach to calculating ecology for the built environment

Chapter two summarised the ecological principles on which this suggested approach is based. In addition some of the previous sections that have presented a range of drivers that have been developed from the consultation with ecologists as part of the interview process. This essentially ensures that the process meets the need of the end user, the ecologists themselves. The next few sections outline the suggested approach which is based mainly in landscape ecology theory (but is influenced by other ecological disciplines).

5.5.1 The aims of the new methodology

The methodology has been developed with a number of key aims in mind, namely:

- To protect and maintain current biodiversity – it has been seen in the literature that the loss of species and biodiversity is a risk to provision of long-term ecosystem services. The initial stand point will be to keep a net freeze on biodiversity loss, and not reward loss of species as is currently the case.
- To allow the continuation of ecosystem services – it is these services that create the 'ecological value' from a human perspective and as such features and habitat types that promote key services will themselves be promoted within the process.

- To reduce the phenomenon of fragmentation and create habitat networks – it is possible for ecology to 'survive' in metapopulations across small patches of similar habitat, but this makes the services they provide fragile. By promoting connectivity of habitat and the reinstatement of key features such as hedgerows or de-culverting rivers it becomes possible to create significant habitat networks.
- To generate a net positive change – although it will not be possible in each case the emphasis within the calculation will be on improving the ecological quality of the site. This will be achieved through the recognition of efforts to increase appropriate habitat types as well as key resources such as ponds.
- To make the best use of available space – the concept of multifunctional spaces is not just a design feature; ecologically speaking it too has a role to play in the landscape too. Within the new methodology space that has multiple roles will gain extra credit, e.g. designs which include sustainable urban drainage, nature trails and out door class rooms, plots for food production, green roofs, vegetative walls.
- To create a tool that can be used as a data resource – the ecological survey data as well as the methodologies utilised to improve ecology on site should be kept centrally so it does not become a wasted resource. It is envisaged that the data set could be utilised by more than just BRE, making it a serious resource for urban ecologists.

5.5.2 Using habitat type rather than species number as the starting point

The literature has shown that any process which looks to evaluate an ecological process based on the distribution of species data alone is likely to generate a final result which is at risk of significantly under representing reality. This is why the approach suggested here utilises habitat distribution rather than that of species to more accurately depict what is really happening in terms of ecological viability. In this sense, given that individual species can be associated with particular habitat types (Simonson and Thomas, 1999), it becomes possible to consider likely individual species distribution using habitat data if the need arises.

The use of habitat as a starting position is not without its risks. In the same way that species identification is highly subjective, the identification of habitat types is also open to recorder error. However by using a recognised and longstanding survey technique this risk can be to some extent mitigated, though not eradicated.

5.5.3 Integrating the phase one survey technique into BREEAM

The current survey requirements within BREEAM have been established as identifying firstly the general landscape type (either pastoral, arable, marginal upland, upland, building & derelict land & urban mosaic) then the vegetation plot type:

- Crops
- Tall grassland/herb
- Fertile grass
- Infertile grass
- Lowland wooded
- Upland wooded
- Moorland grass/mosaic
- Heath/bog
- Wildlife garden planting

Although some of these plot types are obvious, others require a high amount of skill to determine accurately and equally there are significant habitat types present in the UK which do not feature within this list of types for example. Technically reed beds or wetlands would have to be ignored as it is not listed, a difficult position for any ecologist given the obvious ecological benefits inherent with wetlands. Equally open areas of water are not included and can skew the calculation particularly if the pond or lake is lost as part of the redevelopment (as the before and after site area figures will be different). In addition the lack of inclusion of ecological value created by such a water body is an opportunity missed.

It is for these reasons the suggested approach is based on the Phase 1 Habitat survey approach (JNCC, 2007), which is well established in the UK and forms a significant part of the work stream for many ecologists. The approach is a method of classification introduced in the 1970s which has been updated several times since (1982, 1990 and most recently 2007). The process is designed to rapidly categorise large areas of land but is equally suitable for smaller areas. It provides a standard system for the classification of semi-natural vegetation and other wildlife habitats. Each type of habitat under the system has a specific name, an alpha-numeric code and a unique mapping colour making it useful for these purposes to ensure consistency amongst projects. The process has been undertaken in many county wide surveys as well as significant localised mapping projects (Wyatt 1991). The whole of Wales has been surveyed which saw completion in 1997 (Howe et al., 2005) and it is a well-known approach typically used by ecologists in the preparation of environmental impact assessments and base line surveys. Although similarly to the BREEAM approach it has a number of high level categories namely:

- Woodland and scrub
- Grassland and marsh
- Tall herb and fen
- Heathland
- Mire
- Swamp, marginal and inundation
- Open water
- Coastland
- Exposure and waste
- Miscellaneous

With each category having further subdivisions, the total number of habitat subtypes reaches a total of 155, making it very accurate and capable of covering every habitat type possible throughout the UK.

5.5.4 The key factors within a new calculation methodology

From the above analysis of both ecologists interviews and scientific literature in the fields of conservation biology, landscape ecology and ecosystem theory the following ecological factors have been determined to be included within the calculation process so as to a) include the key ecological principles established in chapter two and b) meet the needs of the aims and goals set out in section 5.5.1. The ecological factors which make up the calculation approach are:

Habitat context rarity – how common a type of habitat is to a location and historically how appropriate it is utilising at first historical documentation, however palaeoecological studies can also provide historic data.

Species value – a measure of how valuable a given habitat type is in terms of the type and numbers of species it maintains and therefore a reflection of services and goods it can provide.

A multifunctional landscape factor – how many roles a given habitat type within a design plays in improving the value. A reed bed which provides nesting for wintering birds, controls water run off, purifies waste water and provides amenity and educational space will be of significantly more value than a manicured lawn.

A species population level – if an existing habitat currently has a population of key species or has a population demography above expected norms for whatever reason, this habitat type in this instance will score more highly than others, making it harder to remove it as part of the development and still maintain a high ecological value score.

A replication factor – the ability for the habitat type to be replaced in the effect of a catastrophic loss. In essence, well-established locally historic and appropriate habitats will score higher than younger inappropriate habitat types.

5.5.5 The new calculation process

Within the current calculation process species number values are obtained for the various plot types. These are area weighted and then added together to create an overall site value. The new calculation process is very similar in that it utilises the same process of gathering data across different plots as well as the use of area weighting. Where it differs however is through the data used, which is not plant species number but a centrally controlled (by BRE) value assigned based on its significance as a habitat, thus including fauna as well as flora. Effectively each plot types score is weighted for habitat value before being area weighted. In addition the survey technique mirrors that of a Phase 1 Habitat survey approach giving clarity to ecologists who don't need to undertake a specific BREEAM survey. The data used will also be locally weighted giving it context not limiting it to national averages. The following sections outline the stages in more detail.

5.5.6 Establishing the factor values

The aim of the process is to create a localised set of values based on a range of national data sets and surveys. By using a central data set it would be possible to enter a post code or grid reference within the system to generate local values for habitats, giving them context. In addition the following will be factors in determining which habitats will rank higher in certain locations.

The use of existing and historic data will influence the value of particular habitat types, for example if heath land is a traditional, native and locally appropriate habitat type it will be rated higher than grassland and marsh for example. The information required to support this contextual ranking currently exists across a number of surveys which are presently available, including the national countryside survey, various Phase 1 Habitat surveys and the Joint Nature Conservation Council's (JNCC) UK biodiversity indicator project. In addition Geographical Information System (GIS) based habitat data is becoming available to determine the potential for creating habitat networks. Currently the north east of England, Wales and

Scotland have been analysed and the remaining parts of England are being undertaken as a contribution to the development of a national ecological network for the UK (Catchpole, 2006). Finally given that under this proposed scheme the BREEAM assessment data will be gathered and held centrally, BREEAM as a system will be able to reinforce itself, using its own data to help build the ecological habitat picture. This will become stronger as a data set as the number of projects becoming certified increases.

The ranking of habitat is also scored based on its ‘permeability’, a factor which determines functional connectivity and ranks differing types of habitat based on the ability of Fauna to migrate through it. Based on the work of Watts et al. (2005), the details of permeability and the scientific calculations utilised to help rank habitat types can be found in Appendix 4.

5.5.7 The process outlined

Essentially the process remains the same as the current BREEAM survey approach. Ecologists will survey a site. However this time they will be recording habitat types according to the JNCC Phase 1 Habitat methodology (2007), as well as any key features they encounter. This information will then be entered into a database through a potentially web-based interface which will determine the values of each habitat type allowing for localised variation and historical context as outlined in section 5.5.6. It will be possible to work out the higher rated habitat types using a spiral analysis of the area from the centre of the site. However to avoid confusion the process will be done automatically by the web-based interface rather than the ecologist themselves. This eliminates the errors currently inherent in the system caused by the ecologists undertaking the calculation themselves. The process is then repeated using the intended design values (habitat types and areas) and the system will generate first an overall score to determine a positive or negative change as well as a range of options both in terms of habitat types and features that would be appropriate and can be used to raise the final score. At the end of which credits will be awarded according to the degree on improvement of the ecological value.

5.5.7.1 Establishing the current value of habitat plots

Each plot has a value calculated by the system effectively weighting each area, thereby increasing the probability of retention of good quality habitat, particularly habitat with a strong population of relevant species (in terms of ecosystem services). Although the intention would be to have a web-based system able of calculating the value automatically and not seen by the ecologist, the equation is expressed here to demonstrate the mechanics of the calculation. The most significant advantage of this approach is its flexibility. The factors follow a set formula, but are determined independently from tables held centrally by BRE. This allows the calculations to be altered centrally, to react to changes in legislation or new studies. If a particular habitat type is in decline for example, BRE could easily raise its relative value and change its weight in future calculations.

Essentially the ecological value of a particular plot of habitat (EV) is the sum of localised individual factors associated with the Habitat Context Rarity (HCR), the Species Value (SV), the Multifunctional Landscape Factor (MLF) and the Species Population Level (SPL) all weighted using a Replication Factor (RF) to help protect rare habitats (these terms are described within section 5.5.4) Figure 5.5 shows the calculation in schematic form.

This EV score is then area weighted by multiplying the total score for an individual plot type by the area of that particular plot type. It should be noted that it is possible (using this approach) to have two plots of the same habitat type with different scores (Plot Values) on the same site resulting from contextual weighting, giving further flexibility within the system.

Figure 5.5: The new ecological calculation approach in schematic form

5.5.7.2 Establishing the current value of the site

In a similar approach to the current system, the individual plot values (PV) are added to give an overall score for the site (Figure 5.6). This score forms the baseline for the awarding of credits based on improvement as a result of the development. In addition the system will generate a site map demonstrating key areas (the areas that scored the highest) to help the ecologist inform the design process by maintaining areas of strong habitat. These habitat areas may not be obvious as they are given contextual weighting often based on factors outside the site boundary.

Figure 5.6: The new ecological calculation approach for the site area in schematic form

5.5.8 How the system would work in practice

Ecologists would undertake their surveys as standard noting key ecological features such as significant populations of particular species as they go. The information would then be inputted into a web based interface which will compare the site with historical data as well as other locally logged records which would determine a prioritising habitat score list. The list is created based on frequency of habitat occurring in the local area. This will make it easier to integrate locally appropriate habitats (as these will be ranked higher in this instance). The ideal position would be to introduce data in a GIS format. So the system could accurately measure areas of habitat types and score more accurately. However a user interface for simplified entry would also be provided where this information is not available. This would introduce an element of risk at this stage as this is heavily reliant on the ecologist to establish the correct areas of the various habitat types. However this risk is no more significant than the current approach as each area of species number also has to be measured. At this point suggested habitat types as well as locally sensitive enhancement would be generated to help the ecologist gain more points as part of the next phase, intended final design. The ecologist (or the landscape architect for that matter) could then input the intended design and the system will score it accordingly, again offering options that would help to improve the score overall. The end result is number of a credits being awarded automatically by the online system based on the changes of habitat type and features integrated into the design. All the calculations are made by the system improving both accuracy and consistency as well as flexibility for BRE in updating the system off line without the involvement of the end user.

5.5.9 Establishing the new approach – what the project would entail

Obviously the creation of a nation-wide data-base system is beyond the time scale of this work, the purpose of this chapter is to demonstrate an alternative approach to calculating ecological value which has a better integration with ecological science and practical application. This can be demonstrated on a smaller scale and forms the basis of the next chapter where the process is applied to a case study. However a separate project would need to be created to establish this process as a central web-based system. It is envisaged this would take around three years to complete. This will entail data gathering from all the major bodies (and is also reliant on their co-operation) 'cleaning' it where necessary and consolidating it in a single specifically designed database. This should be relatively straight forward as much of the habitat data needed is currently in the public domain. There would need to be at least two other facets of the work stream, one would be integrating with key bodies and institutions to ensure the ecological principles and science remains up to date, as well as spending time with ecologists nationally both to establish user groups to get the interface right but also establish training programmes with the end users. Such a project would be both challenging and rewarding resulting in a key database useable by significant bodies to influence decision making as well as influence the study of ecology in the built form.

5.6 Chapter outcomes

The work undertaken within this chapter aimed to provide a bridge between science and practice and show how ecological science could be applied to the BREEAM calculation process to integrate landscape ecological thinking into the development process. Using existing information and integrating with an existing system, the new approach to ecological calculation recognises the shifting agenda for conservation within the UK context whilst maintaining the stability of a well-established assessment system in BREEAM. Elements of the approach (in particular the concept of a centralised data set) allows the potential to inform a number of emerging priorities and create a resource for other organisations to use and input into the process of ecosystem stabilisation and management. This is a potentially significant part of the approach as the effects would be far reaching and would help establish BREEAM as a complete sustainability assessment tool, not just a building rating tool.

One of the key outcomes of this approach is the potential for linking protected areas with their wider landscape, as well as to help meet sustainable development objectives (though the focus on ecosystem services) at different scales and provide a credible basis for climate change adaptation through the introduction of appropriate and contextual habitat types. The approach set out here does not substitute for site-based conservation activity and the appointment of a suitably qualified ecologist will establish a good position to make the recommendations and suggestions created by the process possible. The purpose of this work represents an attempt to place sites in a wider, ecological context, as it is the ecologist's role to interpret the outcomes and inform the overall design to boost ecological value.

The data set created if this approach were to be adopted by BRE will create a significant landscape characterisation framework which will allow environmental objectives to be set across entire regional land areas, irrespective of those areas already rich in biodiversity. This system allows integration with the potential activity of locally led conservation initiatives, which is different from the current planning policy approach, in which only sites of significant interest are focused upon. A key component of this methodology would be to provide localised context for habitat. The database approach allows the inclusion of cultural and historical information which helps to create a thematic map for appropriate habitat types. The value of thematic maps can be determined through scientific means, namely the value of the habitat rated on the types of species it contains and thus the services it can provide. In addition to the permeability of a landscape which establishes the efficiency of that habitat.

The approach also improves the connectivity between existing patches of habitat through a functional analysis of the potential for the movement of species between sites. This highlights key areas across a development area that indicating features that might enhance or inhibit the movement of individuals and therefore creating a more holistic view of ecological value. The approach also explicitly supports local decision making both within the system data (local interest groups can input requests to prioritise key species in any given area), but also within the development itself by allowing users (i.e. ecologists) to utilise the best applicable options relative to the site to increase biodiversity. The aim of this chapter was to determine what needed to change in the long-term within the calculation methodology and indicate a possible route to integrate ecological science into it. The next chapter will see this process as well as the short-term changes outlined in chapter 4 applied to a real case study to establish if these changes are both practicable and effective.

6 Whipps Cross University Hospital – Testing the new approach

6.1 Introduction and aims

Chapter four has highlighted the benefits of the BREEAM 2008 assessment methodology as well as the flaws in the system in relation to ecology. In addition the chapter introduces a new approach based on the 2008 format for potential inclusion in the 2010 revision of BREEAM (the new criteria for which can be found in appendix three). This chapter will compare the new approach and subsequent outcomes with variations of one type of BREEAM assessment: BREEAM healthcare. It will also undertake scenario testing through the use of a case study, Whipps Cross University Hospital. The chapter will outline how well the site scores utilising the current BREEAM healthcare 2008 for ecology, following this will be an application of the new approach to ecology designed through this research project (and from this point onwards referred to as BREEAM Eco) in order to compare the changes made to the system. Finally the chapter will review both approaches in light of the NHS Environmental Assessment Tool (NEAT) approach (the first BRE dedicated assessment methodology for healthcare) to ascertain how well sustainability assessment methods have progressed for healthcare buildings. The outcome of each approach will be summarised and evaluated in relation to each assessment of the site and the site's overall potential.

This chapter has three main aims, namely to test the outcomes of chapters four and five using a case study approach, to highlight any practical issues with the application of both the current system and suggested amendments as well as to undertake a comparison study between the current healthcare approach utilising the Land Use and Ecology sections of BREEAM healthcare 2008 and the original NEAT approach to estimate how far the assessment methodology has progressed through its revision process.

6.2 Methodology – Using a case study approach

The following sections outline the case study process utilised within this research, explaining the logic behind its use and the steps taken to build an ecological dataset in order to establish if the proposed changes to BREEAM actually create a positive outcome for both ecology and the project being assessed. As outlined in chapter three, the use of qualitative approaches are viable in relation to BREEAM, especially in relation to Land Use and Ecology as it is a highly qualitative element of an otherwise quantitative assessment process. In analysing the application of the approach developed in chapters four and five, it is crucial to utilise the most appropriate qualitative methodology. It is important that this will return the best demonstration of an outcome (either positive or negative), for this research the best approach is the use of a case study. This is because case study allows the potential to emphasise the detailed contextual analysis of what is essentially a limited number or events or conditions and the relationships between them.

Case studies have been utilised for many years across many differing disciplines to examine the basis of application of ideas and extensions of methods. According to Yin (1984), case study research is defined as:

"An empirical inquiry that investigates a contemporary phenomenon within its real-life context, when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used".

In addition the use of a case study approach lends itself not only to theory generation but more crucially they are effective tools in the testing of hypotheses (Taplin et al., 2006).

6.2.1 Why use the field of healthcare to demonstrate changes in BREEAM?

BREEAM as an assessment system is capable of covering any building type, many of which have dedicated individual systems (e.g. offices, schools and residential buildings), with the BREEAM bespoke system being capable of assessing other types of building. As a result, it is feasible that any construction project can be used to demonstrate changes in BREEAM. However, given that the relationship between the differing types of assessment and ecology is relatively constant across the dedicated systems, the project itself becomes more important than the type of construction (e.g. education, housing or offices). Therefore it is important to utilise a case study subject that can demonstrate repetition of results and relevance to the construction market.

Healthcare is appropriate for case study because the scale of construction within the healthcare sector is sizable. A programme of construction is underway which will see major redevelopments and refurbishment on a range of sites and scales. The NHS is the largest nongovernmental employer in Europe (National Health Service Careers, 2009) and as a result has significant estate holdings and one of the largest construction programmes in the UK. The NHS was one of the first public bodies to insist on BREEAM in construction (for both newly built developments and renovation projects) making it revolutionary in the procurement sector in terms of a public bodies approach to sustainability.

The range of projects is of particular importance to this work, as a developed ecology section that works on healthcare buildings will as a result be viable on a wide range of complex construction schemes and projects. The healthcare sector is unique in terms of operational use; healthcare buildings are often in constant use and therefore generate not only significant potential impacts but also continuous ones. The immediate environment for healthcare buildings is of importance to the healthcare sector as the quality of the environment is fundamental to the successful rehabilitation and recuperation of patients. Therefore using a system such as BREEAM to improve the quality of environment will benefit the healthcare sector by improving the relationship between the building and its contextual environment.

6.2.2 Approach and viability to testing in this case

The use of Whipps Cross University Hospital as a case study is supported through significant background data, obtained through field studies of the site and surrounding environment as part of this research project. The ecological surveys undertaken in this research in conjunction with historical survey data for the site have been used as a baseline to measure the outcome of the assessment process by comparing the results with the actual ecological value of the site. This research has benefited from the opportunity to monitor the Whipps Cross University Hospital development project as well as having the opportunity to directly observe the planning and design process. These opportunities have allowed this research to be conducted with an understanding of the pressures of hospitals in relation to new builds as well as issues over maintaining services. It is this combination of field research, desktop study and observation of the design process that has made it possible to review the BREEAM assessment process and give it a contextual strength.

The use of case studies as a research study method is not without its flaws. Critics of the case study methodology argue that demonstration of results across a small number or single cases do little to demonstrate grounds for reliability or establish generality of findings, equally the intensity of exposure of the study subject can lead to bias accounts (Hall, 2007). Whereas proponents of the methodology feel that if carefully planned and well crafted, the studies of real-life situations, issues, and problems, outlined in a case study approach will result in a successful demonstration in even singular cases. Subsequently reports on the beneficial use of case studies as a tool for testing and proving hypotheses can be found within many disciplines and are widely available in the literature (Yin, 1989, 1993, 1994).

One of the key outcomes in chapter three outlined the parameters of this case study, and identified that, as BREEAM is essentially a desktop exercise, it is feasible to determine if a project is effective using a case study approach. In order to make it more effective in this case a significant amount of survey data has been gathered to determine the ecological value of the site and thus the real benefits of changes to the scheme.

The case study used here, i.e. Whipps Cross University Hospital, has been chosen for a number of reasons, namely:

- The potential of the site,
- The scale of the construction project,
- The opportunity to gain access to the design process from the early conception and planning stage,
- The extensive ecological baseline data gathered as part of this research.

All this makes the project a very effective case study.

6.2.3 Key elements of the approach

Through having an effective case study project and a strong dataset on both the ecological makeup of the site, and the planned design of the redevelopment, it allows the option of building scenarios by layering the assessment on a fixed baseline. As a result comparison is then possible of not only the differing variations of BREEAM assessment (in this case, BREEAM healthcare 2008, the proposed 2010 changes, and

NEAT) with each other but also the baseline to compare how much 'improvement' is made to the site ecologically through their use. Given that they are based on the same scheme, the scenarios can be overlaid to generate viable datasets that are comparable and therefore strengthening the case study approach. The data gathered for the ecological site surveys use extended Phase 1 Habitat survey techniques, a recognised and proven approach to habitat mapping which will create strength to the baseline data for comparison.

6.3 Methodology – Undertaking ecological surveys

Within the case study approach used here, data has been collected using field research for ecology in the form of surveys. Data has been gathered using the Phase 1 habitat survey methodology which is a standardised approach developed by the Joint Nature Conservation Committee in 1979 (JNCC, 2007). The Phase 1 habitat classification and associated field survey technique provide a relatively rapid system to record semi-natural vegetation and wildlife habitats. Within the approach each habitat type/feature is defined by way of a brief description and is allocated a specific name, an alpha-numeric code, and unique mapping colour. This is then mapped on a base ordinance survey map at an appropriate scale for the site or area. Originally designed for rapid surveying and mapping of habitat, the system is a standardised system for the classification of habitat throughout all parts of Great Britain (JNCC, 2007). Each element from the planning to the execution of the survey is outlined in the manual and field note guidance which has been updated and reissued several times over the last 30 years. Historically before the JNCC Phase 1 approach, an alternative methodology was in use, the Special Sites of Scientific Interest (SSSI) habitat mapping system. This approach was considered too detailed for wider countryside surveys and a simplified, yet compatible, version was produced for this purpose (NCC 1983).

This methodology has been widely used for habitat surveys on a large-scale such as the Phase 1 Survey of Cumbria (NCC 1986; Kelly & Perry, 1990), but has been found to be directly applicable to urban surveys, with only slight modifications to allow for the larger scale and greater detail which may be required. Due to the limited range and extent of wildlife habitats in most urban areas, the significance of relatively small sites is increased. Typically a Phase 1 Habitat survey will utilise a large scale ordinance survey map as a base, usually at the 1:10,000 scale. However on larger areas, 1:25,000 can also be used.

The Phase 1 Habitat methodology guidance states that using a 1:25,000 scale map, a minimum area of 0.5 ha can be assessed. However a 1:10,000 scale map allows smaller sites to be assessed down to 0.1 ha. In relation to urban sites, the map scale can be raised further to very large scales such as 1:2,500 to allow for the complex nature of the habitat in a built environment. However the use of very large map scales, is only likely to be feasible where the total survey area is quite small. The use of a scale of 1:10,000 has been found suitable for many urban surveys such as the surveys of Greater London and West Midlands (JNCC, 2007). The aim of the Phase 1 habitat survey approach is to provide a relatively rapid recoding of the semi-natural vegetation and wildlife habitat over large areas of countryside.

The approach set out in the guidance and manual allows the survey of specific habitat types, large areas of countryside as well as densely populated urban areas where every parcel of land is classified and recorded, a full listing of the 90 habitat types, plus additional subtypes used within the system can be found in appendix five. The classification of habitat types within the manual utilises vegetation augmented by reference to topographic and substrate features, particularly where vegetation is not the dominant component of the habitat (JNCC, 2007). The use of vegetation as an indicator is relatively simple to observe, identify and record and can thus be surveyed fairly rapidly. As most fauna is mobile, fugitive and small, they are often much more difficult to observe and record in the field. So comprehensive, and large-scale faunal surveys are not a practical proposition. However as described in chapter 5, the nature and condition of the vegetation of a site will embody information about many of the living and non-living components of that environment. As a result the study of the vegetation of a landscape can provide an effective means of classifying and surveying habitats and the fauna that exist with in them.

Within this research, ground surveys were conducted across the site and mapped at a scale of 1:2,500. Full access of the site has been made possible improving the accuracy of the survey over other Phase 1 Habitat surveys which often rely on access from public rights of way and aerial photography. The use of specific number codes and map colours has been conducted in accordance with the methodology outlined within the JNCC Handbook for Phase 1 habitat survey - a technique for environmental audit, 2007. Target notes have also been produced in line with the methodology for each survey and can be found in appendix six.

6.4 The Whipps Cross University Hospital case study

The hospital is run by Whipps Cross University Hospital NHS Trust which came into being on the 1st of April 2001 following the dissolution of Forest Healthcare NHS Trust. The hospital serves a local population from Waltham Forest, West Redbridge, Essex and East London in addition to both regional and national specialist services and operations. In 2008/09 the Trust had a budget of £169,776,000 and as of the 31st of March 2009, employed around 3,015 staff, three-quarters (74%) of whom are directly involved in patient care (NHS, 2009a). The hospital has approximately 734 beds making it one of the largest healthcare Trusts in London. The hospital is located in Waltham Forest, which is one of the greenest boroughs in London, with over 80% of the borough comprising of landscaped parks, open green spaces and playing fields. The nearest green space to the hospital is Epping Forest (which the 18.2 ha hospital site is adjacent), and forms part of a significant 'green chain' into central London (NHS, 2009a).

Following government approval of its business case the hospital is undergoing great change including substantial re-planning and rebuilding of the existing hospital site. The redevelopment requires a total capital investment of £328m (NHS, 2009b). Of this, £303m is required for the main redevelopment and £25m is required for works to support and enable the main redevelopment. Of the £25m of enabling schemes, £11m is associated with a new energy centre and construction of this is the first phase of the redevelopment. The new hospital represents a major investment in services and buildings that will help bring about NHS modernisation in northeast London. The hospital serves a large and relatively deprived population, from buildings that are old and mostly of poor quality. Redevelopment will therefore address estates problems as well as service modernisation. Importantly, it will also contribute to the economic regeneration of northeast London (NHS, 2009b).

Figure 6.1 represents an architectural view of the public sector design view (drawn by the Trusts architecturally led design team Avanti Architects –2006a) and represents a significant rebuild effort, with no current structural elements being left untouched by the design process. Much is to be replaced with some of the more recent buildings to be refurbished and integrated into the new buildings. The view of the current design shows the extent of landscaping and habitat around the hospital.

Figure 6.1: Axonometric view of the final proposed scheme (public sector comparator design) from the east looking west (Avanti Architects)

6.4.1 The Ecological context of the Whipps Cross Hospital Site

Figure 6.2 shows the grounds of Whipps Cross University Hospital (drawn by redevelopment design team, Avanti architects 2006b). It is somewhat unique in relation to its environment, as it is a busy London city hospital, but on the edge of the largest green space in greater London, Epping Forest. It provides modern healthcare from a mixture of buildings of various ages and types of construction, generating a highly distinctive eco-environment. The land to the north of the site (Epping Forest) is a candidate Special Area of Conservation, whilst access to the site is gained by passing through Green Belt, Green Chain Corridor, and Ancient Woodland. The area to the east, beyond James Lane, is a Conservation Area (JNCC, 2009).

The original Victorian buildings within the north-western part of the site are “locally listed” and most of the trees within and around the site carry Tree Preservation Orders (LBWF, 2008). All these habitat designations are effectively seen to create a number of planning constraints which will affect the redevelopment, and future operation of the hospital. They do however generate a significant number of ecologically rich habitat types that have infiltrated and spread into the site creating pockets of ecological value on site.

Figure 6.2: The current Whipps Cross Hospital site (Avanti Architects, 2006b)

The remarkable blend of habitat on site and the busy daily operation of the hospital itself create a complicated and exceptional ecosystem. In order to better understand that ecosystem, the Trust commissioned a number of habitat surveys in 1984, 1990, and 1995 which were undertaken by reputable ecological consultancies. Surveys were undertaken as part of this research in 2003, 2004 and 2005 by the author during the investigative phase of this work. A final survey was conducted in 2008 as a review stage to understand the level of changes that occurred following part of the construction process. The extended Phase 1 Habitat surveys identified the woodland on site (mainly the wooded area to the northern Whipps Cross road boundary) to be 'self-established' before 1939, with average plant diversity, identifying the dominant tree species as Quercus robur (oak) and Carpinus betulus (hornbeam). There was significant invertebrate and bird interest from the habitat on site.

Surveys conducted independently of this research by the local council (London Borough of Waltham Forest) identified that a number of uncommon species of fungi have been found in this woodland area, although none were recorded as part of the habitat surveys in 2003, 2004, 2005 or 2008. Epping Forest lies directly to the north of the site and is designated as a Special Area for Conservation (SAC) by the Joint Nature Conservation Committee in 2005, for its Atlantic acidophilous beech (Fagus sylvatica) forests and stag beetles (Lucanus cervus)(JNCC, 2009) Epping Forest contains one of the largest communities of stag beetles in southern England. The local council surveys also identified the Hollow Ponds (a series of lakes), just beyond Whipps Cross Road, is a notable feeding site for three species of bat, and that a number of buildings on the hospital site are suitable for breeding and roosting (JNCC, 2009). The hospital site itself consists largely of buildings, paved areas and roads, but also contains a number of mature planted trees, an area of planted woodland and a wildlife pond. A new access road to the A114 Whipps Cross Road is planned to the north of the site, and this will affect a strip of semi-natural woodland lying between the hospital and the A114 road.

6.4.2 Ecological baseline - Results of the extended Phase 1 Habitat survey for Whipps Cross University Hospital

The following sections outline the findings of the 2003 habitat survey, the first to be undertaken as part of this research by the author and identify the key areas of interest within the design stage of the redevelopment. The building works for the redevelopment began in 2005 and will affect both buildings and areas of vegetation. The changes in habitat across the site over the various surveys are recorded in section 6.4.6. The surveys show minimal changes in habitat type, but notable changes in area and location within the site. The Phase 1 Habitat surveys of land at Whipps Cross University Hospital followed the standard methodology as set out by the Joint Nature Conservation Committee (JNCC, 2007) and the methodology outlined in 6.3. The surveys covered the current hospital site, the strip of woodland that separates the hospital from the A114 Whipps Cross Road, and the area of woodland to the east of the site beyond James Lane. Epping Forest SAC to the North of the A114 Whipps Cross Road was not surveyed.

Areas of similar habitat were mapped as accurately as possible using the JNCC Phase 1 habitat categories. Typical plant species assemblages were recorded for each category of habitat, and species names used follow the conventions of Stace (1997). White areas of Figure 6.3 represent roads and hard standing and are incorporated into building figures in terms of habitat area. Target notes were made on any habitat features of particular ecological interest (and are recorded in Appendix four). Habitats potentially suitable for legally protected species were noted, and signs of such species (e.g. sightings, tracks, presence of droppings, burrows etc.) were recorded. Particular attention was paid to buildings and trees suitable for roosting bats, water bodies suitable for great crested newts, dead wood suitable for stag beetle larvae and the presence of badger sets.

Figure 6.3: Phase 1 Habitat survey mapping of the Whipps Cross site in 2003 (Author)

6.4.3 Survey results - Site Overview

The main hospital site consists largely of buildings, asphalt roads and paved areas. The buildings range from old and disused (1890) to the more resent (2002), with a number offering potential roost sites for bats. There are considerable number of planted trees across this area, mostly covered by Tree Preservation Orders, particularly limes (Tilia x europaea) and London planes (Platanus x hispanica), many of which are mature. Within this area, numerous small patches of amenity grassland, small areas of native and non-native hedges and shrubs, and areas of bare ground and / or weedy ephemeral species may also be found. A small rectangular pond is isolated towards the south of the site. The wooded areas surrounding the main site include a strip between the hospital and the A114 Whipps Cross Road, and an area to the east, beyond James Lane. The former contains a variable canopy, with a number of mature oaks (Quercus robur) towards the eastern end. Mature planted lime and horse chestnut (Aesculus hippocastanum) dominate the central section, and young and semi-mature sycamores (Acer pseudoplatanus) are dominant to the northwest. A strip of bramble (Rubus fruticosus agg.) and grass dominated road verge lays between this latter strip of woodland and the A114. The woodland beyond James Lane is dominated by mature oaks.

6.4.4 Survey results – Habitats present

In order to measure how effective BREEAM is at assessing the ecological value of the site, it is crucial to understand what ecological value is present on site before the development occurs. Within this case study significant amounts of data have been collected over successive years to establish the range and extent of habitat types on the development site. This section outlines the various habitat types present on site, based on the 2003 survey. Alphanumerical codes (such as A1.1.1. and J1.2) are used to relate areas of habitat to the standard Phase 1 habitat categories (JNCC, 2007), and are used through out this chapter.

A1.1.1 Semi Natural Woodland

Semi-natural broadleaved woodland covers considerable areas north and east of the main hospital site. The strip of woodland separating the hospital from the A114 Whipps Cross Road is heterogeneous in structure and species composition. In addition a small strip of young woodland is recorded along the south west boundary of the site. The area around the hospital access road at the north east of the site has a rather mixed canopy without one species dominating. The majority of canopy trees are immature or semi-mature. Sycamore with trunk diameter to 0.35 m is abundant, and mature oak to 1.5 m trunk diameter is occasionally present. Other canopy and sub-canopy species included hawthorn (Crataegus monogyna), elder (Sambucus nigra), ash (Fraxinus excelsior), wild cherry (Prunus avium) and goat willow (Salix caprea). Holly (Ilex aquifolium) is abundant in the shrub layer, and the field layer is dominated by bramble with cleavers (Galium aparine) and bindweed (Calystegia sepium) locally abundant. The area of woodland northwest of the Woodbury hospital is dominated by mature planted horse chestnut and lime, and has only a sparse shrub layer. The field layer is dominated by nettle (Urtica dioica) and bramble with Spanish bluebell (Hyacinthoides hispanica) occasionally present.

Towards James Road, the woodland is dominated by mature oaks with trunk diameters greater than 1 m. Hornbeam (Carpinus betulus), holly and English elm (Ulmus procera) forms an occasional shrub layer, and the field layer is dominated by bramble but also contained wood avens (Geum urbanum), cow parsley (Anthriscus sylvestris), herb robert (Geranium robertianum) and cleavers. The area of woodland lying south of the Woodbury hospital is dominated by semi-mature sycamores with trunk diameters of c.0.35 m. The shrub layer contains holly, elder, hawthorn and the field layer is dominated by bramble, cow parsley and ivy (Hedera helix). Several large Rhododendron ponticum shrubs (to 3.5 m in height) are also present. The small area of woodland on the triangular traffic island at the north end of James Lane is dominated by mature oak (trunk diameter to c.1.5m) and semi-mature sycamore. The shrub layer is again dominated by holly, but also contains hornbeam (Carpinus betulus), elder and wild cherry. The field layer contained nettle, sterile brome (Bromus sterilis), and a number of herbs and ruderal species including rosebay willow herb (Chamerion angustifolium) and broad-leaved dock (Rumex obtusifolius). Occasional young yew (Taxus baccata) (to 1.5 m in height) is also recorded, as are Spanish bluebells.

The woodland to the east of James Lane has a similar species composition, except that sycamore is largely absent. The open canopy is dominated by very large mature oaks, and the shrub layer by holly. Again, young yew is present in the field layer. There were also a number of paths and open grassy areas through the woodland, where the sward was dominated by perennial ryegrass (Lolium perenne), cocksfoot (Dactylis glomerata) and smooth meadow grass (Poa pratensis), and lacks herbaceous species. The linear woodland towards the south of the site consists largely of young and slender trees and saplings with a trunk diameter of c.0.2 m. Canopy species include oak, sycamore and grey poplar (Populus x canescens). A range of field layer species is present including bramble, nettle, wood avens and Spanish bluebell.

A2.1 Scrub

Areas of scrub are present along some boundaries and at the rear of some buildings. These are dominated by varying quantities of sycamore, hawthorn, elm (Ulmus procera) and elder. Scrub dominated by bramble forms a strip along the south side of the A114 Whipps Cross Road. A range of tall ruderal and grass species is also present and locally dominant in this area, including nettle, cocksfoot and false oat grass (Arrhenatherum elatius).

J1.2 Amenity Grassland

A large number of lawn areas and closely mown verges are present throughout the site. These generally contain grass species such as perennial ryegrass and red fescue (Festuca rubra). A few herbaceous species are present including clover (Trifolium repens), dandelion (Taraxacum sp.), shepherd's purse (Capsella bursa-pastoris), daisy (Bellis perennis) and smooth sow thistle (Sonchus oleraceus). Some areas have been mown less frequently and contained a longer sward, although these generally have a similar species composition, and the relaxed mowing schedule is not intentional.

B2.2 Semi-Improved Neutral Grassland

Some areas of rough uncut grassland dominated by false oat grass are present towards the south west boundary of the site. These are generally rather species poor, but contain locally abundant sterile brome, cleavers and nettle.

J1.3 Ephemeral/Short Perennial

Many areas have recently been bare ground and have been colonised by ephemeral weedy species including shepherd's purse, wild radish (Raphanus raphanistrum), smooth sow thistle, pineapple weed (Matricaria discoidea), groundsel (Senecio vulgaris), bristly oxtongue (Picris echioides) and mugwort (Artemisia vulgaris).

J1.4 Introduced shrub

A range of amenity plantings is present across the site and these were generally dominated by introduced shrubs including Pyracantha coccinea, Prunus laurocerasus, Rosa sp. Mahonia aquifolium and Forsythia x intermedia. In some cases these areas also contain planted or naturalised native shrubs and trees such as oak saplings or hazel (Corylus avellana).

J3.6 Buildings

Much of the area of the site consists of a wide range of types of built structure. These ranged from old to new, and a number are disused. The principal ecological value of these structures lay in their suitability for roosting bats. This is discussed fully in the next section. Buildings of little or no ecological value were not included in the target notes recorded but were noted for area calculation purposes. The site has no vegetative walls or green roofs.

J4 Bare Ground

Several areas across the site had been cleared of vegetation at the time of surveys in preparation for planned construction works, namely an additional temporary extension to the A&E department, a new pay and display car park and other ancillary enabling projects. This rolling programme will inevitably create area in a transitional phase and have been recorded in line with the Phase 1 Habitat survey methodology (i.e. a snapshot of habitat is recorded at the time of the survey). Areas of bare ground were common throughout the individual surveys and in conjunction with new buildings form the main reason for the areas of habitat changing from year to year.

G1 Open Water

A single pond is found in the nature area at the south of the main hospital site. This pond has potential as a breeding area for amphibian species. However it is newly introduced in 2002 and has yet to mature and settle into a significant habitat. The size of the pond is relatively small and is potentially lost in the area of other habitat types. However it is a potentially valuable habitat in the longer term and so is recorded in line with the Phase 1 Habitat survey methodology. Plant species present included Potamogeton natans and Callitriche stagnalis.

Individual Trees

The site benefits from a significant number of mature planted trees across the hospital site. A separate arboricultural survey was undertaken of the site in 2002 by a reputable and professional arboriculturist. This survey shows that there are 1845 individual trees on site over 75 mm trunk diameter. This information has been gathered in parallel to the Phase 1 Habitat surveys and such detailed knowledge does not form part of the phase 1 survey. It is included here however to strengthen the ecological benchmarking of the site. The collected trees included a range of broadleaved and some coniferous species, but the commonest tends to be lime and London plane. There are also large mature Scots pine (Pinus sylvestris), cedar (Cedrus libani), horse chestnut, and red chestnut (Aesculus carnea). In addition to providing food and shelter to a wide range of mammals and invertebrates there are significant opportunities for nesting birds as many of the trees are mature and infrequently pollarded or trimmed. In addition a significant ecological value of these trees lays in their suitability for roosting bats as again, these trees are mature (in some cases have hollows) and remain undisturbed for much of the year.

Invasive plant species

Whipps Cross does, like many sites in the UK, have a number of invasive species on site with Japanese knotweed (Fallopia japonica) found to be present in four areas on the site. These areas tend to be in disturbed or otherwise bare areas, and present a real risk to the redevelopment as spread of the plant into newly disturbed land is rapid and intensive and would contravene the Wildlife and Countryside Act (1981). Rhododendron ponticum is present in the woodland area to the north. Other introduced/invasive species included Spanish bluebell, ragwort (Senecio jacobaea), goat's rue (Galega officinalis) and alkanet (Anchusa officinalis).

6.4.5 Survey results – Legally protected animal species

Great Crested Newts

Great crested newts were not recorded on site during the 2003. This is to be expected as up until the introduction of the nature pond in 2002, there has been no suitable habitat on site. Equally the construction of the nature area (and pond) is in conjunction with three local schools and regularly has various classes of children dipping the pond for invertebrates to study. This disturbance (especially given the size of the pond) would create unfavourable conditions for great crested newts (Triturus cristatus) and/or other amphibian species. However it remains a valuable habitat for invertebrates and potentially healthy amphibian populations in the longer term.

Birds

The habitat for bird is sizable considering the active nature of the site. The presence of large areas of shrub, woodland and planted trees mean that much of the site comprises good nesting habitat for bird species. Throughout the habitat surveys signs of roosting and old nest sites are common.

Badgers

No evidence of this species is apparent as part of the habitat survey of 2003, and their presence on the site would seem unlikely; Equally given that the site has a high factor of human activity and is lined on each side by roads, it is unlikely that they will become present due to the isolation of the site for such a large mammal, however not all areas of dense scrub have been fully investigated to the required level of depth to see badger signs, and there is potentially suitable habitat on site.

Bats

The site was not surveyed for bats, as part of this survey (due to the legal ramifications of not having the appropriate licences); but habitat suitability was assessed and a large number of buildings and trees likely to provide suitable roosting sites were found. The large number of mature oaks and other species make all of the wooded areas suitable roosting areas for bats; but in addition a number of buildings and planted trees within the main hospital site also offer suitable habitat. Suitable buildings include the disused residences and roofs of the occupied residences at the west of the site, buildings towards the centre of the site, a number of small buildings towards the perimeter of the main hospital site and the disused air raid shelters behind the Woodbury mental health unit. Planted trees likely to be suitable for roosting bats (generally because of the presence of holes and cracks in the bark) are included in target notes within Appendix six. In addition, some dense growths of Ivy and other climbing plants seemed suitable for summer roost sites. Vegetation likely to be suitable for foraging and to provide flight corridors was noted in and recorded within the target notes.

Reptiles

No reptiles were evident in any survey, although the site was not surveyed systematically for these species. There is little habitat suitable for reptiles on the site.

Stag Beetles

At the time of survey no stag beetles (Lucanus cervus) were observed. However as part of a Phase 1 Habitat survey, the site would not be surveyed systematically in enough detail for this species. Quantities of dead wood can be found in the woodland strip between the hospital and the A114 Whipps Cross Road, and in the woodland to the east of the site. These will provide suitable habitat for stag beetle larvae. No suitable habitat or dead wood is located within the operational centre of the hospital site itself.

6.4.6 Previous surveys

Previous surveys have been conducted prior to this research as part of earlier efforts to support redevelopment projects on site. These surveys were conducted by reputable ecologists all of which are covered by a professional code of conduct from recognised ecological professional bodies. The veracity of the data therefore, cannot be assured in the same manner as the other surveys undertaken as they were not conducted but the author. However on analysis of the data contained therein, the previous surveys are comparable, which would suggest the data is reputable. Table 6.1 sets out the author and date information for the surveys undertaken. The data arising from these surveys in terms of habitat area has been replicated within Table 6.2.

Survey	Author	Date carried out
1984	AKS – Environmental	April 1984
1990	RPS Consulting	May 1990
1995	Access Ecology Ltd	July 1995
2003	Jon Kirkpatrick, Brunel University	June 2003
2004	Jon Kirkpatrick, Brunel University	June 2004
2005	Jon Kirkpatrick, Brunel University	July 2005
2008	Jon Kirkpatrick, Brunel University	May 2008

Table 6.1: Phase 1 Habitat survey information, authors and dates

6.4.7 The ecological value of the site from the 2003 survey

Figure 6.4 shows the results of the 2003 Phase 1 Habitat survey in terms of percentage area across the site to give an indication of the scale of each habitat type. The site is dominated by buildings and hard landscaping. However for a site located within a large metropolitan area, it has significant amounts of habitat (41% of the total area, the remainder being hard surfaces and buildings). The most important type of habitat in terms of area is semi-natural broadleaved woodland (at just over 22% of the site). It is also important for its lack of fragmentation. Other habitat types make up significant areas, but do so in a large number of small patches and so have reduced value.

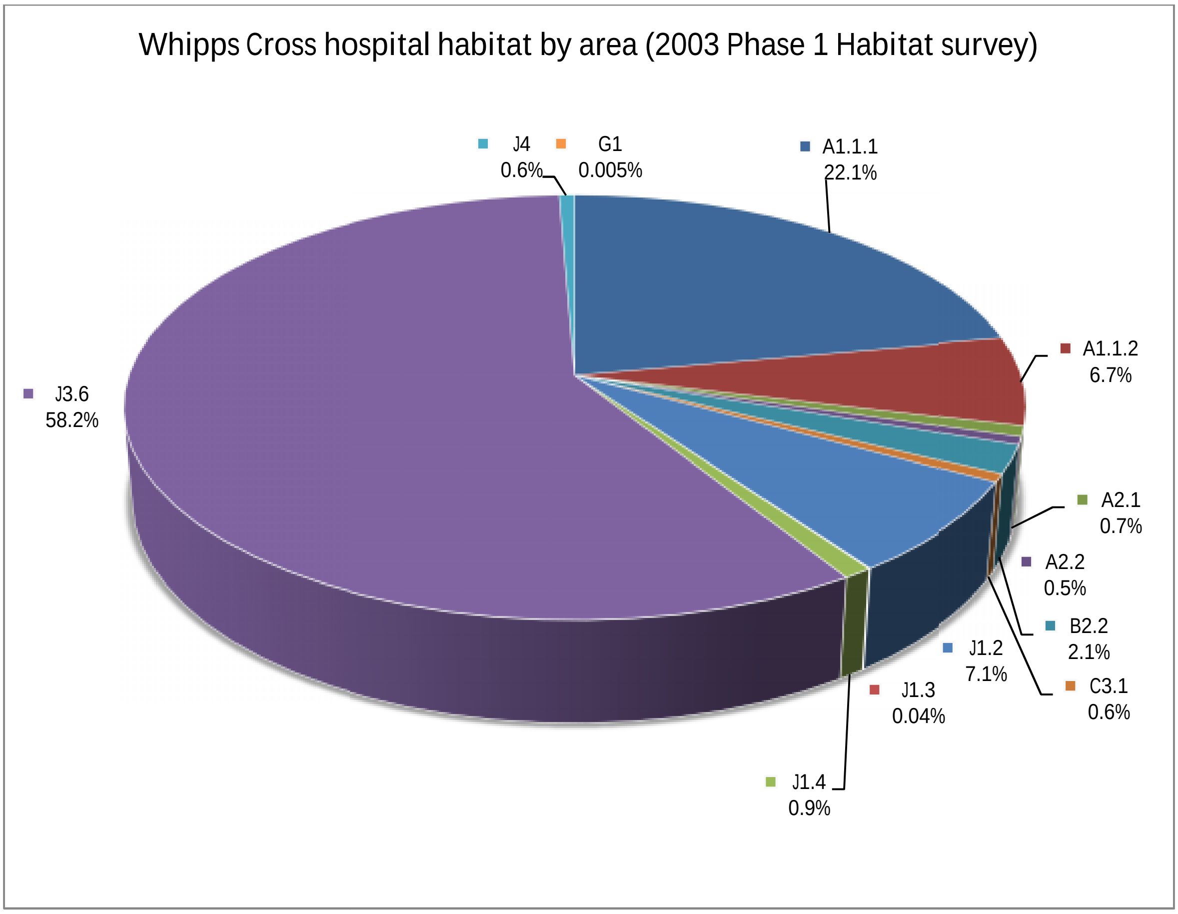

Figure 6.4: Results of the 2003 Phase 1 Habitat survey for Whipps Cross Hospital (Percentage of site area)

The current habitat on site and the identified species present indicate that the site has not only well established ecosystems but also significant potential. The habitat value of the main hospital site lies largely in its mosaic of different habitats, as well as its large areas of mature woodland and mature planted trees. In the area surrounding the site, the woodland areas of mature oak trees and other locally relevant species are of particular value to biodiversity and therefore have 'ecological value' for species found on site. The majority of the mature and semi-mature trees on the site are protected by Tree Preservation Orders (TPOs) which allows them to be refuges for various species on site further increasing the site's potential.

The nature area and pond to the south of the site is immature in stature but has significant potential for ecological value as it connects with neighbouring gardens, many of which are overgrown and provide considerable cover for invertebrates and small mammal species. The pond is a potential source of significant biodiversity. However in relation to the site, it is almost negligible in area. The established woodland to the north of the site is the most significant bank of habitat and given the age and species mix is an incredibly stable area for wildlife. The site currently has a wide range of species present even though it is largely fragmented, and contains a significant area of hard surfacing and buildings. The site demonstrates strong biodiversity within established habitat types. For a London site, this is especially significant given the nature of the site, its high levels of activity and therefore disturbance. The site has significant connectivity off site with a network of scrub, wooded areas and gardens on its borders however on site connectivity is poor. Limited by fragmented habitat and hard landscaping, species are relatively restricted in their movements.

6.4.8 The ecological value of the site comparing survey data

Table 6.2 shows the area changes in habitat type across the Whipps Cross Hospital site, taken from the seven Phase 1 Habitat survey undertaken on site, surveys marked with an asterisk represent those surveys undertaken as part of this research project.

	1984 (M^2)	1990 (M^2)	1995 (M^2)	2003* (M^2)	2004* (M^2)	2005* (M^2)	2008* (M^2)
A1.1.1.1	43452.5	43049.6	42646.8	40632.5	41035.4	41438.2	42243.9
A1.1.2	25621.5	12932.5	12810.5	12200.4	12322.4	11571.4	11643.4
A2.1	1539.4	1525	932.6	1438.7	1453.1	1467.5	1496.2
A2.2	847.9	1118.3	1107.8	1055.0	1065.6	1076.1	1097.2
B2.2	10671.6	8918.1	2659.3	3961.3	2181	4040.5	2884.7
C3.1	1180.2	1169.2	1168.2	1103	1114	1125.1	1147.9
J1.2	12605.5	13776.3	13646.4	12996.5	13126.5	10489.7	8916.0
J1.3	92.3	91.5	90.6	86.3	87.1	88.1	89.7
J1.4	1775.5	1758.9	1742.3	1659.3	1675.9	1692.5	1725.7
J3.6	83329.7	97350.2	104351.6	106053.9	107114.5	108175.1	110296.1
J4	1231.5	658.0	1191.5	1150.9	1162.5	1174	797
G1	0.0	0.0	0.0	9.5	9.5	9.5	9.5

Table 6.2: Changes in areas of differing habitat types across the Phase 1 Habitat suveys of Whipps Cross Hospital

Figure 6.5 demonstrates a comparison of the Phase 1 Habitat surveys in terms of changes to habitat areas, expressed as area changes (M^2) of the site.

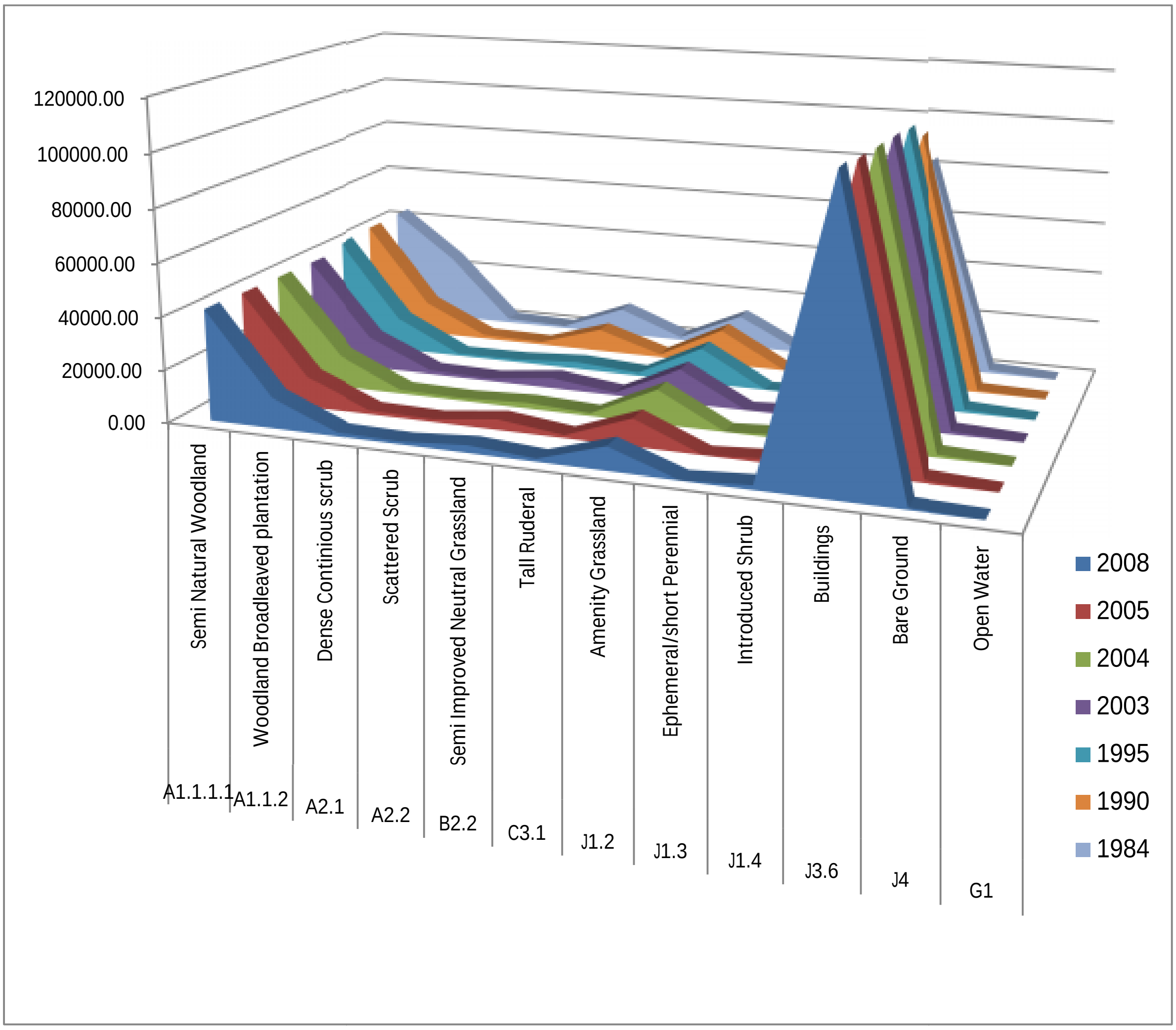

Figure 6.5: Changes in habitat composition of the Whipps Cross Hospital site (percentage area) from 1984 to 2008

From this figure, it can be construed that the site is relatively stable in certain habitats (such as woodland and scrub) with both areas changing little over the course of surveys from 1994 to 2008. This is to be expected as much of the habitat is found on the extremities of the site. Equally the most predominant changes over this period have been in the ratio of building area and other habitat types. Table 6.3 links the changes in site use, construction and management and their effects on the areas of habitat throughout the habitat surveys.

Phase 1 code	Habitat type	Changes from 1984 to 2008
A1.1.1.1	Semi Natural Woodland	Decline in habitat due to building programme; but increase of habitat in unused areas of the site
A1.1.2	Woodland Broadleaved plantation	Planting effort as part of the 1995 building programme; however steady tree removal due to expansion in later years
A2.1	Dense Continuous scrub	Slight increase over recent years from improved edge management by grounds staff
A2.2	Scattered Scrub	Little change until 2003, then a slight increase in habitat
B2.2	Semi Improved Neutral Grassland	Lots of grass land in 1984, lost in 1990 with construction of 2 car parks, beyond which relatively stable
C3.1	Tall Ruderal	Infill habitat, relatively stable as limited to edges; but increase in 2003 with introduction of nature area
J1.2	Amenity Grassland	High in 1984, lost with introduction of car parks by 1990, improved with introduction of grassed helipad area in 2003, stable to 2008
J1.3	Ephemeral/short Perennial	Land management caused reductions, often turned into amenity grassland
J1.4	Introduced Shrub	Reduction of planting budgets reduced this habitat type, areas developed into other areas typically amenity grassland (increase however in 1995 from 1st phase of redevelopment)
J3.6	Buildings	Constantly changing over the survey period, ranging from a mix of temporary to permanent constructions, sharp rise in redevelopment in 1995
J4	Bare Ground	Product of survey timing, as construction/change is a constant on site, and so fluctuates yearly. Ground does not stay bare for long, it is typically built upon, but occasionally colonised due to delays in construction
G1	Open Water	Non existent on site until pond introduction in 2003, no expansion to date

Table 6.3: Analysis of changes to habitat types throughout survey periods (1984 -2008)

The changes to the habitat areas are to be expected as the hospital has had to adapt and develop new ways of delivering increasing services to an increasing local population. This will inevitably mean the creation of new more appropriate buildings and is the justification for the redevelopment of the site, as the assortment of various structures can no longer provide the services needed. The changes also demonstrate it is possible to demolish and build on parts of the site without eradicating the habitats present, though the changes to the site have been small when compared to the scale of the planned redevelopment.

The significance of this data collection of habitat on site is that it allows review of the various sustainability assessment methodologies to be placed in context. Not only can they be undertaken and compared with each other, but with the knowledge obtained from the survey programme within this research, it is possible to compare the outcomes of each assessment to the ecology of the site. This will in turn enable comparison of what changes could be made to the site and how effective they would be at protecting or increasing levels of biodiversity if implemented. The next few sections summarise the planning of the redevelopment of Whipps Cross Hospital and then the undertaking of the various BREEAM assessments and comparison to the ecological landscape associated with the site.

6.4.9 Proposed New Redevelopment – 'The building'

The project, as envisaged, will present new opportunities to maximise healthcare in the north east London sector, utilising innovative technology and modern healthcare planning in a facility suited for its delivery. The problem arises in that although there is a need for great change in the way healthcare is provided at Whipps Cross, the environment in which it is situated cannot change. The habitat surrounding the hospital is of national importance, and the species found within that environment are of international importance. Therefore the problem lies in developing the site in a manner to provide and promote progressive healthcare, whilst effectively managing the risks to the hospital's environment.

The proposal is for the redevelopment of a new consolidated hospital on the western, southern and central part of the site, within a retained framework of existing buildings, trees, woodland and open space. The north-eastern part is to be developed for key worker housing, based around the most distinctive parts of the existing Victorian hospital buildings and existing trees. The scheme therefore aims to integrate existing features with new development, retaining the best of both the older and more recent architecture, within a landscape framework that reflects the forest setting of the site.

6.4.10 Problems presented by the redevelopment, the need for assessment

The risks presented by the Whipps Cross University Hospital redevelopment are similar to most other construction schemes of a similar size and form. In addition there are other risks associated with delivering a project in the NHS including financial and technical risks to name but a few. However given the

Hospital's location and scale, its environmental risks are of significant note. The risks to the environment from the Trust's current activities are numerous. Incorporate the risks associated with the construction of a new hospital, the demolishing of an old one, while maintaining a constant level of healthcare service and the risks are highly significant. A large proportion of these risks are ecological in nature (the construction and demolition of buildings are significant contributors to the ecological risks).

Following the introduction of NEAT, the Department of Health issued a mandate that required all newly built NHS developments to meet an overall excellent rating, and all refurbishments to meet a rating of good. With the introduction of BREEAM and replacement of NEAT in 2008, the mandate remained with the criteria simply changing to the new assessment system. The aim of this mandate set the NHS as a leader in sustainable design, ensuring that each construction project utilised NEAT (and now BREEAM) as a design tool, not just as a ratings tools in assessing buildings. With BREEAM's criteria requiring more design integration, this has led to greater environmental input at key design junctions. Equally the use of BREEAM has led to key stages in the designs development to be scored and provisionally rated, to help predict the final overall outcome.

6.5 Results – applying the systems to the case study baseline

The following sections outline the same base case (the redevelopment of Whipps Cross University Hospital) with an overlay of three different ratings systems in relation to Land Use and Ecology. First is the use of current NHS best practice, and forms the latest effort to improve ecology on medial orientated sites and projects – The BREEAM Healthcare 2008 Assessment Tool. The second is the application of the revised process as determined within the last two chapters of this research (BREEAM Eco). The third is an assessment using NEAT. The purpose of overlaying BREEAM healthcare 2008 and the revised process BREEAM Eco is to determine the differences in outcome in order to assess the advantages of the revised process. The purpose of overlaying NEAT is to understand how far the evolution of BREEAM has come. The outcomes of each assessment methodology will be related to the ecology of the site as set out in 6.4.1 using a set of ecological indicators. The indicators have been chosen based on the research set out in chapter two as those ecological principles are deemed appropriate by the literature to improve levels of biodiversity and thus ecological value of a development. The benchmarks will be to assess each outcome in relation to five key areas:

- Habitat area post development – more habitat area creates stability for biodiversity.
- Locally appropriate – better chance of survival for habitat type and species found therein, as well as contributing to the areas ecological matrix of habitat types.
- Movement barriers - how well the site connects together to allow species migration, on and off site.
- Permeability – how well the design allows for the movement of species and reduced ecological cost to species as identified in chapter two.
- Fragmentation of habitat types – large areas are only effective if they are connected. Fragmentation of habitat by the redevelopment reduces biodiversity and stability.

6.5.1.1 Whipps Cross ecology and BREEAM 2008

Table 6.4 outlines the outcomes of a BREEAM 2008 survey in relation to the Land Use & Ecology section only applied to Whipps Cross Hospital. The assessment has utilised available design information for the site and is based on the 2008 designed scheme outlined in Figure 6.6. The assessment scored well obtaining nearly all available credits with minimal cost to the project. The consolidation of buildings has freed up space within the design and allowed room for new habitats to be introduced. However much of the original landscaping and thus habitat is lost, as there is little incentive within the scheme to keep it throughout the redevelopment process. This is due to the 'all or nothing' approach to the criteria of the assessment, when one ecological feature is lost for example the credit is unachievable and so retaining the remainder is pointless (in relation to the assessments scoring).

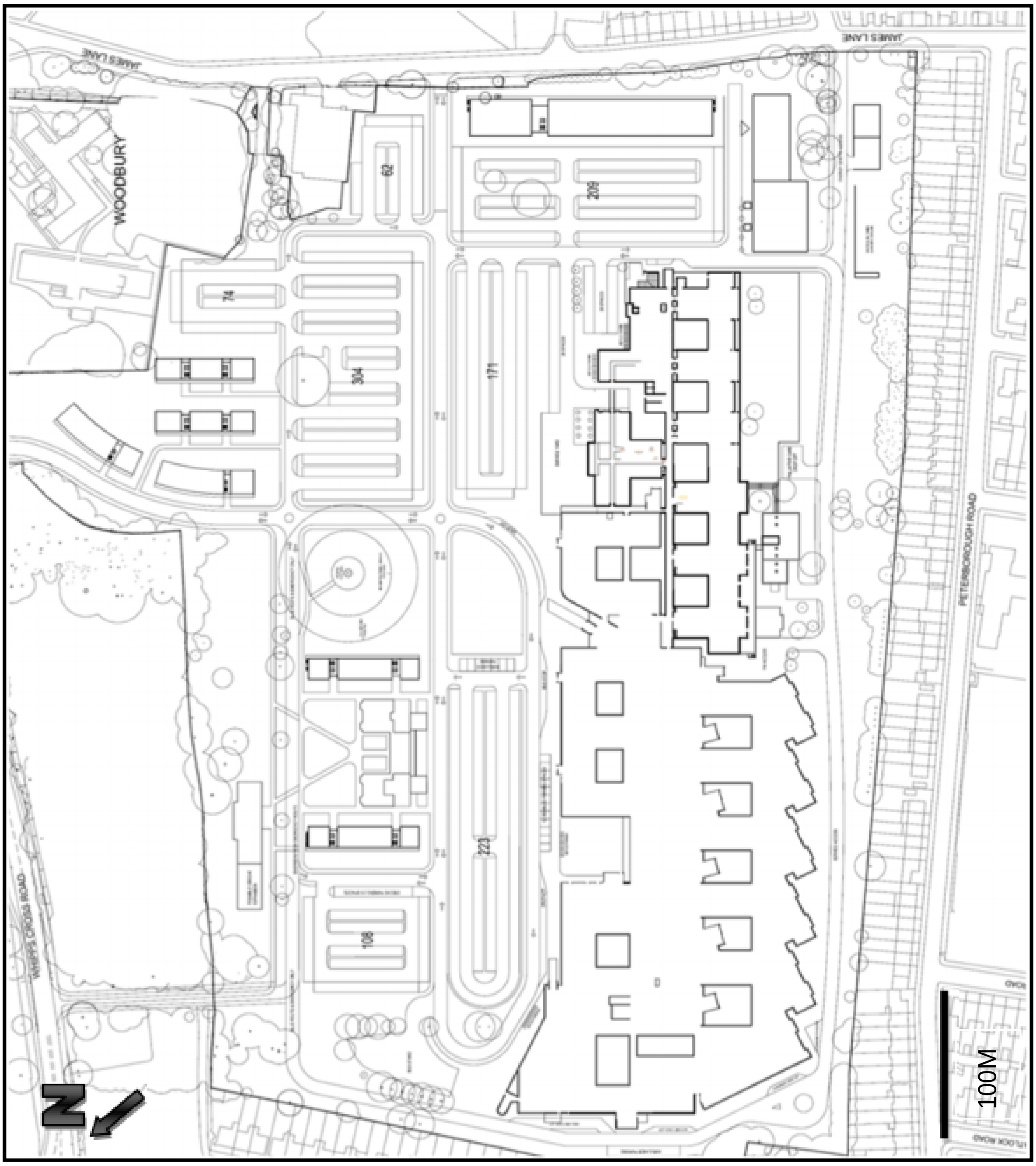

Figure 6.6: Site plan for the redeveloped Whipps Cross utilised for the BREEAM 2008 assessment.

BREEAM 2008			
Element	Credits available	Credits scored	Criteria notes
LE1 – Reuse of Land	1	Yes	At least 75% of the proposed development is on previously used land
LE2 – Contaminated land	1	Yes	The site has confirmed contaminated land and will be decontaminated prior to construction
LE3 – Ecological value of site AND Protection of ecological features	1	No	The site cannot be considered of low ecological value, and not all ecological features can be protected
LE4 – Mitigating ecological impact	2	Yes (2 Credits)	Both credits can be awarded as evidence can be provided for there being a minimal change as well as no negative change. This is made possible through a consolidation of built form creating new habitat areas and the introduction of a significant number of new species onto the sites landscaping plan creating bias within the calculation methodology and a slight positive value score (+1.16 species over current value)
LE5 – Enhancing site ecology	3	Yes (2 Credits)	A suitably qualified ecologist was appointed by the design team and recommendations implemented (1 Credit) & through the use of the ecological calculator the species value of the site increased positively (credit 2) but not above 6 species or greater (credit three not awarded)
LE6 – Long term impact on biodiversity	2	Yes (2 Credits)	The mandatory criteria were met (1st credit): • A suitably qualified ecologist was appointed, • All ecological legislation was complied with, • A landscape and habitat plan was produced. And four of the optional requirements were also met (2nd credit): • A contractor nominated 'biodiversity Champion' was appointed, • Training for protecting ecology was provided for workforce • Actions to protect ecology were recorded • Works were timed to minimise disturbance of the site
	Total	8	Out of a Possible 10

Table 6.4: A summary of scoring for BREEAM 2008 on the redevelopment of Whipps Cross Hospital

Reviewing the assessment outcomes in relation to the ecological indicators set out in section 6.5 it is noticeable that although the section scored well (8 out of 10 available credits) in relation to the ecology of the site little has changed to strengthen future biodiversity.

- Habitat area post development (Positive result)
    - The area available for habitat has increased and as a result there are potential opportunities for biodiversity to spread.
- Locally appropriate (Negative result)
    - Although the area of habitat has increased (as has the number of different plant species to meet the needs of the calculation process) they are not found locally. Essentially wild meadow species would be introduced within the landscaping strategy to boost numbers

on site which is a habitat type that is not locally present. This reduces the chances of this habitat type surviving in the longer term as well as not benefiting the ecology outside the site reducing biodiversity.

- Movement barriers (Negative result)
  - Patches of habitat prevent migration on or off site due to isolation within the redevelopment, equally significant barriers exist within the site with no integrated strategy for movement (e.g. corridors, hedges, edge treatments, vegetative banks)
- Permeability (Negative result)
  - The habitat types within the landscaping strategy and planned design do not blend well. Hard landscaping is utilised in many areas for aesthetic and management reasons however this will have a high ecological cost for ecology due to the exposed nature of the landscaping
- Fragmentation of habitat types (Negative result)
  - No effort has been undertaken to link habitat types as a result the areas on site suffer greatly form isolation. Equally the context has not been addressed and opportunities lost in connecting habitats off site have been missed.

6.5.1.2 Whipps Cross ecology and BREEAM Eco

Table 6.5 outlines the outcomes of a BREEAM survey using the proposed changes to ecology within the Land Use & Ecology section outlined in this thesis (termed BREEAM Eco). Again only this section has been included here for comparison purposes. The assessment has utilised available design information for the site and is based on the 2008 designed scheme outlined in Figure 6.6. The assessment scored well obtaining nearly all available credits (18 out of 20) with minimal cost to the project. As with the 2008 assessment, the consolidation of buildings has freed up space within the design and allowed room for new habitat to be introduced. However much of the original landscaping and thus habitat has been retained within this assessment because the scoring approach allows higher ratings for retained habitat. In addition infill habitats have been introduced to link existing habitat areas. This is most notable around the boundary of the site which helps to connect the habitats both on and off site, as well as other beneficial factors such as screening for neighbouring properties. The outcome of this landscape planning is demonstrated in Figure 6.7.

BREEAM Eco			
Element	Credits available	Credits scored	Criteria notes
LE1 – Ecological Value - Baseline	1	Yes	The site was evaluated using the new habitat mapping calculation approach, meeting the criteria
LE2 – Ecological Value - Potential	2	Yes (2 Credits)	A maximal beneficial landscape habitat option was produced using the new habitat mapping calculation approach to integrate with the landscape strategy and design, and the report was presented to the design team, meeting the criteria
LE3 – Efficient use of land	1	Yes	Consolidation of the estate within site meets the criteria freeing up land for new habitat
LE4 – Planning for protection (pre construction)	1	Yes	A pre construction plan was established identifying key areas of habitat, features of importance and legally defined areas such as trees under preservation orders
LE5 – Protection of habitat during enabling	2	Yes (1 Credit)	Hoarding for trees was introduced meeting requirements of the British standard BS 5837: 2005 Trees in relation to construction, in addition fencing was erected to isolate key habitats and features from construction traffic and impacts however not all habitat was protected as doing so would inhibit the construction zone detrimentally
LE6 – Creation of temporary refuges	1	Yes	Temporary habitats of various forms were created and monitored in key locations on site to create refuges during enabling and construction.
LE7 – Creation of construction phase management plan	1	Yes	A construction management plan was established identifying key areas of habitat, features of importance and legally defined areas such as trees under preservation orders to be protected during construction. In addition to planned protection measure to be phased throughout the developments construction
LE8 – Introduction of impact reduction measures	1	Yes	Measures set out in the construction management plan were implemented during construction works
LE9 – Training and awareness of site staff	2	Yes (2 credits)	Training sessions and material were made available to contractors site staff
LE10 – Early introduction of Permanent habitats	1	Yes	Habitat areas were introduced prior to final construction as phased elements of the site became available, especially in the border regions of the site, promoting habitat growth in stages
LE11 – Ecological enhancements	3	Yes (2 credits)	Key enhancements were introduced into the site to meet the criteria for 2 credits, the level required for 3 credits in this case was deemed cost prohibitive by the design team
LE12 – Ecological value – positive changes	1	Yes	Recalculation of the site following the integration of elements from the maximal beneficial landscape habitat option identified in LE2 demonstrates a positive change to the landscape strategy and design, improving most notably the connectivity and area of locally relevant habitat on site.
LE13 – Green Infrastructures	1	Yes	A network of sustainable urban drainage has been designed into the scheme, along with vegetative shading and wind shelter belts. Vegetative walls have increased connectivity to green roofs.
LE14 – Multifunctional landscapes	1	Yes	The landscape has multiple functions including among others: Drainage and flood management • Education • Recreation

			• Local amenity • Minor food production • Threatened Species preservation
LE15 – Protection of Keystone &/or threatened species	1	Yes	Key features were introduced to create habitat for the locally occurring stag beetle population (a national recognised threatened species)
	Total	18	Out of a possible 20

Table 6.5: A summary of scoring for the revise ecology section of BREEAM eco on the redevelopment of Whipps Cross Hospital

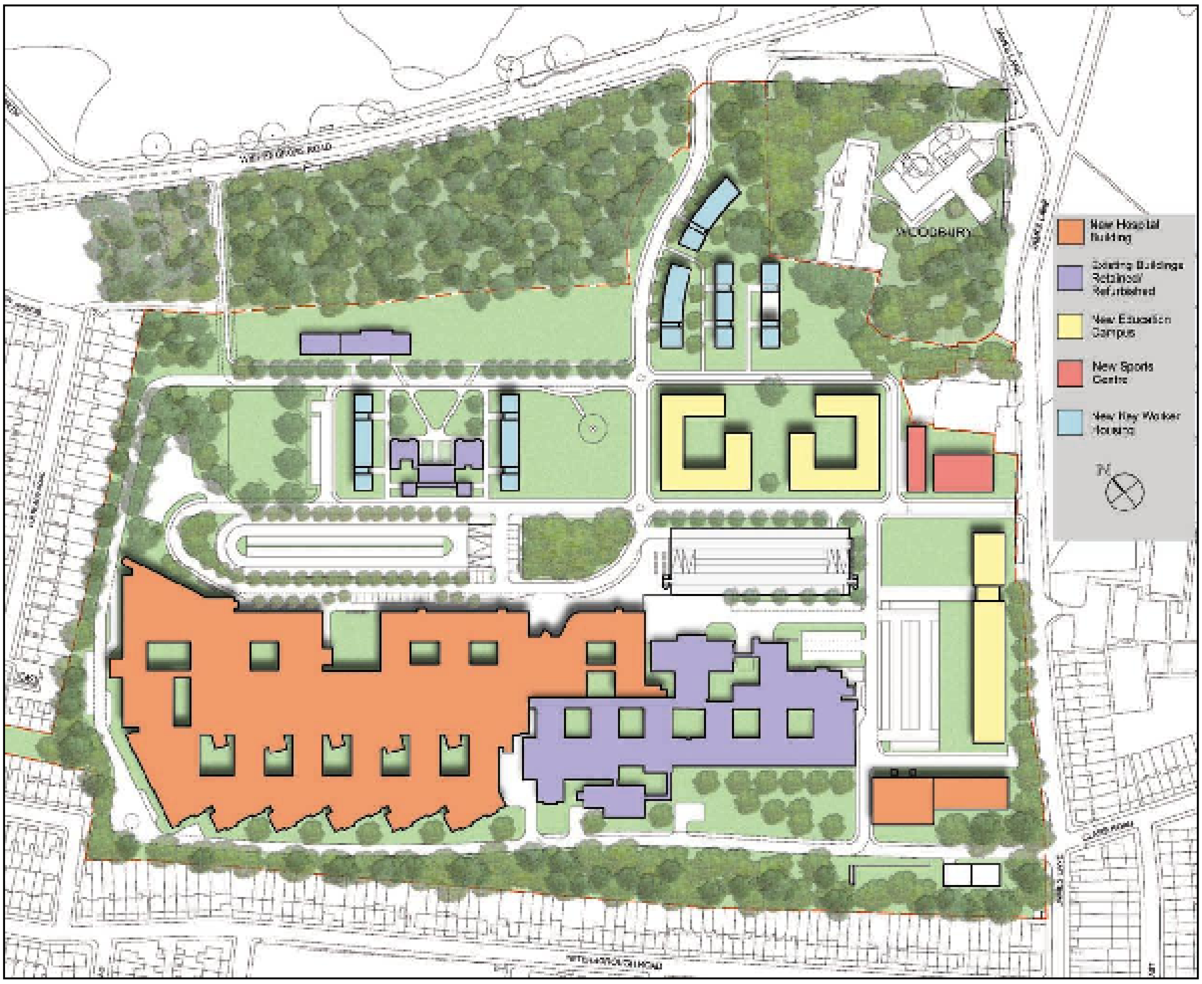

Figure 6.7: The revised plan for Whipps Cross University Hospital (Background as in fig 6.6 + Landscaping) identifying extent and location of habitat areas using BREEAM eco (Avanti Architects, 2006)

Reviewing the assessment outcomes in relation to the ecological indicators set out in section 6.5, it is noticeable that section scored well (18 out of 20 available credits). In relation to the ecology of the site much has changed to strengthen future biodiversity.

- Habitat area post development (Positive result)

    - The area available for habitat has increased and as a result there are potential opportunities for biodiversity to spread.
- Locally appropriate (Positive result)
    - Given that the scoring mechanism within the assessment integrates a bias for locally appropriate habitat types, the benchmarking and subsequent potential mapping of the site creates a pallet of locally acceptable habitat types.
- Movement barriers (Positive result)
    - Although the site by its nature creates barriers to ecology such as roads and hard landscaping, efforts have been made to integrate within the design routes to allow ecological movement. Tree canopies, hedges, drainage channels, and banks of habitat planting (as opposed to ornamental planting).
- Permeability (Positive result)
    - The habitat types within the landscaping strategy have been designed to integrate. The permeability and connectivity within the new calculation methodology allows the design to utilise appropriate edge treatments to habitat areas that reduce the ecological cost for ecology movement due to the exposed nature of the landscaping.
- Fragmentation of habitat types (Positive result)
    - The approach outlined within this research integrates habitat wherever possible and aggregates habitat types using infill habitat to reduce fragmentation. Equally because the approach utilises context data for the site, it recognises the value of local habitat and further reduces fragmentation by linking habitat around the site.

6.5.1.3 Whipps Cross and NEAT

As outlined in more detail in chapter two, The NHS Environmental Assessment Tool (NEAT) was the first effort by BRE to tailor a sustainability assessment system to a healthcare environment. Issued in 2002, it a consists of 10 units all adding together to create an overall percentage score, within which certain thresholds determine the rating of the scheme, fail, pass, good, very good and excellent. The ecological elements are covered within the Land Use and Ecology section, which is weighted to be worth in equal terms, credits for percentages. Essentially, one credit within Land Use and Ecology equates to one percentage point overall. Given that each Trust had a duty to utilise NEAT when undertaking a redevelopment or refurbishment project (and achieve high scores), it represents a chance to see how BREEAM 2008 (NEATs replacement) has evolved within the healthcare sector, as well as the changes in its approach to ecology. Table 6.6 outlines the results of a NEAT assessment for Whipps Cross Hospital, focusing solely in the Land Use and ecology section. The assessment has utilised available design information for the site and is based on the 2008 designed scheme outlined in Figure 6.6

NHS Environmental Assessment Tool (NEAT)			
Element	Credits available	Credits scored	Criteria notes
L&E2.1 – Land of Low ecological value	1	No	Under the NEAT definition of land of low ecological value the land is considered valuable and so the credit is not awarded
L&E2.2 - Protection of ecological features	1	No	Even though a significant proportion of the sites ecological features will be saved in the new design, the loss of even one feature is sufficient to loose the credit
L&E2.3 - Change in ecological value	4	Yes (2 credits awarded)	Use of the ecological calculator tool identifies an increase number of species rich habitats on site however a significant proportion of the site is still buildings and so misses the maximum score
L&E2.4 - Ecological actions	1	Yes	Minor ecological enhancements were introduced including a small pond, bird and bat boxes, on the advice of a qualified ecologist and as such the credit can be awarded
L&E2.5 - Natural habitats	1	Yes	'Natural habitats' for the benefit of the patients were introduced in a number of small areas and courtyards, qualifying for the credit
L&E2.6 - Land previously built upon	1	Yes	To qualify the site must have had a building or industrial purpose on site at some point within the last 50 years, as the site has been a hospital for over 100 years it qualifies as previously built upon.
L&E2.7 - Use of contaminated land	1	Yes	Part of the site is considered contaminated from ruptured diesel and heavy fuel oil storage tanks, which will be decontaminated as part of the redevelopment
	Total	6 Credits	Out of a possible 10

Table 6.6: A summary of scoring for NEAT on the redevelopment of Whipps Cross Hospital

Reviewing the assessment outcomes in relation to the ecological indicators set out in section 6.5, it is noticeable that although the section scored reasonably well (6 out of 10 available credits) like BREEAM 2008, in relation to the ecology of the site little has changed to strengthen future biodiversity. Suffering from the 'All or nothing' approach to criteria, credits are easily lost, and the evolution of this approach into BREEAM 2008 is clearly evident. The changes in ecological value are calculated using national data averages and have no local context. Equally the calculation is undertaken using a habitat orientated approach but does not need to be carried out by a qualified ecologist. Estates staff are expected to know and be able to identify habitat types from a potential list and this leads to significant errors in mapping and calculation. Finally many credits require minimal effort to be achieved reducing the positive impacts on ecology dramatically.

- Habitat area post development (Positive result)
    - The area available for habitat has increased and as a result there are potential opportunities for biodiversity to spread.
- Locally appropriate (Negative result)
    - Although the area of habitat has increased (as has the number of different plant species to meet the needs of the calculation process) they are not found locally. Essentially the calculation methodology will be manipulated to achieve a positive result, thereby introducing habitat with nationally averaged high species numbers. This reduces the chances of this habitat type surviving in the longer term as well as not benefiting the ecology outside the site thus reducing biodiversity.
- Movement barriers (Negative result)
    - No effort is required to link patches of habitat within NEAT, this prevents migration on or off site due to isolation within the redevelopment, equally the area mapping calculations are so basic that significant barriers are created and methods for alleviation such as habitat corridors, hedges, edge treatments, vegetative banks for example are ignored
- Permeability (Negative result)
    - The habitat types introduced are based on national average species numbers and not the ability to blend in with each other. In essence within the scheme frequent patches of high species rich habitats are preferable even if they are isolated or adjacent to dramatically different habitat types
- Fragmentation of habitat types (Negative result)
    - Again no effort has been undertaken to link habitat types as the calculation is based on a national average, not what is locally appropriate. As a result the areas on site suffer

greatly form isolation. Equally the context has not been addressed and opportunities lost in connecting habitats off site have been missed.

6.6 Chapter outcomes

The chapter has undertaken a number of assessments on a case study project (Whipps Cross University Hospital). Through extensive habitat mapping and survey work, these assessments have been compared to the actual ecology on site to give an indication of how well these assessment systems integrate the design process with the environment. In undertaking the three assessment protocols on the same project it has been possible to compare the efficacy of all three. NEAT as an assessment tool is easy to use, but basic in composition. Its represents a first effort to integrate the environment within building design of healthcare projects, but has limited scope and capacity. NEAT is potentially flawed given the general nature of who can apply it, essentially allowing habitat mapping with no background or expertise being needed by the assessor. This has been vastly improved within BREEAM 2008 with the introduction and increased role of the suitably qualified ecologist. BREEM 2008 also represents an improvement in the relationship of a building and its immediate environmental context, as well as the outcome of the assessment and the 'real' effects on the ground. However this is still not truly effective as the relationship between buildings and ecology off site (as well as key principles of biodiversity have been ignored)

BREEAM 2008 is a more rigorous methodology than NEAT as a higher standard of demonstration is required to meet criteria. However in terms of healthcare, the absorption of NEAT into the 'generalised' BREEAM family of assessment tools means elements specific to healthcare have been lost such as the introduction of nature for patient benefit. This is a clearly lost opportunity to provide a benefit unique to healthcare projects, and makes the assessment no different from those undertaken on an office block or supermarket. The changes outlined for the BREEAM Eco assessment methodology meet many of these problems and challenges and can demonstrate better integration with the ecology of a site and the buildings design. Habitats are strengthened both on and off the site allowing the opportunity for development projects to act as habitat bridges in an environmental matrix context. It has demonstrated that not only does the approach work, but it is also superior to the current BREEAM standard in terms of generating ecological integrity. By having key ecological principles at its core it can be more effective at showcasing excellence in landscape design and integration (a core tenet of the BREEAM assessment methodology).

The most significant outcome of this chapter however is to demonstrate the largest flaw within BREEAM 2008 and its efficacy in relation to ecology. The flaw being that BREEAM 2008 scores well on projects but has little real effect on the potential for biodiversity generation and stability. This generates an 'illusion of benefit' to ecology and biodiversity and leads to significant efficacy concerns for the standard of the assessment system itself. Buildings are being labelled as 'excellent' or 'outstanding' by meeting criteria set out with no demonstrable value to biodiversity or ecological integrity. This flaw and what it means to the standard as a whole will be discussed within the next chapter. In addition a key element that needs closer analysis and discussion is the change in calculation approach, and to what degree the new approach better integrates habitat, this too will be discussed in the next chapter.

7 Analysing the risks and discussing ecology within BREEAM

7.1 Introduction and aim

The last chapter has successfully proven that the new improvements to the BREEAM rating system not only works in the case study used but generates a positive ecological outcome over the current BREEAM version especially in terms of habitat connectivity and cohesion. The most significant outcome of the last chapter however is the realisation and identification of the true flaw in the current BREEAM process, the illusion of ecological benefit. In addition, chapter four highlighted some potential risks that can arise through the change of the current system and this forms part of the focus of this chapter in the identification and quantification of those risks. The aim of which is to establish if the changes in the system are both valid and if so, are the changes made to the system meaningful?

This chapter uses risk as an assessment tool to establish the benefits of the work undertaken within this research but more importantly, risk is also used here as a discussion tool. In critically reviewing and discussing the work undertaken as part of this study it will be possible to evaluate what has been achieved, and what the likely direction is for ecology within BREEAM. The logical progression of which will lead to conclusions being established that will form the core of the next and last chapter.

7.2 Using risk to discuss ecology in BREEAM

From previous chapters it can be seen that in relation to the ecological function and services provided by ecological diversity, it is important to maintain ecological function to levels capable of sustaining human life. Degradation of these services has a direct link to environmental worth and therefore quality of life and represents a potential risk. Although BREEAM is not designed to be a risk management tool, it could be argued that any effort to develop and secure biodiversity is, ecologically speaking, an endeavour in risk management. Recognising this, it should become feasible to analyse the risks inherent in the BREEAM system as well as the risks to the proposed changes to that system. Such a debate would also create drivers for change and either justify the improvements proposed here, or highlight the costs of doing so, either way it is a useful discussion tool to establish the value of this research to the UK environment, BREEAM as a system and BRE as an organisation. In order to utilise risk as a tool for reviewing this research a brief understanding of risk and how in particular ecological risk can be used as a comparative factor is required. The next few sections outline this key information before applying it to BREEAM as well as the changes proposed in this research.

7.2.1 What is ecological risk?

Risks to ecology are those that have the potential for adverse effects to living organisms. These can be generated from a wide range of stressors from direct routes such as the intentional release of pollutants into the environment through effluents, emissions or wastes, or unintentional such as accidental chemical releases and spillages (Porteous, 2000). Equally indirect routes such as energy generation and use as well as the depletion of natural resources will present ecological risks. Ecologists are familiar with assessing ecological risk either as part of dedicated assessments such as environmental or ecological impact assessments or simply in their professional lives making expert judgements on how best to undertake ecological management of sites.

Approaches to assessing risk for ecology currently exist and are typically incorporated in a formal Ecological Impact Assessment Process (EcIA). The objective of Ecological Risk Assessment (EcRA) as a process is to provide a robust approach to incorporating a precautionary, transparent, scientific and most importantly ecologically sustainable approach to the management of environmental risks. Given the implications of a loss of ecosystem services, identifying and understanding the risks involved through using the BREEAM process serves a wider function in measuring efficacy, the core goal of this research. According to Axel et al. (2005), Ecological risk management as a concept serves four main needs:

- To accommodate change
- To anticipate the emergence of environmental problems
- To factor in risk and uncertainty in decision making

- To plan in the face of uncertainty

The last of these is arguably the most crucial (Miller, 1994) as many ecologists believe there is not a complete picture in relation to the linkages of ecosystems and that in truth the extent of the danger of not controlling ecological risks is an impossible topic to debate. Science does recognise however the potential significance of losing even one small species from the food chain and as such given the levels of uncertainty, all efforts should be made to define the consequences of any risk event (Miller, 1994). Following this, all efforts should be made to prevent an ecological risk event from actually occurring. Where this is not possible, effort should be made to minimise its impacts, because the full effects of an event may not present themselves for several years to come, or be directly visible within the ecosystem.

7.2.2 Assessing ecological risk

Typically EcIA forms two distinct levels of risk assessment, either detailed or high level (Treweek, 1999). Detailed EcIA will incorporate a wide range of test studies to establish direct estimation of effects at a community level, e.g. looking at benthic species diversity. Alternatively indirect estimation is feasible at the local population-level (e.g. the use of toxicity tests on individual species to establish toxic levels). This detailed approach often taken by conservation biologists as it allows the introduction of measures to an ecosystem designed to protect organisms on an individual basis. This is important when protecting key species or legally protected species.

Additionally according to Treweek (1999), high-level EcIA is primarily used to protect local populations and communities of biota rather than individuals and focuses on the stability of habitat as its main agent of protection for ecosystems. Elements designed to protect local populations and communities can be estimated by extrapolating from effects on individuals as well as groups of individuals using a lines-of-evidence approach. As a result the performance of multi-year field studies is often not needed and data from laboratory and discrete field studies, if properly planned and executed, can be used to estimate local population or community-level effects. Neither of these approaches is appropriate to assessing risk within BREEAM as even high-level assessment makes assumptions on species populations not possible given the level of data gathering within BREEAM. BREEAM is not an ecological risk tool; it is simply not detailed enough. As such EcIA is too detailed to be used directly on assessing the risks within BREEAM

7.2.3 Distilling the core elements of risk assessment

If ecological impact assessment is an approach that is too complicated to be applied directly to a simple high-level approach such as BREEAM, is it possible to extract the core elements of the EcIA process to establish the same end goal? According to Hart & Pollino (2006), the essential framework process of assessing ecological risk at a strategic level is:

- Defining the problem – the first stage is to identify the problem. This will involve a careful scoping exercise of the problem, formation of an agreement on how it is to be assessed, and in addition how the acceptability of actions will be judged. Once a hazard has been identified, establishing what ecological assets will be affected becomes crucial. Typically within EcIA, these hazards are prioritised by establishing their likely effects on valued elements of ecosystems and ecosystem services.
- Analysing the risks to the ecological elements – the analysis process used needs to be appropriate for the situation in order to provide adequate information for decision making.
- Characterising the risks - the technical details of risk analyses needs to be made accessible to decision-makers and broader stakeholders. In particular, the uncertainties and assumptions associated with analyses require careful and transparent documentation.
- Making decisions – selection of the best management option or strategy will be the one that results in the effective minimisation of the ecological risks, while also being cost effective and acceptable to the stakeholders. Guidance is provided on a number of multicriteria methods for assisting this process.
- Managing the risks – a risk management plan provides recommendations on managing or mitigating all high or unacceptable risks. The risk management plan should include a robust program to monitor progress to ensure the strategies are working, and a review and feedback process for making changes if needed.

In essence this approach shares the same core approach to risk management as any other risk management strategy, essentially Identifying impacts, determining the probability of a hazard occurring, their likely consequences and weighting accordingly (Frame, 2003). If this is the case then utilising such an approach will allow the risks to be assessed and help make them comparable whilst keeping the same core elements of risk assessment, in essence ecological risk is not the overriding factor in applying risk assessment to ecology within BREEAM, the process itself is.

7.2.4 The risk management matrix

The following outlines a basic risk scoring approach (Frame, 2003) utilised here to assess both the likelihood of an event occurring as well as the levels of impact such an event could have, this process will allow comparison of risk inherent and introduced into the system. Using professional judgement and any additional appropriate data available, risks are rated on an impact Table 7.1 and likelihood scale Table 7.2.

A numerical value is achieved using both ‘impact’ and ‘likelihood’ scores, which are then translated to low, medium, high or extreme risk values as demonstrated in Table 7.3: The resulting assessed risk is then prioritised using a simple ranking system (Table 7.4). This allows risks to be identified as acceptable or not and identifies key risks that need to be addressed.

Impact A number from 1 to 6 is given to indicate the impact of the risk as follows:	
1	Insignificant
2	Temporary or Short Term Damage
3	Major Pollution/effect
4	Severe Pollution/effect
5	Widespread Damage
6	Catastrophic Damage

Table 7.1: Impact ratings of risks (Frame, 2003)

Likelihood A number from 1 to 6 is given to indicate the likelihood of the risk as follows:	
1	1 in 1,000,000 (Extremely remote)
2	1 in 100,000 (Improbable)
3	1 in 10,000 (Remote)
4	1 in 1,000 (Occasional.)
5	1 in 100 (Probable)
6	1 in 10 (Frequent)

Table 7.2: Likelihood ratings for risks (Frame, 2003)

		Impact					
		1	2	3	4	5	6
Likelihood	1	1 (Low)	2 (Low)	3 (Medium)	4 (Medium)	5 (High)	6 (High)
	2	2 (Low)	4 (Low)	6 (Medium)	8 (High)	10 (High)	12 (Extreme)
	3	3 (Low)	6 (Medium)	9 (High)	12 (High)	15 (Extreme)	18 (Extreme)
	4	4 (Medium)	8 (Medium)	12 (High)	16 (Extreme)	20 (Extreme)	24 (Extreme)
	5	5 (Medium)	10 (High)	15 (Extreme)	20 (Extreme)	25 (Extreme)	30 (Extreme)
	6	6 (Medium)	12 (High)	18 (Extreme)	24 (Extreme)	30 (Extreme)	36 (Extreme)

Table 7.3: Risk rating table (Frame, 2003)

Low	Acceptable, but action should be taken to reduce risk if appropriate
Medium	Action must be taken to reduce risk
High	Urgent Action must be taken to reduce risk
Extreme	Unacceptable, Immediate action taken to reduce risk

Table 7.4: Priority rankings of assessed risks (Frame, 2003)

7.2.5 Risks to ecology presented by the current version of BREEAM

There have been a significant number of phenomena or events identified through out this research in relation to the current use of BREEAM and many risks highlighted as a result. Many of these have been identified through the literature review as well as the interview process undertaken with the ecologists in chapter three. This has identified significant flaws in BREEAM's current design in relation to ecology. The following table is a risk register which assesses the 30 most frequent phenomena (detailed in more depth within chapter four). Key elements are discussed in the following sections.

Ref	2008 Risk Description	Impact	Likelihood	Risk Score	Management option (2010 Version)	Revised Impact	Revised Likelihood	New Risk score
A04	BREEAM has become a tick box exercise, with ecological science not represented.	6	6	36 (Extreme)	This is a significant risk to ecology and has been addressed within the new approach by introducing principles throughout the credits and by breaking the credits available into project stages ensuring ecology is thought about and integrated. However some will always see BREEAM as a tick box exercise so the likelihood remains significant	1	3	3 (Low)
A14	The confusion on the status of protected species within BREEAM results in no protection at all	4	6	24 (Extreme)	There is some reference to protected species within the current BREEAM version however there is no impetus to include efforts to or make significant changes to the design, this has been included in the suggested approach with specific wording and individual credits to identify 'flagship' species and make provisions for them	1	1	1 (Low)
A10	Ecology is introduced into the scheme too late to have any real effect	6	6	36 (Extreme)	This is a significant risk identified as part of the interview process, this has been reduced by creating incentives to developers through the use of stages to metre out credits, late involvement will result in reduced potential credits being available, this reduces the likelihood as developers will be looking to gain as many credits as possible however not the impact to ecology if it is left to the last minute.	6	1	6 (High)
A24	Differing formats of reports creates inconsistency of ecology involvement in projects	3	3	9 (High)	The recommendation to move to a more automated reporting structure using a web based system will reduce this risk as it will become clear to assessors and ecologists what will be required	1	1	1 (Low)
A22	The terms development site and construction site cause increased risk and need clarification	1	1	1 (Low)	This risk is minimal in the first instance with only a few ecologists claiming this to be a problem, however it has been addressed within the suggested approach based on the possibility that there are more ecologists not willing to come forward on the issue.	1	1	1 (Low)
A18	Assessors are overriding SQE's and allowing inappropriate planting to occur harming ecology	5	1	5 (Medium)	This is a significant risk however the incidents of this happening make the likelihood unlikely. This has been addressed by recommending improvements to the assessor training as well as centralising and automating the system so suggested planting lists can be generated automatically.	1	1	1 (Low)
A13	The manual is unclear causing misinterpretations between the ecologist, the clients and the BREEAM assessor.	4	3	12 (High)	There does seem to be some ambiguity within the current manual causing some confusion, however this is more likely to be due to the different standpoints and therefore approaches to the assessment. The language has been improves within the suggested approach as well recommendations on training of assessors to alleviate the problem	1	1	1 (Low)

A23	There is no consistency of what constitutes 'non native' species with wildlife benefit, and what is acceptable.	5	3	15 (Extreme)	The ambiguity here is based on differing ecologists opinion of the term 'of wildlife benefit' and as a result opportunities are being missed. This has been addressed by centralising the planting schedule to those species with recognised benefit (non native or otherwise) and making the proof available as part of the assessment process (i.e. indications such as 'this species is being recommended because…' will feature on the suggested planting list) however some scope for what is locally appropriate will still lie with the ecologist.	2	1	2 (Low)
A11	No guidance or a field manual/ examples of best practice mean opportunities are lost	4	3	12 (High)	This is a significant risk and addressing this will dramatically improve ecology on construction projects by being able to demonstrate practical examples that have worked and are costed. Recommendations around communications between BRE and ecologists have helped to minimise the risk of lost opportunities on projects. Therefore the impact remains the same, but the likelihood reduced	4	1	4 (Medium)
A09	There's no outline of what the client needs to supply for a comprehensive assessment, means different assessments are not comparable in terms of baseline data	4	4	16 (Extreme)	This is a significant risk and would appear from the evidence from the ecologists to be a reasonably frequent occurrence. This has been reduced by outlining within the suggested changes to the manual what is required of developers and to what level. Equally assessor training will be improved to make them aware of the information needed by the ecologists. The impact is still high if information is not available, however the changes have reduced the likelihood of this being the case.	4	1	4 (Medium)
B05	The calculation methodology is flawed and results in incorrect results.	6	6	36 (Extreme)	This is a crucial risk to address, not just based on likelihood (as it was by far the most common problem identified by ecologists) but also in terms of impact as the calculation methodology applies to 40% of the credits available. This has been reduced with the creation of a new calculation methodology, in addition to a redistribution of credits to minimise the domination of this one element, it does remain an important element of the process however and so will have some impact.	3	2	6 (Medium)
B27	Lack of ecological principles built into the system means there is no real benefit to ecology	6	6	36 (Extreme)	This is arguably the most important element of risk inherent in the current process, as the lack of base ecological principles or science causes the greatest risk to the environment. This has been addressed not only in the new calculation methodology but also in the orientation and focus of each potential credit (any of which can be attributable to specific ecological principles)	1	1	1 (Low)
B18	Lack of fauna included within the calculation process means the section is unbalanced	6	6	36 (Extreme)	This risk is significant as it is inherent in every assessment that is undertaken and creates (ecologically speaking) a bias towards flora irrespective of faunal biodiversity. Fauna has been introduced into the suggested approach as a cornerstone principle, aspects of which can be seen in most credits and is tenet of the new calculation methodology.	1	1	1 (Low)

B07	Damage can be caused or opportunities missed because there are currently no links with ecosystem functions	6	4	24 (Extreme)	This risk is not only crucial to ecology but to the environment in the wider context and therefore also to humans as we relies heavily on many of the services provided by ecology. The potential impacts are severe, however the professionalism of ecologists would appear throughout the interview process caused ecologists to consider ecosystem services regardless, reducing the likelihood. Ecologists are unsupported by the current system and so this has been addressed in the proposed changes, however the impact remains high if opportunities are not taken.	6	1	6 (High)
B21	The value of priority species is lost as all species are considered of the same level of value	5	5	25 (Extreme)	This risk is important as ecologists recognise a hierarchy of value within ecological systems, this however is not reflected within BREEAM and less beneficial plant species are being introduced based on other factors alone such as speed of growth or cost. Equally existing or locally known species of value are being ignored as there is no mechanism for providing support or incentives to include features to promote these species. This has been addressed within the new approach as a cornerstone principle, as well as dedicated credits to allow for ‘flagship species’. Therefore the likelihood has been reduced, however impact if not included remains high	5	1	5 (High)
B28	Legislation is not evident through the current credits risk of infractions as a result	1	1	1 (Low)	BREEAM is not, and has never been a legislative tool as a result the risk of legal infractions is small from using the assessment methodology as legal issues are typically addressed in other elements of the construction process. This position has not changed in the suggested changes to BREEAM and so the risk remains low.	1	1	1 (Low)
B20	There are missed opportunities by not taking into account what would naturally occur on any given site (and thus what has the strongest viability for biodiversity)	5	2	10 (High)	Like similar risks the impact is considerable and it important in terms of creating habitat that will survive, however the likelihood is low, as few ecologists would allow the creation of such inappropriate habitat and have commented throughout the interview process that this would be unethical and unprofessional. There is however no contingent within the current BREEAM scheme that would stop a developer from having inappropriate landscape types and as such this has been addressed within the new approach to ecology within BREEAM, nationally data feeding into localised planting schedules will help to minimise the specification of inappropriate landscape types, reducing but not eliminating the likelihood and impact from this risk.	3	1	3 (Medium)

B08	There is no efficient use of spaces, (either ecological or practical use of space) and opportunities are being lost.	6	3	18 (Extreme)	The title of the section 'Land use and Ecology' has always been misleading according to the ecologists interviewed as it has 'little of either' however of the two efficient land use is the least represented element. Current requirements of BREEAM only look at the footprint of the building in relation to existing and makes now allowances for efficient use of the rest of the site (if there is land to be landscaped) this has been addressed in the new approach with dedicated credits and the principle feeding into several others, reducing the impact and likelihood.	3	1	3 (Medium)
B26	The site can become isolated as there is no strategic value recognition of a site in the wider context or on a landscape scale (no inclusion of corridor links or migratory routes)	6	3	18 (Extreme)	This is a considerable risk as sites (in relation to ecology) cannot be thought of in isolation, as all manner of fauna and flora will move in and out of the site (which will aid in the viability of the site in the longer term). As it currently stands the impact on ecology is immense as a poorly designed site can 'cut off' ecology from other suitable habitat or interrupt migratory routes. This has been reduced by using nationally significant data to ensure chosen habitat types are appropriate (and match the local area) as well as dedicated credits for including issues outside the boundary on the design.	2	1	2 (Low)
B14	Ecology component only used to make up a shortfall in credits from other areas, resulting in patchy and ill thought-out measures being introduced	3	6	18 (Extreme)	The likelihood of this risk occurring has been addressed by phasing the credits available, and integrating the design process in an attempt to ensure ecologists inputs are introduced to the design process appropriately.	3	1	3 (Medium)
C05	Risk of poor information spread to ecologists and increased errors in assessments due to poor communication routes with BRE	3	5	15 (Extreme)	This risk has been addressed by suggesting new methods of communication from forums, web pages, newsletters and information sheets on best practice	1	1	1 (Low)
C10	The lack of a BREEAM /Code users' forum available online to help solve problems causes queries to be dealt with slowly.	2	4	8 (Medium)	The suggestion of a dedicated ecologist forum for BREEAM assessments has eliminated this risk	1	1	1 (Low)
C08	The lack of a single point of contact with BRE to provide support on ecological issues results in confused and conflicting advice.	3	4	12 (High)	It has been suggested that BRE employ an ecologist to act as a gateway for queries to address this risk, failing this the recognition of a single dedicated point of contact will alleviate this risk.	1	1	1 (Low)
C03	There layout, and use of poor English in the manual results in confusion for ecologists and ambiguities	2	3	6 (Medium)	The language of the manual has been reviewed and ecological principles included to ensure that ecologists can follow the significance of each credit, it is recommended that this be reviewed as part of the revision process each year to ensure that any ambiguities are remedied.	1	1	1 (Low)
C07	No methodology for spreading information to ecologists results in risk of error as ecologists rely on past history to use new systems	5	5	20 (Extreme)	This is a significant risk as many ecologists admitted to using past reports as a template for future projects. Any errors therefore will be introduced into the next report. The use of a web based approach for new sites will help to eliminate this along with improved training of both assessors and ecologists. This will essentially reduce the likelihood but not the impact should it occur.	5	1	5 (High)

C09	Opportunities are missed as ecology will affect other sections such as Transport, lighting and pollution sections.	3	4	12 (High)	This is an opportunity that is currently missed within BREEAM and can easily be addressed within the nest revision. Suggestions have been made for other areas and what credits could be affected to reduce the risk of missed opportunities and help create a more joined up approach.	1	1	1 (Low)
C04	There is no benchmarking or demonstration /guidance on best practice, new ecologists unaware of expectations	3	4	12 (High)	This is a significant problem and many ecologists interviewed felt that they had to 'find their own way' when they first undertook BREEAM surveys, this has been addressed through the suit of communication and training measures recommended.	1	1	1 (Low)
C01	Risks inherent in unqualified assessors making ecological decisions as they control the reporting process	6	1	6 (High)	This risk was rare in relation to the responses to the interviews; however the impact of assessors 'knowing best' is sizable. Measures such as a reporting mechanism for ecologists in this position as well as improved training can help minimise the risk but not the impact when it does occur.	6	6	6 (High)
C06	Ecologists have no access to reference material and have to rely on assessors to pass on information, this use of 'middle men' creates risk as not every ecologist gets all the appropriate or required information	5	3	15 (Extreme)	The purpose of assessors issuing information to ecologists does make distribution easier for BRE but is highly reliant on those assessors in duly passing on the correct information. This has changed recently as BRE have now made the manuals freely available to all on their web site, this in conjunction with the communication measures recommended for ecology should eliminated this risk from happening as ecologists will not have to rely of assessors for the information.	1	1	1 (Low)
C02	There is confusion on what constitutes a report putting the client at risk of not achieving credits through poor demonstration of compliance.	2	2	4 (Low)	This risk is minimal as irrespective of the reports look and content, demonstration of compliance is shown using a dedicated form within the manual, this would be continued within the suggested new approach although training on what makes up a minimal report will be included in suggested training.	1	1	1 (Low)

Table 7.5: A risk register assessing the performance of the current 2008 BREEAM in relation to ecology and comparing them to the suggested changes for the 2010 revision

It is evident from Table 7.5 that the suggested changes to BREEAM outlined in previous chapters have reduced the risks associated with its use. This is further consolidated in Table 7.6 which shows the change in risk values as a result of the proposed changes. The number of extreme and high risks is reduced by moving them into the medium and low categories the risks have been effectively managed by the proposed changes.

Level	Number of risks associated with BREEAM 2008	Number of risks associated with BREEAM 2010	Change resulting from use of BREEAM Eco
Low	3	19	+16
Medium	3	6	+3
High	8	5	-3
Extreme	16	0	-16

Table 7.6: Changes in ecological risk values resulting from proposed changes to BREEAM 2008

7.2.6 Are the risks comparable?

It is fair to say in many respects that the risks highlighted here are inherent in the current BREEAM 2008 system and have been addressed by the proposed changes. It is unfair however to expect BREEAM 2008 to meet these risks due to the illusion of ecological value. This concept was highlighted at the end of the last chapter and indicates that BREEAM 2008 seemingly deals with ecology effectively, scoring well in many cases. On closer inspection to what is actually happening, as is demonstrated by both the Whipps Cross Hospital case study and the risk analysis in table 7.5 ecologically speaking this is not the case. This is due to the reduced benchmarking of the 2008 scheme where poor (or even negative) changes in value can still score well. In essence the above risk assessment is measuring what BREEAM 2008 should be doing to minimise risks not what it is capable of. BREEAM 2008 cannot meet these risks (hence the large number of Extreme risks identified) as it is limited by its design.

It is clear that BREEAM is a design tool not a risk management tool, and so cannot be expected to manage risk. Understanding that ecology is a significant part of sustainability however means that as a result ecological risk threatens the stability of sustainability and make ecological risk a core component

7.3 Ecological risk and its relationship with BREEAM

Given BREEAM's driving focus is to promote excellence in sustainable design, there must be a role for the system to play in minimising ecological risk for the benefit of sustainability. The changes outlined as part of this research have strengthened the ecological content of BREEAM, however these proposed changes will themselves cause risk. The following sections identify three key relationships between BREEAM and risks from such changes to the environment as a whole, to the system as it currently operates and risks to projects.

7.3.1 Risks to the environment - Low

The suggested changes to BREEAM's Land Use and Ecology section have dramatically reduced the chance of impact on the habitat and environment of a construction project. This is mainly due to the introduction of basic ecological principles, which allow the viability of existing habitat to remain or recover. As well as management elements to phase the land use changes to prevent a more typical 'before and after' scenario associated with 'instant' landscaping. Due to this new focus of protecting and maintaining rather than enabling a replacing or introducing mentality, the new approach works with the existing habitat to make the best of what is currently there, or in poor ecological areas to introduce appropriate habitat types and therefore improve the efficacy and viability of the habitat.

Risk is also reduced by moving to a more centrally operated system, by having better links within BRE and ecological advice available to ecologists and assessors. The chances of 'operator error' is then significantly reduced, giving clarity and further stability to the BREEAM system through consistency. This central database approach however does introduce a risk of replication of poor data if it is incorrect or gathered in error. As a result it is crucial that the data set be maintained and regularly assessed for accuracy. This however is a minimal risk in comparison to the wide range of data quality currently being undertaken. On the whole the new system is a significant improvement over the current system in relation to ecological risk and a significant benefit to BREEAM.

7.3.2 Risks to BREEAM as a system - Low

A key tenet from the outset of this research was the intention of making viable changes to BREEAM's Land Use and Ecology section that did not compromise the system as whole. Doing so would make the research purely academic and eliminate any real world benefits. The changes made here have made full use of BREEAMS structure and weighting approach to ensure that any additional credits that have been introduced have been done so in such a manner so as to eliminate the risk of bias to ecology within the system. There is a risk associated to any shift in the weighting due to the increase in credits however this has been identified and can be managed. It is of course arguable that a current bias exists to the buildings structure (90% of the current credits are associated with the building and its use). Therefore a shift towards the Land Use and Ecology section may not be a negative result.

The real risk to the system lies in change itself and the lack of knowledge of the changes by those involved: ecologists, assessors, project managers and clients. This is of course a risk with any change and will occur with each update and revision of BREEAM. BRE has in place currently processes to ensure the changes are understood by those assessing projects as well as the ability to update training for new assessors easily (as all assessors are trained centrally by BRE). Within the suggested changes to the ecology section, the risks have been minimised by centralising data and improving consistency and an effort has been made throughout the process to ensure risks are removed by limiting potential errors and miscommunications when applying the BREEAM process. A significant improvement for BREEAM's ecology section will improve the profile of BRE reducing risks to reputation and strengthen BRE's credibility in environmental circles

7.3.3 Risks to projects, such as time, cost and quality -Medium

Traditionally the Land Use and Ecology section of the BREEAM rating system has had little impact on projects. This has been demonstrated throughout the interview process with ecologists often considered an afterthought on construction schemes. The section as it currently exists carries more weight with those developers who are aiming to achieve an excellent (or now an outstanding) rating as every credit is crucial. On the whole most developers would appear to only consider the ecology credits at the end of a project if they find they need them. Therefore the new system makes it harder to achieve credits with timing becoming a crucial issue. This is the new suggested approach apportions credits based on the construction stage, consequently leaving it until the end of a construction project will net minimal credits. It is therefore essential to any developer looking to maximise credits to get an ecologist involved in the scheme as soon as possible.

To achieve higher credits within the section there is an inevitable cost, as some of the technologies involved such as the introduction of green roofs or sustainable urban drainage systems can have cost implications. This is not always the case however and are relative to projects and the intended scope of the development. This is a risk but no more than is currently applicable to other areas. Energy use and efficiency for example will have significant costs attached to achieve higher credits within the scheme, and the suggested changes here are only bringing ecology into line with the rest of the system as it currently stands raising the profile and relevance of ecology within BREEAM. In addition there is a requirement for more ecologists' time and input into the design process. This is a short-term cost for significant long-term gain for the project. The increased costs have been minimised within the changes where ever possible. With many credits available through simple low-cost initiatives or design/ management changes.

Risk has also been reduced by making the survey and reporting system easier, thereby standardising the amount of time and resources needed by ecologists to undertake surveys and make recommendations. As a result the risks from the changes are of a medium level (especially in relation to the developer). However the benefits to strengthening the ecology section of BREEAM and improving its profile within the scheme are highly valuable and therefore meaningful.

7.4 Discussing the effects on ecological integrity

This research has developed BREEAM into a sustainability assessment system which is now capable of integrating ecology into projects to a much higher efficacy than is currently experienced. Due to the changes proposed derived from this research, it is now a more ecologically defensible and flexible system. This system is capable of reacting to new guidance and research on ecology and can be demonstrated by:

- The inclusion within its criteria of the latest thinking in urban sustainable landscape design (e.g. multifunctional landscapes and urban drainage)

- As well as though the use of a flexible centrally controlled calculator approach this can be rapidly updated to reflect current ecological guidance.

7.4.1 Lessons learned from this research – a move towards ecological integrity

The use of a habitat orientated approach as well as the integration of several missing ecological principles has resulted in a system which is capable of promoting ecological integrity. As a result there is a real likelihood that sustainably constructed buildings using BREEAM as a system of certification will not only recognise but also capitalise on opportunities that promote biodiversity. This simple fact of moving away from an increase in species number to the introduction of sensible and appropriate habitat type's results in a much stronger localised ecosystem. This brings ecosystem services closer to the building and can help achieve the main aim of this research project, which was to integrate buildings and landscape more efficiently and boost urban ecology.

Through the construction of a building it is obvious that some sort of habitat displacement must take place; as a result, either through the building process, or the actual final presence of a building, an ecosystem can be damaged or simply lost. The current approach is to replace habitat lost through the construction process which results in a assessment scheme stacked towards the building and its design not the environment. Due to the changes here however, the environment has more value to the developer as they will have to be conscious of it before, during and after the construction process. This helps maintain the stability in services and therefore, in the longer term, the integrity of the habitat surrounding buildings.

One of the key elements highlighted in chapter two is the replication of risk from BREEAM's use. If ecological integrity is compromised by using BREEAM 2008, this will be replicated across the country as more and more buildings are rated (Figure 7.1). This builds possibly the best argument for including the changes resulting form this research into the system as it becomes clear that if BREEAM were to continue to enjoy the grow in its use that it has to date (Mistry, 2007), ecological integrity would conversely be in rapid decline.

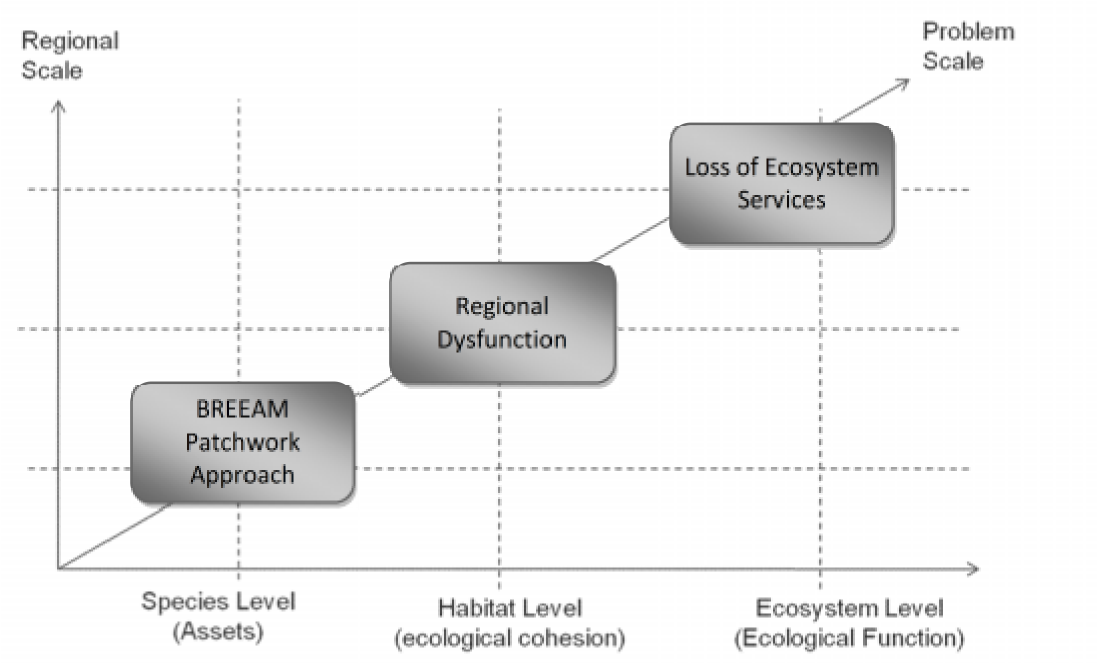

Figure 7.1: The problem of ecological integrity within BREEAM 2008 and its escalation fom use (adapted from Daily 2005)

Equally if other systems around the world continue, as outlined in chapter 2, to look to BREEAM to lead within the sustainability assessment market, they too are likely to be affected by the proposed changes if adopted. It would be a relatively straight forward exercise to investigate and implement changes for schemes such as Green star, HK BEAM and LEED. All three have a shared origin in BREEAM and as such a compatible homogeneous approach and structure. The implications of how BRE could proceed with the update of BREEAM and how best to utilise the outcomes of this research will addressed in the conclusions of this research.

7.5 Research discussion

The following sections form a discussion across the entire breadth of this research, looking at what has been achieved and how it fits within the academic environment of ecological risk management and construction. This discussion seeks to answer three key questions following the suggested changes to BREEAM's ecology section namely:

- How has the calculation change improved the integration of ecology into a projects design?

- Do the changes suggested here create a better solution than that which is currently in place?
- Is there value in changing the scheme in changing it in light of this research?

7.5.1 Changes to the calculation methodology

The calculation methodology featured within the case study outlined in chapter 6 forms only a small part of the greater system. Yet as has been determined from the interview process, it is a crucial flaw in the current scheme. BREEAM 2008 is highly dependent on the methodology and accounts for 40% of the available credits. However, its value as a component had been reduced within the suggested changes to reduce dependency of points scoring associated with one single element. Although it is only one component part of the process (and its relative value in terms of credits has been reduced) as a result of this research effort, the way in which ecological value is calculated has become one of the most significant changes suggested. As such the next sections discuss some of the important factors and benefits to changing the schemes calculation process.

Using data from the case study and the calculation methodology for BREEAM 2008 (as outlined in 5.2.3) Table 7.7 identifies the ecological value scoring for Whipps Cross used in the case study calculation by vegetative area. Table 7.8 shows similar scoring data (utilised in the calculation within the case study) for habitat areas scored within the Whipps Cross Hospital site using the new approach (BREEAM Eco) outlined in 5.5.7.

Vegetation type	Ecological value score	Area	Species, area weighted
Building & Derelict land	0	94,035.50	0
Low land wooded	13.8	52,485.60	3.97
Urban Mosaic	17.6	35,264.90	3.41
Wildlife garden Planting	0	214	0
		Total ecological value	7.39

Table 7.7: BREEAM 2008 area scores for Whipps Cross Hospital (Values based on Table 3.0 of BREEAM technical guidance)

Habitat type	Total PV Ecological value score
A1.1.1.1 - Semi Natural Woodland	1238.146719
A1.1.2 - Woodland Broadleaved plantation	164.9962603
A2.1 - Dense Continious scrub	7.504442688
A2.2 - Scattered Scrub	3.075056653
B2.2 - Semi Improved Neutral Grassland	19.20337391
C3.1 - Tall Ruderal	4.149312253
J1.2 - Amenity Grassland	16.90139763
J1.3 - Ephemeral/short Perennial	0.215810277
J1.4 - Introduced Shrub	2.470212385
J4 - Bare Ground	0.575494071
G1 - Open Water	0.070498024
Total site score	1457.308578

Table 7.8: BREEAM Eco area calculation scores for Whipps Cross Hospital

The two tables are not directly comparable as BREEAM 2008 utilises a scoring system based on average species density change to calculate value, whereas BREEAM Eco utilises scores determined from a range of factors outlined in 5.5.7 but essentially equate to areas of habitat and changes to that area to calculate value these values have been determined manually (in the longer term it is envisaged that a web based calculator would simplify the process for the end user) and the scoring can be found in Appendix four. The most critical difference in scoring data is that BREEAM Eco scores a site based on locally appropriate survey data as opposed to BREEAM 2008's use of National countryside survey data. The two tables however help to illustrate a number of key points and advantages BREEAM Eco has over the incumbent 2008 system, namely:

- A more sensitive calculation – using the Phase 1 Habitat classification system as a base gives BREEAM Eco a pallet of 90 direct habitat types which can be subdivided into subtypes giving 155 options of classification. BREEAM 2008 has only 5 general landscape types and 12 vegetative sub types. It is therefore clear in terms of habitat development and ecological integrity BREEAM Eco is significantly more sensitive.
- Local sensitivity - the data used in calculating BREEAM 2008 is based on average plant species numbers for given habitat types. However these values are determined nationally from data collected as part of the countryside survey from 2000. Equally not all vegetative plot types have species number data (as there is insufficient data to produce national averages) and so cannot be

calculated. By using locally gathered data in the form of surveys and comparing it to national data in terms of habitat range BREEAM Eco establishes local sensitivity. Certain habitats may be nationally common but locally rare. This factor is missed by BREEAM 2008, but is a key tenet of BREEAM Eco.

- Advantages of maintaining habitat – habitat scoring for BREEAM 2008 uses vegetation type, before and after the construction process but not the same vegetation. It is feasible to remove all vegetation from a site and replace it with new planting and still score well. This ignores the crucial element of ecological stability. Ecology at a community level will be drastically impacted upon if such a strategy were to be employed, but this is not reflected within the 2008 approach. As the scores are weighted within BREEAM Eco for their age and potential to be replicated, maintenance of current habitat and integration into a new design is encouraged, further strengthening ecological integrity.
- Habitat can allow for fauna not just flora – the BREEAM 2008 approach uses plants as a reference to measure change, more importantly the change in the number of plants. By ignoring the types of plants and thus habitat, an opportunity to link in fauna to the scheme is missed. By simply utilising data identifying which habitats are suitable for certain classes of fauna, it becomes possible to integrate into a design measures for both flora and fauna. This is especially important in terms of targeting elements which focus on locally relevant species as they may have very specific habitat requirements. By using habitat as a core element BREEAM Eco has developed a methodology that opens up new avenues of ecological management within a scheme, allowing it to focus on animals as well as plants.

The end result is a new approach which generates a more holistic outcome through the minimisation of ecological disturbance, improved integration of habitat types and the linking of habitats.

7.5.2 Do the changes suggested here create a better solution than that which is currently in place?

The outcome of this research has been to develop a new approach to integrating ecology into project design and construction. Built from the ground up and based on a philosophy of providing solutions to problems inherent in the current approach the end result is a methodology which improves the current system in terms of ecological integrity and scientific rigor but still remains practicable and relevant to the construction industry.

7.5.3 Is there value in changing the scheme in changing it in light of this research?

There are three key factors that lead to the changes suggested here being integrated into BREEAM's future development:

- Makes the scheme more ecologically robust- a chief complaint by ecologists established through this research is the lack of ecological science and principle within the system. This has been addressed using key ecological principles as cornerstones in the new approaches construction, and has been a key driver in the new calculation methodology. As such the integration of these proposed changes can only strengthen BREEAM as a system.
- Balance of building and landscape – up until now there has been a clear divide within the scheme of factors that affect the building and those that affect its immediate environment, with the focus on building factors dramatically out weighing the focus on the landscape. By introducing the elements proposed here, this boundary between 'the building' and 'the landscape' is softened, as the intention of these proposed changes has always been to integrate the building into the landscape, not to replace it, as is currently the approach.
- Strengthening sustainability - The environment and ecological services are a prime focus for true sustainable development, and are in need of development within BREEAM 2008. The changes here focus on ecosystems services as one of the guiding ecological principles in their development and so will help to strengthen this element of sustainability for BREEAM as a system.

7.6 Chapter outcomes

The chapter has outlined some of the risks associated with change as well as assessed the risks inherent in the current system. It has been shown that although there are risks in changing the current Land Use and Ecology section, the benefits (in terms of ecology) outweigh the risks of not doing so. The urbanisation and building construction represents key potential harmful effects to the environment and in particular to ecology. These can be both significant and detrimental and if left unchecked they can dramatically affect the viability of habitat to produce the services we need to survive. This is especially important in light of rising numbers of construction projects, and the risks of the current BREEAM system to ecology. There are significant risks inherent in a 'do nothing' model of approach as there are in not changing BREEAM. These risks to the environment from the construction of the urban realm will severely impact on the integrity of ecosystems, effectively making them unsustainable and can have consequences to human populations from reduced ecosystem services. As such the changes suggested here to BREEAM will only strengthen and underpin the validity of the BREEAM assessment process as it continues to grow into the de facto standard for sustainability assessment in the UK in addition improving its role as a leader to change similar systems worldwide. The efforts undertaken as part of this research have demonstrated an improved efficacy of BREEAM in terms of both effective integration of ecology into the building design process as well as protection measures introduced to maintain ecological stability of existing habitat.

8 Conclusions

8.1 Introduction and aims

The purpose of this research project was simple, to ascertain to what extent BREEAM as the UK's leading sustainability assessment system effectively includes ecology into the design and planning of a new development to promote excellence, and to identify how it can be improved.

The challenge centres on the lack of an evidence base illustrating the impact of BREEAM's use of ecology. This resulted in a two-phased approach to this research project:

- The first being the need to identify what information was missing from the literature using interviews, to confirm the level of efficacy of BREEAM for ecology.
- The second was to develop and test a feasible methodology of improving it within the constraints of the system using an extensive case study approach.

This chapter reviews the outcomes of each of the previous chapters drawing conclusions on the work undertaken, its value as new knowledge and its use to the industry by establishing the way forward for ecology within BREEAM.

8.2 Research summary

The research project set out to understand how ecology fits into the BREEAM process prior to developing a more effective way of integrating ecology into the built form.

The hypothesis was that:

Ecology does not have to exist outside the urban realm. It can be integrated into the urban form and through the use of a nationally recognised sustainability assessment vehicle such as BREEAM, the boundary between human development and nature can be blended for the benefit of both.

This hypothesis was tested by the investigation into the level of effectiveness within BREEAM and then through the development of improvements to make BREEAM as an agent of sustainability in design as effective as possible. The research project showed that BREEAM as a sustainability assessment system is an effective tool in rating the overall performance of a building but that ecology is a weak link in the sustainability chain within BREEAM. This research has also demonstrated through a review of current literature that ecology is a key principle of sustainability, and the ecosystem services that nature provides are crucial to the betterment of all humankind. This disparity between the significant level of importance within the sustainability concept but seemingly lacking emphasis within BREEAM was not recognised until this research looked at the principles inherent to the BREEAM system.

No dedicated investigation into ecology within BREEAM has been made by the systems creators (BRE) since its conception, as a result this research forms a significant move forward in this area. Ecologists have had concerns with the approach since the system had its last major review in 1998. However no large scale review of these concerns has ever been undertaken. This research is the first in its kind, and the new knowledge generated throughout this process has been vital in creating a new approach to the valuation of ecology in sustainable development.

This new approach (referred to as BREEAM eco) has been developed because, as this research has demonstrated, although there is a wide array of alternative systems in place globally (of which BREEAM is a market leader), none of them have taken a holistic approach to integrating ecology into the construction process. To compound the problem, as many of the systems in use have evolved from BREEAM, any issues with BREEAM will be replicated into these systems. This will be even further exacerbated as these systems become more and more popular and competition for new markets mean that they spread into international arenas. The interviews undertaken as part of this research have identified significant concerns on the part of the ecologists involved. With many feeling that although the BREEAM assessment as an approach is a good starting point with many good qualities, it may be the right tool for assessing the sustainability of a building, but not its effect on ecology. In a similar way that problems within sustainability assessment systems will spread with use, the problems with ecology within BREEAM will affect every type of building rated, as the same core approach is used no matter which standard is applied. As a result any building rated using BREEAM will be missing opportunities to integrate better with ecology.

To improve the efficacy of BREEAM several approaches were needed. It was recognised that the issues and concerns expressed by the ecologists could be collected into groups as they had similar core themes. Essentially issues stemmed from the lack of ability of BREEAM to integrate ecology, the mechanics of the system as well as the administration of the system formed the three theme areas to be addressed through this research. Through changes in format, and a review of the criteria in use, it became possible to strengthen BREEAM as a system for the integration of ecology into developments. This will also enable BREEAM to maximise its potential by approaching ecology holistically in terms of the ecological content of BREEAM and its practical application to developments. This led to the final outcome of this research which is a better way to integrate ecology into the design of developments and thus cities as more and more building projects utilise the BREEAM certification standard.

8.3 Research objectives

The beginning of this research project set out six core questions in order to objectively determine the efficacy of the system. These questions have been outlined in 1.3.1. From a critique of the BREEAM system itself and a review of literature around the topic areas, it became clear that although some ecological principles were inherent in the system such as prudent use of land and protection of key features, many were not. The literature on how important biodiversity is to generating valuable ecosystem services is clear and needs to be a core tenet of the BREEAM system. As a result this research has shown that in answer to objective one, BREEAM addresses some ecological issues but not sufficiently enough to support excellence in sustainable design as BREEAM sets out to do.

In relation to the second objective and whether BREEAM is actually harming ecology, it is clear from both the 43 interviews and 3 workshops with ecologists that the introduction of inappropriate habitat types and the disregard of connectivity in habitats will have a detrimental effect to ecology and the ability of species to migrate and thrive. This will only be compounded as more and more development occurs in the urban realm, and developments are not linked using ecology.

Objective three sought to ascertain if BREEAM is the right tool for integrating ecology into sustainable design. This research has shown that it is capable but more importantly it has to be, as ecology must be considered a core element of sustainability. BREEAM is a sound vehicle for change, as it is constantly updated, and kept above the legislative minima required from construction projects and now has significant government backing in its use as a standard. The rating of ecology using criteria (as is the format of BREEAM) is problematic in this case as ecology is not as easily rated as say thermal efficiency, but it is feasible and it should be a vehicle to be used and worked with and not derailed.

In terms of objective four, i.e. the system format, this research has shown that the format needs to be changed and changed significantly to be more effective, as simply tightening up the current credits or criteria will not address the lack of key principles missing from the system.

The interview process confirmed that key ecological elements were missing, and in the opinion of the end user (the ecologists), BREEAM could be significantly improved. Using data collected from the interview process the Land Use and Ecology section was developed, with a change in focus and approach in key areas. This also addressed objective five, as the research clearly sets out how BREEAM can be improved.

The last chapter has shown that there are a number of risks associated with change. Firstly, there is a risk that, if the current system is left, there will be a continued reduction in biodiversity through habitat fragmentation and area reduction, which under the current system forces metapopulations of species by creating concentrated areas of habitat with increased numbers of plant species. Secondly there is a risk to destabilising the system itself by deviating from the current format of BREEAM. However through building an understanding of the system as a whole, it has been proved with this research that there is sufficient flexibility in the scheme to allow changes to be made with minimal risk.

8.4 New knowledge resulting from the research

This research project has generated several new elements that were at the outset either known but lacking in evidence or unknown and identified as a result. The most significant is the phenomena of the illusion of ecological benefit. Without a review of the benchmarks set by BRE for ecology, changes to a development scheme as demonstrated in chapter six, can score well under BREEAM 2008 for ecology without actually having any real benefit when factors to promote biodiversity are applied.

Within the design of the ecology section of BREEAM 2008, it is clear that the ecological value of a development is the value to 'wildlife' on site. The value in essence is the potential for wildlife gain. This starting point fails to recognise the value that well-managed ecology can offer humans in an urban setting. The value of ecosystem services and the value of ecology to human beings is both diverse and vital and has been shown by this research as a fundamental flaw in BREEAMs ecology section. Understanding how ecological value is measured within BREEAM is the quintessential element to understanding how to improve the system. The focus must shift from ecology for ecology's sake to recognise how buildings and nature can blend together. This research therefore has taken significant steps for BRE to allow this to happen.

This research has consolidated and tested the thinking of ecologists in the field. This provided a credible and evidence based argument for the need to change BREEAM 2008. This research has also considered the issues and risks in developing a blue print for transforming BREEAM 2008 into a robust and comprehensive ecologically sound tool based on scientifically defensible principles, i.e. BREEAM Eco. This research in effect has identified the drivers and created the vehicle for BRE to move forward.

8.4.1 Potential applications of the research's findings

The most significant application of this investigation into BREEAM is to BREEAM itself. The outcomes of this research will demonstrate how ecological science can be better integrated into the system, strengthening it significantly. It will help the Building Research Establishment better understand the limits and problems inherent in the current design of the BREEAM system. It is envisaged that the outcomes of this research study will help developers and designers understand not only the implications of poorly integrated urban design, but also that solutions to these problems are available and not purely within the realm of complex science. The most significant potential application of this research is the integration of the findings into the next major development of the BREEAM standard in 2010. The integration into such a nationally recognised sustainability assessment platform would see the findings outlined here impacting on the design of hundreds of thousands of buildings across the UK. In addition the government owned code for sustainable homes - a BREEAM derivative, traditionally follows the lead of BREEAM in relation to updates and reforms. As a result following any integration of this research's findings into the BREEAM update in 2010, the changes suggested here will in all likelihood be introduced into the code.

8.5 Further avenues of research for ecology within BREEAM

There are two distinct avenues to take the outcome of this research project forward, and they focus on and around BREEAM. The first avenue is to undertake further internal work to the BREEAM system, by expanding what has been achieved here and by looking to see how BREEAM can be used as a system for further embedding ecology into developments. BREEAM is a system which is constantly evolving and it is essential ecology does not get left behind. Further research in cementing its position as a key section within BREEAM is vital. As more and more projects utilise BREEAM as a ratings tool the opportunities for projects to connect using ecology will grow in number. Further investigation into the application of BREEAM overseas is another element in need of research. The research carried out here has been conducted with the UK market as the focus, and determining if such an approach would work in other countries has been outside the scope. However as BREEAM develops into an international standard, this is becoming increasingly important, and understanding the implications through further research is a distinct element in its own right.

The second avenue is to look at areas which are external to the BREEAM system, either in developing new linkages to other existing and rating systems, sources of data or building a better relationship between the information available from external organisations and BRE. One such project to support BREEAM (outside the scope of this research) has already been outlined in chapter five. Section 5.4.9 has described the requirements of a project to make the approach to ecology outlined as part of this dissertation easily accessible to all who use the BREEAM system, understanding the implications and progressing this avenue is a vital step in moving ecology within BREEAM forward. The project would see a database of national information collated for use by ecologists as part of the background to measuring changes in ecological value. If this approach were to be adopted by BRE such a dataset would create a significant landscape characterisation framework which would allow environmental objectives to be set across entire regional land areas, irrespective of those areas already rich in biodiversity. This would allow BRE to become a key player internationally in ecological integration as part of sustainable design.

8.6 The future of development of BREEAM - recommendations to BRE

Obviously the first recommendation to BRE would be to include the outcomes of this research in the next round of changes to BREEAM, and early indications show that BRE are keen to utilise knowledge such as this to boost the effectiveness of BREEAM. This research is a self-contained entity in that it creates a new approach and effective solution for BRE to change ecology within the next revision in 2010 with minimal upheaval to other sections. However some work will be required to ensure the changes suggested here (BREEAM Eco) can integrate within their current plans for the update of the other sections within BREEAM.

The second recommendation is to find solutions to make the smooth running of ecology within BREEAM a priority. The suggested new approach to ecology within this research is derived from analysis of those flaws inherent in the system as identified by the end user of BREEAMs ecology section, the ecologist. Chapter four analysed the results of the interview investigation and concluded that the issues for ecology within BREEAM can be split into three categories:

- Those concerning the practical application of BREEAM,
- Those concerning how effective the process is (BREEAM's fundamental approach to ecology) and,
- Those relating to the administration of the process and ecologists relationship with BRE.

The first two have been addressed through the outcomes of this research, and have resulted in a new approach to ecology within BREEAM. However the last group is arguably the most important. Because no matter how many changes are made to the system, or by what degree it is improved in efficacy, if the way the scheme is administered is not working efficiently, the changes become purely academic. All of the concerns identified in this group by the ecologists can be solved with BRE implementing the following:

- The creation of one point of contact – if there is one route to gain information and clarifications from BRE the numbers of errors being introduced into the ecology section of BREEAM can be dramatically reduced. To give the position credibility this individual should be or have an ecological background and therefore be able to communicate more effectively with ecologists undertaking assessments.

- Improved guidance – creating information on best practice, manuals for ecological sound design, or a collection of case studies will help ecologists communicate ideas to designers and architects on projects.
- Training on the system (for both assessors and ecologists) will reduce errors and make resulting assessments more beneficial to both the buildings design and the ecology surrounding the scheme.
- Share more information – generating dedicated resources for ecologists such as websites, email subscriptions, newsletters and online forums help distribute information and give alternative routes for ecologists to gain the latest information on ecology within the scheme.

8.7 Final Remarks

In relation to urban ecology, there are three key factors that have been clear throughout this research project:

- The rates of human transformation of the earth are increasing, and urbanisation is a growing concern
- The diversity of life is fundamental to human wellbeing and
- Ecology is the glue that holds the concept of sustainability together, more than just a method of producing resources, it is a way of renewing resources and a core tenet of the sustainability philosophy because the earth is a closed system.

Given that a biodiverse system is stable, all the above are linked, meaning that a truly sustainable development will be one that uses ecology as a driving factor in its design. BREEAM 2008 as it currently stands looks to attach ecology to a building and assign a value to it. What this research has achieved is an integration of a building into ecology taking into account the wider habitat implications.

According to BRE (2009) in the UK, there are over 115,000 buildings certified using the BREEAM system, and over 700,000 homes and buildings currently registered to be assessed. In addition from 1990 to 1998 approximately 54,000 ha of undeveloped land was changed to developed land (this is equivalent to 13,300 football pitches). The projected change from rural to urban uses in England between 1998 to 2016 is a further 110,000 ha (BRE, 2009). There can be no doubt therefore that BREEAM presents a significant opportunity to integrate ecology as a true element of sustainable design into the country's construction programme. Equally, however not adopting the outcomes of this research presents a significant opportunities loss. Perhaps however rather than integrating ecology into our developments we should be taking lessons for sound design from nature itself:

"There is nothing in which the birds differ more from man than the way in which they can build and yet leave a landscape as it was before."

Robert Lynd (1879 -1949)

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10 Appendices

Appendix 1 – Interview procedure and background for ecologists

Appendix 2 – BREEAM 2008 Land Use & Ecology section including calculation data and supporting information (BREEAM: Healthcare 2008)

Land Use & Ecology Section

Credit aim

To encourage the reuse of land that has been previously developed and discourage the use of previously undeveloped land for building.

Credit criteria

Credits	
I	Where evidence is provided to demonstrate that the majority of the footprint of the proposed development falls within the boundary of previously developed land.

Compliance requirements

The following demonstrates compliance:

I. At least 75% of the proposed development's footprint is on an area of land which has previously been *developed* for use by industrial, commercial or domestic purposes in the last 50 years.

Compliance notes	
New Build	There are no additional or different requirements to those outlined above specific to new build projects.
Refurbishment	In the case of refurbishment, the credit can be awarded by default where no new building work or infrastructure is being constructed as part of the refurbishment.
Extensions to existing buildings	Where a refurbishment includes new buildings, hard landscaping, or infrastructure, 75% of the total proposed development footprint (refurbished plus new build and/or hard landscaping and/or infrastructure) must comply with the requirement.
Infill development	New buildings developed within the boundary of existing sites do not automatically comply with the requirements. The land on which at least 75% of the new building will be sited must meet the definition of *previously developed*.
Temporary works	Undeveloped areas of the site to be used for temporary works (e.g. temporary offices/parking, material/machinery storage) must be considered as development on undeveloped land and therefore included in the calculations unless they have been defined as 'land of low ecological value' (Ecological Value and Protection credit, LE3).

Developed more than 50 years ago	Where a site has been previously developed (more than 50 years ago) but is now considered undeveloped, the credit may only be awarded on this basis if the site is deemed to be "contaminated" as defined in BREEAM credit LE2.

Schedule of evidence required

Req.	Design Stage	Post Construction Stage
I	Existing site plan, report or site photographs confirming: Previous land use. Area (m^2) of previous land use.	Assessor's building/site inspection or as built drawings confirming: The footprint or orientation of the developed area has not altered from that confirmed in the design stage evidence. Where alteration has occurred the % must be re-calculated using 'as built' plans.
	Proposed site plan showing; Location and footprint (m^2) of proposed development and temporary works.	

Additional information

Relevant definitions

Proposed Development: Is defined as the area of any building, hard landscaping, car park and access roads that fall within the boundary of the proposed site.

Previously Developed Land: For the purposes of this credit, BREEAM uses the definition from Planning Policy Statement 3 which defines previously developed land as that which is or was occupied by a permanent structure, including the curtilage of the developed land and any associated fixed surface infrastructure.

The definition includes:

a. Defence buildings

The definition excludes:

a. Land that is or has been occupied by agricultural or forestry buildings.
b. Land that has been developed for minerals extraction or waste disposal by landfill purposes where provision for restoration has been made through development control procedures.
c. Land in built-up areas such as parks, recreation grounds and allotments which, although may feature paths, pavilions and other buildings, have not been previously developed.
d. Land that was previously developed but where the remains of the permanent structure or fixed surface structure have blended into the landscape in the process of time (to the extent that it can reasonably be considered as part of the natural surroundings).

References

England and Wales

4. Planning Policy Guidance (PPG) 3: Housing. Available from the Government's Planning Portal website: www.planningportal.gov.uk.

Scotland

5. Scottish Planning Policy Guidance (SPPG) 3: Housing. Available from the Scottish Government's website: http://www.scotland.gov.uk/Publications/2003/02/16499/18894

Credit aim

To encourage positive action to use contaminated land that otherwise would not have been remediated and developed.

Credit criteria

Credits	
I	Where evidence is provided to demonstrate that the land used for the new development has, prior to development, been defined as contaminated and adequate remedial steps have been taken to decontaminate the site prior to construction.

Compliance requirements

The following demonstrates compliance:

I. The site is deemed to be *significantly contaminated* as confirmed by a contaminated land specialist's site investigation, risk assessment and appraisal identifying:
   a. the degree of contamination
   b. the contaminant sources/types
   c. the options for remediating sources of pollution which present an unacceptable risk to the site.

2. The client or contractor confirms that remediation of the site will be carried out in accordance with the remediation strategy and its implementation plan.

Compliance notes	
New Build	There are no additional or different requirements to those outlined above specific to new build projects.
Refurbishment	There are no additional or different requirements to those outlined above specific to refurbishment projects.
Extensions to existing buildings	There are no additional or different requirements to those outlined above specific to the assessment of extensions to existing buildings.
Prior Decontamination	The credit can only be awarded where remediation has taken place to enable current development of the site for the assessed building, or part of a larger phased development that includes the assessed building (see below). The credit is not achievable for instances where historical remediation and development of the site has occurred outside the scope of the current development proposals.

Large sites split into smaller plots	Where a large site has been decontaminated and is then packaged up into smaller plots of land for individual buildings (possibly as part of a phased development strategy), the credit can be awarded regardless of the plot location of the assessed building. This is on the condition that the whole site could not have been developed without remediation work taking place.
Health and Safety-related decontamination	Contaminated land that has been decontaminated solely for health and safety reasons (rather than for the specific purpose of re-development) does not comply.
Asbestos	Where the only decontamination required is for the removal of asbestos within an existing building fabric, this cannot be classified as contaminated land. However, where asbestos is found to be present in the ground this will be classed as contamination for the purposes of assessing this credit.

Schedule of evidence required

Req.	Design Stage	Post Construction Stage
l	A copy of the specialist's land contamination report confirming: The degree, type and sources of site contamination. The options for remediating the site. Existing site plan(s) showing: Location of areas contaminated and to be remediated in relation to any proposed development.	The evidence required at the post construction stage is the same as for a design stage assessment.
2	A letter from the main contractor or remediation contractor confirming: The remediation strategy for the site. Summary details of the implementation plan. If a contractor has not yet been appointed, a letter from the client, or their representative confirming: That the appointed contractor will undertake necessary remediation works to mitigate the risks identified in the specialist report.	A copy of the verification report (or relevant sections of the report) confirming: Description of remedial works undertaken. Description of relevant *pollution linkages* addressed*. * This may not be applicable where the contaminant is a non-native invasive plant species.

Additional information

Relevant definitions

Contaminant: Is defined as any solid, liquid or gaseous material in, or on the ground to be covered by the building, which is classed as a hazard and therefore presents an unacceptable risk to human health and the environment. The definition also includes land significantly infested by *non-native invasive plant species* (see below).

Significant contamination: For the purposes of this credit, significant contamination is contamination compliant with the above and that, without remediation, development of the site is not possible.

Remediation: Activity undertaken to prevent, minimise, remedy or mitigate the risk caused by contaminated land to human health or the environment.

Non-native invasive plant species: Are non-indigenous species that adversely affect the habitats they invade economically, environmentally or ecologically. For the purposes of BREEAM this currently includes Japanese Knotweed and Giant Hogweed only. Further information on the control and disposal and how this fits into the legislative framework relating to such species can be obtained from DEFRA.

Pollution Linkages: A relevant pollutant linkage is one that has been identified during the risk assessment stage as representing unacceptable risks to human health or the environment.

References

I. CLEA Overview Documents (These and other documents relating to CLEA are available from the Environment Agency's website: www.environment-agency.gov.uk):
   a. CLR 7: Assessment of risks to human health from land contamination; an overview of the development of Soil Guideline Values and related research.
   b. CLR 8: Potential contaminants for the assessment of land.
   c. CLR 9: Contaminants in soil: collation of toxicological data and intake values for humans.
   d. CLR I0: The Contaminated Land Exposure Assessment (CLEA) model: technical basis and algorithms.

2. Further advice and technical publications are available for download from the Environment Agency's website: www.environment-agency.gov.uk, including;

   a. Remedial methods for contaminated groundwater.
   b. Verification of treatment performance – How sure can you be?
   c. Issues for the selection of remedial strategies, good practice guidance.
   d. Process-based remediation of land contamination.

3. Approved Document C: "*Site Preparation and Resistance to contaminants and moisture*", 2004 edition, ODPM. (http://www.communities.gov.uk)

4. "*Environment Agency Guidance on Requirements for Land Contamination Reports*", Environment Agency, 2005.

5. Scottish Environment Protection Agency (SEPA) www.sepa.org.uk

Credit aim

To encourage development on land that already has limited value to wildlife and to protect existing ecological features from substantial damage during site preparation and completion of construction works.

Credit criteria

Credits	
I	Where evidence provided demonstrates that the site's construction zone is defined as land of low ecological value and all existing features of ecological value will be fully protected from damage during site preparation and construction works.

Compliance requirements

The following demonstrates compliance:

I. Land within the *construction zone* is defined as 'land of low ecological value' using either:
   a) BREEAM checklist A4 **0R**
   b) A *suitably qualified ecologist* who has identified the land as being of 'low ecological value' within an ecological assessment report, based on a site survey.

2. All existing features of ecological value surrounding the *construction zone* and site boundary area are adequately protected from damage during clearance, site preparation and construction activities as listed below:
   Trees of over I00 mm trunk diameter, and/or of significant ecological value, are protected by barriers. Barriers must prohibit construction works in the area between itself and the tree trunk. Minimum distance between tree trunk and barriers must be either the distance of branch spread or half tree height, whichever is the greater.
   In all cases trees must be protected from direct impact and from severance or asphyxiation of the roots.
   Hedges and natural areas requiring protection must either have barriers erected and be protected, or, when remote from site works or storage areas, be protected with a prohibition of construction activity in their vicinity.
   Watercourses and wetland areas are to be protected by cut-off ditches and site drainage to prevent run-off to natural watercourses (as this may cause pollution, silting or erosion).

3. In all cases, the contractor is required to construct ecological protection prior to any preliminary site construction or preparation works (e.g. clearing of the site or erection of temporary site facilities).

Compliance notes	
New Build	There are no additional or different requirements to those outlined above specific to new build projects.
Refurbishment	A refurbishment of a building (with no new construction), must protect any existing ecological features of value. Protection includes clear exclusion procedures for construction traffic/personnel and material storage, as well as physical barriers.
Extensions to existing buildings	Where a refurbishment includes new building work or infrastructure, the land on which the new build area and its associated infrastructure (e.g. roads, pavements, car parks etc) will be situated, must comply with the criteria.
No features of ecological value	Where the construction zone is defined as 'land of low ecological value' and where the surrounding site contains no features of ecological value, this credit can be awarded.
Suitably qualified ecologist report	The suitably qualified ecologist must base their findings on data collected from a site visit conducted at appropriate time(s) of the year, when different plant and animal species are evident. The content of the Ecology Report is to be representative of the existing site's ecology prior to the commencement of initial site preparation works (i.e. before RIBA stage K, Operations On Site). Where the ecologist has made no on-site visit, the credit cannot be awarded. See additional guidance for definition of a suitably qualified ecologist.
Features of little or no ecological value	If a suitably qualified ecologist has confirmed that a feature has little or no ecological value, or where a tree is deemed to create a significant danger to the public or occupants by a statutory body or qualified arboriculturalist, then that feature may be exempt from the protection of ecological features requirement of this credit.
Removal of features of ecological value	If features of ecological value have been removed as part of site clearance then the development cannot achieve this credit, even if they are to be replaced as part of a new landscaping strategy.
Site clearance prior to purchase of the site	For sites that have been cleared more than five years ago, the ecological value of the site would be its present ecological value, on the basis that in the intervening five years, ecological features would have started to re-establish themselves and therefore act as an indicator of the site's ecological value. For sites that have been cleared less than five years before assessment, a suitably qualified ecologist should make an estimation of the site's ecological value immediately prior to clearance on the basis of available desktop information (including aerial photography) and the landscape type/area surrounding the site.

Schedule of evidence required

Req.	Design Stage	Post Construction Stage
1&2	A completed copy of checklist A4 signed and dated by the client, their representative or a design team member e.g. architect. **AND** One of the following: A plan and/or site photographs of the existing site highlighting any ecological features **OR** A copy of the ecologist's report containing: Confirmation that the land within the construction zone is of low ecological value. A description of any ecological features within the site or on the site boundary. Date(s) of site survey(s).	The evidence required at the post construction stage is the same as for a design stage assessment.
	A completed, signed copy of sections A and B of checklist A6 'Guidance for relating ecology reports to BREEAM' to confirm the ecologist's professional status **OR** A copy of the ecologist's report containing the information in sections A and B from the above.	

2&3	A copy of the relevant section of the contract specification confirming: Requirement to protect all identified features of ecological value. Scope of protection measures required. Protection measures implemented prior to commencement of site activities.	Assessor site inspection report **OR** ecologist's report confirming: The boundary of the site and the construction zone has not been altered. Where applicable, all existing ecological features still remain.

Additional information

Relevant definitions

Construction zone: For the purpose of this BREEAM, credit the construction zone is defined as any land on the site which is being developed (and therefore disturbed) for buildings, hard standing, landscaping, site access, plus a 3m boundary in either direction around these areas. It also includes any areas used for temporary site storage and buildings.

If it is not known exactly where buildings, hard standing, site access and temporary storage will be located it must be assumed that the construction zone is the entire site.

Suitably qualified ecologist (SQE): An individual achieving all the following items can be considered to be "suitably qualified" for the purposes of a BREEAM assessment:

1. Holds a degree or equivalent qualification (e.g. N/SVQ level 5) in ecology or a related subject.

2. Is a practising ecologist, with a minimum of three years relevant experience (within the last five years). Such experience must clearly demonstrate a practical understanding of factors affecting ecology in relation to construction and the built environment; including, acting in an advisory capacity to provide recommendations for ecological protection, enhancement and mitigation measures. Examples of relevant experience are: ecological impact assessments; Phase 1 and 2 habitat surveys and habitat restoration.

3. Is covered by a professional code of conduct and subject to peer review.

Peer review: Is defined as the process employed by a professional body to demonstrate that potential or current full members maintain a standard of knowledge and experience required to ensure compliance with a code of conduct and professional ethics.

Full members of the following organisations, who meet the above requirements, are deemed suitably qualified ecologists for the purposes of BREEAM:

Association of Wildlife Trust Consultancies (AWTC)
Chartered Institution of Water and Environmental Management (CIWEM)
Institute of Ecology and Environmental Management (IEEM)
Institute of Environmental Management and Assessment (IEMA)

Landscape Institute (LI)

Where a suitably qualified ecologist is verifying an Ecology Report produced by another ecologist who does not meet the SQE requirements, they must, as a minimum, have read and reviewed the report and confirm in writing that they have found it to:

a. represent sound industry practice
b. report and recommend correctly, truthfully and objectively
c. be appropriate given the local site conditions and scope of works proposed
d. avoid invalid, biased and exaggerated statements.

Additionally, written confirmation from the third party verifier that they comply with the definition of a *Suitably Qualified Ecologist* is required.

References

1. British Standard BS5837 "*Trees in relation to construction*", BSI, 2005.

2. "*The Hedgerows Regulations 1997*", Office of Public Sector.

3. Environmental good practice on site (CIRIA C502): "*Guidance on how to avoid causing environmental damage and the financial penalties that can follow*", CIRIA, 1999.

4. Environmental good practice on site (CIRIA C503): "*Practical advice on how to carry out construction works without harming the environment*", CIRIA, 1999.

5. Working with wildlife site guide (CIRIA C567): "*Guidance to understand and implement good practice in relation to wildlife on development and construction projects*", CIRIA, 2005.

6. "*RSPB Good Practice Guide for Prospective Developments – General Principles", RSPB,* 1997: www.rspb.org.uk.

7. Pollution Prevention Guideline (PPG) 5: "Works in, near, or liable to affect watercourses", Environment Agency.

8. Pollution Prevention Guideline (PPG) 6: "*Working at construction and demolition sites"*, Environment Agency.

Minimum BREEAM Standards					
Rating Level	P	G	VG	E	O
Min. credits to achieve rating	-	-	I	I	I

Credit aim

To minimise the impact of a building development on existing site ecology.

Credit criteria

Credits	
I	Where evidence provided demonstrates that the change in the site's existing ecological value, as a result of development, is *minimal*.
2	Where evidence provided demonstrates that there is *no negative change* in the site's existing ecological value as a result of development.

Compliance requirements

The following demonstrates compliance:

I. Where the change in ecological value of the site is less than zero and equal to or greater than minus nine plant species i.e. a minimal change (one credit).

2. Where the change in ecological value of the site is equal to or greater than zero plant species i.e. no negative change (two credits).

   The change in ecological value of the site is calculated by **EITHER** of the following:

3. Determine the following information and input this data in to Ecology calculator I within the spreadsheet tool:
   a. Plot type(s) and areas (m^2) that define the landscape of the assessed site, in its existing pre-developed state and proposed state (see additional guidance).

   OR

4. Where a *suitably qualified ecologist* has been appointed and, based on a site survey, they confirm the following and the assessor or ecologist inputs this data in to the Ecology calculator 2:
   b. Actual plot/habitat types that define the landscape of the assessed site in its existing pre-developed state and proposed state
   c. Area (m^2) of each plot/habitat type
   d. Number of plant species found within each plot type

Minimum BREEAM Standards					
Rating Level	P	G	VG	E	O
Min. credits to achieve rating	-	-	▮	▮	▮

Compliance notes	
New Build	There are no additional or different requirements to those outlined above specific to new build projects.
Refurbishment	There are no additional or different requirements to those outlined above specific to refurbishment projects.
Extensions to existing buildings	There are no additional or different requirements to those outlined above specific to the assessment of extensions to existing buildings. Refer also to the note below on infill developments.
Completing Ecology Calculator ▮	First, define the landscape type (based on the typology of the surrounding sites, table I). This category is unlikely to change through the development, although it may in some cases, e.g. when a disused site is developed as part of a master plan for a large multi-use or multi-building development/regeneration project. Then, define and calculate the area (m^2) of each vegetation-plot type (table 2) and building or hard landscaped area, both before and after development, for the site. Once the data is entered, the Ecology Calculator I will indicate the indicative change in ecological value. The result must be used to award the credits.
Number of plant species	BREEAM measures ecological value using number of plant species. The plant species figures for each land type are programmed into the Ecology Calculator tool I. These figures are based on national figures from the Countryside Survey prepared for the Digest of Environmental Statistics (see table 3).
Wildlife garden planting	In the 'change of ecological value' table (table 3), 'garden planting (typical)' and 'wildlife garden planting' will always record a score of zero, unless a suitably qualified ecologist has been appointed: whereby they will make the distinction between 'typical' and 'wildlife' garden planting species and record 'actual' species numbers.
Derelict Sites	The ecological value of derelict sites is time dependent (table 3); a linear scale has been used to determine intermediate values between zero ecological value at I year from dereliction/demolition to a value at 30 years based on marginal upland figures. This presents a worst case figure which can be amended on the advice of a suitably qualified ecologist.
Assessment of a single development on a larger site	Where the assessment is of a single building that forms part of a larger site development and the landscaping and ecological features form a common part of the whole site, for the purpose of assessing this credit the plot types and areas for the entire site must be used.
Infill developments on existing occupied site	Where a development is an infill (or new building) on an existing occupied site, then the construction zone for the new building would be the area of site assessed for the purposes of this credit.

Site clearance prior to purchase of the site	Refer to the compliance note in LE3 on this issue.
Green Roofs	The contribution of species from a Green roof can only be incorporated where a suitably qualified ecologist has been appointed.

Schedule of evidence required

Req.	Design Stage	Post Construction Stage
First & Second Credit		
1,2 & 3	Existing and proposed site plans and, if required, maps and aerial photographs confirming: Landscape and vegetation plot types Area (m^2) of vegetation plot types **AND** A completed copy of Ecology Calculator 1.	The evidence required at the post construction stage is the same as for a design stage assessment. Plus: Assessor's/ecologist's building/site inspection confirming: Post construction vegetation plot types and areas are in accordance with design stage evidence.
1,2 & 4	A copy of the suitably qualified ecologist's report confirming prior to and after the development: Landscape and vegetation plot types Area (m^2) of vegetation plot types **AND** A completed, signed copy of checklist A6 – Relating ecology reports to BREEAM **0R** a copy of the ecology report containing the information outlined in checklist A6. **AND** A completed copy of Ecology Calculator 2.	

Additional information

Relevant Definitions

Construction zone: As defined for credit LE3 – Ecological Value of site AND Protection of ecological features

Suitably qualified ecologist (SQE): As defined for credit LE3 – Ecological Value of site AND Protection of ecological features

Table 1: General Landscape Types

Pastoral	Mainly grasslands.
Arable	Land dominated by cereals and other arable crops, as well as intensively managed grasslands.
Marginal Upland	Areas which are on the periphery of the uplands, and which are dominated by mixtures of low intensity agriculture, forestry and semi-natural vegetation.
Upland	Land generally above a height suitable for mechanised farming and frequently dominated by semi-natural vegetation.
Building & Derelict Land	Land currently or previously occupied by buildings.
Urban Mosaic	A complex mix of habitats located within cities, towns, or villages, which will include; buildings, hard standing, pockets of disused land and scrub, and areas of managed green spaces, such as gardens, allotments, and parkland. Parklands can be characterised as being accessible to the public and will usually be fairly intensively managed spaces, consisting of a matrix of grassland (grazed or mown) with scattered trees at various densities and areas of dense planting. This landscape type is to be used only when no other landscape type in the table is more appropriate l predominates.

Table 2: Vegetation Plot Types

Cropslweeds	Mostly highly disturbed vegetation of arable fields and their boundaries; includes cereal and vegetable crops.
Tall grasslandlherb	Typical vegetation of overgrown lowland field boundaries, ditches and roadside verges.
Fertile grass	The bulk of agriculturally improved grasslands, intensive pasture and silage crops; but also includes mown areas of improved grasslands for recreational and amenity purposes, as well as re-sown roadside verges.

Infertile grass	A diverse group of semi-improved and semi-natural grasslands; includes acidic to basic, wet to dry grasslands, and tall-herb vegetation mainly present in the lowlands; often found on stream sides and roadside verges.
Lowland wooded	Includes wooded vegetation of hedges and broadleaved woods in the lowlands.
Upland wooded	A varied group of acidic vegetation types usually associated with upland woods, including: semi-natural woodland; conifer plantations; bracken and wooded streamsides.
Moorland grassimosaic	Typically grazed moorland vegetation, including extensive upland acidic and peaty grassland, and species-rich but very localised flushes.
Heathibog	Mostly heather moorland, blanket bog and montane heath, but also lowland heath and raised bog.
Wildlife garden planting	Garden planting that uses native species andlor those that have a known attraction or benefit to local fauna, based on the advice of a suitably qualified ecologist.

Table 3: Number of plant species by plot for different landscape types

Types of Plot	Landscape Types									
	Arable	Pastural	Marginal Upland	Upland	Existing BuildingiHard Landscaped Areas	Urban Mosaic	Derelict Land <▮ Years	Derelict Land < ▮0 Years	Derelict Land < 20 Years	Derelict Land <= 30 Years
Crop Weeds	5.4	8.3	-	-	-	-	-	-	-	-
Tall GrasslandiHerb	12.7	15.0	-	-	-	17.6	0	6.3	15.8	21.1
Fertile Grassland	11.6	12.7	15.3	-	-	11.6	0	4.6	11.5	15.3
Infertile Grassland	17.1	17.6	21.1	-	-	17.6	0	6.3	15.8	21.1
Lowland Wooded	12.9	12.5	-	-	0	13.8	-	-	-	-
Upland Wooded	-	12.7	13.8	20.4	0	13.8	-	-	-	-
Moorland GrassiMosaic	-	2.0	20.4	21.0	-	-	-	-	-	-
HeathiBog	-	-	14.3	20.0	-	-	-	-	-	-
Hard Landscaping	0	0	0	0	0	0	0	0	0	0
Buildings	0	0	0	0	0	0	0	0	0	0
Garden Planting (typical)	-	-	-	-	0	0	0	0	0	0
Wildlife Garden Planting*	-	-	-	-	0	0	0	0	0	0

- Insufficient data to produce national averages, as not all vegetation plot types are found in all landscaped types.
* Only where the rule concerning wildlife garden planting in table 2.0 has been met can actual species values be used.

Calculating the change and increase in ecological value

BREEAM calculates the change in ecological value by comparing the diversity (number and area) of plant species on the site pre and post construction. The ecological value of the site is expressed as an area-weighted average of plant species for the site's landscape type. This enables BREEAM to use this as an indicator of the proposed development's impact on the site's existing ecological value.

A simple example of the calculation is outlined below.

1. Calculate the ecological value of a previously developed existing site:

   A 2065m^2 existing site consists of the following types of land:

   a. 1865 m^2 hard landscaping = 0 species
   b. 200m^2 urban mosaic - infertile grassland = 17.6 species (Table 3.0).

   The ecological value of the existing site is calculated as follows, for each plot type;

   Number of species on plot type x plot type area as % of total area.

   Therefore, for our example site:

   a. Hard landscaping: {(0 species x (1865m^{2}i2065m^2)} = 0 species
   b. urban mosaic-infertile grassland: {(17.6 species x (200m^{2}i2065m^2)} = 1.70 species
   c. Ecological value of the existing site = 0 + 1.70 = 1.70 species

2. Calculate the ecological value of the proposed site:

   The 2065m^2 post-construction site consists of the following types of land:

   a. 1375m^2 of building = 0 species.
   b. 550m^2 of hard landscaping = 0 species
   c. 140 m^2 has remained as urban mosaic-infertile grassland = 17.6 species

   The ecological value of the proposed site is as follows:

   a. Building: {(0 species x (1375m^{2}i2065m^2)} = 0 species
   b. Hard landscaping: {(0 species x (550m^{2}i2065m^2)} = 0 species
   c. Urban mosaic-infertile grassland: {(17.6 species x (140m^{2}i2065m^2)} = 1.19 species
   d. Ecological value of the proposed site = 0 + 0 + 1.19 = 1.19 species

The ecological impact is the difference between the two ecological values:

Change in ecological value: 1.19 – 1.70 = - 0.51 species

<u>Therefore, for this example 1 credit is achieved.</u>

BREEAM : Healthcare : 2008
Land Use & Ecology
LE4 – Mitigating ecological impact

Minimum BREEAM Standards					
Rating Level	P	G	VG	E	O
Min. credits to achieve rating	-	-	▮	▮	▮

References

1. Figures are based on data from the Countryside Survey which can be accessed through the Digest of Environmental Statistics:
    a. http:iiwww.defra.gov.ukienvironmentistatisticsiwildlifeiwdcs.htm
    b. http:iiwww.countrysidesurvey.org.ukiarchiveCS2000i

Minimum BREEAM Standards					
Rating Level	P	G	VG	E	O
Min. credits to achieve rating	-	-	-	-	-

Credit aim

To recognise and encourage actions taken to maintain and enhance the ecological value of the site as a result of development.

Credit criteria

Credits	
1	Where the design team (or client) has appointed a suitably qualified ecologist to advise and report on enhancing and protecting the ecological value of the site; and implemented the professional's recommendations for general enhancement and protection of site ecology.
2	Where there is a positive increase in the ecological value of the site of up to (but not including) 6 species.
3	Where there is a positive increase in the ecological value of the site of 6 species or greater.

Compliance requirements

The following demonstrates compliance:

First credit

1. A *suitably qualified ecologist* (SQE) has been appointed to report on enhancing and protecting the ecology of the site.
   a. The SQE provides an Ecology Report with appropriate *recommendations* for protection and enhancement of the site's ecology.
   b. The report is based on a site visitisurvey by the SQE prior to the commencement of initial site preparation works.

2. The general *recommendations* of the Ecology Report for enhancement and protection of site ecology have been, or will be, implemented.

Second credit

1. The first credit is achieved.

2. The *recommendations* of the Ecology Report for enhancement and protection of site ecology have been implemented, and the *suitably qualified ecologist* confirms that this will result in an increase in ecological value of the site up to (but not including) 6 species.

3. The increase in plant species has been calculated using Ecology calculator 2, using actual species numbers.

Third credit

1. The first credit is achieved.

2. The *recommendations* of the Ecology Report for enhancement and protection of site ecology have been implemented, and the suitably qualified ecologist confirms that this will result in an increase in ecological value of the site of 6 species or greater.

3. The increase in plant species has been calculated using Ecology calculator 2, using actual species numbers.

Compliance notes	
New Build	There are no additional or different requirements to those outlined above specific to new build projects.
Refurbishment	There are no additional or different requirements to those outlined above specific to refurbishment projects.
Extensions to existing buildings	There are no additional or different requirements to those outlined above specific to the assessment of extensions to existing buildings.
Timing of Ecologist Report	It is recommended that the suitably qualified ecologist is appointed to carry out site surveys of existing site ecology, on which their report is based, or to provide verification where the report is prepared by others, at the feasibility stage (RIBA Stage B or equivalent) in order to facilitate and maximise potential ecological enhancement.
General recommendations	'General' recommendations for enhancing and protecting the ecological value of the site are to include, and go beyond, compliance requirements for all current EU and UK legislation relating to protected species and habitats. These 'general' recommendations may include ecological recommendations as detailed in the definitions.
Guidance for ecologists and assessors	Please refer to Checklist A6 – Relating ecology reports to BREEAM, section D for assistance in assessing and interpreting the requirements of this credit.
Native species	Only native floraliplant species and those with a known attraction or benefit to local fauna can be considered for the purpose of increasing the number of species on site, as well as general enhancement.
No ecological survey completed or construction works have commenced	Where it is not possible to determine 'actual' number of species per vegetation plot type, either because an on-site ecological survey has not been conducted, or, because construction works have already commenced, the second and third credits cannot be achieved.

Schedule of evidence required

Req.	Design Stage	Post Construction Stage
First Credit		
I	A copy of the ecologist's report containing: Details and scope of the site survey. Information as outlined in checklist A6 – Relating ecology reports to BREEAM. **OR** A copy of the ecologist's report containing a completed, signed copy of checklist A6.	The evidence required at the post construction stage is the same as for a design stage assessment.
2	Proposed site plan highlighting implementation of the ecologist enhancement recommendations. **AND** One of the following: A copy of the relevant section of the specification requiring the main contractor to implement the SQE's recommendations for protection and enhancement **O R** A letter from the client or design team member confirming: That the specification will require the main contractor to implement the	Assessor site inspection report and photographic evidence confirming that the ecologist's recommendations have been implemented. For large mixed-useimulti-building developments, where the whole site has not been completed and ecological enhancements have not been added, or where features are being added at a later date in an appropriate planting season: A copy of the contractispecification or a letter from the main contractor confirming when the planting will be complete. This must be within I8 months from completion of the development.
Second & Third Credit		

1-3	Evidence as outlined above, confirming compliance with the first credit. A copy of the SQE's report containing the information outlined in checklist A6 – Relating ecology reports to BREEAM. **OR** A copy of the SQE's report containing a completed, signed copy of checklist A6. **AND** A completed copy of Ecology Calculator 2.	Evidence (as outlined above) confirming compliance with the first credit.

Additional information

Relevant Definitions

Suitably qualified ecologist (SQE): As defined for BREEAM credit LE3.

Ecological recommendations are defined as measures adopted to enhance the ecology of the site, which may include:

- The planting of native species or those with a known attraction or benefit to local wildlife
- The adoption of horticultural good practice (e.g. no, or low, use of residual pesticides)
- The installation of bird, bat andior insect boxes at appropriate locations on the site
- Development of a full Biodiversity Management Plan including avoiding clearanceiworks at key times of the year (e.g. breeding seasons)
- The proper integration, design and maintenance of SUDs and Green Roofs, community orchards etc.

Only native floral species or those with a known attraction or benefit to local wildlife can be considered for the purpose of enhancing the ecological value of the site.

References

1. **AWTC:** The Association of Wildlife Trust Consultancies, www.awtc.co.uk
2. **CIWEM:** Chartered Institution of Water and Environmental Management, www.ciwem.org
3. **IEEM:** The Institute of Ecology and Environmental Management, www.ieem.org.uk
4. **IEMA:** The Institute of Environmental Management and Assessment www.iema.net.

5. **LI** - Landscape Institute www.landscapeinstitute.org

Credit aim

To minimise the long term impact of the development on the site's, and surrounding area's, biodiversity.

Credit criteria

Credits	
1	The client has committed to achieving the mandatory requirements listed below and at least two of the additional requirements.
2	The client has committed to achieving the mandatory requirements listed below and at least four of the additional requirements.

Compliance requirements

The following demonstrates compliance:

Mandatory Requirements

1. A *suitably qualified ecologist* (SQE) has been appointed prior to commencement of activities on site.

2. The *suitably qualified ecologist* (SQE) confirms that all relevant UK and EU legislation relating to protection and enhancement of ecology has been complied with during the design and construction process.

3. A landscape and habitat management plan, appropriate to the site, is produced covering at least the first five years after project completion. This is to be handed over to the building occupants and includes:
   Management of any protected features on site
   Management of any new, existing or enhanced habitats
   A reference to the current or future site level or local Biodiversity Action Plan.

Additional Requirements

1. The contractor nominates a 'Biodiversity Champion' with the authority to influence site activities and ensure that detrimental impacts on site biodiversity are minimised in line with the recommendations of a suitably qualified ecologist.

2. The contractor trains the site workforce on how to protect site ecology during the project. Specific training should be carried out for the entire site workforce to ensure they are aware of how to avoid damaging site ecology. Training should be based on the findings

and recommendations for protection of ecological features highlighted within a report prepared by a suitably qualified ecologist.

3. The contractor records actions taken to protect biodiversity and monitor their effectiveness throughout key stages of construction. The requirement commits the contractor to make such records available where publicly requested.

4. Where a new ecologically valuable habitat, appropriate to the local area, is created. This includes habitat that supports nationally, regionally or locally important biodiversity, andior which is nationally, regionally or locally important itself; including any habitat listed in the UK Biodiversity Action Plan (UK BAP), Local Biodiversity Action Plan (LBAP), those protected within statutory sites (e.g. SSSIs), or those within non-statutory sites identified in local plans.

5. Where flora andior fauna habitats exist on site, the contractor programmes site works to minimise disturbance to wildlife. For example, site preparation, ground works, and landscaping have been, or will be, scheduled at an appropriate time of year to minimise disturbance to wildlife. Timing of works may have a significant impact on, for example, breeding birds, flowering plants, seed germination, amphibians etc. Actions such as phased clearance of vegetation may help to mitigate ecological impacts. This additional requirement will be achieved where a clear plan has been produced detailing how activities will be timed to avoid any impact on site biodiversity in line with the recommendations of a suitably qualified ecologist.

Compliance notes	
New Build	There are no additional or different requirements to those outlined above specific to new build projects.
Refurbishment	There are no additional or different requirements to those outlined above specific to the assessment of refurbished buildings (unless the building is listed – see below).
Extensions to existing buildings	There are no additional or different requirements to those outlined above specific to the assessment of extensions to existing buildings.
Refurbishment of listed buildings	The refurbishment of a listed building may be exempt from the credit requirements if they conflict with the need to maintain the building's listed features, or are counter to the conservation requirements. Confirmation is required from a suitably qualified ecologist that all possible requirementsienhancements have been achieved before the credit can be awarded (i.e. if no suitably qualified ecologist has been appointed then this credit cannot be awarded).
Biodiversity Champion	A Biodiversity Champion does not have to be an ecologist or ecological expert but must have sufficient authority and time on site to influence activities and ensure that they have minimal detrimental impact on biodiversity.

Local biodiversity expertise	Local biodiversity expertise should be sought at, or before, the design stage to help identify species of local biodiversity importance on site. It is likely that their recommendations will draw on the Local Biodiversity Action Plan (LBAP) where one exists.
The site and surrounding areas	The steps taken in the above requirements will depend on the nature of the site, e.g. urban sites, and the surrounding areas. It is likely that either all, or none, of the optional items will apply. Where the optional items and the mandatory item 3, the management plan, are deemed, in writing, by the appointed suitably qualified ecologist not to be applicable, all credits can be awarded. Mandatory items 1 and 2 must be met in all instances. This is likely to be the case in the majority of assessments in central towncity areas which have a high proportion of surrounding and existing development and no existing external landscaped areas within the boundary of the assessed site.
Sites of no ecological value	Where a site is deemed to have no ecological value, it is still necessary to employ a suitably qualified ecologist to achieve this credit. The ecologist must confirm that all the mandatory items (1), (2) and (3) have been achieved and provide guidance on how to achieve optional item (4). Note that in such cases, mandatory item (1) and additional requirement (4) is likely to be applicable in relation to any ecological enhancements (e.g. green roofs, bird boxes, etc.) adopted in order to achieve the Enhancing Site Ecology credit (LE5).
Not all additional items are applicable	Where the SQE confirms that not all additional items are applicable to the development, for example it is a city centre refurbishment on a confined site with no external areas, then the credits can be awarded accordingly:

No. applicable items	No. of BREEAM credits	Requirements
1 item	One credit	Meet mandatory reqs. plus applicable item
	Two credits	
2 items	One credit	Meet mandatory reqs. plus all applicable items
	Two credits	
3 items	One credit	Meet mandatory reqs. plus 2 applicable items
	Two credits	Meet mandatory reqs. plus all applicable items
4 items	One credit	Meet mandatory reqs. plus 3 applicable items
	Two credits	Meet mandatory reqs. plus all applicable items

Schedule of evidence required

Req.	Design Stage	Post Construction Stage
First & Second Credit		

Mandatory Requirements		
I&2	The SQE report or letter confirming: That they were appointed prior to commencement of activities on site. All relevant UK and EU legislations will be complied with. **AND** A completed, signed copy of checklist A6 – Relating ecology reports to BREEAM **OR** A copy of ecology report containing the information outlined in checklist A6.	A letter from the SQE confirming: That all relevant UK and EU legislation relating to protection and enhancement of ecology has been complied with.
3	A copy of the site management plan. **O R** A copy of the specification requiring the development of plan and outlining the scope of its content. **O R** Where the timing of assessment does not permit either of the above, a letter from the client confirming: A commitment to produce a	A copy of the site's landscape and habitat management plan.
Additional Requirements		
I	A letter from the contractor confirming: The appointment of the biodiversity champion and their job title. Their on site role and responsibilities. **O R** Where not yet appointed, a copy of the specification clause requiring the appointment of a biodiversity champion.	A copy of the relevant sections of the site log book, highlighting: Details of any actionievents taken by the biodiversity champion. If no actions requireditaken, this should be confirmed in the log book.

2	Training schedule or letter of confirmation from the contractor committing to provide relevant training. **OR** Where not yet appointed, a copy of the specification clause requiring the training of the site's workforce.	A record of training undertaken by the site workforce confirming: Who delivered & developed the training The scope of the training delivered.
3	A letter from the contractor confirming: Monitoring and reporting requirements for the development. The records will be publicly available if and when requested. **OR** Where not yet appointed, a copy of the specification clause outlining the contractor's monitoring and reporting requirements	A copy of the relevant sections of the site log book, highlighting: Records of monitoring and actions taken to protect biodiversity. Records and outcome of any requests to view such information.
4	A copy of the proposed site plan highlighting the new ecologically valuable habitat. A SQE's report or letter confirming that the habitat supports the relevant biodiversity action plan(s)	Assessor's (or SQE's) site inspection report and photographic evidence confirming the existence of the proposed habitat.

5	The SQE's report or letter confirming: Wildlife on site that needs to be accounted for in programming works. Actions required with respect to programming site works to minimise disturbance. A copy of the contractor's main programme of works. **OR** A copy of the relevant section of the main contract confirming: The programme of site works will minimise disturbance to wildlife in accordance with SQE's recommendations.	A letter from the SQE, or a copy of their report confirming: Site works executed in a manner that minimised disturbance to wildlife in accordance with their recommendations.

Additional information

Relevant definitions

Suitably qualified ecologist (SQE): As defined for credit LE3 – Ecological Value of site AND Protection of ecological features

Biodiversity: Is defined as the variety of life on earth. It includes all species, animal, plants, fungi, algae, bacteria and the habitats that they depend upon.

Biodiversity Action Plan: A plan which sets specific, measurable, achievable, realistic and time bound conservation targets for species and habitats. The UKBAP website www.ukbap.org supports the implementation of the UK Biodiversity Action Plan (UK BAP) on behalf of the UK Biodiversity Partnership and the UK Government.

Steps to produce a site level BAP are outlined in the UK Business and Biodiversity Resource Centre website, hosted by Earthwatch Institute Europe http:iiwww.businessandbiodiversity.org under 'your sector'

References

1. Earthwatch Europe: www.businessandbiodiversity.org

2. UK BAP: www.ukbap.org.uk

3. Construction Industry Key Performance Indicators: www.kpizone.com

Minimum BREEAM Standards					
Rating Level	**P**	**G**	**VG**	**E**	**O**
Min. credits to achieve rating	**-**	**-**	**-**	**-**	**-**

4. Natural Environmental and Rural Communities Act, 2006: www.opsi.gov.uk

5. "*A Handbook of Good Practice for Public Bodies Dealing with Best Value and Biodiversity in Scotland*", The Scottish Government, 2004.

6. Delivering the Scottish Biodiversity Duty: www.biodiversityscotland.gov.ukidutyiindex.htm

7. "*Action for Scotland Biodiversity*", Scottish Biodiversity Group.

Appendix 3 – New criteria for ecology within BREEAM

(BREEAM eco)

Summary of changes for ecology from BREEAM 2008 to BREEAM Eco.

The following pages outline the changes suggested to the 2008 BRE Environmental Assessment Methodology in relation to the Land Use & Ecology section, and forms the core element of research undertaken within the Institute of the Environment at Brunel University as part of PhD research. BREEAM Eco therefore represents an opportunity to 'upgrade' the Land Use and Ecology section of BREEAM and represents a baseline approach that can be integrated into the 2010 revision of BREEAM as a system.

Principle changes:

<u>Number of credits</u>

The number of credits available for the section has doubled from 10 to 20, this has been achieved by keeping the weighting the same thereby keeping the influence of the section neutral in relation to the overall assessment scheme. This means that there is more scope for ecology to interact with the development thereby helping to rectify the imbalance of 'the building' which represents 90% of the current scheme and 'the environment in which its sits'.

<u>Number of Issues has changed</u>

The current number of issues within this category stands at 6 (LE1 to LE6) with a number of credits attached to each, this has changed in line with the increase of available credits to 15 (LE1 to LE15)

<u>Category brought in line with project management approaches</u>

Ecology is an important factor throughout the project development process, not just the final construction phase, as a result the suggested changes here move the issues into groups or phases in line with the project management process. The phases are:

- Planning and Design
- Demolition & Pre-construction (enabling)
- During Construction
- Post Construction

As a result credits within these 'phases' are only available during these phases. In order to obtain the maximum chance to gain credits, land use and ecology will need to be integrated into the design process from the outset.

<u>The focus of the category has changed</u>

The current focus of the 2008 BREEAM process is to minimise the impacts on the environment from the development and aim to improve the ecology of the site through increased species number. The proposed changes here change the focus of the category by aiming to eliminate the impacts at their source by integrating land use and ecology decisions into the design and planning process. In addition the focus is shifted to working with the existing habitat and maintaining it wherever possible and finally to improve the ecology of the site by maintaining or introducing (in ecologically poor areas) the most appropriate local habitat type.

<u>The changes alter the role of the ecologist</u>

In order to maximise credits the developer will have to change the role of the ecologist within their development, through these changes the current advisory and survey role has been expanded to include design advice and integration into the planning process. This will require ecologists to interact with design teams and contractors on ecological issues as well as issue guidance and or training to contractors in methods to protect habitat from construction impacts. Much of this already exists unofficially within the ecologist's role, the changes here look to solidify this position.

<u>Integration of ecological principles</u>

Within the aim of each issue description is now a clear link to the ecological principles driving the available credits, this will help the ensure that assessors, ecologists and developers alike will now have a greater understanding and thus the importance of each credit and the role it plays in integrating the building and its environment.

Removal of contaminated land

The concerns of contaminated land have been removed from the land use and ecology section and the credits redistributed. Following analysis and assessment it is recommended that the issue be more appropriately located within the pollution section of the BREEAM assessment.

The calculation process has been changed

The calculation process has been completely overhauled to enable a more ecological measure of change on site, utilising habitat as its core focus rather than number of plant species it allows a more holistic approach to measuring what is currently on site and the context in which the site sits. Equally the process will be automated within an easy to use web based system and centrally coordinated to minimise errors in calculation and change in ecological value. The principles and the process are indicated within this document however the exact details are not. These have been omitted to prevent the calculations being done by hand, and thus reducing the risks of operator error.

Planning & Design Phase

LE1 – Ecological baseline

Credit aim and ecological principles:

To establish a benchmark level of understanding of site ecological value pre development, in order to inform the design process through the use of existing ecology on site.

Credit criteria (For 1 Credit):

Provide evidence that a survey has been undertaken and resulting information has been used within the web based BREEAM Eco ecological calculation methodology for the site before development occurs.

Compliance requirements:

Where a survey has been undertaken in accordance with the BREEAM Eco methodology by a suitable qualified ecologist (SQE) and data entered into the BREEAM Eco online calculator to establish a baseline.

Schedule of evidence required:

A digital copy of the report and associated maps to be uploaded to the BREEAM Eco online website, information on habitat areas uploaded by ecologist will be made available to the BREEAM assessor.

Additional Information:

An SQE is determined by BRE as:

An individual achieving all the following items can be considered to be “suitably qualified” for the purposes of a BREEAM assessment:

1. Holds a degree or equivalent qualification (e.g. N/SVQ level 5) in ecology or a related subject.
2. Is a practising ecologist, with a minimum of three years relevant experience (within the last five years). Such experience must clearly demonstrate a practical understanding of factors affecting ecology in relation to construction and the built environment; including, acting in an advisory capacity to provide recommendations for ecological protection, enhancement and mitigation measures. Examples of relevant experience are: ecological impact assessments; Phase 1 and 2 habitat surveys and habitat restoration.

Is covered by a professional code of conduct and subject to peer review

LE2 – Ecological value - Potential

Credit aim and ecological principles:

To establish opportunities within site ecological value, in order to inform the design process through the use of existing ecology on site and introduced ecology as a result of the development.

Credit criteria (For 1 credit):

Carrying out BREEAM ecological potential assessment using the online calculator to determine optimal ecological benefit from the sites current habitat

Credit criteria (For 2nd credit):

Generation of ecological design report for design team

Compliance requirements:

Credit one automatically awarded if information is entered and logged into the online BREEAM Eco system and can be checked centrally by assessors
Credit two requires a submission by the architect to demonstrate where the ecological design report has affected the design.

Schedule of evidence required:

Online input for credit 1 by an approved ecologist, credit two uploaded information from the site architect or designer either as a report or letter detailing out how the project design has been altered to accommodate the findings of the Ecological design report

LE3 – Efficient use of land

Credit aim and ecological principles:

To encourage the efficient use of land on site, maximising ecological potential and discourage the use of previously undeveloped land for building.

Credit criteria (For 1 credit):

Provided evidence to demonstrate that the majority of the footprint of the proposed development falls within the boundary of previously developed land and key ecological features have not been displaced for building footprint.

Compliance requirements:

At least 75% of the proposed development's footprint is on an area of land which has previously been developed for use by industrial, commercial or domestic purposes in the last 50 years.

Schedule of evidence required:

Design drawings before and after detailing the % calculations of building landtake by the site architect or designer to be submitted to the assessor.

LE4 – Planning for protection

Credit aim and ecological principles:

To develop a plan for the protection of sensitive ecology and key features prior to construction beginning on site.

Credit criteria (1):

Provide evidence of a site wide plan based on ecologist advice to highlight key areas of sensitive habitat and indicate a suitable working area around them to aid the onsite architect or designer to better plan the design.

Compliance requirements:

Site specific plan drawing and attached target notes to be created

Schedule of evidence required:

Drawings and guiding target notes to be issued to both the architect and BREEAM assessor by the projects ecologist before demolition starts.

Demolition & Pre construction phase

LE5 – Protection of habitat during enabling

Credit aim and ecological principles:

Instigation of a plan for the protection of sensitive ecology and key features during early or enabling works beginning on site.

Credit criteria (for 1 credit):

Provide evidence that the planning within LE4 is in use and as a result 50% or more of the area indicated by the plan remains unaffected by the enabling and demolition works

Credit criteria (for 2 credit):

Provide evidence that the planning within LE4 is in use and as a result 80% or more of the area indicated by the plan remains unaffected by the enabling and demolition works

Compliance requirements:

Verification by the ecologist post the demotion and construction stage is required. Comparison of the post demolition site with the LE4 protection plan and percentage calculation of areas affected or lost.

Schedule of evidence required:

Written letter or report by the ecologist to the assessor identifying the percentage area affected.

LE6 – Creation of temporary refuges

Credit aim and ecological principles:

To create dedicated temporary habitat areas and features within the site boundary to enable wildlife to remain on site during development, increasing the long term ecological value of the site.

Credit criteria (1):

Under guidance by an ecologist introduce temporary habitat during the demolition phase equal to half the land displaced or affected by the enabling works. Areas or features can be within the enabling zone, but not the demolition zone.

Compliance requirements:

Creation of fenced areas of habitat, use of temporary vegetation (potted planting strategically placed) creation of temporary hiding areas, or appropriate stacking of materials to create refuges under ecologist supervision, temporary habitats must be dismantled at an appropriate rate, after permanent habitat is introduced and recommendations to do so by the ecologist must be followed

Schedule of evidence required:

Written evidence (letter or report) by ecologist showing that the site has created suitable refuges and in sufficient number to have an effect during the demotion process.

LE7 – creation of construction phase management plan

Credit aim and ecological principles:

To develop a management plan for ecology in line with the construction programme to ensure key ecological features are appropriately protected and measures to improve ecological value on site occur at the earliest possibility.

Credit criteria (1):

As an extension of LE4, the ecologist must expand the site wide demolition protection plan to include all phases of the construction project. This will then be issued to the architect or designer prior to construction starting on site.

Compliance requirements:

An extension of the site wide demolition protection plan using site specific drawing and attached target notes to be created by the ecologist.

Schedule of evidence required:

Drawings and guiding target notes to be issued to both the architect and BREEAM assessor by the projects ecologist before construction starts (can be undertaken in conjunction with LE4).

During Construction phase

LE8 – Introduction of impact reduction measures

Credit aim and ecological principles:

Implementing the management plan for ecology in line with the construction programme to ensure key ecological features are appropriately protected and measures to improve ecological value on site.

Credit criteria (1):

Provide evidence that the planning within LE7 is in use and as a result 50% or more of the area indicated by the plan remains unaffected by the Construction works for the duration of the development

Compliance requirements:

Verification by the ecologist that protection works are in place throughout the construction stage, ecologists will make 3 random site visits to ensure compliance with the plan developed in LE7.

Schedule of evidence required:

Written letter or report by the ecologist to the assessor identifying the outcome and complicate during the site visits

LE9 – Training and awareness of site staff

Credit aim and ecological principles:

To ensure construction site staff is aware of both the ecology on site, and have undergone training to recognise how it can be affected by the construction process.

Credit criteria (for 1 credit):

Create an awareness training briefing for site staff (minimum 15 minutes) for all staff working on the site during the construction phase, (staff working purely inside constructed buildings need not attend, e.g. fit outs unless outside space is to be utilised as work area or storage)

Credit criteria (for 2nd credit):

Production of awareness materials by the ecologist for distribution to all site staff posters signs pocket guides

Compliance requirements:

Credit 1 requires a site register detailing members of staff who have been briefed on the ecology on site and what to look out for. All staff must be briefed to be awarded the credit.

Credit 2 requires production of materials such as posters leaflets, pocket guides and presentation handouts to be issued to site staff, and be displayed in public areas.

Schedule of evidence required:

Copy of site register and signatures for attendance of training briefing to be verified by Ecologist and confirmed in writing to the assessor

To achieve credit two, examples of produced materials to be issued to assessor.

LE10 – Early introduction of permanent habitat

Credit aim and ecological principles:

To introduce habitat areas and features in the final landscape design at the earliest opportunity to encourage wildlife to remain on site.

Credit criteria (For 1 Credit):

Implement landscaping before construction of the building s finished.

Compliance requirements:

The early introduction of landscaping and final habiat needs to be introduced before construction is complete, strategically located and at least 25% of the area of the final landscaping plan be introduced.

Schedule of evidence required:

Photographic evidence is required that the landscaping plan has been put into effect before the construction phase is over.

Post Construction phase

LE11 – Ecological Enhancements

Credit aim and ecological principles:

The introduction of key appropriate enhancements to the site to encourage wildlife and help foster biodiversity.

Credit criteria (for 1 credit):

Introduce a number of low level ecological enhancements on site as determined by BRE through BREEAM eco online, low level enhancements must be approved in terms of type and location by an ecologist.

Credit criteria (for 2nd credit):

Introduce a medium level ecological enhancements on site as determined by BRE through BREEAM eco online, low level enhancements must be approved in terms of type and location by an ecologist.

Credit criteria (for 3rd credit):

Introduce a high level ecological enhancements on site as determined by BRE through BREEAM eco online, low level enhancements must be approved in terms of type and location by an ecologist.

Compliance requirements:

Each enhancement will have a value based on size and complexity as determined by BRE. The ecologist will need to build a site wide score to achieve credits 0-25 points = Low level enhancement & 1 credit, 26-50 points = Medium enhancements & therefore 2 credits, 51+ represents a High level of enhancement therefore the full 3 Credits can be awarded.

Schedule of evidence required:

A written listing of enhancements and values to be issued to the assessor by the ecologist detailing how the enhancements are spread on site and provide strategic ecological value. The professional judgment of the ecologist is to be accepted as to the correct placement and appropriateness of the enhancements

LE12 – Ecological Value – Positive change

Credit aim and ecological principles:

Measuring the final ecological value of the built design against the baseline generated in LE1 to demonstrate a positive influence of the development

Credit criteria (For 1 Credit):

The final landscape design is to be measured in terms of habitat area and imputed into the online calculator to determine a final ecological value

Compliance requirements:

A positive score is required to be awarded the credit, when the final design is compared to the original habitat value on site (outcome of LE1)

Schedule of evidence required:

Assessor can access outcome online

LE13 – Green infrastructure

Credit aim and ecological principles:

To generate green infrastructure opportunities for roles of the landscape to interact with the building, blending the boundary between the built form and the landscape.

Credit criteria (For 1 Credit):

A number of roles have to be established and outlined by BRE as benefits, and must be integrated in to the design

Compliance requirements:

In order to gain the credit, a project must demonstrate the inclusion of at least three examples e.g. A network of sustainable urban drainage, vegetative shading, wind shelter belts, Vegetative walls and or green roofs.

Schedule of evidence required:

Written report to detail which elements of the design demonstrate green infrastructure principles

LE14 – Multifunctional landscapes

Credit aim and ecological principles:

To demonstrate that the landscape and ecology it contains has multiple functions, creating a more efficient use of land.

Credit criteria (For 1 Credit):

A number of roles have to be established and outlined by BRE as multifunctional uses for the landscape, and must be integrated in to the design

Compliance requirements:

In order to gain the credit, a project must demonstrate the inclusion of at least three examples e.g. Drainage and flood management, Education opportunities, Recreation opportunities, a level of local amenity, minor food production, localised recycling (waste station), Threatened Species preservation (nature areas)

Schedule of evidence required:

Written report to detail which elements of the design demonstrate multifunctional landscape principles

LE15 – Promotion of Keystone &/or Threatened species

Credit aim and ecological principles:

Planning for the protection and encouragement of appropriate species that are either threatened or demonstrate status as a keystone species within the localised ecosystem.

Credit criteria (For 1 Credit):

Identification of locally relevant keystone or threatened species and introduce habitat or features appropriate to population increase

Compliance requirements:

An ecologist is required to identify which species are good candistaes for the credit and outline opportunities within the design to increase habitat to boost population numbers, the client must champion at least one species within the design to gain the credit.

Schedule of evidence required:

The ecologists is to issue a report on the species identified, why it is locally appropriate and the level of habitat enhancements to improve it s numbers for peer review to the assessor.

Appendix – 4 Supporting Habitat Calculation Data for BREEAM Eco

Calculations for BREEAM Eco have been undertaken using the formula outlined in chapter 5 and utilise data gathered in the course of the research, the calculation is applied to each subplot of the surveyed area

$$EV = \left(\{ HCR + SV + MLF + SPL \} \times RF \right)$$

Area data is taken from the 2003 survey as only one survey would be undertaken for the BREEAM Eco assessment. Additional data has been established based on local data raised from either survey work or data available from literature e.g. (watts et al., 2005) all scores are converted to a ranked scale of 100 and represented as a decimal to keep the numbers manageable, equally the overall EV values are 'normalised' to remove anomalous data entries and to further manage the number size and therefore overall values. The scoring of each factor can be changed independently as appropriate and represents one of the greatest strengths of this framework style approach. The sub plot scores are then combined to give plot EV scores, these are further combined to give an area score as outlined in Chapter 5. It is envisaged that all these calculation would be automatically undertaken by BREEAM Eco as part of the online data system that would be created by BRE.

The following table represents the data and calculations used for the Whipps Cross University Hospital Case Study outlined in Chapter 6, and forms the key elements of the new LE1, 2 & 12 Credits.

Area ident		HCR	SV	MLF	SPL	RF	AREA	EV values	Normalised	Plot EV's
A1.1.1	A	0.99	0.9	0.8	0.8	0.9	37407.11462	117495.747	1174.95747	
	B	0.99	0.6	0.8	0.2	0.9	1438.735178	3353.6917	33.536917	
	A	0.99	0.4	0.6	0.5	0.9	479.5783926	1074.735178	10.74735178	
	B	0.99	0.1	0.8	0.3	0.9	959.1567852	1890.498024	18.90498024	1238.146719
A1.1.2	A	0.95	0.2	0.5	0.3	0.7	2637.681159	3600.434783	36.00434783	
	B	0.95	0.2	0.5	0.1	0.7	383.6627141	469.9868248	4.699868248	
	C	0.95	0.1	0.5	0.1	0.7	287.7470356	332.3478261	3.323478261	
	D	0.95	0.14	0.5	0.14	0.7	287.7470356	348.4616601	3.484616601	
	E	0.95	0.5	0.5	0.17	0.7	287.7470356	427.0166008	4.270166008	
	F	0.95	0.16	0.5	0.08	0.7	239.7891963	283.6706192	2.836706192	
	G	0.95	0.7	0.5	0.19	0.7	767.3254282	1256.879051	12.56879051	
	H	0.95	0.17	0.5	0.06	0.7	38.36627141	45.11873518	0.451187352	
	I	0.95	0.17	0.5	0.14	0.7	38.36627141	47.26724638	0.472672464	
	F	0.95	0.14	0.5	0.19	0.7	38.36627141	47.80437418	0.478043742	
	K	0.95	0.8	0.5	0.18	0.7	719.3675889	1223.644269	12.23644269	
	L	0.95	0.08	0.5	0.2	0.7	469.9868248	569.1540448	5.691540448	

	M	0.95	0.14	0.5	0.5	0.7	345.2964427	505.1686957	5.051686957	
	N	0.95	0.2	0.5	0.17	0.7	431.6205534	549.884585	5.49884585	
	O	0.95	0.18	0.5	0.8	0.7	431.6205534	734.1865613	7.341865613	
	P	0.95	0.17	0.5	0.08	0.7	431.6205534	513.6284585	5.136284585	
	Q	0.95	0.19	0.5	0.2	0.7	230.1976285	296.4945455	2.964945455	
	R	0.95	0.15	0.5	0.17	0.7	38.36627141	47.53581028	0.475358103	
	S	0.95	0.1	0.5	0.1	0.7	86.32411067	99.70434783	0.997043478	
	T	0.95	0.06	0.5	0.14	0.7	38.36627141	44.31304348	0.443130435	
	U	0.95	0.16	0.5	0.11	0.7	38.36627141	46.19299078	0.461929908	
	V	0.95	0.14	0.5	0.16	0.7	38.36627141	46.99868248	0.469986825	
	W	0.95	0.11	0.5	0.7	0.7	38.36627141	60.69544137	0.606954414	
	X	0.95	0.17	0.5	0.19	0.7	38.36627141	48.61006588	0.486100659	
	Y	0.95	0.11	0.5	0.06	0.7	767.3254282	870.1470356	8.701470356	
	Z	0.95	0.19	0.5	0.14	0.7	767.3254282	956.0874835	9.560874835	
	AA	0.95	0.1	0.5	0.19	0.7	230.1976285	280.3807115	2.803807115	
	AB	0.95	0.2	0.5	0.18	0.7	287.7470356	368.6039526	3.686039526	
	AC	0.95	0.14	0.5	0.2	0.7	191.831357	240.3646904	2.403646904	
	AD	0.95	0.16	0.5	0.14	0.7	767.3254282	939.9736495	9.399736495	
	AE	0.95	0.18	0.5	0.16	0.7	191.831357	240.3646904	2.403646904	
	AF	0.95	0.17	0.5	0.17	0.7	134.2819499	168.2552833	1.682552833	
	AG	0.95	0.7	0.5	0.14	0.7	287.7470356	461.258498	4.61258498	
	AH	0.95	0.2	0.5	0.8	0.7	191.831357	328.9907773	3.289907773	164.9962603
A2.1	A	0.81	0.17	0.2	0.18	0.4	479.5783926	260.8906456	2.608906456	
	B	0.81	0.1	0.2	0.15	0.4	479.5783926	241.7075099	2.417075099	
	C	0.81	0.11	0.2	0.1	0.4	191.831357	93.61370224	0.936137022	
	D	0.81	0.19	0.2	0.14	0.4	287.7470356	154.2324111	1.542324111	7.504442688
A2.2	A	0.74	0.7	0.1	0.19	0.2	479.5783926	165.9341238	1.659341238	
	B	0.74	0.19	0.1	0.2	0.2	575.4940711	141.5715415	1.415715415	3.075056653
B2.2	A	0.86	0.18	0.4	0.2	0.3	3117.259552	1533.6917	15.336917	
	B	0.86	0.15	0.4	0.1	0.3	374.0711462	169.4542292	1.694542292	
	C	0.86	0.16	0.4	0.06	0.3	239.7891963	106.4664032	1.064664032	
	D	0.86	0.11	0.4	0.2	0.3	191.831357	90.35256917	0.903525692	
	E	0.86	0.01	0.4	0.5	0.3	38.36627141	20.37249012	0.203724901	19.20337391
C3.1	A	0.45	0.2	0.2	0.16	0.4	863.2411067	348.7494071	3.487494071	
	B	0.45	0.18		0.06	0.4	239.7891963	66.18181818	0.661818182	4.149312253
J1.2	A	0.67	0.5	0.7	0.18	0.1	613.8603426	125.8413702	1.258413702	
	B	0.67	0.17		0.16	0.1	143.8735178	14.38735178	0.143873518	
	C	0.67	0.1		0.14	0.1	95.91567852	8.728326746	0.087283267	
	D	0.67	0.17		0.2	0.1	38.36627141	3.990092227	0.039900922	
	E	0.67	0.1		0.17	0.1	95.91567852	9.016073781	0.090160738	

	F	0.67	0.16		0.11	0.1	374.0711462	35.16268775	0.351626877	
	G	0.67	0.14		0.19	0.1	2685.638999	268.5638999	2.685638999	
	H	0.67	0.11		0.7	0.1	863.2411067	127.7596838	1.277596838	
	I	0.67	0.2		0.19	0.1	239.7891963	25.41765481	0.254176548	
	F	0.67	0.16		0.15	0.1	38.36627141	3.759894598	0.037598946	
	K	0.67	0.1		0.01	0.1	239.7891963	18.70355731	0.187035573	
	L	0.67	0.1		0.1	0.1	1007.114625	87.61897233	0.876189723	
	M	0.67	0.7		0.14	0.1	5754.940711	868.9960474	8.689960474	
	N	0.67	0.8		0.11	0.1	230.1976285	36.3712253	0.363712253	
	O	0.67	0.14		0.16	0.1	575.4940711	55.8229249	0.558229249	16.90139763
J1.3	A	0.45	0.2	0.4	0.2	0.2	86.32411067	21.58102767	0.215810277	0.215810277
J1.4	A	0.41	0.2	0.2	0.2	0.2	86.32411067	17.43747036	0.174374704	
	B	0.41	0.11		0.19	0.2	191.831357	27.2400527	0.272400527	
	C	0.41	0.19		0.16	0.2	613.8603426	93.30677207	0.933067721	
	D	0.41	0.16		0.17	0.2	38.36627141	5.678208169	0.056782082	
	E	0.41	0.18		0.5	0.2	38.36627141	8.363847167	0.083638472	
	F	0.41	0.17		0.1	0.2	153.4650856	20.87125165	0.208712516	
	G	0.41	0.11		0.17	0.2	537.1277997	74.12363636	0.741236364	2.470212385
J4	A	0.2	0.01	0.1	0.19	0.1	1150.988142	57.54940711	0.575494071	0.575494071
G1	A	0.67	0.1	0.5	0.2	0.5	9.591567852	7.049802372	0.070498024	0.070498024

Estimated movement costs

Example of external data that can be used by BRE to influence factor scores, in this case the Permeability of habitat for species (combined with local frequency) can rank habitats within the Habitat context rarity factor (HCR) art of the calculation

Relative costs to movement as determined through expert judgement (lowest cost=1 and highest=50). In order to make the calculation manageable, the numbers have been inverted for the BREEAM eco calculation

broad land cover type	specific land cover type	woodland	heathland	mire/fen/bog	grassland
	sea	50	50	50	50
	water (inland)	40	50	20	50
Littoral rock	rock	50	50	50	40
	rock with algae	50	50	40	40
Littoral sediment	mud	50	50	50	30
	sand	50	20	40	20
	sand with algae	50	40	40	20
Saltmarsh	saltmarsh	45	50	50	30
	saltmarsh (grazed)	50	50	50	30
Supra-littoral rock	rock	45	50	50	40

Supra-littoral sediment	shingle (vegetated)	45	50	50	20
	shingle	45	50	50	25
	dune	20	5	30	10
	dune shrubs	15	3	30	15
	bog (shrub)	20	3	1	30
	bog (grass/shrub)	25	1	1	20
	bog (grass/herb)	25	1	1	15
	bog (undifferentiated)	25	1	1	25
	dense (ericaceous)	20	1	10	30
	gorse	15	1	20	10
	open	25	1	5	10
Montane habitats	montane	20	40	30	20
	deciduous	1	40	50	10
	mixed	1	40	50	15
	open birch	1	20	30	10
	scrub	1	20	40	5
	conifers	5	10	40	10
	felled	3	3	30	5
	new plantation	5	3	30	20
	barley	35	50	50	50
	maize	35	50	50	50
	oats	35	50	50	50
	wheat	35	50	50	50
	cereal (spring)	35	50	50	50
	cereal (winter)	35	50	50	50
	arable bare ground	35	50	50	45
	carrots	35	50	50	50
	field beans	35	50	50	50
	horticulture	35	50	50	50
	linseed	35	50	50	50
	potatoes	35	50	50	50
	peas	35	50	50	30
	oilseed rape	35	50	50	30
	sugar beet	35	50	50	30
	unknown	35	50	50	50
	mustard	35	50	50	50
	non-cereal (spring)	35	50	50	50
	orchard	25	50	50	10
	arable grass (ley)	30	50	50	40

broad land cover type	specific land cover type	woodland	heathland	mire/fen/bog	grassland
	setaside (bare)	30	50	50	40
	setaside (undifferentiated)	25	50	50	40
Improved grassland	intensive	35	50	50	50
	grass (hay/ silage cut)	30	50	50	10
	grazing marsh	30	50	40	5
Setaside grass	grass setaside	25	50	40	5
Neutral grass	neutral grass (rough)	20	50	50	3
	neutral grass (grazed)	25	50	40	2
Calcareous grass	calcareous (rough)	25	50	50	2
	calcareous (grazed)	25	50	40	1
Acid grass	acid	20	10	40	1
	acid (rough)	20	20	20	2
	acid with *Juncus*	20	20	5	2
	acid *Nardus/Festuca/Molinia*	20	5	10	2
Bracken	bracken	15	50	50	3
Fen, marsh and swamp	swamp	20	50	1	10
	fen/marsh	20	50	1	5

	fen willow	5	50	5	5
Suburban/rural developed	suburban/rural developed	10	50	50	45
	urban residential/ commercial	30	50	50	50
	urban industrial	35	50	50	50
Inland Bare Ground	despoiled	30	50	50	10
	semi-natural	25	50	50	1

Example of how movement costs might be estimated for woodland species.

Ecological cost	**Land cover type**	**Movement costs (as a function of distance for a 1km network)**
LOW	eg broadleaved deciduous woodland	1 – high permeability max. dispersal distance = 1000 ecological cost = 1 movement 1000/1=1000m
	eg broadleaved scrub	3 - medium high permeability max. dispersal distance = 1000 ecological cost = 3 movement 1000/3= 333m
MEDIUM	eg bracken	10 - medium permeability max. dispersal distance = 1000 ecological cost = 10 movement 1000/10= 100m
HIGH	eg rough neutral grassland	20 - medium low permeability max. dispersal distance = 1000 ecological cost = 20 movement 1000/20= 50m
	eg arable - cereals	50 – low permeability max. dispersal distance = 1000 ecological cost = 50 movement 1000/50= 20m

Adapted from:

WATTS, K., GRIFFITHS, M., QUINE, C., RAY, D., & HUMPHREY, J.W. 2005. *Towards a woodland habitat network for Wales.* Contract Science Report, 686. Bangor: Countryside Council for Wales.

Appendix 5 – Phase 1 Habitat Survey Habitat types and subtypes

The JNCC/RSNC habitat classification (revised 1984)

Taken from the JNNC Phase 1 Habitat survey field manual 2007

First level hierarchy	Second level hierarchy	Third level hierarchy	Fourth level Hierarchy
A Woodland and scrub	i Woodland	i Broadleaved	i Semi-natural
		2 Coniferous	2 Plantation
		3 Mixed	
	2 Scrub	i Dense/continuous	[i Acidic]
		2 Scattered	[2 Neutral]
			[3 Basic]
	3 Parkland and scattered trees		
	4 Recent/y felled woodland		
B Grassland	i Acidic	i Unimproved	i Upland
		2 Semi-improved	2 Lowland
	2 Neutral		
	3 Basic/calcareous		
	4 improved/reseeded		
	5 Marshy grassland	i Upland	
		2 Lowland	
C Tall herb and fern	i Bracken	i Continuous	
		2 Scattered	
	2 Upland spp.- rich vegetation		
	3 Other tall herb or fern	i Ruderal/ephemeral	
		2 Other	
D Heathland	i Dry dwarf shrub heath	i Acidic	i Upland
		2 Basic	2 Lowland
	2 Wet dwarf shrub heath	i Upland	
		2 Lowland	
	3 Lichen/bryophyte heath		
	4 Montane heath/dwarf herb		
	5 Dry heath/acidic grass mosaic		
	6 Wet heath/acidic grass mosaic		
E Bog and flush	i Bog	i Blanket bog	i Open *Sphagnum* carpets
		2 Upland raised	2 *Eriophorum vag.* and other bog veg. over *Sphagnum*
		3 Lowland raised bog	3 Mosaic of i and 2
		4 Valley bog	4 Bog veg. over *Sphagnum* (no *Eriophorum vag*)
		5 Basin mire	5 Mosaic of i and 4
			6 Wet heath over deep peat (no *Sphagnum*)
			7 Dry heath over deep peat (no *Sphagnum*)
			8 Bare peat
			9 Open bog pools

		2	Flush	i	Acidic flush		
				2	Basic flush		
				3	Bryophyte-dominated flush		
F	Swamp and fen/inundation communities	i	Swamp and fen	i	Single sp. dominant swamp		
				2	Tall fen vegetation		
		2	Open marginal/ inundation communities	i	Fragmentary marginal vegetation		
				2	inundation communities		
G	Open water	i	Standing water	i	Eutrophic	[i	Small ponds]
				2	Mesotrophic	[2	Ponds, etc <0.5 ha]
				3	Oligotrophic	[3	Lakes 0.5 ha]
				4	Dystrophic	[4	Large lakes >5 ha]
				5	Mari	[5	Canals and ditches]
				6	Brackish	[6	Reservoirs]
		2	Running water	i	Eutrophic	[i	Spring and small stream<1 m wide]
				2	Mesotrophic	[2	Streams and rivers i-3 m wide]
				3	Oligotrophic	[3	Rivers >3m wide]
				4	Mari (5)*		
				5	Brackish (6)*		
H	Coastland	i	intertidal	i	Mud-sand	i	*Zostera* beds (4)*
				2	Shingles/cobbles	2	Green algal beds (5)*
				3	Boulders/rocks	3	Brown algal beds (6)*
		2	Saltmarsh	i	*Spartina*		
				2	Other sp.(p)		
				3	Saltmarsh/dune interface		
				4	Scattered plants		
				5	inland saltmarsh		
		3	Shingle				
		4	Rocky boulders				
		5	Strandline vegetation				
		6	Sand dune	i	Fore dune		
				2	Yellow dune		
				3	Grey dune		
				4	Dune slack		
				5	Dune grassland		
				6	Dune heath		
				7	Dune scrub		
		7	Lagoon			i	Crevice/ledge vegetation (3)*
		8	Maritime cliff	i	Hard	2	Seacliff grassland (4)*
				2	Soft	3	Seacliff heath (5)*
						4	Bird cliff vegetation (6)*
i	Rock	i	Natural rock exposures and caves	i	inland cliff	1	Acidic
				2	Scree	2	Basic
				3	Limestone pavement		
				4	Other	1	Acidic
				5	Cave	2	Basic
				[6	Mountain top]		

				[7	Riverine]
				[8	Ravine]
		2	Artificial rock exposures	i	Quarry
				2	Spoil heap
				3	Mine
J	Other	i	Cultivated land		
		2	Boundary	i	intact hedge
				2	Defunct hedge
				3	Hedgerow with trees
				4	Fence
				5	Wall
				6	[Dry] ditch (7)**
		3	Building	i	Agricultural (incl. forestry)
				2	industrial
				3	Domestic
				4	Caravans
		4	Bare ground		
		5	others		
K	Marine				

Note

This classification is very similar to the i982 NCC SSSi habitat mapping system, (which follows the L982 version of the NCC/SNC classification). The differences are indicated on the tabie thus:-

[ ]	-	Not inciuded in the SSSi habitat mapping system.
*	-	Numbered differentiy in the SSSi habitat mapping system - the SSSi number codes in parentheses.
J(7)**	-	Boundary removed - an additionai category in the SSSi habitat mapping system.

Appendix 6 – Phase 1 Habitat survey target notes for Whipps Cross University Hospital

Phase 1 Habitat survey - Whipps Cross University Hospital Target Notes

to Accompany the 2003 survey with updates for the 2004, 2005 & 2008 Surveys.

Jon Kirkpatrick

1 2003: Strip of amenity grassland 4m wide. Includes a row of young planted hornbeam (Carpinus betulus) c.1m tall and a row of semi-mature pollarded London planes (Platanus x hispanica). Some potential for roosting bats in trunk holes. Japanese knotweed (Fallopia japonica) present in a single patch c.1m in diameter. Several stems less than 1m tall.

2004: No change – Species still present

2005: Pollarding of London planes recently undertaken, Japanese Knotweed no longer present

2008: Additional Hornbeam planting as part of the energy centre project.

2 2003: Mature horse chestnut (Aesculus hippocastanum) with trunk diameter of c. 2m. Potential for roosting bats, though no trunk holes were visible form the ground. Field layer consists of weedy plants such as chickweed (Stellaria media) and alkanet (Anchusa officinalis).

2004: No change

2005: Field layer removed bare ground

2008: Bare ground replaced by established amenity grassland

3 2003: Mature and semi-mature London plane (Platanus x hispanica), oak (Quercus robur) ash (Fraxinus excelsior). Field layer of amenity grassland with some weedy species such as

chickweed (Stellaria media), also Spanish bluebell (Hyacinthoides hispanica).

2004: No change – Species still present

2005: Field layer being managed as amenity grassland

2008: No change – Species still present

4 2003: Pollarded London plane (Platanus x hispanica), sycamore (Acer pseudoplatanus), ash (Fraxinus excelsior) and oak (Quercus robur). Field layer contained grasses, nettles (Urtica dioica) and Spanish bluebell (Hyacinthoides hispanica).

2004: Small sycamores no longer present

2005: Pollarding of London planes recently undertaken

2008: No change

5 2003: Young coppiced willow (Salix sp.) and sycamore (Acer pseudoplatanus) along site boundary. Potential as a bat foraging area. Field layer contained plants in target notes 2 and 3 and also bramble (Rubus fruticosis agg.).

2004: Bramble strong component of field layer in this survey

2005: No change – Species still present

2008: Field layer heavily managed, bramble reduced.

6 2003: Exotic Acer species.

2004: No change – Still present

2005: No change – Still present

2008: No change – Still present

7 2003: Hedge and shrubs to 1m including hazel (Corylus avellana), hornbeam (Carpinus betulus) and exotic shrubs (e.g. Pyracantha coccinea, Mahonia aquifolium and Rosa sp.). Also areas of Cotoneaster sp., Rosmarinus officinalis and Cornus sp. Some planted Sorbus sp. to c.0.2m trunk diameter.

2004: No change – Species still present

2005: No change – Species still present

2008: No change – Species still present

8 2003: Mature London plane (Platanus x hispanica) with trunk diameter c.1m. Small trunk holes providing potential bat roost sites.

2004: No change – Still present

2005: No change – Still present

2008: Damaged from on site accident (crane working on site reduced crown)

9 2003: Area of bare ground and weeds including shepherds purse (Capsella bursa-pastoris), smooth sow thistle (Sonchus oleraceus), fat hen (Chenopodium album), bristly oxtongue (Picris echioides), also some young planted Pyracantha coccinea.

2004: Area changed to amenity Grassland

2005: No change

2008: Area changed to hard standing

10 2003: Non native shrubs including Kerria japonica, Acuba japonica and a young Eucalyptus sp. tree.

2004: No change – Species still present

2005: No change – Species still present

2008: No change – Species still present

11 2003: Large Virginia creeper (Parthenocissus quinquefolia) growing up multi-storey brick building. May offer protection and roosting areas for bats. The building may offer suitable roosting sites as well.

2004: No change – Species still present

2005: No change – Species still present

2008: reduction in area from maintenance of building in particular around window opening, around 40% of 2003 area remaining

12 2003: Strip of young woodland along site boundary. Constitutes part of site wildlife area. Slender saplings (trunk diameter to c.0.2m) of sycamore (Acer pseudoplatanus), oak (Quercus robur), and grey poplar (Populus x canescens). Field layer consists of cleavers (Galium aparine), wood avens (Geum urbanum), Spanish bluebell (Hyacinthoides hispanica), mallow (Malva sp.) and burdock (Arctium minus). Possible summer bat roosting area.

2004: No change – Species still present

2005: Sycamore saplings diameter no at 0.25cm evidence of lack of maintenance (dessication)

2008: Additional planting of Sycamore and Oak to strengthen wooded boundary

13 2003: Area of bramble (Rubus fruticosus agg.) scrub with nettle (Urtica dioica), cow parsley (Anthriscus sylvestris) sterile brome (Bromus sterilis) and herb robert (Geranium robertianum). Trees form an open canopy and include a large lime (Tilia x europaea) (trunk diameter c.0.8m), hazel (Corylus avellana), pear (Pyrus sp.) and cherry (Prunus avium). Likely to be a suitable foraging area for bats, and a mature horse chestnut (Aesculus hippocastanum) provides possible bat roost sites.

2004: No change – species still present

2005: Field layer heavily managed, bramble reduced

2008: Brambles returned to 2003 levels, partially managed (path clearance)

14 2003: Small plastic-lined pond c.8m x c.3m. Contains duckweed (Lemna minor) broad leaved pondweed (Potamogeton natans), water starwort (Callitriche stagnalis) and marsh marigold (Caltha palustris). Pebble beach at one end. This pond may provide breeding habitat for amphibians including the great crested newt (Triturus cristatus). Surrounded by herbaceous vegetation and grasses, including goats rue (Galega officinalis).

2004: No change, no evidence of great crested newt

2005: area surrounding the pond increasingly unmanaged, no evidence of great crested newt

2008: Reduced vegetation in pond duckweed now dominant species, no evidence of great crested newt.

15 2003: Japanese knotweed (Fallopia japonica). Three stems to 1m.

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

16 2003: Mature London plane (Platanus x hispanica) offering potential bat roost sites due to trunk holes.

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

17 2003: Brick buildings with four stories and pitched roofs, in disrepair. High suitability for bat roost sites in holes in wall, roof and roof space.

2004: No change

2005: No change

2008: No change

18 2003: Horse chestnut (Aesculus hippocastanum) with trunk diameter of c.1m. High possibility of bat roost sites in trunk.

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

19 2003: London plane (Platanus x hispanica) with potential for bat roosting sites.

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

20 2003: Row of London planes (Platanus x hispanica) with potential for bat roost sites due to holes in trunks. Several rows of newly planted native saplings below.

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

21 2003: Small building c. 3.5m in height. Potential bat roost sites both within building and surrounding ivy (Hedera helix). Surrounded by elder (Sambucus nigra) bushes.

2004: No change – Building and Species still present

2005: Building still present, increased ivy growth 50% over 2003 area

2008: Building still present, increased ivy growth, significant Elder growth in both size and number

22 2003: Mature oak (Quercus robur) and ash (Fraxinus excelsior) trees.

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

23 2003: Mature oak (Quercus robur) and ash (Fraxinus excelsior) trees and building form a possible flight line for bats.

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

24 2003: Mature oak (Quercus robur) with trunk diameter of c.1m, likely to offer suitable roost sites for bats. Also sycamore (Acer pseudoplatanus) and ash (Fraxinus excelsior).

2004: No change - Species still present

2005: No change - Species still present

2008: Tree removed to allow access to new car park

25 2003: Line of pollarded planted lime trees (Tilia x europaea) to 8m tall. Possible bat flight line. Ivy covered fence along site boundary offers possible bat roost sites.

2004: No change - Species still present

2005: recent pollarding evident

2008: No change - Species still present

26 2003: Linear stand of Japanese knotweed (Fallopia japonica) c.8m long and to c.2m tall.

2004: No change - Species still present

2005: No change - Species still present

2008: removed as part of neighbouring car park works

27 2003: Two mature sycamores (Acer pseudoplatanus) and two mature oaks (Quercus robur). Some trunk holes present and therefore potential for bat roost sites.

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

28 2003: Pollarded London planes (Platanus x hispanica). Some trunk holes mean potential for bat roost sites, but next to busy road.

2004: No change - Species still present

2005: recent pollarding evident

2008: No change - Species still present

29 2003: Sweet chestnut (Castanea sativa) with trunk diameter of c.1.3m. Several trunk holes offer potential for bat roost sites.

2004: No change - Species still present

2005: Tree removed, vehicle accident rendered it unsafe

2008: Not present

30 2003: Avenue of London planes (Platanus x hispanica) with trunk diameters of c.0.3m, also limes (Tilia x europaea). Very limited potential for bat roost sites. Also small patch of ragwort (Senecio jacobaea) in this area.

2004: No change - Species still present

2005: recent pollarding evident

2008: No change - Species still present

31 2003: Car park - no trees present.

2004: Car park - no trees present.

2005: Car park - no trees present.

2008: Car park - no trees present.

32 2003: Trees no longer present.

2004: Trees no longer present

2005: Trees no longer present

2008: Trees no longer present

33 2003: Aging buildings with corrugated roofs. Limited potential for bat roost sites.

2004: Building present – No change

2005: Building present - No change

2008: Building abandoned due to health concerns (asbestos) still low level potential for bat rooting, single story buildings, no obvious flight path

34 2003: Three mature holly (Ilex aquifolium) trees. Unlikely to be suitable as bat roosting sites, but very obvious bird roosting site.

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

35 2003: Overhanging brickwork road support. Brickwork cracked with many small holes. Small

possibility of bat roost sites in this structure.

2004: No change

2005: No change

2008: No change

36 2003: Linear area of Japanese knotweed (Fallopia japonica) c.6m in length.

2004: No change – Species still present

2005: No change – Species still present

2008: No change – Species still present

37 2003: Wooden fence along site boundary, thick growth of Ivy (Hedera helix) offering potential summer roost sites for bats.

2004: No change Ivy still present

2005: Section rebuilt ivy removed potential roost lost

2008: No change

38 2003: Small brick building with open door and grille. Unlikely to be suitable as a roost site for bats due to exposure.

2004: Building still present no change

2005: Building still present no change

2008: Building still present no change

39 2003: Aging brick building (house). No obvious holes, but some potential for bat roost sites.

2004: Building still present no change

2005: Building still present no change

2008: Building still present no change

40 2003: Horse chestnut (Aesculus hippocastanum) with trunk diameter of c.1m, and Leyland cypress (X Cupressocyparis leylandii). No obvious holes and hence low likelihood of bat roost sites being present.

2004: No change species still present

2005: No change species still present

2008: No change species still present

41 2003: Large brick building with three stories. Better condition than the similar building in target note 11, but potential for bat roost sites in roof spaces.

2004: Building still present no change

2005: Building still present no change

2008: Building still present no change

42 2003: Brick building, tile cladding on second floor and some dislodged. Excellent potential for bat roost sites.

2004: Building still present no change

2005: Building still present no change

2008: Building still present no change

43 2003: Mature (dying) oak (Quercus robur) with many holes highly suitable for use as bat roosts.

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

44 2003: Flat roofed buildings in disrepair. Wood cladding may provide suitable roost sites for bats.

2004: Building still present no change

2005: Building still present no change

2008: Building now unoccupied due to relocation on site.

45 2003: Three storey brick building. Many cracks, grilles and openings in walls provide areas highly suitable for bat roost sites. In particular the brick infills have come away from the arches at the base of the walls on the south east allowing access to wall cavities etc.

2004: Building still present no change

2005: Building still present no change

2008: Building still present no change

46 2003: Large mature London plane (Platanus x hispanica) c.1.5m trunk diameter. Possible bat roost sites, although no obvious holes or cracks in trunk.

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

47 2003: Single storey building with pitched roof, wood cladding and some gaps present. Possibly offers suitable bat roosting sites.

2004: Building still present no change

2005: Building still present no change

2008: Building still present no change

48 2003: Flat roofed old brick building, some gaps in mortar, possible wall cavities. May provide suitable bat roost sites.

2004: Building still present no change

2005: Building still present no change

2008: Building still present no change

49 2003: Brick building with rendered walls. No roof cavity and door open. Too open to offer much potential for bat roost sites.

2004: Building still present no change

2005: Building still present no change

2008: Building still present no change

50 2003: Old air raid shelters with open doors. Very overgrown with scrub and under a tree canopy. Potentially highly suitable for bat roosting sites. Could be considered an artificial cave.

2004: Building still present no change

2005: Building still present no change

2008: Building still present no change

51 2003: Modern buildings with pitched roofs no obvious bat roost sites. Surrounded by mature planted trees with some potential for bat roost sites.

2004: Buildings still present no change, trees still evident

2005: Buildings still present no change, trees still evident

2008: Buildings still present no change, trees still evident

52 2003: Large oak (Quercus robur) of c.1.4m trunk diameter. Cracks and holes in trunk may provide suitable bat roost sites.

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

53 2003: Woodland with path between James Lane and Whipps Cross Road. Dominated by oaks (Quercus robur) with large trunk diameters. Hornbeam (Carpinus betulus) is also present but does not reach the (rather open) canopy. Shrub layer species include holly (Ilex aquifolium), hawthorn (Crataegus monogyna) and English elm (Ulmus procera). Field layer dominated by bramble (Rubus fruticosus agg.) but with wood avens (Geum urbanum), ivy (Hedera helix), cow parsley (Anthriscus sylvestris), nettle (Urtica dioica), hogweed (Heracleum sphondylium), cleavers (Galium aparine), herb robert (Geranium robertianum) and grass species. Oaks offer very good potential for bat roost sites. No signs of badgers were seen here.

2004: No change - Species still present, no evidence of badgers

2005: No change - Species still present, no evidence of badgers

2008: No change - Species still present, no evidence of badgers

54 2003: Roadside verge along Whipps Cross Road. Dominated by bramble (Rubus fruticosus agg.), false oat grass (Arrhenatherum elatius) and nettle (Urtica dioica).

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

55 2003: Woodland composed of mature (presumably planted) horse chestnut (Aesculus hippocastanum) and lime (Tilia x europaea). Dense canopy and rather sparse field layer consisting of nettle (Urtica dioica) and bramble (Rubus fruticosus agg.) with the occasional holly (Ilex aquifolium). Spanish bluebell (Hyacinthoides hispanica) also present.

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

56 2003: Woodland composed of tall trees with small trunk diameters (to c.0.3m). Dominant species is sycamore (Acer pseudoplatanus).

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

57 2003: Lime (Tilia x europaea) with trunk diameter of c.0.9m. Several trunk holes offer potential for bat roost sites.

2004: No change species still present

2005: Tree removed through work on car park

2008: Tree no longer present

58 2003: Garden area behind Woodbury Hospital. Contains planted trees, amenity grassland, introduced shrubs, wooden fencing and gazebo.

2004: No change, maintenance evident

2005: No change, maintenance evident

2008: No change, maintenance evident

59 2003: Woodland dominated by sycamore (Acer pseudoplatanus) with trunk diameter to c.0.35m. Some larger trees. A number of other canopy and shrub layer species present including: horse chestnut (Aesculus hippocastanum), holly (Ilex aquifolium), elder (Sambucus nigra), hawthorn (Crataegus monogyna), grey poplar (Populus x canescens) and Rhododendron ponticum. Some mature trees were present which are likely to offer suitable bat roost sites. No signs of badgers were seen.

2004: No change - Species still present, no evidence of badgers

2005: No change - Species still present, no evidence of badgers

2008: No change - Species still present, no evidence of badgers

60 2003: Triangle of woodland bordered by the James Lane fork and Whipps Cross Road. Dominated by mature oaks (Quercus robur) with large trunk diameters (to 1.5m). Shrub layer dominated by holly (Ilex aquifolium), but with other species also present: hornbeam (Carpinus betulus), sycamore (Acer pseudoplatanus), cherry (Prunus avium), elder (Sambucus nigra) and occasional young yews (Taxus baccata). Field layer consists of cleavers (Galium aparine), ivy (Hedera helix), cow parsley (Anthriscus sylvestris), wood avens (Geum urbanum), herb robert (Geranium robertianum) and sterile brome (Bromus sterilis). Mature trees likely to provide abundant bat roost sites. No signs of badgers were seen here.

2004: No change - Species still present, no evidence of badgers

2005: No change - Species still present, no evidence of badgers

2008: No change - Species still present, no evidence of badgers

61 2003: Woodland dominated by open canopy of very large mature oaks (Quercus robur). Open shrub layer dominated by holly (Ilex aquifolium) and field layer dominated by bramble (Rubus fruticosus). Oaks likely to provide abundant bat roost sites. No signs of badgers seen. Some deadwood noted which may provide suitable habitat for stag beetle larvae.

2004: No change - Species still present, no evidence of badgers or stag beetles

2005: No change - Species still present, no evidence of badgers or stag beetles

2008: No change - Species still present, no evidence of badgers or stag beetles

62 2003: Open areas where dominant oaks (Quercus robur) are widely spaced. Several foot paths. Field layer dominated by grasses such as perennial ryegrass (Lolium perenne) cocksfoot (Dactylis glomerata) and smooth meadow grass (Poa pratensis).

2004: No change - Species still present

2005: No change - Species still present

2008: No change - Species still present

63 2003: Open woodland as in target note 62 but with occasional oak saplings and scrub species.

2004: No change - Species still present

2005: No change - Species still present

2008: Species still present with addition of Sycamore saplings

64 2003: Strip of woodland between the north boundary of Whipps Cross Hospital and the A114 Whipps Cross Road. Mixed canopy of trees, most of which appear to have grown rather recently. Abundant sycamore (Acer pseudoplatanus), oak (Quercus robur) hawthorn (Crataegus monogyna), cherry (Prunus avium) ash (Fraxinus excelsior) and holly (Ilex aquifolium). Trunk diameters are generally less than 0.35m but some oaks are larger and a single mature beech (Fagus sylvatica) was noted toward Whipps Cross Road. Larger diameter trees are likely to provide suitable bat roost sites. No signs of badgers were seen.

2004: No change - Species still present, no evidence of badgers

2005: No change - Species still present, no evidence of badgers

2008: No change - Species still present, no evidence of badgers