Soils in the Built Environment
- A Strategy for the Construction Sector

DEFRA

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First Soil Action Plan

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Abbreviations

AGS	Association of Geotechnical and Geo-environmental Consultants
APL	Association of Professional Landscapers
BALI	British Association of Landscape Industries
BMV	Best and Most Versatile
BRE	Building Research Establishment
BREEAM	Building Research Establishments Environmental Assessment Method
CCS	Considerate Contractors Scheme
CDM	Construction Design Management
CEEQUAL	Civil Engineering Environmental Quality Assessment and Award Scheme
CFEF	Construction Federation Environmental Forum
CIBSE	Chartered Institute of Building Services Engineers
CIEF	Construction Industry Environment Forum
CIRIA	Construction Industry Research and Information Association
CSD	Commission on Sustainable Development
CSR	Corporate Social Responsibility
DEFRA	Department for the Environmental, Farming and Rural Affairs
DMRB	Design Manual for Roads and Bridges
EIA	Environmental Impact Assessment
EMS	Environmental Management Systems
EMAS	Eco-management and Audit Scheme
EU	European Union
FAO	Food and Agricultural Organization
GDO	General Development Orders
GDP	Gross Domestic Product
HTA	Horticultural Trade Association
ICE	Information Centre for the Environment
IEEM	Institute of Ecology and Environmental Management
IEMA	Institute of Environmental Management and Assessment
IMS	Integrated Management System
KPI	Key Performance Indicators
LACL	Local Authority Contaminated Land Network
MLPM	Master of Landscape Planning and Management
NBS	National Building Specification

NHS	National Health Service
NR	Nature Reserve
ODPM	Office of the Deputy Prime Minister
PFI	Private Finance Initiative
PPP	Polluter Pays Programme
R & D	Research and Development
RIBA	Royal Institute of British Architects
RICS	Royal Institution of Chartered Surveyors
SCS	Soil Conservation Service
SAPE	Soil Action Plan for England
SSSI	Site of Special Scientific Interest
SUDS	Sustainable Urban Drainage Techniques
UNCED	United Nations Conference on Environment and Development
WRAP	Waste and Resources Action Programme
WSSD	World Summit on Sustainable Development
WWW	World Wide Web

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Executive Summary

1.1.1 General awareness of soil issues and use of existing soil guidance in the construction sector is low. Developers and contractors rely heavily on consulting specialists such as landscape architects, engineers and environment /geo-environmental consultants for guidance and techniques for soil handling, management and protection.

1.1.2 The feedback confirms that while a proportion of the construction and building industry are taking steps to proactively address environmental issues this is driven primarily by legislation, liabilities, reputation and competitiveness.

1.1.3 As a result there are a number of levels within the construction sector that need to be targeted to raise awareness of soil in the built environment. We would recommend that a strategy for the built environment includes short term, medium term and long term actions that will address the construction sector at different levels.

1.1.4 DEFRA should prioritise the compilation of concise guidance on best practice techniques for soil management and protection for use by the construction sector, e.g. a Toolbox Talk for operatives on construction sites, with more detailed guidance available for specialised consultants. Guidance from other sectors such as the minerals and landscape industry should be transferred to the construction industry and made centrally available e.g. DEFRA website.

1.1.5 DEFRA should collaborate with leading institutes and research bodies including the BRE and CIRIA, to develop technical specifications, industry codes of practice, EMS codes and voluntary incentives.

1.1.6 A voluntary approach is unlikely to achieve a significant impact across the whole sector but the inclusion of soil issues into existing voluntary best practice schemes such as BREEAM and CEEQUAL will start to raise awareness and help the industry prepare for possible future legislative drivers.

1.1.7 For the construction industry as a whole, including the vast number of 'micro' construction companies, to implement better soil management procedures and achieve a step change in soil awareness and protection, a statutory requirement appears necessary. In parallel to discussions with central and local government, there should be consultation with industry stakeholders, and the aims and objectives of potential statutory requirements will need to be clearly defined.

2 Introduction

2.1 PROJECT BACKGROUND

2.1.1 WSP Environmental have been appointed by the Department for the Environmental, Farming and Rural Affairs (DEFRA) to help devise a strategy for the delivery of the construction related action from DEFRA's *First Soil Action Plan for England: 2004-2006*[1]; Actions 4, 47 and 50.

2.1.2 The First Soil Action Plan for England (SAPE) sets out the aspirations and objectives for England's soil resource. The vision of the Strategy is '*to ensure that England's soils will be protected and managed to optimise the varied functions that soils perform for society, in keeping with the principles of sustainable development and on the basis of sound evidence'.*

2.1.3 The SAPE report aims to encourage better understanding of soil as a resource, highlight its value to society and promote a wider agenda of soil protection and better management.

2.1.4 The actions specifically focussed on the construction industry and the built environment within the SAPE report, are Actions 4, 15, 47 and 50:

2.1.5 Action 4: 'DEFRA will engage with the Department of Trade and Industry, and other professional bodies, to raise standards of sustainable construction practices in respect of soil stripping and avoidance of compaction, and disseminate knowledge throughout the development and construction sectors. DEFRA will review progress in 2006.

2.1.6 Action 15: DEFRA will work with the ODPM to clarify the use of existing mechanisms, including the Building Regulations, to ensure proper consideration of soil implications during the planning and development process. The first milestone will be to examine criteria for designating soils that should be protected from building during the current review of BMV Land Policy. Subject to the agreement of other partners, a second milestone will be the issue of revised guidance during 2005.

2.1.7 Action 47: DEFRA will promote within industry a better understanding of the potential benefits to sustainable construction through specific tests and British Standards for soil use – e.g. soak away function and infiltration tests; construction specifications; electrical earthing tests and specifications, good practice guide in respect to soils and subsidence. We will aim to have developed and implemented specific measures in 2005.

2.1.8 Action 50: DEFRA will consult the Environment Agency and local planning authorities with the objective of devising a proportionate and targeted programme to improve monitoring of use of soils in relation to built development, compliance with soil protection conditions of planning permissions and for reducing off-site impacts. DEFRA will report progress in 2005.

2.1.9 To facilitate a strategy to deliver these actions WSP have undergone consultation with a range of construction industry stakeholders, including foundation/piling professionals; geo-environmental land remediation specialists; developers; house builders; real estate companies; contractors; and the Environment Agency.

2.1.10 The aims and objectives of this consultation process are as follows:

- To establish the current uptake of existing information relating to soils management and protection
- To identify what additional information and areas of research will most benefit the construction industry and enable better soil handling and protection in the future
- To understand commercial and practical requirements of the industry and how these influence future information
- To recognise what incentives would most encourage the industry to proactively embrace best practice soil management and protection
- What existing networks are potentially available and appropriate to disseminate future information

2.1.11 This information has been gathered from voluntary participants and WSP and DEFRA are grateful for their contribution.

3 Background

3.1 DEFINITION OF SOIL

3.1.1 Soil is a complex and finite living resource that is fundamental to the natural and continuing functioning of our environment. An integral and dynamic component of the environment anchoring several interconnecting ecological and geological elements such as air, water, rocks, flora and fauna, soil supports multiple functions and provides human society with a range of vital services. If used sustainably, the exploitation of soil for one service or function should not impact on the long term ability of the soil to provide other functions.

3.1.2 These functions and services can be divided into six main headings: **environmental regulation** including pollutant prevention through attenuation and degradation of chemical contaminants, carbon sequestration that minimises the effects of climate change, water flow regulation and flood risk reduction. Fertile soil provides a growing medium for **food and fibre production,** essential for human existence and providing economic prosperity; providing a **habitat** for plant and animal communities contributing to **biodiversity** and a gene pool source for survival of humanity; providing a **source of raw materials**; **cultural heritage** services including defining the character of local landscapes and preserving archaeological remains; and providing a **platform for construction** supporting buildings and transport infrastructure. The number of functions delivered by a soil resource will change over time and according to the context in which the soil is used.

3.1.3 Man's activities directly and indirectly impact on soil. Our expanding population results in a greater demand for food and agricultural output, raw materials, land to build homes and infrastructure, and land to dispose of our waste products. These all increase the pressure on our soil resources and result in the physical, biological and chemical condition of soil changing, altering the ability of soil to deliver its environmental functions and services to society.

3.1.4 The rate of soil degradation far exceeds the rate at which it is assimilated and reconstituted, defining soil as a non-renewable resource. The fact that soil degradation is not always immediately recognised and is often highlighted indirectly through damage to other ecosystem elements such as air and water, means that declining soil quality is often underestimated. This is reflected in the lack of specific soil protection measures incorporated into UK legislation and a deficit of awareness and understanding in those handling soil in the UK. Left unchecked, the lag time between soil degradation and acknowledgment could lead to an irreversible and critical situation.

3.1.5 As a result, protection and appropriate management of our soil resource is key to the delivery of sustainable development and the Government's commitment to achieving a better quality of life for everyone[2,3].

3.1.6 Globally, environmental issues such as desertification; deforestation; land contamination and changing agricultural practices are gaining increasing public awareness and attention, with soil as a non-renewable resource becoming a topic of international importance. For example, in the United States alone, it is estimated that more than 5 tons of soil per acre are eroding over an area estimated to be 1 million acres of crop land[4] (SCS, 1980b). However, soil management and protection in the UK, particularly soil in the built environment, has not been the focus of attention, however, with new policy drivers resulting in the publication of DEFRA's First Soil Action Plan, appropriate management of soil in the built environment can now be addressed.

3.2 SOILS IN THE BUILT ENVIRONMENT

3.2.1 The term 'built environment' is not restricted to urban areas only but refers to a variety of areas where construction has occurred or where development is planned. The term 'built environment' can therefore be applied equally to both urban and rural environments. According to government statistics, nearly 11% of England and 3% of Wales is covered with residential and industrial development and associated infrastructure[5]. In addition, within urban areas green space accounts for only 10% compared with car parks and roads that consist of over 40% of development areas. Future predictions estimate that by 2016 an additional 1.3% of England's soils will be covered by development, most of this resulting from the pressure to accommodate the extra 3.8 million households[6].

3.2.2 The principle function of soil in the built environment is perceived to be the provision of a platform for construction and secondly as a component of aesthetic landscaping. Similarly, soil in the built environment is generally perceived as a secure medium on which to construct buildings and infrastructure (roads and railways).

3.2.3 Construction and development have several impacts on soil, from soil stripping and stockpiling that result in soil losses and degradation, to pollution or contamination that reduces the functions a soil can provide. Construction and development also result in 'soil sealing', defined as being the covering of soil with impermeable materials such as buildings, or changing of the properties of the soil's surface so that it becomes impermeable e.g. through compaction.

3.2.4 In the built environment soil quality and quantity is also degraded through compaction by heavy pedestrian traffic, vehicles and machinery. Inadequate protection or vegetation establishment on soil stockpiles causes soil loss through wind erosion and surface runoff. Soil pollution results from exhaust hydrocarbons arising from transport, industrial process and contamination. All these reduce the soil's capacity to provide the functions and services associated with a 'healthy' soil.

3.2.5 Whilst erosion decreases the quantity of soil available and pollution leads to a loss of fertility and productivity, soil compaction leads to changes in the soil structure. Specifically, compaction reduces the size of pore spaces between the soil particles[7]. This inhibits drainage and gaseous exchange leading to a soil that retains water and has an anaerobic environment, which in turn leads to both the death of aerobic organisms living in the soil and the suffocation of plant roots causing trees and other vegetation to grow poorly and eventually die. The occurrence of compaction is most likely and most acute in wet conditions.

3.2.6 The use of soil within the construction sector is very poorly defined and, to a significant extent, unregulated in terms of quality and activities to ensure protection of the resource. This is not particularly surprising given the structure of the construction industry, the number of companies operating within it and the huge number, size and range of sites being developed. There are a large number of variables to consider when defining the use of soils within this sector.

3.2.7 General overall understanding of soil, its full properties and functions is poor within the construction industry. Knowledge of the structural and geotechnical qualities of soil is, of course, well understood. The sector relies heavily on consulting specialists and landscape architects to raise awareness of other soil qualities and ensure the soil is adequately protected. However, the number of different trade contractors on site before the landscape architects and contractors take over responsibility of the soil resource often means that significant and often irreversible damage has already been done. This operational complexity compares unfavourably with the agricultural industry, where an

individual farmer whose livelihood depends on the integrity of the soil and understands the importance of maintaining quality and quantity, is fully responsible for the protection and management of that resource.

3.2.8 Taking a typical, large construction company as an example it is evident that the range of development activities will vary across the company and may potentially cover commercial /residential development sites, rail and road transport developments, ports and airports, hospital and school developments etc. These development sites may be located on Greenfield or Brownfield sites (or both).

3.2.9 From discussions with one such 'typical construction company' in the UK the scale of operations and the potential impact of these upon soils and soil quality was considered. As a very rudimentary benchmarking exercise some interesting information can be extrapolated from the data provided and is summarised below.

3.2.10 The land bank presently being used for operational purposes i.e. construction of some type, comprises approximately 60 sites in England and Wales and covers in the region of 125ha – 175ha in total. The sites vary in size from small 0.5ha commercial development sites to much larger road transport schemes. As a general rule approximately 50% of the land taken in these sites is Greenfield land, the remainder being Brownfield of some sort. It is normal for sites to be one or the other rather than a combination of both. Rather confusingly, due to the nature of the industry and the reliance on sub-contractors to develop individual sites, it is possible for more than one construction company to consider itself to be responsible for a particular site thus there is a high potential for double counting in the industry as a whole. However, this particular company questioned is one of approximately 20 similarly large construction companies in the UK and operationally they do not commonly act as sub-contractors (being normally the main contractor) nor subcontract works to their direct competitors among the 20 similar companies. With both this assumption and the presumption that each of the other 20 large construction companies has, on average, a similar land bank of construction projects and division of land, it can be calculated that the land use of these construction companies is between 2500ha – 3500ha at any one time. In the region of 1250ha – 1750ha of land under construction could therefore be Greenfield sites. This is a very large area of land which could contain in the region of 3 million cubic metres of topsoil. According to the Environment Agency, approximately 6,500 hectares of land shifts from rural to urban use every year in spite of pressures to encourage Brownfield development[8]. This figure tallies quite well with our rudimentary benchmark figure.

3.2.11 Unlike the mineral extraction industry where it has become an established practice, within the construction industry it is not common practice to carry out a detailed soil quality survey on Greenfield sites to determine the quality of the soil present. Superficial surveys to determine the depth and volume of topsoil present combined with geotechnical surveys are carried out. Many sites are very small <2ha and Local Planning Officers do not require for soil quality surveys or soil protection/handling strategies within planning conditions imposed on the site. However, even on the larger construction sites, it is not common practice for soils to undergo a detailed survey unless contamination is suspected as being present. Unsurprisingly, on Brownfield sites, where the soil can generally be anticipated to be of lower quality due to the potential presence of contamination and historic use of the land, the soils are often extensively surveyed and detailed soil handling strategies are developed. Discussions with our 'typical construction company' confirmed this is generally the case.

3.2.12 As well as providing a platform for construction, the other primary function of soil within the built environment is as a medium for soft landscaping, providing a habitat and anchor for plant and animal communities. The cost of procuring top soil is

insignificant compared to the overall cost of construction and development of a particular site. Efforts are not concentrated on the protection and retention of the soil, rather on speedy preparation of the site as a base for construction works. The geotechnical qualities of a soil are of more importance to the construction works than its quality as a growing medium and valuable resource. Furthermore, the procurement of top soil for a development is often part of the contract of the landscape contractor near the completion of a particular project. The cost is therefore relegated to become part of the landscape appointment, which is one of the smaller costs compared to other contractor and consultant appointments. This perceived 'lack of value' in comparison to other aspects of the construction and development works on a site is a problem within the industry as it has the effect of relegating the importance and true value of soil.

3.2.13 It is common practice for construction sites to have topsoil and subsoil removed, at least in part, at the commencement of the site development process. Responsibility for this work is normally delegated to a third party responsible for clearing a particular site and undertaking site preparation works. Occasionally a site will have soil stripped in stages by different contractors responsible for different elements of the overall construction project rather than as one process. The treatment and handling of the soil resource on site can therefore vary widely. In some circumstances the topsoil and subsoil will be stripped, then stockpiled separately either for future use on site or, quite commonly, for exportation as a saleable asset or waste material. It is not uncommon, however, particularly on small sites for the topsoil and subsoil to be stripped and handled as one unit. Because the responsibility for handling soils is often delegated to a sub-contractor and not dealt with in a strategic manner, the management of soils is not always of the highest priority. The delegation of soil handling and the number of parties involved prior to any landscaping contributes to the high number of post completion disputes associated with poor growth and eventual death of landscape planting.

3.2.14 It is worth noting that the landscaping costs associated with drainage, fertilisation and weed control are not solutions but may be a direct consequence of the degraded soil resource caused by compaction during the early phases of construction. In effect the costs associated with these activities are substantially increased as a result of poor planning and practice in regard to soil protection and management.

3.2.15 It is common, particularly on Brownfield sites for top soil to be imported from other sites or areas. This practice has a number of problems associated with it, including incompatibility with the subsoil and site conditions (drainage), and the potential to import contaminants, or plant and animal diseases.

3.2.16 There is also a growing UK market within the built environment for soil-forming materials, such as organic compost materials and other manufactured soils to be utilised either as a replacement for, or additive to, topsoil and subsoil. This use of soil forming materials is presently applied to a limited number of products either by waste regulatory requirements restricting use of a produced, e.g. waste derived compost, or constrained by excessively restrictive construction industry specifications. Many of the soil specifications in use within the industry were not developed to be applied to recycled or alternative soil resources.

3.2.17 Comparison to the minerals extraction industry is not necessarily judging like with like, however, it provides a benchmark for what may be achieved in terms of soil protection. Mineral sites vary in size, averaging 5ha -20ha, and are far fewer in number. All mineral extraction sites have planning controls in place to control the use and handling of soil. A key reason for this is obviously that the majority of mineral sites require the soil to be returned and reinstated at some stage in the life of the quarry. Retention of this material in good condition is therefore a priority to the mineral extraction

company. The end product of the mineral extraction industry is land, often agricultural land.

3.2.18 In comparison, the end product of the construction industry is either a building or road etc. within which structure the need for soil is limited to peripheral surrounding landscaping in most situations. The minerals industry has a focus on the end product, i.e. land, and the cost associated with producing this to a high quality which requires large volumes of good quality soils. Purchase of large volumes of soil material is always extremely difficult so protection of the original soil asset removed prior to mineral extraction is always a priority. On a construction site there is, more often than not, a surplus of soil material (normally subsoil of varied quality) and a need to remove the surplus so that it does not interfere with construction. The end product may require some soil for landscape 'beautification' but this is a visual amenity function rather than focussed on 'productivity' of the soil. The end product is the building or structure created.

3.2.19 Whilst there are clear comparisons to be made between the construction sector and the minerals sector in terms of land-take and soil volumes affected, the strategic planning and regulatory background of the two industries is very different. The incentives for proper management of soils within the mineral industry are clearly understood and primarily financial as well as regulatory in nature. In the construction sector there is little regulation controlling the use of soil and financial aspects of soil use are secondary to the primary cost issues.

3.2.20 The objective of DEFRA is to promote sustainable use and protection of soils in the urban environment.

4 Policy and Legislation Context

4.1 COUNCIL OF EUROPE'S EUROPEAN SOIL CHARTER

4.1.1 The importance of soil as a resource has been acknowledged in Europe since the publication of the Council of Europe's European Soil Charter (1972) with improved soil management and protection being practiced throughout Europe as a consequence.

4.1.2 Following the Council of Europe's European Soil Charter (1972), a Revised European Charter for the Protection and Sustainable Management of Soil was adopted by the Committee of Ministers of the Council of Europe on 28 May 2003[9].

4.2 WORLD SOIL CHARTER

4.2.1 In November 1981, the United Nations Food and Agriculture Organization (FAO) adopted the World Soil Charter[10], which is non-binding in nature. The Charter outlines a number of principles and guidelines for action. This includes a call for governments, organisations and land users to implement management practices that will protect land in the long term. It promotes the development of land-use policies that will encourage and reward better soil management and conservation.

4.3 AGENDA 21 RIO CONFERENCE

4.3.1 With growing concern over environmental pollution and long-term sustainable use of environmental resources, the global community came together to develop objectives to progress sustainable development.

4.3.2 This resulted in Agenda 21, the Rio Declaration on Environment and Development and the Statement of principles for the Sustainable Management of Forests being developed and adopted by more than 178 Governments at the United

Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil in 1992. Agenda 21 is a plan of action addressing the human impact on the environment to be implemented globally, nationally and locally by organisations and governments associated with the United Nations.

4.3.3 Agenda 21 was followed by the Commission on Sustainable Development (CSD) created in December 1992 to monitor and report on implementation of the agreements at the local, national, regional and international levels.

4.3.4 Progress was reviewed in 1997 at the United Nations General Assembly meeting and a full implementation of Agenda 21, the Programme for Further Implementation of Agenda 21 and the Commitments of the Rio principles were reaffirmed at the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa from 26 August to 4 September 2002.

4.4 EC SIXTH ENVIRONMENTAL ACTION PROGRAMME

4.4.1 Following from the success of European environment policy, the programme identified a further four priority areas for environmental improvement: climate change, nature and biodiversity, environment and health and quality of life, and natural resources and waste.

4.4.2 Thematic Strategies are one component of the actions drawn up within the 6th Environmental Action Programme to specifically address seven key environmental issues and one of these Thematic Strategies is soil protection.

4.5 EU THEMATIC STRATEGY FOR SOIL PROTECTION

4.5.1 In response to the 6th Environmental Action Programme document '*Our Future Our Choice*'[11] the European commission published '*Towards a Thematic Strategy for Soil Protection'*[12], the fist publication to solely address soil protection adopted in 2003. The strategy examines three of the eight identified threats to soils - erosion, decline in soil organic matter and soil contamination, and two cross-cutting themes - monitoring and R&D. Other threats to soil identified by the Commission include: soil sealing, soil compaction, decline in biodiversity, salinisation, and floods and landslides. Outlining steps to better protect soils, the Strategy charts the way to an EU policy to protect soils against erosion and pollution.

4.6 ENVIRONMENTAL AGENCY

4.6.1 The Environment Agency published '*The State of Soils in England and Wales*'[13] in 2004, and accepts there is a lack of understanding of soil in many areas that impedes the development of effective policies to tackle the problem of soil degradation in those areas. The government has identified the interdependency of soil, water and air and how this affects their management. To this end;

- Diffuse pollution of water from agricultural soils needs to be addressed. There is a need for increased knowledge of the effects of climate change on soil.
- Reductions in air pollution are necessary to protect soils from acidification and nitrogen enrichment.

4.6.2 It summarises the current knowledge of soils and sets out the Agency's main concerns and challenges in ensuring greater protection of soil resources in the future. The publication identifies the need to improve the knowledge base and deals with both agricultural soils and soil in the built environment.

4.6.3 With regard to soils in the built environment, the two major concerns for Environment Agency are contaminated land and flood management, with the Agency calling for greater planning controls to adequately protect soils. Contaminated land can

have a negative effect on groundwater quality and is a partial deterrent to redevelopment. The Environment Agency will continue to encourage sustainable flood management that utilises natural flood control functions provided by soils and sustainable urban drainage techniques.

4.6.4 Following from the challenges identifies in '*The state of soils in England and Wales*'[13], the Environment Agency published a consultation document toward a strategy for soil protection, management and restoration, '*Soil the Hidden Resource – a Consultation Document*'[14.] This sets the out the Agency's aims for soil protection, identifies the impacts on soil and sets out the role of the Environment Agency.

4.7 A BETTER QUALITY OF LIFE

4.7.1 The UK Government's published '*A Better Quality of Life: A Strategy for Sustainable Development in the UK*'[2] in May 1999. The strategy identified four central priority areas:

- social progress which recognises the needs of everyone;
- effective protection of the environment;
- prudent use of natural resources; and
- maintenance of high and stable levels of economic growth and employment.

4.7.2 This strategy highlighted the long-term pressures facing soils, particularly from new development. It was acknowledged that soils had not received the attention that air and water had been given previously and that soils would be equally prioritised in the future.

4.7.3 The objectives of the 1999 strategy were pursued by different government departments and resulted in the production of the *Draft Soil Strategy for England* in March 2001 and the *Fist Soil Action Plan for England: 2004-2006*[1] published in May 2004.

4.7.4 Following developments both nationally and internationally, including stronger international pressure for sustainable development following the World Summit on Sustainable Development in Johannesburg in 2002 and taking into account devolution to Scotland, Wales and Northern Ireland, a new framework was required to integrate these aims and develop the earlier strategy with more emphasis on regional delivery. This resulted in the government producing a new strategy for sustainable development, '*Securing the Future*'[15] in March 2005. All departments have the shared responsibility to make the strategy a reality but DEFRA are the leading government department overseeing the delivery of the Strategy.

4.7.5 In the Strategy, there are five principles with explicit focus on environmental limits and four agreed priorities: sustainable consumption and production; climate change; natural resource protection and sustainable communities.

4.7.6 The strategy recognises the importance of ecosystem health and identifies ecosystem elements including biodiversity and soil that are considered in general as renewable but emphasises that long-term exploitation will result in permanent damage, leading to the concept of 'environmental limits'.

4.7.7 Environmental limits are the level at which an environmental resource is unable to maintain the level of exploitation and undergoes irreversible change and environmental degradation. To address these issues the Strategy commits to researching environmental limits and inequalities, and producing an integrated policy approach for protecting and enhancing our environmental resources.

4.8 CLIMATE CHANGE PROGRAMME

4.8.1 The climate change programme in the UK stems from its commitments under the Kyoto Protocol on greenhouse gas emissions. Under this, the EU agreed a CO_2 reduction of 8% on 1990 levels by 2012[16]. However different member states have differing targets to achieve this EU wide reduction. The UK therefore has agreed to a reduction of 12.5% by 2012[17].

4.8.2 The UK's climate change programme has set out a number of measures aimed at achieving its obligations under the Kyoto Protocol. These aims are;

- to improve business' use of energy, stimulate investment and cut costs;
- the stimulation of new more efficient sources of power generation;
- to cut emissions from the transport sector;
- to promote better energy efficiency in the domestic sector;
- the improvement of the energy efficiency requirements of the building sector, and
- to ensure the public sector takes a leading role.

4.8.3 The Climate Change Programme recognises that climate change is likely to have a major impact on soils in the areas of erosion and organic matter storage. It is therefore recognised that the use and management of soils will have to adapt under increasing climatic induced changes.

4.8.4 Tackling the issues raised by climate change will be of the utmost importance as changes in temperature and the water balance will have a major impact on the general built environment. Increased temperatures and humidity together with the increased risk of flooding and subsidence could lead to a deterioration of buildings' structures as well as a disruption of road, rail and power supplies thus having a huge economic cost.

4.8.5 The improved management of soils in the UK could help the country to adapt to climate change in that increases in water storage reducing flooding and subsidence, decrease of local temperatures and reducing the need for air conditioning will have a positive impact.

4.9 SUSTAINABLE COMMUNITIES & REVIEW OF PLANNING SYSTEM

4.9.1 Reform of the planning system is seen by the Government as a key to the delivery of sustainable communities. A programme of reform was set out in the planning *Green Paper*[18] of December 2001 followed by the Government's policy statement on planning in July 2002 *'Sustainable Communities - Delivering Through Planning'*[19] with commitment to review existing planning guidance.

4.9.2 In February 2003 the Office of the Deputy Prime Minister (ODPM) published the '*Communities Plan -Sustainable Communities: Building for the Future*'[20]. The Plan outlines the long-term programme of action for delivering sustainable communities in both rural and urban areas. With a pledge to increase resources and a £22 billion programme of action, the Plan aims to tackle housing supply issues, provide quality public spaces and increase land designated as Greenfield through a new approach to how and what is built.

4.10 DEFRA STRATEGIC PRIORITY: PROTECTING NATURAL RESOURCES

4.10.1 DEFRA published its five strategic priorities in *'Delivering the Essential of Life: DEFRA's Five Year Strategy*'[21] in December 2004. One of the main priorities is the need to 'protect natural resources' and a key challenge identified by DEFRA will be managing

the impact of human activities on land (and soil), as our landscape is under ever increasing pressure to accommodate the expansion of residential development and associated infrastructure.

4.10.2 DEFRA is continuing to develop its evidence base in order to ensure that any potential impact on natural resources is properly assessed. They are working in conjunction with ODPM, HM Treasury, Department of Transport and local government to ensure that Growth Areas are developed in a more sustainable manner where environmental benefits are maximised while negative impacts stemming from long-term unsustainable use of natural resources, such as soil and water, are minimised. In addition, flood risk management must also be taken into account when considering any new development.

4.10.3 DEFRA, along with industry, is developing the *Code for Sustainable Buildings*[22]. The plan is to work in conjunction with local authorities and developers in ensuring that a full-scale demonstration of the code's practical application is available throughout the Thames Gateway and a plethora of other locations. In 2006, the code will be applied on a national basis.

4.10.4 The Egan[23] and Barker[24] reports have drawn a positive response from government. This offers increased opportunities to create and maintain a more sustainable approach to land use, planning and construction, and provide planners, engineers, architects and construction employees with the necessary skills to apply that approach on the ground.

4.11 PROTECTED SITES

4.11.1 Although no specific legislation exists to address soil protection, soils are protected indirectly through broader conservation legislation and policy measures. For example, designated sites such as SSSIs and NRs indirectly protect the soil resource. Similarly, development planning through Town and Country Planning Acts protect soil from pollution through legislation controlling the disposal of certain wastes and pollutants. However, these do not directly or indirectly protect soil in the built environment and Action 50 is aimed at working with the planning authority over the next couple of years to introduce soil protection conditions as part if planning permissions and to reduce off site impacts to address soil protection in a more legal framework in the built environment.

5 Current Information and Guidance

5.1.1 In response to concerns of soil degradation in the UK and Europe, a number of papers have been published identifying the impacts of soil degradation, rates of soil loss and future actions to conserve soil resources.

5.1.2 The minerals, forestry, landscaping and horticultural industries are directly involved in soil handling and depend (with the exception of the minerals sector) on high quality soils to produce high quality planting and landscaping schemes with well established and healthy growing vegetation. As a result, the horticultural and landscaping sector in the UK has a long history of research and development (R&D) and continually invests in further R&D programmes today. This has produced a wealth of information related to soil handling and quality.

5.1.3 Organisations such as ICI, ADAS and the former British Coal have produced many research papers and guidance documents relating to the restoration of mineral sites and in particular the management of the soil resource. In addition, Government

agencies such as DEFRA (previously DETR and MAFF) have published many research documents looking at the development and use of soil forming materials, see below.

Subject area	**Soil resources and degradation**	
Publication title & author	**Summary**	**Comments**
Rickson, R., J. *Conserving Soil Resources: European Perspectives*. 1994[25].	This is a collection of selected papers that were presented at the First International Congress of the European Society for Soil Conservation. In response to a growing realisation that soil degradation in Europe was an observable fact and accelerating; the Society was founded in 1988. The congress was organised to promote and identify best practice protection of soil. The first of the papers assess soil degradation and the other papers focus on both traditional and new technological soil conservation measures. The paper concentrates on European soil issues and considers agricultural, industrial and engineered sites. Social and economic aspects of soil degradation were not covered in details and the Society calls for consideration of the non-technical aspect s of soil conservation planning to be a priority for future research.	The number of selected papers contained within this collection total over 425 pages making it a substantial document in its current form and not suitable for quick reference. A number of papers will not be directly relevant although do provide an informative background to the issues and drivers behind the need for soil conservation in Europe. The latter papers will provide a beneficial reference for informing best practice, for example in the development of a central data base of useful information and guidance.
McHugh, Marianne. *Extent, Causes and Rates of Upland Soil Erosion in England and Wales*. 2000[26].	This research used a number of field sites and analyses the rates and causes of soil erosion of ecologically important upland sites in England and Wales. It was estimated that soil erosion increased by more than 518 ha between 1997 and 1999, and in 1999 alone this represented approximately 24,566 ha and 0.284 km^3. Of this 18,025 ha was attributed to water erosion including blanket peat degradation resulting directly from human land use and animal activity. The extent of erosion represents 2.58% of the uplands of England and Wales. The thesis highlights the rate at which upland soil erosion is occurring and discusses the consequences of erosion, proposals for remediation and mitigation policies.	This paper is narrowly focused on the rates and causes of upland erosion and is therefore not informative for avoidance of compaction in the built environment.
Bullock, P. *Soils in the Urban Environment*. 1991[27].	This book identifies that soil is a neglected resource in urban areas, after sustaining the impacts from human activities for centuries, the UK's soil resource is starting to suffer increasing problems associated with contamination, erosion, acidification, and compaction. Previously, attention has been focussed on soils in an agricultural context due to the importance of soil for food production. However, there is a significant soil resource in urban areas that is classed as open space such as allotments, parkland and derelict sites. It is noted that one of the failures of new amenity space provided in urban areas is the failure of trees, with estimates in the region of half of all trees planted annually die within the first five years, representing an estimated £10 million of public money. This highlights the value of good quality top soil and the importance	The short book is particularly useful as it identifies a number of properties characteristic to urban soils that provides a useful reference for the basis of soil classification.

	and benefits of protecting and handling soil correctly on site. It is acknowledged that there is a disappointing knowledge base for the urban environment, whose soils often consists of very different materials compared to rural soils. To transfer existing knowledge and information on soils successfully, Bullock calls for a classification system that encompasses the properties of man-made soils, most relevant to urban environment. However, it was accepted that there are a number of problems encountered with classifying soils such as the extent of modification to the profile of urban soils.	
Gordon, J. E. *Scotland's Soil: Research Issues in Developing a Soil Sustainability Strategy*. Scottish Natural Heritage. 1994[28].	This study commissioned by Scottish National Heritage reviews the main stakeholders utilising soil in Scotland and the key issues affecting the sustainable use of soil. The study assesses the existing knowledge of soil and makes recommendations for future action and identifies areas of research in each main interest group. The study provides a preliminary framework to assist the development of a soil sustainable strategy. The study focussed in the following key issues: soil erosion, acidification, pollution and rehabilitation, soils and the hydrological cycle, land use changes and sustainability in relation to forestry, and soil monitoring. The review by Scottish National Heritage concentrated on soil and its importance as a national heritage resource. The recommends that the development of a strategy should be coordinated with a multidisciplinary approach in partnership with all interested parties and that existing knowledge should be transferred and applied when formulating policy and guidance.	Soils in the built environment is not a key focus of this study, however, the aims of the Scottish soil strategy can be equally applied to the development of a strategy focussed on the construction sector in England.
Subject area	**Compaction**	
Kendle, T., Schofield, J. *Saving Our Soil, Countering Compaction*. Landscape Design, May, pp 36-39. 1992[29].	The article outlines how the problem of compaction is an important issue. It details the compaction process which is the moving of the soil closer together. It then proceeds to outline the effects of compaction. There are six major changes in soil due to compaction. The first is the increase in mechanical impedance, where roots cannot push the soil. Secondly, is the reduction in the level of aeration, which reduces oxygen levels and impedes drainage of the soil. Thirdly, is the change in moisture availability which can come in the form of waterlogging or even drought. Then there is the change in thermal conductivity, which can be beneficial as well as detrimental. There are changes in nutrient availability. Lastly, there are changes in the microbial population. The article then goes on to detail the behaviour of different soil types, patterns of compaction,	Much of this article is concerned with the technical aspects of compaction but is provides a particularly informative, short introduction to compaction in relation to the UK landscaping industry, and these issues are equally relevant to the construction sector as a whole. In the last section, there are some useful tips on avoiding compaction that that would complement a central database of best practice guidance.

	measurements of compaction, the choice of planting stock and how to avoid compaction through in-situ soil and imported soil.	
Kendle, T., Schofield, J. *Saving Our Soil, Countering Compaction*. Landscape Design, Vol 221, pp 25, 27-28. 1992[30].	This article is a follow on from the above article by the same authors. It deals with ways of counteracting the problems posed by soil compaction. The first solution posed is that of pan busting and deep drainage. Where a deep pan exists then all that may be required is deep sub soiling or chisel ploughing. This may not work if the soil structure is poor or if the soil is plastic or wet. Ameliorants is another solution put forward in the article. Radical drainage through cultivation may be short lived if the inherent structure of the soil is poor as it may collapse in wet conditions if there is not enough organic matter in the soil. Organic matter helps to keep pores open and therefore improves soil drainage. In addition, where organic matter is mixed well with sandy soil it may improve water retention. Another solution can be flocculating the soil. On clay soils low in calcium particles may be deflocculated which leads to slumping. The application of lime or gypsum can help to re-flocculate the soil and avoid the slumping process. Organic matter can aid the soil by acting as food for soil organism which can lead to improved soil conditions. Artificial soil conditioners are available which can mimic the actions of some of the organic components which can help stabilise soil.	This concise article outlines proven landscaping techniques to reduce compaction and ameliorate compacted soils, and is a very good source of information that can be transferred to the wider construction sector.
Subject area	**Soil conservation and erosion control**	
Pierce, F.J. and Frye, W., W. *Advances in Soil and Water Conservation*. 1998[31].	This publication draws on American research and technological development shaping soil and water conservation. It addresses the processes of soil erosion and control, along with policy and social forces that have influenced research in the American, principally agricultural context.	The majority of this article is not particularly relevant to UK soils in the built environmental but some of the techniques to control erosion discussed could be applied to the UK context.
Gray, D. H., and Leiser, A., T. *Biotechnical Slope Protection and Erosion Control*. 1982[32].	This report focuses on the prevention of soil erosion from slopes through the utilisation of engineering and horticultural techniques. Combining horticulture and engineering methods for slope stabilisation, an environmentally sustainable and cost-effective solution is achieved. The report details best practice biotechnical design solutions such as contour wattling, brush layering, live staking and brush matting. Techniques for planting vegetation on slopes above low toe-walls, retaining walls and structures; wired walls, gabions and cellular revetments are also described. Guidance and technical details are provided for use by professionals, students and laymen alike in the fields of geotechnical engineering, geology, soil science, forestry, landscaping and environmental horticulture.	This article has been designed to be accessible to a wide audience, however, soil erosion techniques are principally focussed on slope soil stabilisation and therefore not particularly relevant to soil handing during construction.

Santvoort, G. *Geotextiles and Geomembranes in Civil Engineering*. Revised Edition. 1994[33].	This manual is a comprehensive guide to the use of geotextiles and geomembranes, utilising experience and knowledge from Dutch civil engineering projects. The manual deals with all aspects of geotextiles and geomembranes, from production to properties, to applications and uses. There is a whole chapter dedicated to soil reinforcement (in relation to soil as a platform for construction) and a number of chapters dealing with drainage.	This book is too detailed for quick reference and does not provide useful guidance for soil handing. For information on geotextiles for soil stabilisation the above reference (Gray 1982) is more accessible.
Subject area	**Top soil survey and classification**	
Olsen. G. W. *Field Guide to Soils and the Environment*. Chapman & Hall. 1984[34].	The need for more information on soil survey interpretation and utilisation of soil data, in an easily manageable form for use by the layman, teachers and students, resulted in the publication of ***Field Guide to Soils and the Environment.*** The book provides details on the practical application of soil data and soil characteristics for use in engineering (a platform for construction), waste disposal, agricultural land classification, erosion control and community planning. The overall aim is to enable anyone to understand better the soil resource in order to manage and protect them better.	This provides detailed guidance on a range of soil issues in a form that is easily understood by a wide audience. However, only certain chapters within this book will be relevant for example, the information on soil data and soil characteristics provides a useful reference for the development of a soil classification system.
Smith, K., May, P. *The Challenge of Urban Soils*. Landscape Australia. Feb-April, pp 38-42. 1998[35].	This article gives a definition of urban soils and puts them into the five categories of scalpic, garbic, urbic, spolic and dredgic. It then proceeds to explain the characteristics of urban soils listing spatial variability, reduced drainage and aeration, modified physical properties (structure, texture, compaction) restricted root volumes (low porous and high strength soils), modified soil reaction (increased pH levels), modified organic matter and nutrient cycling (variable in distribution and depth compared to normal soils) and the presence of contaminants such as heavy metals. The article then proceeds to deal with site characterisation. This takes into account such parameters as surveying soils, physical characteristics of soil on site, chemical tests, site treatments necessary (depending on problems), structure modification (counteracting compaction through cultivation or gypsum application) and the soil-less site (the replacement of soil with new soil). Landscape design must address site limitations if planting is to be successful. For planting to succeed a better understanding of the site and its soil and of plant biology and techniques is needed.	It should be noted that this article is taken from an Australian publication. However, the broad classification of urban soils provides a key reference for the development of a UK classification system for disturbed urban soils.
Bradshaw, A.D. *Top Soil Quality – Proposals for a New System*. Landscape Design, Vol 141, pp 32-34. 1983[36].	The article begins by explaining the outcome of a previous study of 40 topsoil samples showing that none could be classified as good garden soil. Lack of nitrogen and other nutrients were given as the main reason. The article then explains the importance of soil nitrogen and other nutrients for healthy plant growth. The article discusses the need for assessment of many soils. There are four main methods necessary in	This short article is provides a quantitative body of research that will facilitate the classification of soils and the development of soil standards.

	a soil analysis, place of origin, physical analysis, chemical analysis and a biological analysis. The three principal main methods for treatment are the explained. These are closely related to the analysis and are physical, chemical and biological. Finally the article details the steps necessary to achieve a higher standard of topsoil. It recommends a specification for high grade topsoil (higher than the British Standard 3882; 1965), a minimum specification for low grade topsoil and a specification for non topsoil. A three level topsoil specification system is the final recommendation with grades A, B and C for the varying degrees of quality. In conclusion there are three ways suggested for which sustained grass growth might be obtained. These are that only high grade soils are accepted, low grade soils are accepted but for a low price which allows remediation later and topsoil is not used and the underlying material is treated directly.	
Subject area	**Soil amelioration**	
Kendle, T. *Soil Ameliorants for Landscape Planting*. Plant User Specification No. 3, Part 1, pp 3-5. 1990[37].	Recommendations on the use of ameliorants are uncertain according to the article. This is due to the fact that the subject includes such a wide range of materials with varying properties and because there is often limited knowledge of the properties of soils that are being dealt with. The soil ameliorants dealt with in this article are those which are classified as those additives which have some physical effect. Soil crumb forming is the process whereby there are organic molecules added to the soil which acts as a glue and provides food for micro organisms. Flocculation is the process of adding lime to clay which helps to bind clay particles together. Textural modifiers are those materials which modify the texture of a soil to improve drainage such as milled bark. Resource holding sponges are those which can be applied to sandy soils to trap water. Peat particles can be used in this way. Adding clay to light soils will help the soil hold nutrients and improve the cation exchange capacity (CEC). A rise in the CEC level in a soil leads to improved buffering which protects the soil from sudden chemical imbalances. Soil separators and bulking agents such as peat can be used to keep air holes and drainage pores open. Humus can be added to clay to make soils less sticky and prone to compaction. Ameliorants should work when used on poor quality landscape soils. They are extremely useful on many derelict sites and subsoil but there are question marks in some areas. For example, The Forestry Commission found no benefits in using peat in tree pits. The article identifies several possible hazards with the use of ameliorants. Increased waterlogging, temporary salinity problems, rewetting issues, shrinkage and instability, rooting barriers, nutrient immobilisation and imbalances, oxygen depletion and methane	The relatively old article provides 'tentative' recommendations for improving soil quality. The set of techniques discussed presents a basis for further research and if proven successful in improving urban soil quality can be incorporated into best practice guidance.

	generation, industrial toxins, pathogen increases, weeds and compaction/slumping can all occur through the use of the wrong ameliorants in the wrong conditions.	
Kendle, T. *Soil Ameliorants for Landscape Planting*. Plant User Specification No. 3, Part 2, pp 4-5. 1990[38].	Many of the organic materials mentioned in the above article are variable. Those wastes which contain nutrients may be lacking in other properties. The degree of composting affects longevity, salinity, structure, nutrients etc. Milling can affect the physical properties of some substances and wetting can affect water holding. Alginures contain nutrients. Animal wastes have been used to make organic fertilisers but are also of contain elements of low initial fertility. Bark has become expensive and its quality varies with species, age and soil type. Calcium can affect the clay flocculation. Clays are prone to compaction but can be useful to improve fertility and water retention. Coir comes from coconut fibre extraction but its effects are not well known. Domestic refuse is increasingly being used as a compost source but smells and the varying degree of quality are obstacles. Expanded minerals may contain boron. Animal manures have varying physical properties and have a short lived effect. Inert plastics can be used to keep pores open but can contain chemicals. Leaf mould production is limited. Peat is used in most container plants and is moisture retentive and well aerated. Water holding agripolymer gels hold water well but the benefits decrease significantly if salinity occurs. Sand/grit can be used to improve drainage. Straw can be used as a bulking agent and can hold water after it decomposes. It takes up large quantities of nitrogen however. Topsoil can be used as a planting pit backfill but can be deficient in nitrogen if left in storage. Wood is similar to bark but decomposes faster and can cause nutrient deficiencies. Quality control is necessary in the sourcing and quality of materials used as ameliorants. Many types differ enormously between suppliers. The specification of ameliorants depends on a number of factors. It is not a substitute for practices such as weed control. Organic ameliorants should not be used on waterlogged soils. Un-composted matter should not be used at depth. Most un-composted matter should not be used without the addition of nitrogen as during the process of breakdown the C:N ratio will be impacted. 100% organic matter backfills are unnecessary. The spread of organic matter should be uniform. Quality control should be enforced. Recommendations are as follows; Clay, humic, crumb forming or flocculant effect. Silt; bulking, crumb forming or textural. Sands; colloidal, textural, nutrient rich, resource storage improvers or buffers. Organic matter; humic and nutrient rich. Compacted soils; bulking, crumb forming and resource storing. Poor structure; bulking, crumb forming and flocculating. Contaminated	Soil ameliorants have a number of varying parameters and this research provides a basis for further research to develop standardised amelioration techniques for the building (including construction and landscaping) industry.

	land; humic and buffering, nutrient sources and calcium rich. Droughted land; resource storage ameliorants.	
Subject area	**Soil forming materials**	
Bending, N. A. D. *The Use of Soil Forming Minerals in Land Reclamation.* Mineral Planning Journal. Vol 82, pp 5-8. 2000[39].	This article outlines the rationale for soil forming materials where topsoil and subsoil resources are limited. A 'soil forming material' is classified as the direct equivalent of a 'parent material' which is the starting point for soil development. The difficulties presented by soil forming materials are; physical properties, chemical properties and harmful substances. The physical properties of soil forming materials vary widely. Depending on their origin, they can be rock fragments or fine particles and these are unsuitable for soil formation. In the same way the chemical properties of soil forming materials can vary from very alkaline to acidic. This poses difficulties for the development of vegetation. The content of nitrogen and other nutrients can often be deficient in many types of soil forming materials and this reduces their usefulness. Some types of materials can contain substances which are harmful to animals or humans and this also limits their usefulness. The selection of soil forming materials allows for the identification of unsuitable materials and for a comparison between suitable types to determine the best option. Two approaches to dealing with the difficulties presented by soil forming materials were identified. The first is to choose an undemanding afteruse and the second is to deal with the limitations e.g. to add organic matter to nutrient deficient soils.	This research is focussed towards the minerals industry but may provide a potential alternative to the use of top soil in the construction industry, where the supply of top soil is limited. The article outlines the steps necessary for soil forming materials to be useful and is therefore a key reference if soil forming materials are to be developed for wider use.
Bending, N. A. D., and Mc Rae, S. G. *Soil Forming Materials and Their Use in Land Reclamation*. DETR. Oct 1999[40].	This publication identifies that under the Town and Country Planning Act 1990, the use of 'soil-forming' or 'soil-making' materials as soil substitutes is required, particularly for the reclamation of minerals workings sites where there is little or no soil resource available for restoration. However, while there is a requirement to use soil substitutes, there is (was) no information regarding the classification, selection, handling and treatment of these soil-forming materials. As a result this report provides guidance on best practice for the use of soil-forming materials in the context of land reclamation and is intended for use by consultants, developers, the minerals industry and land reclamation specialists, as well as local and central government. The report covers topics such as the description of major soil-forming materials in the UK; methods for identification; standardisation of soil-making materials; physical and chemical characterisation of such materials; the existing use of these materials in the UK; types of inorganic and organic amendments use in the treatment of soil-forming materials; information on the recovery, handling and storage of soil-making	This body of research, while not directly related to soil handling and protection, and requiring further development, presents an alternative to top soil that could potentially be applied to urban sites in the future. Soil forming materials should be considered as part of a range of alternatives to top soil and part of a long term strategy for soils in the built environment.

	materials; ecological approaches for matching vegetation types to particular soil-forming materials and establishment of vegetation on these soil substitutes. While targeted at land reclamation of minerals working sites, the information could equally be applied to the regeneration of brownfield sites where there is little or no top soil, therefore minimising the need to transport top soil from other sites.	
Goumans, J. J. J. M., van der Sloot, H. A., Aalbers, Th., G. *Studies in Environmental Science. Environmental Aspects of Construction with Waste Materials.* Proceeding of the international Conference on Environmental Implications of construction Materials and Technology Developments, Maastricht, The Netherlands, 1-3 June 1994[41].	Fundamental to the concept of Sustainable Development, is the prudent us of natural resources, including a holistic approach to land use and the protection of soil. One of the key issues associated with sustainable land use is the problem of waste disposal, which is also related to soil and groundwater pollution and prevention. While the Government are committed to achieving targets for municipal waste recycling that will reduce or slow land- take for landfill sites, another significant pressure on land use in the UK is increasing development and associated infrastructure. Hence, by reusing waste materials for civil engineering and construction works, not only are waste materials diverted from landfill and reducing land-take this way, at the same time the need to utilise natural resources for civil engineering and construction works is also decreased. This publication presents the proceedings of the Second International Conference on Environmental Implications of Construction Materials and Technology Developments, WASCON '94. Not directly related to soil management but indirectly associated to soil protection, the conference looked at the reuse of waste materials for civil engineering and construction works, which satisfies two significant problems facing sustainable land use: the problem of land take (& soil) for the disposal of municipal waste to land fill sites and associated environmental (soil and groundwater) pollution; and utilisation of natural resources for civil engineering and construction works, thereby using natural resources (including soil) more efficiently. The conference included environmental aspects of contaminate mobility, material leachates and material solubility. In addition, research and legislation, establishment of criteria and standards, knowledge transfer and technology development are all discussed. Key areas of interest for the built environment and construction are European Standardization of Additions to Concrete; Burning of Hazardous Wastes as Co-Fuel In a Cement Kiln – Does it Affect the Environmental Quality of Cement?; Fly Ash Utilisation in Civil Engineering; Use of Demolition Concrete to Produce Durable Structural Concrete; Improvement of Portland Cement/Fly Ash Mortar Strength using Classified Fly Ashes; Development of Cementitious Products using Industrial Process Wastes as Sources	This is a very detailed collection of papers only very few of which are directly relevant to soil in the urban environment. However, there are many innovative materials discussed that would be useful in the wider construction sector and which would reduce pressure on soil and land take.

	of Reactive Sulfate and Alumina; Recycling of Magnesium Slags in Construction Block Form; Recovery of Raw Materials from Reclaimed Asphalt Pavement; Environmental Life Cycle Analysis of Construction Products with and without Recycling; Environmental Management in Large Construction Projects; A Concept of Environmental Evaluation of Waste Management Benefits; Towards Sustainable Construction and Demolition Waste in Belgium?; Certification Systems for Aggregates Produced from Building Wastes; Microstructure of Concrete Containing Artificial and Recycled Aggregates; Frost Susceptibility of Recycled Aggregate; Use of Crushed Tile and Concrete as Filling in Pipe Trenches; Contaminated Soil Cement Stabilisation for Application as a Construction Material; Ecological and Energy-Saving Advantages and Benefits of Building with Earth; and State of the Art Report: Use of Waste Materials in Construction – Technological Development. All the above discussions contribute to prudent use of natural resources, the creation of closed loop systems and the achievement of sustainable development.	
Subject area	**Soil and implications for urban landscaping**	
Craul, P., J. *Urban Soil in Landscape Design*. 1992[42].	Following the theme and concern of poor tree health in urban environments, this publication sees the need for information highlighting the capabilities and limitations of soil for landscape design and plating within the urban environment. The concepts and conditions of urban soils are discussed, transferring information from landscape ecology literature. It covers soil characteristics and the opportunities and constraints for use in a range of applications. The book describes how soil can be classified, inventoried and mapped. It outlines the contrasts between natural and urban soils and the problems associated with urban soils and drainage in particular. Methods for soil amelioration are presented and appropriate site assessment and soil analysis techniques are recommended.	This is a comprehensive review of poor urban soils and is aimed at landscape designers but the principles can be equally applied to the construction sector. This book is not suitable for quick reference but is a key text for soil classification, mapping and best practice guidance.
Rolf, K. *A Review of Preventative and Loosening Measures to Alleviate soil Compaction in Tree Planting Areas*. Arboriculture Journal, Vol 18 pp431-448. 1994[43].	During construction work, soil is moved, stored, mixed with other materials and compacted by heavy vehicles which radically alter its physical, chemical and biological state. If, after construction has been completed, the area requires landscaping then the soil will have to be reconstituted.	This is an excellent reference for best practice with regards to avoiding and mitigating compacted soil and the information should be transferred from the arboriculture sector to the wider construction industry.
Lindsey, Patricia *Et al*,.	The plight of urban trees is well documented. The article details the causes of this, such as inadequate	This article is narrowly focussed on urban tree growth and is primarily

Redesigning the Urban Forest From The Ground Below. Arboriculture Journal, Vol 16, pp 26-39. 1992[44].	soil volume rooting which is the major cause of tree mortality. Soil in which a tree is planted acts as a vital reservoir holding and then supplying water as the tree demands it. To this end the article explains how a weather based methodology has been developed which allows an aboriculturalist to size a tree pit or container based on the daily water requirements of the tree. This reduces water stress on a tree over the growing season. The recommendation is that a soil volume of $5m^3$ for a medium sized tree is suitable.	useful for highlighting the extent of the problem and indirectly the associated costs as an incentive to encourage better soil handling and conservation.
Craul, P. *Reducing Soils Compaction*. Landscape Architecture. Vol 84, Pt 12, pp 34-36. 1994[45].	This article deals with the issue of soil compaction and uses the National Mall in Washington as an example. How compacted soil is identified is the first point raised. The effects of compaction mentioned in this article are crusting (pulverising soil aggregates), decreased infiltration, increased density, reduced water holding capacity, reduced soil aeration and root impedance. How to reduce compaction is then dealt with looking at the various types of compaction. There are 3 methods of reducing surface compaction. Firstly there is spike and core aeration which involves the boring of holes into the soil. Then rototilling, the process of tilling the soil on the surface level. Finally, there is auguring, the process of auguring two-inch holes on a sixteen-inch grid to a depth of twelve inches then filling the holes with organic matter or fertiliser. Subsurface compaction can be counteracted using 3 methods. Deep jetting which involves injecting air or water at high pressure to fracture the soil. Then there is subsoiling which involves ploughing the soil at depth with a chisel plow or subsoiler. The other process involves trenching, or digging trenches out from a tree trunk and then filling them with soil high in organic matter. Finally, preventing compaction is addressed. The use of compaction resistant soils is recommended.	This is a short article concentrating on techniques to reduce compaction and the information is a key reference when compiling best practice guidance.
Sipes, J.L. *A Soft Approach to Erosion Control.* Landscape Architecture. Feb, pp 34-39. 1999[46].	Hard Revetments, Constructed Of Materials Such As Rock And Concrete Which Deflect Water Away From Unstable Slopes Has Long Been The Choice Of Engineers For Tackling Erosion Problems. These Are Lacking In Aesthetic Appeal And Are Therefore Steadily Being Replaced By Bioengineering Solutions Whereby Vegetation Is Used To Minimise Potential Erosion Problems. The Article Then Outlines The Various Biosynthetic Options Which Can Be Used To Reduce Erosion. Biosynthetic Options Are Inherently Temporary Since They Are Designed To Be Biodegradable. Permanent Solutions Take Place Through The Establishment Of Vegetation Over Time And Can Be Done Using Wooden Stakes Or Turf Mats.	This short article is not directly applicable to soil management or compaction mitigation. However, the best practice bioengineering techniques to minimise soil erosion will complement a central information source of best practice soil handling guidance and raise awareness of holistic approaches to site engineering, landscape, and construction and the interrelationship of these issues.

Subject area	Land Reclamation Using Landscaping	
Moffat, A. and McNeill, J. *Reclaiming Disturbed Land for Forestry*. The Forestry Commission Bulletin 110. 1994[47].	The Forestry Commission published Bulletin 110 to provide practical advice to those wanting to plant trees on previously disturbed and reclaimed land. Due to poor performance of trees planted on sites disturbed by mineral workings, the Commission built upon their research experience to provide advice and techniques that can be applied to many types of disturbed land including derelict and urban sites. Several soil issues are covered including compaction, damage, erosion, stripping, and soil forming materials.	This practical guidance on soil handling provided in this Forestry Commission article is very applicable to urban sites and should be incorporated into best practice guidance for use by a wider audience.
Dickson, N., M., Mackay, J., M., Goodman, A. and Putwain, P. *Planting Trees on Contaminated Soils: Issues and Guidance*. Land Contamination and Reclamation, 8 (2), 2000[48].	The topic of whether utilising trees to remediate and manage low value contaminated land alters the speciation, mobility and availability of toxic chemicals is discussed. The paper argues that in the majority of cases, risk reduction will be achieved by planting trees on contaminated soils in the urban and urban fringe and are particularly beneficial in developing healthy soils at Brownfield sites. Tress planting for remediation should be taken into account during risk assessments for proposed developments, therefore maintaining the soil resource in-situ.	This article is not particularly relevant to soil handling but presents a holistic technique to remediate contaminated land and leave the soil in-situ, therefore, reducing the need for additional top soil use. Likely to be a referenced as an information source rather than used directly to inform best practice with regards to soil handling and protection.
Dobson, M., C. and Moffat, A. J. *The Potential of Woodland Establishment on Landfill Sites.* Department of the Environment. 1993[49].	A study jointly commissioned by the Minerals and Land Reclamation Division and Waste Technical Division of the old Department of the Environment (now DEFRA) investigates landfill as a means of restoring old mineral workings sites and the value of woodlands in ensuring the restored landscape is aesthetically acceptable. Landfill is an accepted and widely used option for waste disposal and where old minerals working sites are used this method does not pressurise undisturbed soil resources. By planting trees, landfill sites can be restored to provide woodland sites of landscape and conservation value, returning the land use to its more natural state. The guidance in the report highlights the effects of a landfill environment on vegetation growth, with advice specifically on soils in relation to tree growth and performance, including soil quality, structure, conditions and influences on tree root growth, soil types, depths and placement.	This is not directly applicable to soil handling but provides an interesting reference on land restoration techniques for amenity use. It also includes guidance on soil quality and characteristics necessary for successful vegetation growth on poor substrate that could be transferred to other poor quality Brownfield sites.
Subject area	**Structural soil**	
Grabosky, J., Bassuk, N., Trowbridge, P. *Structural Soils: A New Medium to Allow Urban Trees to Grow in Pavement.*	This paper explains why there are issues to do with trees in urban areas. On average urban trees survive for a mere seven years. The main problem is the lack of suitable soil for root growth but there is a plethora of other issues such as increased heat, de-icing salts, soil and air pollution and interference from utilities, vehicles and buildings.	This presents the findings of research into structural soil, principally focussed on the need for suitable un-compacted soil for tree growth. However, structural soils have the potential to work well with SUDS and this article provides a good basis for further research into

Landscape Architecture Technical Information Series (LATIS). American Society of Landscape Architects (ASLA). 2002[50].	The article then explains the terminology of soil e.g. what makes up soil and how this affects its usefulness. To this end, texture, structure and fertility are mentioned. Texture is defined as the percentage of sand, silt and clay in a soil and this affects the nutrient holding capacity, susceptibility to compaction and its frost heave potential. Compaction has two important impacts on plant growth. Soil structure is destroyed and the soil becomes denser thus inhibiting root penetration. A method of evaluating compactness is examined which is to measure a soil's weight per volume. Soils begin to inhibit growth when their density reaches 1.4 g cm-3 for clays to 1.7 g cm-3 for sandy soils. In compacted soil water can remain around the roots and therefore deprive roots of oxygen. The article proceeds to detail how much soil a tree needs to grow successfully and flourish, 2 cubic metres per every square foot of crown projection. It deals with where one can find enough soil to grow a tree and what is necessary to meet engineering requirements in urban areas whilst still making tree growth possible. To this end the workings and reasoning for structural soils are explained. The main thrust here is that structural soils contain a stone matrix for strength and soil for horticultural needs. A stone lattice is necessary to provide a base for pavement stability while it allows voids for root, air and water movement. Clay materials are needed for nutrient and water holding capacity. The stones with voids are designed so that compaction is reduced. It then explains where and when the use of structural soils is appropriate. The type of surface must be taken into account such as pavements, shopping areas and some low use access roads. Structural soil is designed to be used when there are no other design solutions available. In addition plant selection is also an issue as some plants are not considered suitable for structural soils. Plant selection should aid toward alkaline tolerant and drought tolerant plant species. The choice of stone, whether limestone or granite will have an influence on pH levels. The article ends on a note of caution explaining that many structural soils are untested taking in pavement and plant considerations. The system is more sensitive to pavement rather than plant needs according to the article and so the most common mistakes are excessive soil and the inclusion of organic materials without proper testing.	the uses and benefits of structural soil, including environmental regulation.
Grabosky, J., Bassuk, N., Trowbridge, P., Urban, J. *Structural Soil: An Innovative Medium Under Pavement that*	This article explains the major issues as to why trees in urban areas are more susceptible to failure. The main reason identified is the lack of adequate soil volumes for tree root growth. Soils under pavements are highly compacted to meet engineering standards and this impedes root growth. The solution identified is to redesign the pavement	This article is not directly related to compaction or urban soil degradation. However, the topic of structural soil is a relatively new area of research and provides an interesting addition to the issues surrounding urban soil and tree growth. There may be a potential to

Improves Street Tree Vigour. Urban Horticulture Institute[51].	structure to meet the load bearing requirements of structurally sound pavements while encouraging deep root growth away from the pavement surface. The article then explains the system devised by Cornell University's Urban Horticulture Institute (UHI). The design allows for root growth while also meeting the requirements for a structurally sound base for pavement construction. This soil contains crushed stone, clay and a stabilising agent.	utilise structural soil to complement better soil handling and site practices, as well as in combination with sustainable urban drainage techniques.
Sorvig, K. *Soil Under Pressure.* Landscape Architecture. June, pp 36-43. 2001[52].	This article is aimed at finding a solution to the problem of the low lifespan of urban street trees which is only an average of seven years. The main problem is that the environment for tree growth in urban areas is extremely hostile as the soil is poor and there is not enough space for roots to spread and flourish. According to the article, to find a solution to the problem requires looking at the many variations on structural soil and an examination of their successes and failures. Questions are raised as to how new, potentially sustainable landscape technologies are discovered, tested, publicised and accepted or rejected thereafter. Structural soil replaces the base course and compacted sub-soil used in the construction of roads and footpaths. This is formed by a structural matrix of crushed stone with soil for root growth filling in any voids. The main structural mix examined in this paper is the one devised by Cornell University's Urban Horticulture Institute (UHI). One main finding of this study was that the mix of structural soil needs to vary according to region as each type has its own special needs. There were 4 different types of structural soil identified in the study, UHI's crushed stone mix, lightweight mixes based on internally porous aggregates, sand based "Amsterdam Tree Soil" and natural compaction resistant sandy loams. The article states that the horticultural viability of CU mix is untested compared to Amsterdam soil and porous aggregate mixes.	This article identifies four different types of structural soil and is a key reference for further research into structural soils and their use in the UK.

5.2 BRITISH STANDARDS

5.2.1 A complete review of the British Standards is being addressed outside of this study. However, document BS 3882:1994[53] outlines guidelines for the use and handling of top soil. This document details the procedures for site preparation and drainage, handling, storage, screening, spreading, matching and modifying soil properties for use, texture, stones, soil contaminants, salinity, soil pH value, plant nutrient content and organic matter.

5.2.2 Careful attention to site drainage is essential to the successful use of soil. The depth of topsoil is important for the thriving of plant species and this should not exceed 300mm. Imperfect site drainage is indicated by blotched or grey colouring. A brown colouring indicates that the soil is well drained. Good drainage is particularly important for playing surfaces and recreational areas.

5.2.3 Sites should have the soil surveyed prior to stripping so that the depths and composition of topsoil can be determined. On sites where soil composition is markedly different the various layers should be stripped separately and stored in different piles. Soils gain strength and become more resistant to damage as they lose moisture. They should therefore only be handled in dry weather when the soils are not wet. Deformation occurs when soil is plastic and should therefore removal should not take place. If soil is handled outside of the appropriate conditions it can lead to loss of structure, compaction, decreased aeration, bad cultivation and ultimately decreased vegetation growth.

5.2.4 When stockpiles are necessary soils should be loosely dumped and shaped to shed water. The site of a stockpile should be graded in advance and rubbish removed. The topsoil on such sites should also be removed. Topsoil needs a diffusion of oxygen and may lose some of their characteristics if this happens. Therefore according to the BS, topsoil should not be stored in piles more than 1 metre deep.

5.2.5 Soil is often screened to remove stones and debris. Finer texture soil can only be screened when it is very dry but this may lead to it becoming weaker when rewetted. The addition of organic matter to screened soil can lead to a more stable structure after it has been spread.

5.2.6 When spreading soil, subsoil should be spread and evened out before the application of topsoil so that the appropriate thickness can be achieved. Spreading should not be carried out after heavy rain.

5.2.7 Particles are classified by size ranges, in millimetres. Stones are classified as > 2.0, sand 2.0 – 0.06, silt 0.06 – 0.002 and clay < 0.002. The proportions of these are put into textural classes derived from properties such as structural stability and water retention.

5.2.8 The texture of some soils is important for certain land uses. Soils with greater than 27% clay or greater than 50% silt should not be used for playing fields or recreational sites.

5.2.9 Soil and soil forming materials can contain toxic elements and soil contaminants. This can be in the form of soluble salts, fertiliser residues or building materials. Some types of heavy metals may be present naturally in the soil such as cadmium and lead and other types may come from former industrial land uses such as asbestos, pulverised fuel ash and organic substances. Phytotoxic contaminants can affect plant growth. Zootoxic contaminants can be toxic to animals. Soil may contain sulphate which attacks building materials, materials that may be flammable such as methane, materials which may be harmful to life and materials such as asbestos, anthrax, radioactive substances and phenols. All soils contain plant seeds which could be considered to be weeds. This can cause problems for crops but can later be controlled by the use of controlled mowing or herbicides.

5.3 MINERALS RECLAMATION

5.3.1 On behalf of the Ministry of Agriculture, Fisheries and Food (now DEFRA) Humphrey Rowell Associates published a range of guidance notes on soil handling in 2000[54] aimed at the minerals and waste sector to improve restoration standards and encourage sustainable development of such sites.

5.3.2 There are 19 guidance notes in total, providing detailed guidance on best practice methods for soil handling using various techniques, from soil stripping; building soil storage mounds; excavation of storage mounds; release and removal of stones; replacement of soil and soil de-compaction.

5.4 NATIONAL BUILDING SPECIFICATION

5.4.1 The National Building Specification (NBS)[55] forms part of the RIBA (Royal Institute of British Architects) Enterprises and publish a number of standardised technical specifications and related products to facilitate designers at all stages of construction projects.

5.4.2 The standardised specifications, including those for buildings and landscaping, provide a standardised and consistent approach for the industry. The use of these standards helps the industry keep up with developments in best practice, legislation and technology. It also offers a basis for quality control, providing benchmarks for minimum standards to be expected at various stages in building and landscaping works.

5.5 DESIGN MANUAL FOR ROADS AND BRIDGES

5.5.1 The *Design Manual for Roads and Bridges*[56] (DMRB) is published by the Highways Agency and provides design details to be followed in road and highways schemes. Volume 11 Geology and Soils states that the impact of road schemes on underlying geology and soils should be 'fully considered'. Section 5.4 of Volume 11 acknowledges that the damage and loss of agricultural soils from road schemes 'self-evident' but the impact on soil quality of soils that are excavated and stored is dependant on the choice of earthmoving machinery, weather conditions, and handling techniques. However, there is no guidance on types of earthmoving machinery or handling techniques that should be employed.

6 Best Practice in the Built Environment

6.1 INTRODUCTION

6.1.1 This section outlines how best practice procedures are being introduced into the construction industry. The Constructing Excellence organisation is the prime driver behind this process. The main tools for improving the construction industry's performance are 'Tool Box' talks, BREEAM and CEEQUAL.

6.2 CONSTRUCTING EXCELLENCE & KEY PERFORMANCE INDICATORS

6.2.1 Constructing Excellence[57] is an organisation funded by the DTi and created to deliver efficient reform of the construction industry. By selling the business case for continual improvement and through focussed programmes in innovation, best practice knowledge, productivity and engagement, Constructing Excellence aims to create a cultural change in the construction industry required to deliver productivity improvements and more sustainable development.

6.2.2 The innovation programme identifies exemplar demonstration projects that will be best practice tomorrow. The best practice knowledge programme aims to improve performance by sharing knowledge of demonstration projects and benefits of best practice, extend the demonstration project process to include business improvement, and publicise success of exemplar projects to drive excellence in industry.

6.2.3 In order to improve performance and engage in a process of continual improvement, an organisation needs to measure and benchmark progress. Constructing Excellence has developed a number of key performance indicators (KPIs) to assist and support companies and industry in improving performance and competitiveness.

6.3 TOOL BOX TALKS

6.3.1 'Tool Box' talks are used by the construction industry as an effective method for communicating and reinforcing relevant information related to construction site activities. Each toolbox talk is a brief overview of a specific procedure appropriate to a site, and there are toolbox talks covering most construction site procedures, from health & safety to protected species present on site. The aim of toolbox talks is to convey procedures and raise awareness in a concise and targeted manner for construction site workers. Toolbox talks are generally limited to one page and are given on site, providing a minimum standard of training.

6.4 BREEAM

6.4.1 The Building Research Establishment (BRE)[58] are a consultancy researching best practice in the construction sector and are at the forefront of engineering, materials science, building energy efficiency and sustainable construction and development.

6.4.2 The BRE has developed BREEAM[59] (the Building Research Establishment's Environmental Assessment Method) which is designed to encourage best practice building design that exceeds building regulations and delivers energy efficient, comfortable and healthy buildings with low environmental impact.

6.4.3 BREEAM is a voluntary market-focused design tool aimed at creating significant improvements in the performance of buildings through the demonstration and recognition of improvements made to those buildings. BREEAM provides a method for evaluating the environmental impact of both new and existing buildings and the BREEAM score can be used to benchmark the environmental performance against other buildings.

6.4.4 BREEAM evaluates the impact of a building against a range of key environmental issues within a number of 'headline' categories, including energy, health & wellbeing, transport, water, pollution, materials and management. At the end of the assessment a single overall score of performance is awarded a scale of PASS, GOOD, VERY GOOD or EXCELLENT, and a certificate awarded by the BRE accordingly.

6.5 CEEQUAL

6.5.1 CEEQUAL[60] is comparable to BREEAM but rather than applied to buildings, CEEQUAL evaluates the environmental performance of civil engineering schemes. The aim is to encourage and reward improved environmental performance across a number of environmental aspects including use of water, energy and land as well as ecology, landscape, nuisance to neighbours, archaeology, waste minimisation and management, and community amenity. Similar to BREEAM, CEEQUAL is a credit-based assessment framework, and awards are made to projects in which the clients, designers and contractors have exceeded legal and environmental requirements to achieve acceptable environmental standards of performance.

7 Current Position of Construction Industry

7.1 INTRODUCTION

7.1.1 The construction sector is a vast and diverse industry, embracing civil and structural engineering, construction, building services and surveying, and encompassing engineering construction, where scientific, mechanical engineering and construction disciplines all meet. It incorporates everything from house building to constructing dams and bridges; to road, rail and air transport infrastructures; and industrial plant, power stations and gas platforms.

7.1.2 Construction is Britain's largest industry and in 2003 was responsible for 5.4%[61] of Gross Domestic Product (GDP). The Construction Industry is essential for growth in other sectors such as housing, infrastructure and improvements in public services, i.e. health, education and urban renewal. Over 30% of total construction output in the UK is for the public sector[62].

7.1.3 The construction industry currently employs some 2 million people in the UK - that is almost one in fourteen of the total working population. Employment levels are expected to grow particularly in regions undergoing development. The predicted annual growth rate is 1-2% which equals approximately 80,000 new recruits to the industry each year[55].

7.1.4 The table 7.1 below illustrates the sizes and numbers of private contractor firms in the UK from 1993 to 2003[63]. It is clear that the majority of private contracting firms function as a single, self-employed one-man-bands and the market is dominated by 'micro' enterprises (firms with less than 10 employees), accounting for 93% of the sector in 2003.

Table 7.1 Sizes and numbers of private contractor firms in the UK from 1993 to 2003

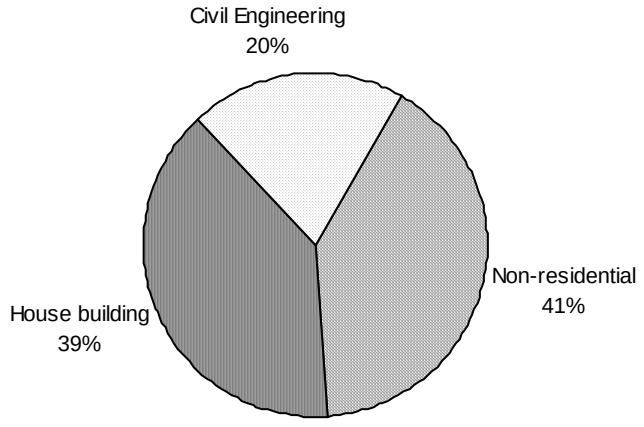
Great Britain											3rd Quarter Each Year
	1993	1994	1995	1996[3]	1997	1998	1999	2000	2001	2002	2003
(a) By Size of Firm											
1	93,585	97,141	99,099	81,363	86,269	87,837	88,018	87,712	77,926	71,431	70,370
2-3	64,438	65,188	64,837	56,106	47,644	47,918	49,350	48,773	50,653	50,306	53,022
4-7	26,072	22,145	20,289	15,317	15,737	16,391	16,969	16,584	22,455	23,963	25,704
8-13	4,630	4,221	4,021	4,366	3,787	3,988	4,148	3,790	8,044	9,819	10,508
14-24	3,129	2,881	2,828	2,952	3,101	3,274	3,271	3,104	4,920	5,427	5,892
25-34	1,086	956	938	1,103	1,176	1,201	1,332	1,201	1,782	1,809	1,932
35-59	1,098	1,008	969	994	1,156	1,263	1,189	1,109	999	1,782	1,821
60-79	294	325	307	325	396	419	397	364	354	457	583
80-114	283	262	258	263	296	319	304	271	304	425	451
115-299	330	356	337	348	381	405	379	341	433	520	535
300-599	96	92	105	101	107	125	105	91	129	123	135
600-1,199	53	50	51	54	60	56	58	51	68	62	75
1,200 and Over	33	32	33	33	36	40	42	35	56	57	64
All Firms	**195,107**	**194,657**	**194,070**	**163,315**	**160,148**	**163,236**	**165,561**	**163,426**	**168,123**	**166,181**	**171,092**
(b) By Trade of Firm [4]											
General Builders	70,765	69,160	68,502	..	..	..	..	..	..	..	..
Building and Civil Engineering Contractors	6,264	6,845	7,043	..	..	..	..	..	..	..	..
Non-residential building	..	..	..	..	..	..	..	..	33,197	26,201	19,857
Housebuilding	..	..	..	..	..	..	..	..	9,332	13,462	19,015
Civil engineering	4,070	4,182	4,298	..	..	..	..	..	14,851	14,380	9,948
Total Main Trades	**81,099**	**80,187**	**79,843**	**66,380**	**63,579**	**63,550**	**60,858**	**59,708**	**57,381**	**54,043**	**48,821**
Constructional Engineers	2,375	2,168	1,976	1,216	1,002	884	1,042	1,105	..	..	..
Demolition	708	685	712	740	750	793	1,021	855	1,076	1,137	1,113
Reinforced Concrete Specialists	729	637	615	415	357	321	351	263	..	..	..
Test drilling and boring	..	..	..	..	..	..	..	..	139	182	185
Roofing	6,891	6,470	6,461	5,457	5,374	5,589	5,636	6,310	5,985	6,252	6,664
Asphalt and Tar Sprayers	1,071	1,077	1,086	866	772	711	584	845	..	..	..
Construction of highways	..	..	..	..	..	..	..	..	1,566	1,640	1,812
Construction of water projects	..	..	..	..	..	..	..	..	309	381	246
Scaffolding	1,645	1,733	1,791	1,270	1,112	1,009	1,262	1,555	1,037	1,194	1,512
Installation of electrical wiring and fitting	20,589	21,004	21,033	19,463	19,077	19,385	19,036	18,426	20,132	20,424	21,953
Insulating activities	1,147	1,131	1,133	977	926	934	832	879	939	993	933
Plumbing	13,880	13,181	13,111	11,698	12,045	12,519	13,600	13,973	18,271	18,853	20,540
Heating and Ventilating Engineers	9,355	9,136	8,892	6,697	5,981	5,500	6,161	5,870	..	..	..
Plastering	3,549	3,160	3,129	2,475	2,443	2,538	2,741	2,389	2,712	2,777	2,839
Joinery Installation	13,302	12,614	12,385	10,202	9,974	10,016	9,725	9,699	17,069	15,295	15,616
Flooring contractors	2,249	2,320	2,298	2,249	2,412	2,694	2,805	2,820	..	..	..
Floor and Wall Tiling Specialists	1,492	1,430	1,394	1,011	872	770	803	791	..	..	..
Floor and wall covering	..	..	..	..	..	..	..	..	3,947	4,058	4,456
Suspended Ceiling Specialists	1,597	1,509	1,522	2,118	3,238	4,529	5,234	3,452	..	..	..
Painting	9,774	8,974	8,939	8,264	8,634	8,969	8,921	8,507	8,232	7,895	7,823
Glazing	6,599	6,918	7,015	4,174	3,484	3,128	3,841	3,581	2,957	3,574	4,066
Plant hire (with operators)	5,567	5,940	5,886	4,607	4,182	3,882	3,549	3,245	2,983r	2,964r	2,757
Other construction work and building installation and completion	11,490	14,383	14,859	13,016	13,934	15,535	17,560	19,154	23,379r	24,566r	29,756
All Trades	**195,107**	**194,657**	**194,070**	**163,315**	**160,148**	**163,236**	**165,561**	**163,426**	**168,123**	**166,181**	**171,092**

Great Britain											3rd Quarter Each Year
	1993	1994	1995	1996r	1997	1998	1999	2000	2001	2002	2003
(c) By Region of Registration [5]											
North East	5,494	5,527	5,461	4,425	4,255	4,210	4,647	4,079	4,246	4,191	4,389
Yorkshire and the Humber	15,336	15,290	15,366	12,676	12,581	12,543	12,442	12,913	12,626	12,476	13,156
East Midlands	13,772	13,877	13,026	11,567	11,469	11,956	11,396	11,759	12,325	12,245	12,911
Eastern:	23,616	23,788	23,468	20,305	20,196	20,949	20,608	21,553	22,129	21,790	22,513
East Anglia	8,968	8,953	8,908	7,559	7,589	7,688	7,220	7,535	7,822	7,727	8,194
Beds, Essex, Herts	14,648	14,835	14,560	12,746	12,606	13,261	13,388	14,018	14,307	14,063	14,319
Greater London	20,539	20,063	20,174	16,977	16,530	17,142	17,222	15,936	17,737	17,610	17,579
South East:	34,621	33,777	33,164	27,938	27,824	28,806	30,707	29,683	30,338	30,094	30,949
Kent, Surrey, Sussex	18,423	17,874	17,541	14,750	14,709	15,348	15,897	15,118	16,032	15,908	16,212
Berks, Bucks, Herts, Oxon	16,198	15,903	15,623	13,188	13,025	13,458	14,810	14,565	14,306	14,186	14,737
South West	20,852	20,032	19,773	16,689	16,462	16,705	16,985	17,700	18,193	17,961	18,397
West Midlands	17,754	17,740	18,058	15,213	14,656	14,844	13,974	14,076	14,917	14,746	15,093
North West	19,281	19,606	19,753	16,299	15,508	15,676	16,112	15,303	15,874	15,661	16,185
England	171,265	169,690	169,143	142,089	139,500	142,904	144,093	143,001	148,382	146,774	151,170
Wales	9,930	10,269	10,274	8,585	8,392	8,273	8,382	7,676	7,916	7,784	7,830
Scotland	13,912	14,698	14,653	12,641	12,256	12,159	13,179	12,748	11,824	11,624	12,092
Great Britain	195,107	194,657	194,070	163,315	160,148	163,236	165,561	163,426	168,123	166,181	171,092

Notes
.. = not available due to change of classification
(r) revised
1. Information relates to the number of private contractors' firms on the Department's register.
2. The number of firms include some which were temporarily inactive.
3. There is a discontinuity in the series between 1995 and 1996 as improved survey techniques, resulting in better coverage and classification of businesses during the previous 24 months, have been incorporated in a single update. This affects the trade classification of all businesses and the number of businesses with 7 or fewer employees.
4. Discontinuity between 2000 and 2001 following move from Standard Industrial Classification 68 (SIC68) to SIC92
5. Government Office Regions

Source of Data: Construction Market Intelligence, Department of Trade and Industry
Contact: 020 7215 1930

Figure 7.1 Proportion of Building Trades Within the Construciton Sector 2003



7.1.5 Medium and large sized companies (over 250 employees) accounted for a combined total of only 1% of the market in 2003.

7.1.6 In terms of trade within the industry, the residential sector accounted for 39% of the construction industry's output in 2003, while non-residential (commercial) accounted for 41% and civil engineering, which includes infrastructure projects accounted for 20%, as shown in Figure 7.1.

7.1.7 Road building is the main source of infrastructure work. The National Audit Office revealed that more than £434m worth of road-construction contracts - 51% of

those awarded - were won by five firms, Balfour Beatty, Budge, Fairclough, Alfred McAlpine and Tarmac[64].

7.1.8 The remainder of this chapter presents 11 case studies representing the views of a range of stakeholders within or associated with the construction industry. Company policies and procedures related to soil are discussed with the aim of establishing how best to take forward the SAPE actions related to soils in the built environment.

7.2 CASE STUDY 1

7.2.1 Case Study 1 relates to the operations and activities of an international real estate company (Company A) that holds a portfolio of 2.9 million sq.m (land area and land under development). The core businesses of Company A is developing and managing commercial industrial accommodation and distribution centres. Construction works are not carried out directly by the company but by sub-contractors and therefore this company is unlikely to be incorporated within the breakdown of construction industry trades as shown in Table 1.0.

7.2.2 This Company is committed to their CSR policy and high standards of environmental performance in all its operations. This commitment is demonstrated by annual CSR reporting, an in-house EMS and a number of policies covering issues such as utilisation of Brownfield land, contaminated land, waste management and a newly formed biodiversity policy.

7.2.3 Company A benefit from having an in-house construction team to assist with the planning of all development operations, but do not get directly involved with on site operations when developing a new site. Instead, all site development works such as site clearance, remediation, demolition, construction and landscaping works are sub-contracted out. As a result Company A have provided feedback representing the viewpoint of soil management from the perspective of a real estate company that develop and manage land and indirectly have an influence on soil. This is a fairly common position within the industry.

7.2.4 Whilst not being directly responsible for site operations, the Environmental Manager for Company A confirmed that environmental workshops are undertaken with their contractors and include contractual requirements, such as compliance with BRE's SMARTwaste[65] (a waste management tool) to address environmental impacts. Workshops and contractual requirements ensure sub-contractors comply with Company A's environmental objectives.

7.2.5 Within their environmental policy Company A has a policy dealing with soil. The aim of this is to minimise the removal of soil and aggregates off site, balancing any cut and fill through appropriate landscaping. This combined with the policy to reuse Brownfield sites in preference to Greenfield sites means the Company rarely needs to purchase top soil. The purchase of soil is, therefore, not a significant cost to their development projects. The quantity of top soil spread in 2004 was approximately 4,640m^3.

7.2.6 Company A have a standard soft landscape specification, produced by their preferred landscape consultants (Company B), which includes procedures for top soil handling. Company A's policy is to retain soil in stockpiles on site wherever it is practical to do so. Where soil is temporarily stored on site, Company A would expect the landscape contractors to appropriately manage this in line with the standards set out in the soft landscaping specification. It is not common practice within Company A to stockpile soil long term, as this is rarely necessary within the scope of their projects. Where long term stockpiling of soil is required on exceptional projects, Company A do

not include requirements to actively manage this and expect some soil to be lost through wind erosion.

7.2.7 Utilising Brownfield land and providing uncontaminated sites for development is a key priority, whereas soil protection specifically, is not high on the environmental agenda for the Company. This is principally because they have previously been unaware of the importance of soil as a finite environmental resource. As soil rarely carries a substantial direct capital cost or an investment commitment and does not deliver substantial capital return, its protection as a resource is often not directly addressed.

7.2.8 Company A confirmed that a clause on minimising soil compaction during site operations is included in the contract documents. This suggests that without purposely intending it, the Company are targeting the causes of soil degradation without connecting this directly to soil protection and management.

7.2.9 Having been made aware of soil protection and soil management as an important environmental issue which they can have direct influence over, Company A will now consider good management of soil in more detail and potentially incorporate further measures in future operations. The Company agree that there is a need to protect soil and are open to addressing this in the future, given the appropriate information.

7.2.10 To raise awareness of soil management and protection, Company A would benefit from the use of 'best practice' specifications with information on soil handling prepared for site teams. Company A could then require project management teams and contractors working on their behalf to apply these guidelines and ensure good site practices. Company A also suggested the production of 'Tool Box' talks to assist in the promotion and understanding of good practice in relation to soil.

7.2.11 There are several possible actions that might encourage similar real estate companies to proactively address soil management, for example raising awareness of the importance of soil as a resource and the need for protection through seminars and conferences.

7.2.12 In addition, soil protection and management could be included in guidance related to the development and review/update of EMS's so that any companies that have operations associated with land development are made aware of this as an impact arising directly from company actions. This will encourage organisations to then set objectives and procedures to address and minimise this impact.

7.3 CASE STUDY 2

7.3.1 Case Study 2 outlines the views of Company B, a landscape architecture practice who provide landscape design and consultancy to a range of companies, including Company A. Landscaping companies are not considered part of the construction sector directly and would not be included in the analysis in Table 7.1 but are associated with the construction industry and the built environment.

7.3.2 Company B wrote the landscape specification for Company A that is implemented for soft landscaping. The Specification for Company A was broadly based on the NBS[49] for Landscape and references include the British Standard for Topsoil (BS 3882:1994[47]). Interestingly, the physical and chemical characteristics specified for top soil exceed those in the British Standard for Topsoil (BS 3882:1994) as Company B feel the BS standards are not ridged enough for high quality landscaping schemes.

7.3.3 Company B have an environmental policy but do not have an EMS or CSR policy. Company B follow the objectives and procedures set out in Company A's EMS. This is not unusual for a landscape architecture practice not to have an EMS.

7.3.4 Company B do not carryout the labour on site but execute schemes through two nominated landscape contractors who are familiar with the landscape specification developed by Company B. Environmental training for the landscape contractors consists of a site induction including raising awareness of issues such as species protected by legislation. Top soil stripping, top soil storage, stockpiling, soil handling and spreading is covered in the specification and the landscape sub-contractors are selected because of their technical ability and professionalism and are relied upon to follow the guidelines in the specification.

7.3.5 The project manager reports back to the practice through standard meeting minutes that include environmental aspects on site.

7.3.6 The landscape contractors purchase top soil following the quality and quantity requirements stipulated by Company B and the soft landscaping specification. In addition, planting lists and soil samples are submitted to soil and land consultants who analyse the soil parameters (chemical, physical) and provide recommendations on amelioration.

7.3.7 It was suggested that problems with imported top soil are mainly a result of the soil characteristics of the imported soil not being matched appropriately to the soil and drainage properties on site. Contractors often purchase top soil from the closest source; this is a direct outcome of the pressures of transportation costs.

7.3.8 Information sources considered appropriate for distributing information on soil handling and protection are the British Association of Landscape Industries (BALI), Association of Professional Landscapers (APL) and the Horticultural Trade Association (HTA) who all provide guidance and best practice to landscape contractors. Other channels suggested by Company B to increase awareness are through regional and national workshop sessions and conferences.

7.3.9 Company B commented that some developers don't understand the landscape and the complex interactions within natural ecosystems and consequently, don't fully grasp the importance of soils as a finite resource. This in turn, may impede a direct link between the landscape and soil, and the importance of soil for environmental processes such as water filtration and attenuation.

7.3.10 It was also the opinion that there is general lack of knowledge of soil handling in the construction sector. It was noted that a significant majority of post construction disputes are associated with issues concerning soil compaction/miss handling and apportioning blame.

7.3.11 It was agreed that toolbox talks would be a useful means to convey information on site, however, our source highlighted that these is also a need for higher level information, through institutes such as BALI.

7.3.12 An increasing number of sites, particularly Brownfield developments, are manufacturing top soil (blends with recycled compost). These can be classed 'as dug' and 'screened'. A focus for the future will be the production of national guidance and the quality of compost products. Structural soils would be a good idea but yet again, will require standardisation in future.

7.4 CASE STUDY 3

7.4.1 Case Study 3 outlines the perspective of global construction services group (Company C) with an annual turnover of £2billion and 17,000 employees. Company C would be classified a 'large' construction company and fall into the few companies with over 1,200+ employees in section a) of Table 7.1. The core business sectors within which Company C operate are health, business services (PFI), Transport and defence. Company C are actively involved in all construction phases, from site clearance; demolition; civil engineering (including piling, foundations, drainage infrastructure etc.); construction; and landscaping. The company also design, manage and maintain buildings, particularly in PFI and similar procurement contracts.

7.4.2 Company C operates an Integrated Management System (IMS) that incorporates both the health and safety issues and the EMS. This IMS is third party certified to EMS ISO 14001 standards.

7.4.3 Each business unit within Company C has an environmental advisor responsible for environmental monitoring and reporting. The environmental advisors meet up regularly to feedback on the environmental performance of their respective business units. This group of advisors are responsible for reporting on the objectives of the IMS and the IMS annual review.

7.4.4 As part of this IMS the company has produced an excellent draft Sustainability Strategy that identifies the current position of the company against 16 strategic objectives and the future position aspired to. These objectives are embedded within the broad headlines of social progress, protection of the environment, prudent use of natural resources and economic growth and prosperity. In addition, Company C holds a Sustainability Week to increase awareness and understanding of sustainability across the company and to encourage employees to lead a more sustainable lifestyle.

7.4.5 Although issues regarding biodiversity, water pollution, land impacts, waste and resource use are identified within the IMS, there are no specific objectives related to soil as a resource. This may result partly from the general EMS framework, which traditionally does not highlight soil as a headline indicator. However, it was noted that there would be scope in future annual reviews to incorporate sustainable soil use into their IMS.

7.4.6 As standard Company C signs up to the Considerate Contractors Scheme[66] (CCS), a scheme promoting good site practice during construction, and annually monitor the number of projects that have undergone a BREEAM assessment and note the ratings achieved.

7.4.7 On every project the company employs a dedicated environmental co-ordinator to ensure that environmental legislation is enforced on site and to report back on environmental issues in general. The environmental co-ordinators undergo a programme of detailed environmental training. The project manager on site will also undertake environmental training and site operatives receive tool box talks on site. However, as part of the environmental training initiatives currently provided, soil handling, protection and management is not specifically addressed.

7.4.8 The communication mechanism of company policy to site managers is considered to be partially successful. This is likely to be a true reflection of all large construction companies where a significant proportion of employees work on site and are therefore detached on a day-to-day basis from head office. This is compounded by the fact that there are also a number of other sub-contractors operating on each site, all requiring supervision and co-ordination. Hence, the implementation of policies and procedures on site and buy-in from external trade contractors is influenced to an extent by the pro-activeness and understanding of individual project managers on site.

7.4.9 The environmental advisor was not aware of the SAPE prior to our meeting and this is similar to feedback received from a number of contacts. The company have no official policies for the preferential reuse of Brownfield land because the location of projects undertaken by Company C is largely dictated by the client. However, the company are moving more and more into regeneration projects which usually involve the reuse of Brownfield sites. Company C have no policies to actively utilise Sustainable Urban Drainage Techniques (SUDS) on projects where suitable but determine the use of SUDS on a site by site basis in line with the project brief and statutory consultation with the Environment Agency.

7.4.10 It has been confirmed that on all projects a ground report is undertaken identifying the strata for foundations etc. as part of the Construction Design Management (CDM). However, soil surveys are not routinely carried out to establish the quality of the soil resource and inform soil handling procedures.

7.4.11 Company C has a dedicated design group including landscape architects, a group for whom top soil is an important resource. However, the importance of top soil is project dependant, for example, education facilities demand higher quality landscaping compared to supermarket developments. It was noted that planning authorities are emphasising the importance of high quality landscaping and biodiversity within developments and these requirements are being applied to schemes that would otherwise not normally address landscaping or habitat biodiversity as a priority. Tree failure on scheme was not seen to be an issue. Transfer of knowledge from the landscaping consultants to the environmental advisors is not carried out to a significant extent within Company C.

7.4.12 Although in general the aim is to keep everything on site and reduce waste, there are no policies regarding top soil reuse. When importing top soil, a significant proportion of the cost is the transportation of the top soil from source to site. For this reason a national database of top soil supply and demand related to locality may be beneficial.

7.4.13 Of the 56 projects currently under construction, it was confirmed that 85% utilise Brownfield sites and only 15% are on Greenfield land. There are no figures available on the volume of top soil purchased annually, as similar to other large construction companies, this is carried out by groundwork or landscaping contractors.

7.4.14 Company C are currently examining the corporate and environmental policies of their clients. Where a client is particularly proactive they are identifying where they align themselves in comparison to their client, and where a client has not progressed as far, Company C will endeavour to highlight the commercial benefits of environmental protection and sustainable business.

7.4.15 At present the construction industry deals with a significant amount of legislation and good practice across several areas including the environment and health and safety. As a result, the environmental advisor suggested that, if potential future guidance on soils is to be widely taken up, referenced and implemented, it is important that guidance is concise, user friendly, and practical.

7.4.16 DEFRA was identified as the first point of contact that Company C would refer to for guidance on soil management. Other sources of information that are commonly utilised by Company C are the Environment Agency and the Construction Federation Environmental Forum (CFEF).

7.4.17 Highlighting incentives for the construction industry was considered to be a key factor in raising awareness of soil within the industry. Concise guidance on soil management best practice would be beneficial, as would brief toolbox talks that pass on information to site operatives. Another area to raise awareness suggested were to

incorporate soils into EMS or similar, which is being addressed to some extent by the EU Thematic Strategy.

7.4.18 Since our meeting, Company C has confirmed that during the next annual review of the IMS, information from the SAPE will be incorporated into the management system to encourage better soil handling and protection.

7.5 CASE STUDY 4

7.5.1 Case Study 4 provides an overview of an international construction services group (Company D) operating under the three business streams of public-private partnerships (PFI/PPP); civil engineering and specialists; and construction with a focus on the residential, health, transport and defence markets. The company employs 53,000 globally and achieved sales in 2004 of $17 billion. The company are actively involved in all construction phases, from site clearance; demolition; civil engineering (including piling, foundations, drainage infrastructure etc.); construction; and landscaping. The company also design, manage and maintain buildings, particularly in public-private partnerships and similar procurement contracts.

7.5.2 Company D, similar to other large construction companies, has a number of business units each with its own dedicated environmental manager. We took the opportunity to speak to the environmental manager for integrated projects, the department that experience the largest turnover within the overall company. Integrated projects are responsible for public-private partnership projects and are therefore actively involved with a development from the outset of concept design, throughout the construction phase, to management and maintenance up to 30 years after completion.

7.5.3 Interestingly, the environmental manager we interviewed is Australian, and has first hand experience of Australian Government policy and the planning process, where soil erosion is considered a key environmental issue. In Australia, any building or scheme applying for planning permission must, at the planning stage, address soil erosion minimisation procedures. As a result the general awareness and knowledge of best practice in Australia with regard to soil erosion is good.

7.5.4 Consequently, when starting work in the UK the environmental manager was surprised at the lack of awareness and understanding of soil as a resource in the UK. This has greatly influenced the EMS (third party certified ISO 14001), introduced by the environmental manager for Company D with soil as a resource specifically identified within the EMS. The environmental manager for Company D was previously aware of the SAPE through a general update on recent Government policy but had not read the document in detail because it was a government policy/action plan paper.

7.5.5 Similar to other large scale construction services companies, Company D routinely sign up to the CCS and use the BREEAM labelling scheme for buildings.

7.5.6 The company proactively design in swales and other SUDS features on all projects where appropriate and also utilises SUDS during construction as a pollution prevention technique. The Environment Agency inspects all UK construction sites of Company D and one project has been a case study of best practice with the Environment Agency for the use of SUDS.

7.5.7 On site Company D employs environmental managers to oversee and report back on environmental issues and ensure that environmental legislation is adhered to. The scope of environmental training for company employees on construction sites depends on the project but often consists of in-depth training consisting of at least one half day and possibly training on sustainability, including the concept of SUDS. Unlike Company C and E, Company D does not directly employ site trade labour. As a result

Company D policies are communicated to sub-contractors through instruction by the project and environmental site managers using simple on site Toolbox Talks, one of which addresses soil specifically.

7.5.8 The soil related Toolbox Talk includes basic soil issues and soil handling techniques. In addition to on site Toolbox Talks, trade sub-contractors are committed to Company D policies through contractual requirements, protocols and site specific method statements.

7.5.9 It was estimated that sites under development by Company D are 60% Brownfield with virtually no virgin Greenfield development, with the exception of some road building projects. The remaining 40% utilises agricultural (modified) Greenfield land.

7.5.10 When planning the development of a site the key issue is to minimise waste, which has transportation and disposal cost associated with it. Where possible, Company D prefers to minimise disturbance of a site during construction therefore leaving the soil resource intact. Where site clearance is necessary soil will be stored, often on rented land plots adjacent to the construction site. Procedures to manage this are incorporated into the sub-contractors contractual documents, e.g. earthworks set at a maximum height.

7.5.11 The key priority for Company D with regards soil management is to minimise erosion. The environmental manager did not consider soil compaction such a major priority. Unlike soil erosion, soil compaction was considered to be both unavoidable on a construction site and reversible through amelioration. When clearing a site, the top soil and sub soil is separated and graded. The top soil is then stored where possible or sold. When stored in stockpiles, the pile will be bladed off and compacted down with an excavator. For short term storage the pile is damped down to seal the surface soil layer and minimise erosion from wind and rain. When stockpiling soil long term (up to 5 or 6 years) the pile is either seeded or covered with crushed gravel to minimise erosion. Covering with crushed gravel enables the pile to take construction traffic on constrained sites. Covers are not used as these often blown away. The soil is then ameliorated before reapplying.

7.5.12 When evaluating the value of soil on a particular site, some of the functions provided by the soil is assessed, chiefly the function associated with the biodiversity of the soil and the flora and fauna associated with that site. For Company D soil is valued as a material asset to be used in the development as either a platform for construction or for landscaping and the value is also intimately linked with the costs of transporting and disposing of top soil. The cultural heritage or environmental regulation functions are not currently valued and according to the environmental manager, this is due to a general lack of awareness. The value of storing the top soil for landscaping as opposed to the transport and disposal costs on just one project was £50,000 however, this is a relatively minor cost saving compared to the overall project value.

7.5.13 In one noteworthy case, the quality of the top soil was too good for the proposed ericaceous habitat planting, planned to increase the ecological value of the site. Hence, the soil was purposely degraded by for example, stockpiling to heights of 15-20m.

7.5.14 The soil awareness of the environmental manager was obtained through personal and professional experience, mostly in Australia. It was the opinion of the environmental manager that the UK planning framework and new planning policy related to soil would be central to a widespread uptake of soil management and protection by the construction sector.

7.5.15 To influence and raise awareness in the UK construction sector the environmental manager suggested greater uptake of soil focussed Toolbox talks and greater availability of best practice guidance outlining what works and what doesn't. CIRIA and CIEF are considered by the environmental manager as suitable information networks to deliver guidance and information.

Figure 7.2 Screening of excavated material to be reused as sub-base.

7.6 CASE STUDY 5

7.6.1 Case Study 5 represents a large scale international engineering and construction company (Company E) operating in the global markets for road, rail, utility services, building and complex structures with an annual turnover in 2003 of £3.7billion and more than 28,500 employees worldwide. As a group, Company E operates in four key business sectors (building and building management; civil engineering; rail engineering; and investments and developments) that cover the complete construction process from initial concept design, demolition and construction to whole life management. Within Company E there are several smaller companies that have particular specialist capabilities within the construction sector and many operate directly with soil during a number of stages in the construction process.

7.6.2 Company E are committed to achieving high environmental standards as demonstrated by their environmental policy. In 2002 they addressed their wider sustainability impacts and produced a strategy to incorporate sustainability into the management of all projects. To facilitate this Company E have developed a five stage sustainability model that aims to incorporate sustainability into the lifecycle of all new schemes. The model focuses on partnerships, planning, resources, process and reporting. The UK business groups are also required to operate under a third party certified (ISO14001) EMS and annually measure and report on environmental performance. In addition, the CCS is implemented on all sites and the civil engineering labelling scheme CEEQUAL is signed up to on some projects. Company E understands that good environmental practice is generally cost effective.

Figure 7.3 Photo taken from of a road widening scheme, showing the cross section of a slope composed of sub-base consisting of recycled material, covered with sub-soil and a layer of top soil for vegetation growth.

7.6.3 We had the opportunity to meet with two representatives of the construction division of Company E, a materials specialist for major projects and a civil engineer on the site of a major road widening scheme located on the outskirts of West London. This provided an insight into the constraints and practicalities of soil movement and handling on a major road building project.

7.6.4 The extension utilises Brownfield land that was once quarried then heavily planted. As a result, the quality of the excavated top soil is poor and full of aggregates and vegetation roots. There is a requirement for substantial volumes of top soil on this site so there is a driver for Company E to reuse existing soil rather than paying for this to be removed and paying for more top soil to be transported in. To recover the top soil component, the excavated material is graded, the soil recovered, stored centrally, screened and improved by adding imported compost and fertiliser to increase the quality of the soil product (see Figure 7.2). The road widening is limited to the current boundary of the existing motorway which requires the use of pre-cast concrete retaining walls with steep grassed banks to minimise land take. The sub-base consisting of recycled material achieves the steep angled banks, covered with sub-soil and a layer of top soil for vegetation growth (see Figure 7.3).

7.6.5 Due to the large areas of soft landscape incorporated into this road widening project, a total of 150 tonnes of additional top soil over 2 years will be imported to satisfy the requirements of this particular scheme. The specification from the client requires all top soil to meet tight parameters so all imported and recycled top soil is screened and tested to meet the high standards required.

7.6.6 Reusing soil minimises the need for additional top soil, which has environmental benefits for the national soil resource. The use of recycled top soil provided other benefits by enabling the works to commence throughout the year and during wet periods where the handling of traditional top soil would result in structural and functional damage. However, the handling of any soils, including recycled soil, when wet is not recommended.

7.6.7 Despite the environmental benefits of ameliorating and reusing poor quality soil, Company E considers that over-specification of a product, i.e. requiring it to meet stringent parameters making it too costly or too difficult to achieve, to be a potential barrier to wider uptake and could make purchasing high quality top soil more attractive.

7.6.8 It was noted that a common problem with soil adjacent to highways and major roads was soil contamination from the use of leaded petrol. However, with the introduction of unleaded and diesel fuels the impact is less, reducing the risk of soil functions being inhibited.

7.6.9 On site for the road widening project the Group had set up a dedicated concrete factory that minimises waste and associated transport CO_2 emissions. This was also a dedicated storage area for recyclables, during which recyclables will be segregated, stored and reused.

7.6.10 At this particular site the use of recycled materials for the highways widening works was in the region of 92% (tonnage), 35% (tonnage) of which originated from the site. Company E worked in association with the organisation WRAP[67] (Waste and Resources Action Programme) to maximise the use of recycled materials. It was noted, however, that the high percentage of recycled materials utilised was only possible due to the local availability of these recycled products and this in turn was due to the close proximity to a major urban conurbation where demolition works produce an excess of demolition material. In addition, highways works are an ideal project type to incorporate recycled aggregates in the sub-base, whereas building works currently require aggregates to comply with a higher specification for structural integrity that limits the use of recycled aggregates. Hence, this demonstration of best practice may not necessarily be repeatable at a site in a rural setting or on a different project type and highlights the reality that every project is different.

7.6.11 This also highlights another significant practical constraint to best practice on site: logistics. For material being removed from a site there are two major questions – where does it go and how will it get there? Where a scheme will require major fill material, the source and transportation of this material is decided and priced at the tender stage, before any site works have commenced. This is particularly relevant to top soil. In the South East of England there is a shortage of top soil due to the relatively small number of Greenfield developments. However, in the north there is a greater availability of top soil but the transportation costs to transfer this from the north to the south of the UK prevents the use of this available top soil.

7.6.12 The general procedures implemented by Company E when starting works on a new site (Brownfield or Greenfield) include the clearing of top soil (if present) off the site, which is then covered with a geotextile material to protect the subsoil. Following this the site is covered in asphalt to avoid the potential for contamination from site works e.g. oil spillages.

7.6.13 If stripping from Greenfield sites where good quality top soil is usually present, specific heights for stockpiling soil are applied, 2-3 metres maximum. The stockpile will be tracked with excavator to seal the surface over winter and when appropriate, reapplied only in dry weather. General Development Orders (GDO) enable the use of

adjacent land to that with the planning consent to be utilised and Company B will often rent land adjacent to development works for storage and stockpiling of top soil.

7.6.14 Company E provides environmental training directly to their environmental manager on site but confirm that soil handling and protection is not referenced as standard within the current training package. Depending on the subject site conditions, site briefings may cover soil handling and protection in more detail.

7.6.15 For guidance on soil issues Company E routinely reference the Highway Agency Design Manual for Roads and Bridges[68] to guide the developments onsite. Other sources of information used to inform site practices with regards to soil are the Good Practice Guides to Soil Handling[48] and Forestry Commission Classification[69] information. Guidance from the client's own soil consultant has also been sought on this particular project.

7.6.16 Company E have a large team of technical specialists with responsibility to implement and communicate new legislation and best practice guidance through the organisation. However, it was considered by the representatives we spoke to that there is plenty of information presently available on soil handling and that large organisations are currently struggling with all the existing rules and regulations required. No further suggestions were provided.

7.7 CASE STUDY 6

7.7.1 Case study 6 outlines the perspective from one of the largest construction companies in the UK (Company F) operating in a number of global markets with an annual turnover in of £1.6 billion in 2004 and more than 16,000 employee's world wide. The company is structured into UK regional building and civil engineering groups.

7.7.2 Currently the company sub-contract out demolition works but operates directly in below ground engineering works (civil engineering) such as foundations and piling, construction, landscaping on small projects to some fitting out works. The future aim of Company F is to provide a one-stop-shop approach for the building sector. Design and Build is an increasing procurement route for the Company during which the Company are actively involved from the start of the design process.

7.7.3 From the broad estimations provided by Company F the majority of sites under development are approximately $100m^2$, of which about 20 sites are Greenfield UK wide. In London and the south east is all sites are Brownfield. From this one can extrapolate that if 200mm (0.2m) is stripped from 20 Greenfield sites a year the total amount of top soil stripped is $40,000m^3$.

7.7.4 The companies EMS has been accredited to ISO 14001 standards for two years and they are currently looking at wider CSR. Company F were frank in stating the company EMS was primarily implemented to improve competitiveness and comply with tender requirements for chain of supply environmental performance. This is probably true of most companies in the building and construction sector.

7.7.5 The Polluter Pays Principle (PPP) is a key driver behind Company F response to the environment. The PPP has resulted in Company F implementing several guidance notes on construction site best practice and Company F always ensure consented approval from the Environment Agency.

7.7.6 The Company sign up to the CCS on all jobs and comply with BREEAM and CEEQUAL when required. In line with the EMS, the Company draft a site specific environmental management plan for each project consisting of a matrix that identifies all

the potential environmental issues such as ecology and contaminated land, associated with a particular site and the mitigation measures to be applied.

7.7.7 Overall, the Companies activities are led by client requirements. For example, Company F has no soil specific policies or procedures and does not have any in-house specifications to deal with the management, handling or protection of soil. All site procedures with regard to soil are carried out in line with the client's specification. In fact, Company F is unaware of a job where soil was not identified and procedures specified within the specification.

7.7.8 In line with most client/developer specifications, Company F will stockpile the soil, apply herbicide and seed the pile to a maximum of 2m. If soil is to be removed Company F will aim to minimise the materials being disposed of as waste to reduce associated costs of disposal. To reduce costs Company F will try to sell the top soil or give it away locally.

7.7.9 Soil compaction is also avoided in accordance from client's specification. The costs associated with top soil (disposal/stockpile, purchase, transportation etc.) are identified at the tender stage and incorporated into the tender repose.

7.7.10 It was the view of Company F that consulting engineers are responsible for informing clients of site requirements and it the resulting briefs that inform activities undertaken by Company F. This suggests that it is the consultants that who should be targeted when raising awareness of soil in the built environment.

7.7.11 Company F conduct soil surveys for all sites – Brownfield and Greenfield – mainly this is to eliminate the potential risks of dealing with contaminated land. The information from the soil survey is not used to inform the company about the quality of the soil on site or management procedures, as these are already set out in the client requirements.

7.7.12 On small jobs, Company F carryout the landscaping but there is no in–house specification or standard procedures for soil handling; Company F work to the client's specification. On these smaller sites Company F don't generally stock pile soil. If soil was identified as a major issue on a site, soil management and handling would be adequately addressed. Company F has not experienced many problems with tree failure as the specifications provided in the client brief are designed to promote vegetation growth.

7.7.13 It is estimated that 50% of work carried out in the London and South East region is design and built procurement therefore the design and construction is all executed by Company F in-house. It is not company policy to inform clients about sustainability issues but the company is moving forward to a more holistic approach and Design and Build procurement provides greater opportunities for a more sustainable design process, as Company F are actively involved at the early stages when many of the decisions influencing sustainability are taken.

7.7.14 ProCure 21, part of the NHS procurement programme, also increases the opportunity to influence the construction process from the beginning and identify more environmentally sustainable solutions that are cost effective. However, this is not company policy but a beneficial outcome of the Procure 21 and the Design and Built procurement process.

7.7.15 The representatives we spoke to would fully support a UK wide database that identifies local sites with excess top soil and those sites in the vicinity that need to import top soil. In fact, Company F has considered setting up an internal database of top soil resources around the country.

7.7.16 The first port of call for information would be to identify legislation behind the initiative (with a clear objective for this legislation); the Environment Agency and DEFRA; conferences provided by industry bodies such as The Institute of Environmental Management and Assessment (IEMA).

7.7.17 It is the opinion of the representatives of Company F that legislation is required as the key driver for companies to address environmental issues more seriously. A planning approach would be appropriate.

7.7.18 It is Company F's view that a voluntary approach in isolation is unlikely to raise the profile of better soil management and protection in the construction industry as a whole. However, a the inclusion of additional soil issues into existing voluntary schemes such as BREEAM and CEEQUAL, would be positive contribution and complement legislative drivers.

7.7.19 Soil issues could potentially be incorporated into the EMS of Company F and the environmental issues matrix to highlight soil impacts to clients but clients would have to buy-in to protection and the additional cost of soil protection measures.

7.7.20 If the site procedures are predominantly client/developer led several implications:

- Who is informing the client/developer?
- Are the landscape architects leading the developer/client on landscaping and soil issues and are these ultimately the ones to target?
- If technical consultants are informing the developer/client on a project by project basis then these are the people to target?
- Where are the consulting professionals obtaining their information?

7.8 CASE STUDY 7

7.8.1 Company G are the within the top five biggest house builders in the UK (completions) and one of the three biggest in the world. Predominantly active in the housing market, Company G also develops commercial property and has a construction group working in several markets including transport, commercial, housing and the provision of facilities management. The discussion took place with the housing and development group of Company G and therefore provides feedback from this perspective.

7.8.2 Similarly to other construction companies, the construction group of Company G has an EMS accredited to ISO 14001, however, the housing group only has an internal EMS. In fact, no other housing company in the UK has an externally accredited EMS and to Company G feel to implement an EMS and set a precedent in the housing market would be commercially uncompetitive.

7.8.3 When asked why housing developers are not as environmentally proactive as other construction groups, it was the opinion of Company G that this is because house building has not traditionally been as complex when compared to commercial developments and therefore not required the same level of intellectual rigour. For example, a project manager overseeing a complex commercial or transport infrastructure development will have a technical and usually higher level degree associated with engineering and/or project management. On a construction site for a housing development the project manager is more likely to be a labourer who has moved into a project management role. It was noted that this is now changing with an

increasing focus on regeneration and mixed use development and a requirement for high density residential necessitating more complex residential schemes.

7.8.4 Hence, the house building sector has not been as proactive in addressing environmental issues and due to the competitiveness of the market, no one house builder is going to lead the way in terms of environmental action, where this will result in additional costs and a less competitive position. There is no voluntary code of practice in the housing sector, with the exception of EcoHomes, which some housing companies have a policy to achieve minimum ratings under this scheme.

7.8.5 It was the opinion of the representative we spoke to that legislation would be the key driver to increase soil awareness, management and protection and would oblige all house builders to operate on equal terms.

7.8.6 According to our contact, house building companies act regionally and fairly autonomously. This makes the collection of statistics difficult (in terms of identifying the proportion of Greenfield/Brownfield development or the amount of top soil purchased annually).

7.8.7 This also has a direct bearing on a certified EMS, central monitoring and reporting on resources consumption would be difficult in this situation and therefore progression and coordination of a certified EMS problematic.

7.8.8 When approaching any site Company G have a policy to carry out detailed professional surveys of features such as trees, existing vegetation, historic structures, archaeological remains, watercourses and ponds to see how they can be integrated into the new environment. They also consider the previous land uses, soil stability and any possible contamination. A soil survey will be completed to identify any potential contamination risks. However, the information from the soil survey is not utilised to identify the quality of soil, even on Greenfield where there is likely to be good quality top soil. The landscape architect and landscape contractor are relied upon for advice regarding top soil application procedures and handling techniques. This is a similar approach to other companies.

7.8.9 Once a site is stripped, Company G ensures subsoil is protected from potential contamination from on site activities through EMS –type practices.

7.8.10 There is no company policy to utilise Brownfield land over Greenfield land but it is harder to secure planning permission for schemes proposed on Greenfield land so it is generally more commercially favourable to utilise Brownfield land.

7.8.11 Top soil is purchased directly by Company F. Information on the quality of top soil purchased from a top soil supplier comes from the consultants and from the vendor, particularly for risks from contamination. It was noted that the market for top soil is unregulated and heavily influenced by the transportation costs and timing. It was noted that top soil can be manufactured from quarry and/or compost products and this is increasing used on Brownfield development.

7.8.12 When asked about the usefulness of a central top soil database, our representative was supportive of investigation into this area but in light of similar ‘waste exchanges’ would question the success of such data exchanges.

7.8.13 According to our source, the housing industry is not overly concerned with the quality of top soil but want an aesthetic base for the landscaping and presentation of the housing. The end user (the housing owner/occupier) will ultimately determine the quality of the top soil resource, improving it for planting purposes or leaving it to gradually improve due to the addition of nutrients from the decay of vegetation and leaf litter over the years. This is a key difference between housing and other commercial developers. The house buyers prefer a blank canvas for a garden, which they can customise. In

addition, the top soil has to be of a minimum quality for a good outcome. Furthermore, housing schemes aim to keep mature trees where possible and utilise saplings rather than semi-mature tree species in the planting plan.

7.8.14 Before any future legislation is produced Company G would encourage DEFRA to undergo further consultation with construction industry. Where future soil policy and actions are developed for the built environment, Company G would require clear aims and objectives before implementing legislation.

7.8.15 For information on environmental issues, including soil guidance, in the first instance Company G would go to the Environment Agency, DEFRA, CIRIA, and the Association of Geotechnical and Geo-environmental Consultants (AGS).

7.9 CASE STUDY 8

7.9.1 Case study 8 outlines the views of a company (Company H) who are a regionally active construction and development company primarily operating in the midlands and Wales. This company operate both as contractor and/or developer on a range of sites that vary both in size (from 0.3ha to 20ha) and in type (Greenfield, Brownfield, commercial, residential etc). It is estimated that at any one time 50 hectares of land are in the control of Company H, the majority of which is Brownfield. Soil activities undertaken by Company H include site investigation, site stripping and landscaping. Company H perceive soil as soil as a platform for construction and material for landscaping.

7.9.2 Company H has a company wide environmental policy but not an Environmental Management System. The company do not provide environmental training to employees or implement Considerate Contractors Scheme or a local equivalent on site. The drivers behind Company H environmental responsibilities/action is reputation risks and reduction in liability.

7.9.3 When staring on a new site, Company H strip the topsoil and manage their own stockpiles but do not have any soil policies, procedures or training specifically for these operations.

7.9.4 Guidance currently utilised includes Building Regulations, Planning Authority Requirements, British Standards and Construction Industry Codes of Practice. These reference sources set the minimum standards.

7.9.5 It was the opinion of our contact that to improve soil handling and management on site, future guidance should be targeted to directors or project managers and that simple best practice documents would be most effective. For Company H to implement soil procedures and raise awareness of soil handling and protection, the most effective method would be through Planning Regulations.

7.9.6 The costs of dealing with soil for Company H include the disposal of contaminated soil, and the purchase or sale of good quality of soil. However, the overall value of soil to Company H is low, which is general reflection of the construction and building sector.

7.10 CASE STUDY 9

7.10.1 Company I are a large national construction company with specialist capability in foundation engineering. The company operates throughout the UK, normally as a specialist sub-contractor, but also operates its own development and waste management sites.

7.10.2 Company I has a company wide environmental policy which is part of an in-house Environmental Management System (not third party certified). The company has an environmental champion and provides environmental training to employees covering basic health and safety in the environment and pollution prevention. It also implements the Considerate Contractors Scheme on site. Company I is aware of or has been involved in BREEAM and CEEQUAL.

7.10.3 Company I stated that the main drivers for them in implementing environmental responsibilities were legislation, company policy, reputation and reduction of risks. Similar to other feedback received.

7.10.4 The company was unaware of DEFRA's First Soil Action Plan and have no policies or procedures to do with the prevention of soil compaction or soil handling. The company stated that it references and uses building regulations, Planning Authority requirements, British Standards and construction industry codes of practice.

7.10.5 Company I recognises soil as being a platform for construction and piling. It is unsure of the cost of to the company from dealing with soils. Top soil is of low value to the company compared to the overall costs of a construction project.

7.10.6 Approximately 50 hectares of land is held by Company I at any one time with all of it consisting mainly of Brownfield sites. The company does not own or manage stockpiles and has therefore no training or procedures relating to this.

7.10.7 Company I was unsure what point of contact they would turn to in order to improve understanding, training and soil handling procedures. They are also unsure as to the need to protect soil as a resource.

7.10.8 The company believes that further information on soil handling would best be targeted at project and environmental managers. The best form of information dissemination for Company I would be Best Practice Guidance documents and technical documents. The company was unsure as to whether a central database for soil handling and protection would improve soil management practices.

7.10.9 Planning conditions were said to be the main incentive that would motivate the company to improve soil handling techniques and procedures.

7.11 CASE STUDY 10

7.11.1 Company J are a relatively small to medium sized construction company concentrating their business on commercial development sites, in particular ground works, foundation construction and the erection of commercial warehousing. At the time of the interview the company were operating on nine sites (projects) of which they were primary contractor in control of the site at six locations.

7.11.2 Case study 10 summarises the perspective of a smaller construction company that are engage in piling, foundation and building contacts, through to construction of buildings and associated soft landscaping works, therefore handling soil at several stages of the construction process. However, the company does not own or manage any significant soil stockpiles and has no training or procedures for dealing with these. It has no point of contact for improving soil handling procedures.

7.11.3 Company J has a company wide environmental policy and an in-house EMS, though this is not third party certified. The company has an environmental champion in-house in the form of an environmental manager. The Considerate Contractors Scheme is implemented on site.

7.11.4 The company is aware of or has been involved in BREEAM or CEEQUAL. Environmental training is provided to employees in the form of health and safety in the environment, environmental protection and pollution prevention. The main drivers for Company J towards environmental protection are legislation, company policy, reputation and risk reduction.

7.11.5 The company was not aware of DEFRA's First Soil Action Plan and have no training policies or procedures in relation to soil management or compaction prevention.

7.11.6 Company J stated that it references and uses building regulations, Planning Authority requirements, British Standards and construction industry codes of practice. This guidance is thought to be very useful to the company.

7.11.7 The company recognises soil as being a platform for construction and piling. The cost of to the company from dealing with soils is said to be minimal except when the soil is contaminated. Top soil is of low value to the company, similar to feedback from other construction stakeholders.

7.11.8 Company J has an estimated 15 hectares of land under its control at any one time and it is evenly split between Greenfield and Brownfield sites.

7.11.9 They are not sure as to what additional information would be of most benefit to improve soil handling. Any additional information would best be targeted at the Environmental Manager. The best form of information dissemination for Company J would be Best Practice Guidance documents and technical documents. The company did not know whether a central database for soil handling and protection would improve soil management practices

7.11.10 Planning conditions and the Environment Agency were stated as the two incentives that would motivate Company J to improve soil handling techniques and procedures.

7.12 CASE STUDY 11

7.12.1 Company K are a large multi-national consultancy organisation that provide advice and support to the construction industry at every stage in site development from site assessment and acquisition through to remediation and development. This company offer consultancy services throughout the UK to a very wide range of construction industry clients from very large corporations to small scale regional development companies.

7.12.2 Whilst being able to provide many specialist consultants in site design, geotechnical, geo-environmental and remediation disciplines, it is interesting that the company contain very few specialists in soil quality. The organisation does have an ecological and landscape design capability, however this is quite often not called upon in the context of construction works.

7.12.3 Within the construction industry the use of consultancy services to provide specialist services is widespread. Many of the consultancy organisations are large multi-disciplinary companies capable of providing a range of support, which may include specialist soil quality and soil management advice. Many, however, are smaller organisations where only the 'core skills' perceived to be of need by the construction industry are offered – these core skills do not include soil management.

7.12.4 The Company is aware of or has been involved in BREEAM or CEEQUAL. Environmental training is provided to employees in the form of health and safety in the environment, environmental protection and pollution prevention. The main drivers for

Company K towards environmental protection are legislation, company policy, reputation and risk reduction.

7.12.5 The company was aware of DEFRA's First Soil Action Plan but have no specific training policies or procedures in relation to soil management or compaction prevention.

7.12.6 The company recognises soil as being a platform for construction and piling utilised by many of its clients but does not directly manage construction land on behalf of the clients. The company does, however, have a supervisory or advisory role in the management of many construction sites and does, on occasion, advise clients on the preparatory works needed on a site.

7.12.7 Planning conditions and the Environment Agency were stated as the two incentives that motivate the clients of Company K to ask for provision of advice on soil handling techniques and procedures. It is commonly not an area where advice or support is requested and therefore not a key priority area for the consultancy organisation. Where necessary, specialist advice is sought on behalf of clients from other consultancy organisations with known expertise in soil.

8 Key Audiences to Target to Facilitate Delivery of Guidance

8.1 INTRODUCTION

8.1.1 The purpose of this chapter is to name key organisations that are widely recognised within the construction industry and therefore ideally placed to help facilitate the delivery of the SAPE actions (Actions 4, 15, 47 and 50) related to the construction sector. In addition, this chapter identifies universities and collages as having the potential to influence future construction professionals, engineers and consultants.

8.2 CIRIA

8.2.1 CIRIA[70] is a not-for-profit company owned by a range of stakeholders in the supply chains of the building industry, including private and public sector representatives of the civil engineering, transport and utilities sectors. CIRIA aims to identify, publish and promote best practice in the built environment and in so doing increase quality, efficiency, cost-effectiveness, and safety standards.

8.2.2 CIRIA provide guidance and improvement products and services to the industry and understand the information delivered must be high quality (the outcome of leading research), pragmatic, usable, relevant to the industry to have an impact.

8.2.3 In response to our questions, CIRIA agreed that there is a need to protect soil as a resource and recognise the relationship between soil/groundwater, rainfall and pollution prevention as well as soils importance in supporting ecological habitats and biodiversity. CIRIA identified that soil in the built environment needs to be stripped, conserved and reused. The organisation does not have guidance relating specifically to soil management or compaction prevention but where soil is an important element of guidance on other subjects it is covered, for example, in CIRIA's environmental handbooks. In association with WRAP, CIRIA have produced guidance on soil conditioning using green compost and topsoil is also dealt with under section two in the CEEQUAL scheme, which is managed by CIRIA.

8.2.4 The industry organisations and professionals associated with CIRIA are only involved in activities such as soil stripping, stockpiling and reuse. According to CIRIA, soil is important as a cosmetic material within the built environment. Where available top soil is generally reused within a development, and has a cost implication where there is an insufficient volume for a project. Similar to other feedback, this cost is insignificant in comparison to overall construction costs and unless there is a specific requirement to conserve and reuse soil, understanding of soil resources is limited within the industry.

8.2.5 CIRIA noted that contractors manage the land during construction phase but are not usually involved in planning, design or specification process. This suggests that raining awareness within the industry will require targeting clients, designers and consultants, as well as contractors.

8.2.6 CIRIA were previously unaware of the Soil Action Plan but feedback from CIRIA was positive, agreeing to link to potential future guidance on soil and possibly raising awareness through CIEF construction/environmental sustainability networks, or through the Local Authority Contaminated Land Network (LACL). Specification guidance for clients and designers and simple tool box talks for site teams were considered the most effective guidance for promoting soil awareness within the industry.

8.2.7 In the response from CIRIA, it was suggested that DEFRA and the CEEQUAL team discuss the CEEQUAL criteria on soil and its appropriateness. We would recommend this as a future action for DEFRA in taking forward the soils actions. DEFRA should enter into more detailed discussions with CIRIA in general, regarding opportunities to raise soil up the construction industry's agenda.

8.3 THE BRE

8.3.1 The Building Research Establishment (BRE) is a UK research-based centre for construction expertise, consultancy and certification. The BRE specialise in the built environment and associated industries, providing best practice guidance on construction, energy, environment, fire and risk. The BRE contribute to the development of national standards and codes for construction, and provide training and education through courses and continual professional development events.

8.3.2 Under the certification services, BREEAM (The Building Research Establishments Environmental Assessment Method) and EcoHomes, the domestic equivalent, are voluntary labelling schemes developed to benchmark the environmental performance of new and converted or refurbished buildings. Used and refined since 1990, BREEAM and EcoHomes are the most widely recognised environmental labelling schemes for buildings in the UK. By acknowledging and rewarding best practice in environmental design and management, the schemes encourage continual improvement in the built environment and construction industry.

8.3.3 When discussing the Soil Action Plan with the BREEAM representatives at the BRE, it was agreed that soil handling and protection is an important environmental issue that fits with the BREEAM aims and objectives.

8.3.4 The BREEAM scheme currently includes a number of credits to help developers identify and reduce the environmental impact of the construction phase. Under the Bespoke BREEAM methodology, a credit encouraging top soil reuse is available to minimise the amount of material being transported off site. Other credits related to soil in the built environment include those related to water pollution and sustainable urban drainage systems, reuse of land and contaminated land remediation.

8.3.5 There would be scope to include additional credits to promote better awareness of soil handling and conservation under the current credit heading 'construction site impacts', or under the category Land Use and Ecology.

8.3.6 The assessment method is intended to be simple to use so future revisions must balance complexity with usability. For new issues to be incorporated into BREEAM and/or EcoHomes, the credit goal needs to be evaluated against standard and measurable criteria. Consequently, before potential soil credits are built-in, a clear set of 'rules of thumb' will be needed on which to base the assessment. A central source of further guidance should accompany this for reference purposes.

8.3.7 The BREEAM and EcoHomes methodologies will be undergoing significant updates in line with the outcomes of the new Part L, EC Energy Performance Buildings Directive and the Code for Sustainable Buildings in the latter part of 2005. This revision would be an ideal time to include a credit addressing soil handling and protection.

8.3.8 The BRE are also on the administrators for CEEQUAL and leading organisation in the construction sector and is an ideal collaborator through which DEFRA can raise awareness of soil in the built environment. DEFRA Soils team and the BRE will take this initial meeting and develop this in the future.

8.4 UNIVERSITIES AND COLLEGES

8.4.1 University courses are educating the technical specialists and project managers of the future. Over the last 20 years, environmental issues and sustainable development have received greater attention from various degree disciplines, with several engineering, construction and building related courses now including specific modules on sustainability and environmental topics. This has resulted in graduates entering professions with a greater awareness and understanding of environmental issues and should enable a more holistic approach to design and construction to be adopted in the future.

8.4.2 As the built environment is delivered by contractors and by a range of consulting disciplines, the breadth of subjects that will influence the built environment in the future is quite broad, consisting of building, construction and project management courses, engineering, environmental and geo-environmental disciplines.

8.4.3 A number of UK universities offer courses relating to soil management. Some of these courses are specifically related to soil management while others incorporate aspects of soil management and protection. These courses range from Cranfield University's Soil Management, Land Reclamation and Restoration to the University of Central Lancashire's many courses relating to construction such as Construction Project Management and Building Services Engineering.

8.4.4 University courses provide an ideal means for raising awareness of soil handling during the construction process. Appendix 1 provides a summary of some of the soil and construction related courses being offered in the UK.

9 Scope and Extent of Construction Industry that Needs Targeting

9.1 INTRODUCTION

9.1.1 This chapter discusses the findings from the construction stakeholder Case Studies. The aim of this discussion is to identify the key targets and drivers within the construction industry and therefore the most effective ways of delivering the SAPE Actions 4, 25, 47 and 50. This chapter draws out the key points from the Case Studies and provides a number of recommendations for DEFRA to take forward.

9.1.2 Finally, Chapter 10 outlines the Strategy for the Build Environment with a number of recommendations to promote better soil protection and management in the construction sector prioritised for DEFRA over time.

9.2 WHO NEEDS TARGETING?

9.2.1 The construction industry consists of a broad range of stakeholders, some of which can be classified as sitting directly within the 'construction sector' for example, demolition and building contractors, and some of whom are classified within other industries such as architects and engineers.

9.2.2 For any one project in the built environment, there is a client and/or developer who commission the development, designers and consultants who work to the brief set by the client/developer and who in turn, develop a specification and the contractual requirements that contractors and sub-contractors are responsible for implementing on site. This raises a number of issues and questions, as listed at the end of Case Study 6 (Section 7.7) and repeated below:

- Who is informing the client/developer?
- Are the landscape architects leading the developer/client on landscaping and soil issues and are these ultimately the ones to target?
- If technical consultants are informing the developer/client on a project by project basis then these are the people to target?
- Where are they getting their information?

9.2.3 In answering the above questions, a set of strategic actions should emerge, that can be prioritised with the aim of improving soil handing and protection within the industry as follows:

9.3 WHO IS INFORMING THE CLIENT/DEVELOPER?

9.3.1 It is clear from the above feedback received from the participating construction stakeholders that developers (clients) rely heavily on consulting specialists such as landscape architects, environmental and geo-environmental consultants for guidance on soil issues. It is then the responsibility of the construction contractors to implement the procedures described in the briefs and specification developed by these specialists and the client.

9.3.2 As a result, the correct procedures for improved soil handling, management and protection need to be captured in the specifications and contractual requirements that direct the site contractors.

9.4 ARE THE LANDSCAPE ARCHITECTS LEADING THE DEVELOPER/CLIENT ON LANDSCAPING AND SOIL ISSUES AND ARE THESE ULTIMATELY THE ONES TO TARGET?

9.4.1 Landscape architects know how to handle the soil to maintain the physical and chemical characteristics and understand the importance of quality soil for a quality landscaping scheme. This knowledge is developed through the education and training of landscape professionals and the landscaping industry has a wealth of guidance on soil related issues.

9.4.2 However, landscape architects are often appointed subsequent to other design team members and landscape contractors are generally on site after the main contactor. As a result, the opportunity to advise on soil handling and protection is lost and/or too late to prevent much of the soil damage that has already occurred. Therefore, targeting landscaping professionals is unlikely to bring about a dramatic change in soils handling and protection.

9.4.3 Finally, as landscaping professionals already understand the issues surrounding soil, targeting these professionals may not be the best use of time and resources. It is clear that there are a number of levels within the construction sector that need to be targeted to raise awareness of soil in the built environment, with the exception of landscape architects.

9.4.4 A more effective course of action would be to transfer the guidance and information on correct soil handling and make this more available to the building contractors who are on site first.

9.5 IF TECHNICAL CONSULTANTS ARE INFORMING THE DEVELOPER/CLIENT ON A PROJECT BY PROJECT BASIS THEN THESE ARE THE PEOPLE TO TARGET?

9.5.1 Consulting specialists from a number of disciplines are involved at several stages during a construction project. A client/developer often relies on these specialists to inform and write the specifications that detail how the site and building will be developed.

9.5.2 As discussed in 7.7.10, it is the responsibility of consulting engineers, environmental and geo-environmental consultants to identify and address environmental risks, opportunities and constraints associated with the site and therefore with the soil. When identifying the environmental risks and impacts posed by a development, civil engineers concentrate on drainage and foundation related issues, geo-environmental consultants are concerned primarily with potential contamination risks, while environmental consultants often focus on the traditional environmental elements requiring protection under legislation, such as air and water. Soil quality is often overlooked as soil is not considered an environmental resource requiring management and protection, even if a soil survey is carried out.

9.5.3 Where a client brief identifies particular environmental factors to be addressed, the driver is generally risk identification, legislation, or corporate and/or environmental policy and management systems. Corporate and environmental policies and EMS often follow the traditional environmental headings of energy, waste, water etc. so again, soil is still not specifically addressed and is therefore not dealt with by the advising consultants and/or contractors.

9.5.4 To address the lack of understanding of soil management and protection it will be necessary to raise the awareness of consulting professionals, who will in turn influence the client/developer and the contactors working on site, through appropriate contractual requirements.

9.5.5 To raise awareness of soil issues and the benefits of better soil handling, guidance and information on soil management and protection needs to be widely available to consultants and help people to understand the added value of quality soil.

9.6 WHERE ARE THEY GETTING THEIR INFORMATION?

9.6.1 The information utilised by consulting engineers, environmental and geo-environmental consultants and landscape architects is a combination of British Standards, article publications, courses and conferences, and codes of practice from leading institutes and research bodies (CIC, CIOB, IStructE,BRE, ICE, RIBA, CIBSE, RICS, BALI, APL, the NBS etc.). Some of the guidance available on soil handing and protection is covered in Sections 5.0 and 6.0 of this report). It is also important to remember that professional understanding a product of education that is supplemented by project experience.

9.7 SOIL AS AN ENVIRONMENTAL RESOURCE THAT NEEDS PROTECTION

9.7.1 A key barrier to soil management and protection is a lack of awareness and understanding through the construction industry and associated sectors. As a result, soil is generally viewed as some thing that can be built on (a platform for construction) and not a resource that requires conservation.

9.7.2 This prevents soil being included in policies (environmental or otherwise), procedures, or management systems and that lack of easily available information makes it difficult for consultants or contractors to access and implement better soil handling procedures to prevent compaction, erosion and poor soil quality.

9.8 STRATEGY FOR THE BUILT ENVIRONMENT

9.8.1 The strategy for the built environment includes short term, medium term and long term actions that will address the construction sector at different levels.

9.8.2 A key barrier to better soil handling is a lack of awareness and understanding of soil that is a resource that needs protecting.

9.8.3 Larger organisations are generally high profile and therefore have reputations to maintain and policies and procedures to minimise their environmental impact. As a result, large companies are also more proactive at implementing best practice whereas smaller companies, in general, do not exceed legal obligations as additional requirements are considered a financial burden and commercially uncompetitive.

9.8.4 Therefore, one of the biggest challenges will be targeting the huge number of 'micro' contracting firms that dominate the construction sector (refer to section 7.1). From the response back from construction stakeholder consulted (Case Study 6, Section 7.7.17) is likely that incentives will be necessary to get the smaller companies on board.

9.9 A VOLUNTARY APPROACH

9.9.1 To ensure soil issues are highlighted to those in the industry that are trying to identify environmental impacts, we would suggest that DEFRA liaise with the bodies that provide guidance on EMS's, such as the International Organisation for Standardisation (ISO) or Eco-Management and Audit Scheme (EMAS). As discussed in Sections 7.2.12, 7.4.17 and 7.7.1, soil protection and management could then be included specifically in guidance related to the development and review/update of Environmental Management Systems (EMS) so that any companies that have operations associated with land development are aware of this as an impact arising directly from company actions. This will encourage organisations to then set objectives and procedures to address and minimise this impact.

9.9.2 A voluntary approach is unlikely to achieve a significant impact across the whole sector but the inclusion of soil issues into existing voluntary best practice schemes such as BREEAM and CEEQUAL would start to raise awareness and help the industry prepare for possible future legislative drivers. In addition, BREEAM is increasingly being required by planning authorities and therefore provides a framework to start incorporating soil guidance and best practice.

9.9.3 It is recommended that DEFRA and the CEEQUAL team discuss the CEEQUAL criteria as a future action for DEFRA for taking forward the soils actions. DEFRA should enter into more detailed discussions with CIRIA in general, regarding opportunities to raise soil up the construction industry's agenda.

9.9.4 In addition, DEFRA could also approach the CCS to discuss the possibility of using this scheme to raise awareness of soil issues on site.

9.10 LEGISLATIVE DRIVERS

9.10.1 The feedback confirms that while a proportion of the construction and building industry are taking steps to proactively address environmental issues this is driven primarily by legislation, liabilities, reputation and competitiveness. For the construction industry as a whole to implement better soil handling and management it will take statutory requirements to achieve a step change in greater soil awareness and action, as suggested in sections 7.5.14, 7.7.17, 7.8.5, 7.9.5, 7.10.9 and 7.11.10.

9.10.2 Projects that are likely to result in 'significant' environmental impacts are legally required to undertake an Environmental Impact Assessment (EIA) under the EIA Regulations 1999, the DETR's Circular 02/99 'Environmental Assessment'. This framework provides an ideal opportunity to highlight soils as a specific environmental resource that needs protecting and which should therefore be addressed at the planning stage before the development is allowed to proceed. Where significant impacts to the soil resource are identified, mitigation measures would have to be established and these could include best practice soil handling and management procedures. DEFRA should encourage planning authorities to identify soils specifically at the scoping stage for appropriate Greenfield projects and possibly include further guidance if the currently used '*EIA - Guide to Procedures*' [71], originally published by the DETR, is superseded in the future.

9.10.3 In the medium to long term DEFRA will be liaising with the ODPM and planning authorities to address how planning can facilitate a greater awareness of soil management and protection. The industry currently feels the pressure of legislation and any future planning requirements of soil directives will need to be balanced with voluntary incentives and ensure competitive and economic sustainability and to avoid the industry becoming overburdened by statutory requirements. As a result, we would recommend that integral to discussions with central and local government, there is consultation with industry stakeholders and that aims and objectives for statutory requirements are clearly defined.

9.11 A CENTRAL BODY OF GUIDANCE

9.11.1 There appears to be a lot of information, research and guidance on soil handling, protection, compaction mitigation and soil amelioration. Feedback from one of our sources (Case Study 5, Section 7.6) also confirmed this view. However, this guidance is currently focused at the landscape and minerals sectors and to obtain this information requires going to a number of information sources.

9.11.2 As a result, a short term action will be to collate the concise and useful guidance appropriate to the built environment and making this easily accessible to construction stakeholders, such as on the DEFRA website.

9.11.3 Furthermore, the production of concise ‘rules of thumb’ will be necessary for the production of a soil ‘Toolbox Talk’, an appropriate method for raising awareness as discussed in section 7.2.10, and for inclusion in voluntary schemes such as BREEAM.

9.11.4 Part of a strategy for DEFRA should include collaboration with leading institutes and research bodies, such as CIRIA (as discussed in Section 8.1) to develop technical specifications, industry codes of practice and voluntary incentives, as well as through seminars and conferences. Such collaboration should ensure a number of construction stakeholders are targeted and would be an effective solution for capturing the ‘micro’ contractor firms. The central body of guidance will need to be prepared in advance of raising awareness through industry bodies.

9.12 ALTERNATIVES TO TOP SOIL

9.12.1 It was noted by a couple of respondents (section 7.3.11 and 7.8.11) that alternatives to top soil, such as structural soils and manufactured mixes including compost, are increasingly used on Brownfield sites where there is a lack of top soil available. Utilising these as alternative to top soil will reduce the burden on the UK national resource. The barrier to further update of these alternatives is the lack of standardisation and therefore variability in quality. As a result this may be a future action for DEFRA or other organisation to research classification and standardisation of the products for more commercial uptake.

10 The Strategy

10.1 INTRODUCTION

10.1.1 The following prioritised actions provide a strategy for DEFRA to deliver the SAPE Actions 4, 15, 47 and 50.

10.2 SHORT TERM ACTIONS

- Collection of best practice guidance and information specifically targeted at the construction sector and relation to soil issues in the built environment. Make this central body of guidance available on the DEFRA website;
- The production of a set of ‘Rules of Thumb’ for the inclusion into voluntary schemes such as BREEAM;
- The production of a soil ‘Toolbox Talk’ for site operatives (based on the Rules of Thumb);
- Collaboration with the BRE, and the CCS to include soil issues into BREEAM, CEEQUAL and the CCS respectively;

10.3 MEDIUM TERM ACTIONS

- Incorporate soil issues into planning policy as a legislative driver to better soil management and protection.
- Encourage soils to be identified as a resource that needs protecting within the EIA framework through liaison with planning authorities and the ODPM.
- Collaboration with CIRIA and other industry bodies to disseminate best practice guidance and organise conferences and workshops to promote techniques for soil management and protection.

10.4 LONG TERM ACTIONS

- A UK wide database could be set up that identifies local sites with excess top soil and those sites in the vicinity that need to import top soil;
- Classification, standardisation and increased commercialisation of alternatives to top soil, including manufactured mixes including compost and structural soils.
- Collaborate with leading Universities and Colleges that train future construction project managers, engineers and consultants.

11 Appendix 1 University Courses

11.1 CRANFIELD

11.1.1 Specialising in second degrees, Cranfield offer a number of land and soil related courses form their Silsoe campus. The Soil Management MSc addresses advanced understanding of the physics, biology and chemistry of soil; understanding of the key scientific and engineering principles that underpin well-managed, sustainable soil systems; technology for soil management; skills to plan and manage the implementation of soil management measures at international, national, landscape and land holding levels.

11.1.2 The MSc in Land Reclamation and Restoration includes Land Improvement Engineering covering soil and water engineering; landscape design and construction for systems used in land/soil/habitat reclamation such as soil conservation structures; Landscape Bioengineering looking at the role of vegetation in soil and water engineering; site assessment, including soil and land assessment methods.

11.1.3 The MSc Natural Resource Management also includes units on Soil Science and Environmental Impact Assessment under the module ecological conservation.

11.2 UNIVERSITY OF READING

11.2.1 The University of Reading has a reputation for soil science and provides courses introducing soil science, soil processes and applications; the chemistry of soil constituents; soil nutrients and plant growth; soil processes and applications: soil microbiology and biotechnology; soils and environmental pollution; soils and the environment: soil and land evaluation; soils and the global environment; soil and mineral equilibrium; and management of soil fertility.

11.2.2 Under the Faculty of Environmental Science at the University of Reading the following bachelors degrees are available including modules related to soil:

11.2.3 BSc Environmental Biology (including modules in Soils, Land & Environment and Biological Processes in Soils, Soil Science)

11.2.4 BSc Rural Environmental Science (including modules in Soils, Land & the Environment, Biological Soil Processes Soil & Pollution, Soil Science Field Studies, Soil & Soil Development, The Chemistry & Fertility of Soils, Soils & Global Environment, & Soil Contaminants)

11.2.5 BSc Environmental Geochemistry (Soil Science , Soil and Mineral Equilibrium, Soil Contaminants, Soils and the Environment)

11.2.6 BSc Environmental Geology (Introduction to Soil Science; Soils, Land & Environment; soil science)

11.2.7 BSc Environmental Science of the Earth and Atmosphere (Soil Processes and Applications; Chemistry of Soils; Soil Development; Soil Survey; Biological Processes in Soils; Soils and the Global Environment; Soil Classification; Soils and Atmosphere)

11.2.8 BSc Environmental Earth Science (Introduction to Soil Science; Soils, Land & Environment; Soil Science; Environmental Geochemistry; the Earth's Economic Resources;

11.2.9 Under the faculty of Landscape Management: BSc Landscape Management (Horticultural plant physiology and soil science; Landscape management techniques

11.2.10 Under the faculty of Horticulture: BSc Horticulture (Soil Science)

11.2.11 BSc Rural Resource Management (Introduction to Soil Science Environmental Science; Agriculture, Environment and Sustainability)

11.2.12 BSc Agricultural Business Management (Biological Soil Processes; Countryside and the Environment; Countryside Management; Soils and Soil Development; Farm Machinery - Selection and Management)

11.2.13 BSc Agriculture (Soil, Land and Environment; Soil Use & Management; Countryside Management; Sustainable Land Management; Rural Environment & Sustainability; Management of Soil Fertility)

11.3 IMPERIAL COLLEGE

11.3.1 Imperial College, London offers a number of graduate, post graduate, short courses and distance learning courses in agricultural and environmental sciences, and environmental management. Courses and research topics address the complex processes underlying sustainable land management, analyse the critical issues surrounding humanity's use of the environment; and the relationship between soils, groundwater nutrition, and pollution and its physical, chemical and biological monitoring; and biodiversity conservation, management and restoration.

11.4 UNIVERSITY OF MANCHESTER (EIA CENTRE AND LANDSCAPE & PLANNING

11.4.1 The EIA Centre of the University of Manchester offer postgraduate courses in Environmental Impact Assessment, including Environmental Planning and Protection; and Environmental Science.

11.4.2 Under the Landscape and Planning school of the University, there are various courses that could incorporate soil protection and management information including: BA Hons Environmental Management; Master of Landscape Planning and Management (MLPM); Master of Urban and Environmental Planning; and MA Environmental Impact Assessment and Management.

11.5 OTHER UNIVERSITY COURSES

11.5.1 **University of Central Lancashire** offers a number of construction related courses including: MSc Construction Project Management; BEng (Hons) Building Services Engineering; Foundation Certificate in Construction; Foundation Certificate in Construction (Civil Engineering) ;Foundation Certificate in Construction (Energy Engineering) ;Foundation Certificate in Construction (Engineering) ; BSc(Hons) Construction Project Management ;BEng (Hons) Energy and Sustainable Design ; BSc(Hons) Sustainable Design.

11.5.2 **Royal Agricultural Colleges (RAC)** that offer a number of soil, land use and environmental based courses.

11.5.3 **University of Exeter** offers Soil Ecology by the Department of Biological Sciences.

11.5.4 **University of Newcastle Upon Tyne** offers the Sustainable Land Management and Rural Development MSc and Diploma and the Structural Engineering and Construction Management MSc and Diploma,

11.5.5 **University of Aberdeen** Department of Plant & Soil Science offers the following modules: introduction to soils; soils in the environment; global soil geography; soil physical environment.

11.5.6 **Heriot-Watt University** offers Construction Management - BSc (Hons) BSc (Ord).

11.5.7 **University of Plymouth** offers: BSc (Hons) Construction Management and the Environment; BSc (Hons) Environmental Construction Surveying; as well as several courses relating to environmental science and civil engineering.

11.5.8 **Coventry University** offers various civil engineering degrees as well as a Construction Management BSc (Three-year Full-time/Four-years Sandwich).

11.5.9 **Kingston University** offers a BSc(Hons) Construction Management.

11.5.10 **Sheffield Hallam University** BSc (Hons) Building Construction Management.

11.5.11 **University of Derby** BSc (Hons) Construction Management.

11.5.12 Geo-engineering and civil engineering courses will also provide suitable gateways for information dissemination.

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