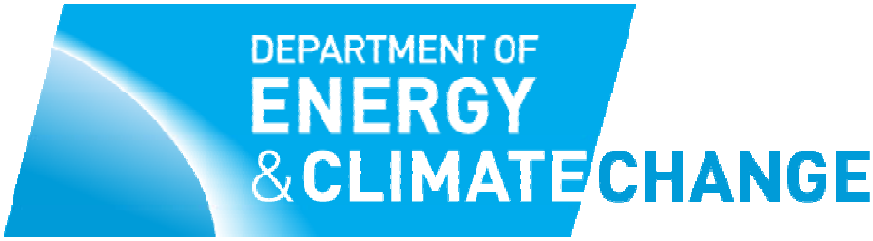

Onshore Oil & Gas Licensing

Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds

Environmental Report

July 2010

URN 10D/553

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NON-TECHNICAL SUMMARY

Introduction

The Department of Energy and Climate Change (DECC) is conducting a Strategic Environmental Assessment (SEA) of a draft plan/programme to hold a 14th and potential further rounds of onshore oil and gas licensing in landward areas in parts of England Scotland and Wales. DECC encompasses the energy functions previously under the remit of the Department for Business, Enterprise and Regulatory Reform (formerly the Department of Trade and Industry), along with various climate change functions previously under the remit of the Department for the Environment, Food and Rural Affairs (Defra).

The SEA is being conducted in accordance with the *Environmental Assessment of Plans and Programmes Regulations 2004* (the SEA Regulations), which apply to any relevant plan or programme which relates either solely to the whole or any part of England, or to England and any other part of the United Kingdom (UK). This SEA is intended to:

- Consider the environmental implications of a draft plan/programme for licensing for onshore oil and gas, virgin coal bed methane and natural gas storage. This includes consideration of the implications of alternatives to the plan/programme
- Inform the UK Government's decisions on the draft plan/programme
- Provide routes for public and stakeholder participation in the process

This non-technical summary provides a synopsis of the SEA Environmental Report, including its conclusions and recommendations.

The Draft Plan/Programme

The 2009 UK Government White Paper '*The UK Low Carbon Transition Plan'* and legislation (including the Climate Change Act and Energy Act 2008), seek to set out medium- to long-term strategies in order to tackle climate change through reducing CO_2 emissions, and to ensure secure, clean and affordable energy. The draft plan/programme indicated below is set within the context of these energy supply and greenhouse gas reduction efforts, while avoiding any compromise of the country's nature and heritage conservation responsibilities and objectives, human health, material assets and other users of the landscape.

The DECC draft plan/programme to which this SEA relates, is to hold a landward licensing round in order to offer for oil and gas licensing, unlicensed blocks in parts of England, Scotland and Wales, though the SEA may also inform subsequent licensing rounds. The licences inclusively cover:

- conventional oil and gas exploration and production, including shale gas
- virgin coal bed methane exploration and production
- natural gas storage in hydrocarbon reservoirs

Note that the licences do *not* cover underground coal gasification or carbon capture and storage (CCS). With the exception of two 'watery' nearshore areas (Inner Forth and Dee) only landward areas above the low water line are included in this plan/programme. Licences would cover the exploration and production of shale gas. Shale gas is typically found in formations with low permeability which require stimulation, usually through hydrofracing (the creation of fractures in the rock containing gas through the injection of water at high pressure along with a proppant (for example sand) that maintains fissures so that gas is able to flow).

Besides the use of larger quantities of water than other methods of gas extraction, the production and environmental management methods required to provide suitable environmental protection with regard to this activity are well established (i.e. are techniques already used to stimulate production in conventional gas development).

What are the Alternatives to the Draft Plan/Programme

The following alternatives to the draft plan for a Landward Licensing Round have been identified as:

1. Not to offer any blocks for licensing
2. To proceed with the licensing programme as proposed
3. To restrict the licensed areas temporally or spatially

The Environmental Report

The Environmental Report of the Onshore SEA provides relevant information for formal consultation with the statutory Consultation Bodies/Authorities and with the public regarding the implications of the draft plan/programme and its alternatives.

The assessment will consider the environmental effects (short, medium, long-term; temporary, permanent; positive and negative; and secondary, cumulative and synergistic) on the following receptors, in accordance with the SEA regulations:

- Biodiversity, habitats, flora and fauna
- Geology and soils
- Water Environment (Aquifers, groundwater, surface water)
- Landscape
- Air quality
- Climatic factors
- Population and human health
- Material assets (infrastructure, other natural resources)
- Cultural heritage, including architectural and archaeological heritage

Information on the environmental baseline and its likely future evolution has been grouped into these subject areas and the assessment has used the same headings in the interest of clarity.

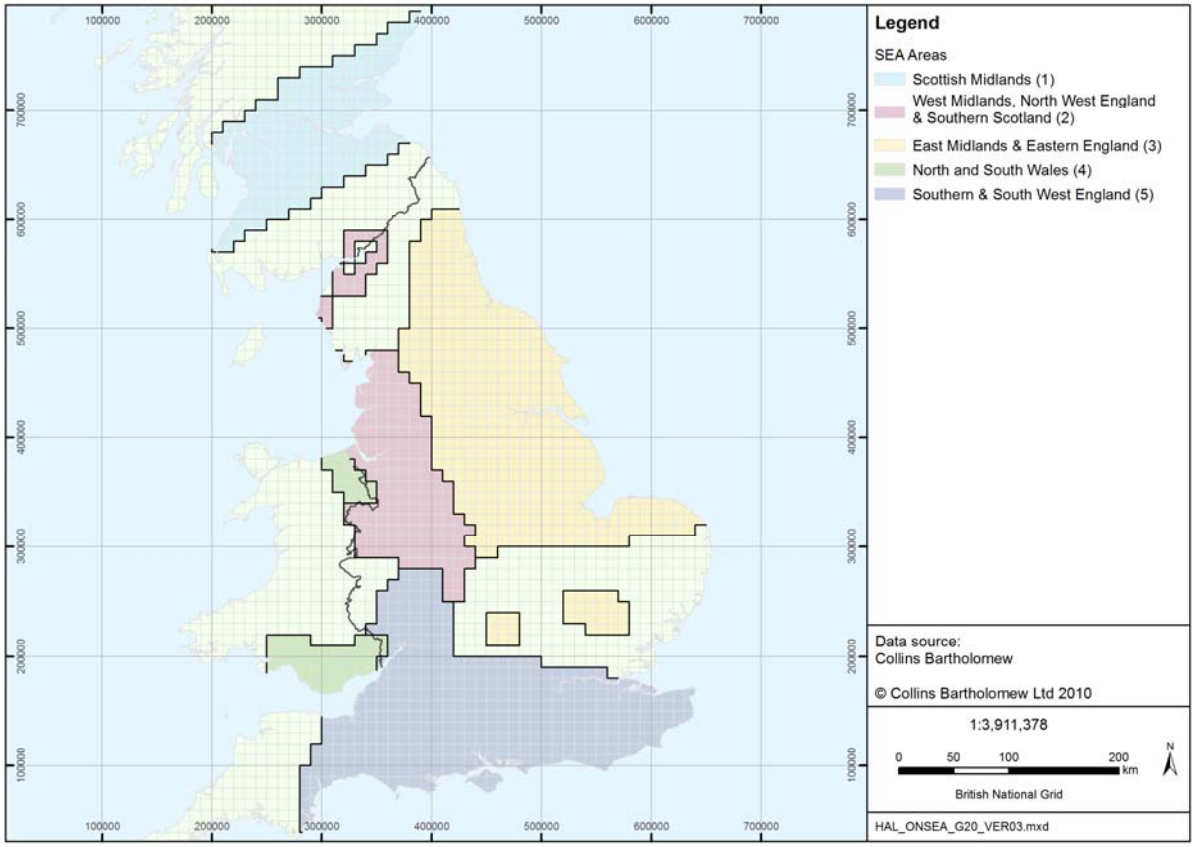
The key points and conclusions of the assessment are summarised below.

The Geographical Extent of the SEA

The SEA area covers the Scottish Midlands, North and South Wales, and most areas of England with the exception of the extreme South West. Five geographical areas were selected due to their coincidence with certain administrative areas and the main geological provinces of interest in this SEA. The five areas are (Figure 1):

1. The Scottish Midlands
2. West Midlands, North West England and Southern Scotland
3. East Midlands and Eastern England
4. North and South Wales
5. Southern and South West England

Figure 1 – The Geographical Scope of the SEA



Prospectivity

For conventional hydrocarbon resources to occur in commercial quantities, a number of geological features have to coincide, including:

- The presence of suitable source rocks with an appreciable organic content
- Adequate depth of burial to allow the conversion of organic material to oil or gas through the action of temperature and pressure
- The presence of rocks with sufficient porosity to allow the accumulation of oil or gas
- Migration pathways which permit oil and gas formed from the source rocks to move to reservoir formations (permeability)
- Cap or seal rocks to prevent the oil or gas from escaping from the reservoir rocks

The process of coal formation generates methane (amongst other gases formed in smaller quantities) which remains trapped under pressure in the coal seam in micro-pores on the coal surface. The methane produced may exceed the adsorptive capacity of the coal and significant quantities may seep into and accumulate in the rock layers surrounding the seam of coal – the absorptive capacity of the coal increases with greater pressure. Some coal types may contain in the order of 10-20m^3 of methane per tonne of coal.

Large areas of the UK are not prospective for oil and gas. Many of the blocks under consideration for inclusion in the Landward Licensing Round are only marginally prospective

(DCLG 2006a, b) and a proportion will either not be applied for or following evaluation will not be explored further.

Although the area of a block is large (100km^2/10,000ha) the footprint of surface facilities is typically small. An exploration well site is a temporary facility covering approximately 1ha, whilst a gathering station which processes production from several development wells might utilise around 4ha (NCC 1986).

Overview of main sources of effect and controls in place

The main stages of oil and gas activity (including gas storage) are:

- Exploration, including seismic survey and exploration drilling
- Development, including production facility installation, generally with construction of an export pipeline, and the drilling of producer and injector wells
- Production/operation, with routine supply, production of wastes, power generation, chemical use, produced water reinjection management and reservoir monitoring
- Maintenance
- Decommissioning, including cleaning and removal of facilities

The main potential sources of environmental effects from activities which could follow adoption of the draft plan/programme are:

- Noise from seismic survey and piling during installation
- Noise (semi-continuous or continuous) from drilling rigs, production facilities, generators and vehicles
- Physical damage to geological or physical (including geomorphological and hydrological) features, biota and features of archaeological interest from drilling rig construction, pipeline construction and cable laying
- Physical presence of structures, visual intrusion
- Chemical contamination (routine) from drilling and other discharges
- Chemical contamination (accidental) from spills
- Atmospheric emissions from fuel combustion, venting and flaring

All the major stages of onshore oil and gas operation are covered by environmental regulations including the requirement for Environmental Impact Assessment at the development stage. Onshore gas storage is covered by the same legislation that controls oil and gas activities. Any depleted oil or gas field used for gas storage operations must be within an existing licensed area and have a revised development plan consent (see: DECC (2009d), field development plan guidance notes for gas storage in onshore oil and gas fields), as native hydrocarbons may be produced during the off-take phase, and there may be incremental oil recovery from depleted oil fields. The drilling of any gas injection/production wells is also subject to Petroleum Operations Notice (PON) requirements.

Assessment Summary

A summary of the assessment process is described in Section 5 and the key points are highlighted below.

Biodiversity, Habitats, Flora and Fauna

Exploration activities are typically of short duration whilst production and export facilities are in place for longer. Environmental Impact Assessment under the operator's Environmental Management System (EMS) and regulatory requirements will provide effective mitigation through consultation and site and timing selection to obviate or minimise effects.

Geology and Soils

Facility siting under the existing planning regime would normally be required to avoid localised geological features of interest, flood plains, highly graded agricultural land etc. Entry onto land requires landowner approval.

Landscape

Valued landscapes include designated and non-designated areas. In general, similar considerations apply to the siting of temporary and longer-term hydrocarbon related facilities, which aim to reduce visibility and promote effective restoration of disturbed ground. The planning consent process is effective in controlling adverse impact on the landscape.

Water Environment (aquifers, groundwater, surface waters)

The location of surface waters and aquifers (especially those of potable water) are well known and their protection is effectively addressed through design standards and the approvals processes for exploration, production and export facilities.

Air Quality

The existing regulatory controls on transport, power generation and gas flaring are regarded as adequate. EIA to support planning and other consents would be expected to give due consideration to the potential implications of the planned activity on attainment of local and regional air quality plans. Atmospheric emissions and contributions to climate change typically form key performance indicators for operators leading to internally driven pressure to control and reduce such emissions.

Climatic Factors

The existing regulatory controls on transport, power generation and gas flaring are regarded as adequate; however, it is recognised that new controls are likely be introduced during the currency of the Plan as part of a suite of measures in response to climate change concerns. Atmospheric emissions and contributions to climate change typically form key performance indicators for operators leading to internally driven pressure to control and reduce such emissions.

Population and Human Health

Existing regulatory controls on the location and design of facilities, the timing of operations, resultant wastes and emissions, accidental events, export routes and facilities etc. are regarded as effective in minimising potential effects on human health and communities.

Material Assets (infrastructure, other natural resources)

Existing planning and other controls e.g. through the Mineral Planning Authorities and equivalent bodies, are viewed as effective in reducing the potential effects of hydrocarbon

exploration and production activities to non-significant levels. Waste minimisation is being promoted through fiscal mechanisms as well as by the implementation of operator EMS processes.

Cultural Heritage, including architectural and archaeological heritage

Through planning controls, archaeological desk studies, field investigations, and watching briefs are required for exploration and production facility site works. In addition planning controls require that due regard is taken of buildings and other features of architectural value.

Nearshore 'watery' areas of the Forth and Dee

Though these areas are offshore, they are considered under the landward regulations as indicated in the Petroleum (Production) (Seaward Areas) Regulations 1988, Schedule 1, Regulation 3(1). Any activities associated with drilling into these areas will take place onshore and involve no direct marine activities, which virtually eliminates the possibility that there could be impacts on marine sensitivities. There is the potential for drilling rigs to be located in close proximity to intertidal habitats which have large and internationally important bird populations, and watercourses associated with these areas (e.g. the Dee and Teith) support anadromous species such as the Atlantic salmon and sea lamprey. Operators should be aware of such environmental sensitivities and avoid contamination through appropriate pollution control measures. Note that these areas are being considered for Virgin Coal Bed Methane (VCBM) only.

Conclusions

The SEA considered the alternatives to the Draft Plan and the potential implications of resultant activities in the context of the objective of the Draft Plan, the SEA objectives, the existing regulatory and other control mechanisms, and the existing environmental problems and their likely evolution over time. The conclusion of the SEA was that a modified alternative 2 should be adopted, that is to proceed with the licensing programme but with some with licensing conditions.

It was recommended that the DECC place an explicit expectation on licence applicants to demonstrate understanding of the environmental sensitivities and potential constraints on blocks both at the application stage and during any subsequent operations.

Next Steps

The Onshore SEA Environmental Report and appendices are available for review and public comment for a period of 12 weeks from the date of publication. The documents are being made available from DECC website, on CD and hard copy. Comments[1] and feedback

[1] **Confidentiality:** Your comments may be made public by DECC in relation to this consultation exercise. If you do not want your name or all or part of your response made public, please state this clearly in the response. Any confidentiality disclaimer that may be generated by your organisation's IT system or included as a general statement in your fax cover sheet will be taken to apply only to information in your response for which confidentiality has been requested.

should be marked “Onshore Oil & Gas SEA Consultation” and may be sent by letter or email, addressed to:

Mr RB Kiff
Department of Energy and Climate Change
Energy Development Unit
3 Whitehall Place
London SW1A 2HH

E-mail: Ricki.Kiff@decc.gsi.gov.uk

On completion of the public consultation phase, a Post Consultation Report will be prepared and made available through the Onshore SEA website. This report will collate the recipients’ comments and responses from DECC, and any technical clarifications required.

Any comments received during public consultation will be considered in decision making regarding the draft plan/programme.

On adoption of the plan/programme a statement will be published detailing:

a) how environmental considerations have been integrated into the plan/programme
b) how the Environmental Report has been taken into account
c) how opinions expressed by the consultation bodies and public consultees on the relevant documents have been taken into account
d) how the results of any consultations entered into with other Member States have been taken into account (if required)
e) the reasons for choosing the plan/programme as adopted, in the light of the other reasonable alternatives dealt with
f) the measures that are to be taken to monitor for potential significant environmental effects of the implementation of the plan/programme.

However, please also note that DECC may disclose information it holds pursuant to a statutory, legal or parliamentary obligation, including without limitation, requirements for disclosure under the Freedom of Information Act 2000 and/or the Environmental Information Regulations 2004. In considering any request for disclosure of such information under the Freedom of Information Act 2000 or the Environmental Information Regulations 2004, DECC will consider and make use of relevant exemptions or exceptions where they properly apply and, where relevant, will consider whether the public interest in withholding the information outweighs the public interest in disclosing the information. It is DECC’s normal practice to consult and consider the views of third parties where necessary although decisions on disclosure are ultimately taken by DECC. However, any decision by DECC against the release of information can be appealed to the Information Commissioner and ultimately the Information Tribunal.
We will handle any personal data you provide appropriately in accordance with the Data Protection Act 1998 and the Freedom of Information Act 2000.

1 INTRODUCTION

1.1 The Strategic Environmental Assessment

This Strategic Environmental Assessment (SEA) is considering a Department of Energy and Climate Change (DECC) draft plan/programme for an onshore oil and gas licensing round. DECC encompasses the energy functions previously under the remit of the Department for Business, Enterprise and Regulatory Reform (formerly the Department of Trade and Industry), along with various climate change functions previously under the remit of the Department for the Environment, Food and Rural Affairs.

The 2009 UK Government White Paper '*The UK Low Carbon Transition Plan*' and legislation (including the Climate Change Act and Energy Act 2008), set out long-term strategies in order to tackle climate change through reducing CO_2 emissions, and to ensure secure, clean and affordable energy. The draft plan/programme indicated below is set within the context of these energy supply and greenhouse gas reduction efforts, while avoiding any compromise of the country's nature and heritage conservation responsibilities and objectives, human health, material assets and other users of the landscape.

The DECC draft plan/programme to which this SEA relates, is to hold a landward licensing round in order to offer for oil and gas licensing, unlicensed blocks in parts of England, Scotland and Wales, though the SEA may also inform subsequent licensing rounds. The licences inclusively cover:

- conventional oil and gas exploration and production, including shale gas
- virgin coal bed methane exploration and production
- natural gas storage in hydrocarbon reservoirs

Note that the licences do *not* cover underground coal gasification or carbon capture and storage (CCS). The area under consideration is indicated overleaf (Figure 1.1) in addition to areas which are already licensed for oil and gas – note only the Landward Areas above the low water line are included in this plan/programme with the exception of the 'watery areas' of the Dee and Firth of Forth. Licences would cover the exploration and production of shale gas. Shale gas is typically found in formations with low permeability which require stimulation, usually through hydrofracing (the creation of fractures in the rock containing gas through the injection of water at high pressure along with a proppant (for example sand) that maintains fissures so that gas is able to flow). Besides the use of larger quantities of water than other methods of gas extraction, the production and environmental management methods required to provide suitable environmental protection with regard to this activity are well established (i.e. are techniques already used to stimulate production in conventional gas development).

1.2 The Requirement for SEA

Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (commonly called the SEA Directive) was adopted to provide a strategic complement to the Council Directives (85/337/EEC and 97/11/EC) which require Environmental Impact Assessments of specific developments and activities.

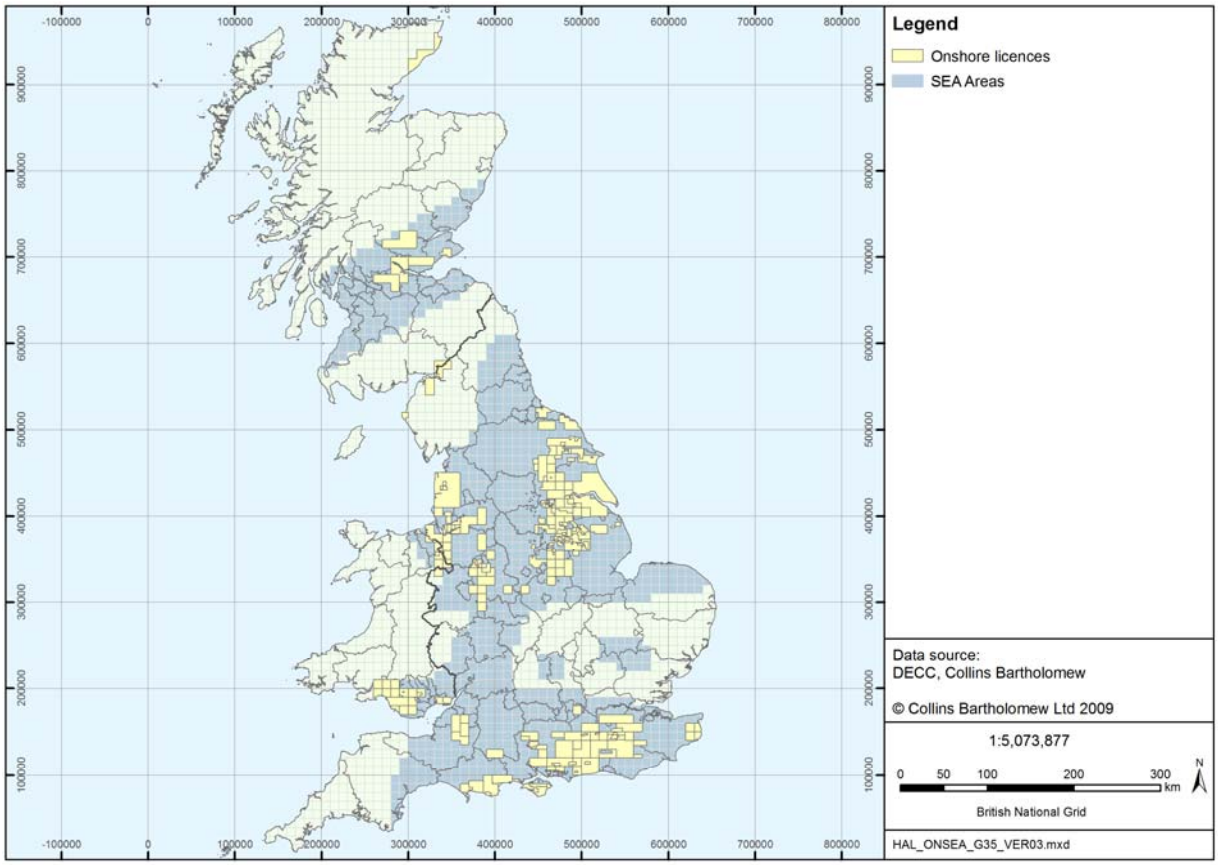
The Directive's stated objective is

"to provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development, by ensuring that, in accordance with this Directive, an environmental assessment is carried out of certain plans and programmes which are likely to have significant effects on the environment."

A series of regulations have been established across the United Kingdom to implement the requirements of the Directive.

The *Environmental Assessment of Plans and Programmes Regulations 2004* apply to plans or programmes which relate either solely to the whole or any part of England or to England and any other part of the UK. The Regulations apply to plans and programmes whose first formal preparatory act was on or after 21st July 2004, and also, with retroactive effect, to those which have not been either adopted or submitted to a legislative procedure leading to adoption by 21st July 2006.

Figure 1.1 – The Geographical Scope of the SEA and Currently Licensed Areas



1.3 The Purpose of the Environmental Report

The purpose of this Environmental Report is to document the assessment of the environmental implications of the proposed draft plan/programme and its reasonable alternatives, together with the potential exploration, development and production activities which could result. The report provides a basis of information for formal consultation with the statutory consultation bodies and authorities, and with the public, regarding the

environmental implications of the draft plan. The Environmental Report and the feedback from consultation will be taken into account during the finalisation of the plan/programme prior to its adoption.

1.4 Consultation Bodies

The draft plan/programme is relevant to parts of England, Wales and Scotland and the consultation bodies for this SEA as defined in the regulations and guidance are:

- Natural England (formerly the Countryside Agency and English Nature)
- English Heritage
- Environment Agency (for England and Wales)
- Historic Scotland
- Scottish Environment Protection Agency
- Scottish Natural Heritage
- Cadw
- Countryside Council for Wales

1.5 Contents of the Environmental Report

Schedule 2 of the Regulations sets out the information to be included in an Environmental Report of a Strategic Environmental Assessment – see Table 1.1. Regulation 12(3) specifies that:

"the report shall include such of the information referred to in Schedule 2 …. as may reasonably be required, taking account of:- (a) current knowledge and methods of assessment; (b) the contents and level of detail in the plan or programme; (c) the stage of the plan or programme in the decision-making process; and (d) the extent to which certain matters are more appropriately assessed at different levels in that process in order to avoid duplication of the assessment."

Table 1.1 – Information to be Included in Environmental Reports as Required by Schedule 2 of the *Environmental Assessment of Plans and Programmes Regulations* 2004

#	Requirement
1	An outline of the contents and main objectives of the plan or programme, and of its relationship with other relevant plans and programmes.
2	The relevant aspects of the current state of the environment and the likely evolution thereof without implementation of the plan or programme.
3	The environmental characteristics of areas likely to be significantly affected.
4	Any existing environmental problems which are relevant to the plan or programme including, in particular, those relating to any areas of a particular environmental importance, such as areas designated pursuant to Council Directive 79/409/EEC on the conservation of wild birds and the Habitats Directive.
5	The environmental protection objectives, established at international, Community or Member State level, which are relevant to the plan or programme and the way those objectives and any environmental considerations have been taken into account during its preparation.
6	The likely significant effects on the environment, including short, medium and long-term effects,

#	Requirement
	permanent and temporary effects, positive and negative effects, and secondary, cumulative and synergistic effects, on issues such as - (a) biodiversity; (b) population; (c) human health; (d) fauna; (e) flora; (f) soil; (g) water; (h) air; (i) climatic factors; (j) material assets; (k) cultural heritage, including architectural and archaeological heritage; (l) landscape; and (m) the inter-relationship between the issues referred to in sub-paragraphs (a) to (l).
7	The measures envisaged to prevent, reduce and as fully as possible offset any significant adverse effects on the environment of implementing the plan or programme.
8	An outline of the reasons for selecting the alternatives dealt with, and a description of how the assessment was undertaken including any difficulties (such as technical deficiencies or lack of know-how) encountered in compiling the required information.
9	A description of the measures envisaged concerning monitoring in accordance with regulation 17.
10	A non-technical summary of the information provided under paragraphs 1 to 9.

The criteria for determining the likely significance of effects are set out in Schedule 1 of the Regulations and are listed Table 1.2.

Table 1.2 – Criteria for Determining the Likely Significance of Effects on the Environment as Specified in Schedule 1 of the *Environmental Assessment of Plans and Programmes Regulations 2004*

1. The Characteristics of Plans/Programmes, Having Regard, in Particular, to:	
a.	the degree to which the plan/programme sets a framework for projects and other activities, either with regard to the location, nature, size and operating conditions or by allocating resources
b.	the degree to which the plan/programme influences other plans/programmes including those in a hierarchy
c.	the relevance of the plan/programme for the integration of environmental considerations in particular with a view to promoting sustainable development
d.	environmental problems relevant to the plan/programme
e.	the relevance of the plan/programme for the implementation of Community legislation on the environment (for example, plans/programmes linked to waste management or water protection)
2. Characteristics of the Effects and of the Area Likely to be Affected, having Regard, in Particular, to:	
a.	the probability, duration, frequency and reversibility of the effects
b.	the cumulative nature of the effects
c.	the transboundary nature of the effects
d.	the risks to human health or the environment (for example, due to accidents)
e.	the magnitude and spatial extent of the effects (geographical area and size of the population likely to be affected)
f.	the value and vulnerability of the area likely to be affected due to: (i.) special natural characteristics or cultural heritage (ii.) exceeded environmental quality standards or limit values (iii.) intensive land-use
g.	the effects on areas or landscapes which have a recognised national, Community or international protection status.

1.6 Organisation of the Environmental Report

A large amount of information has been collated and reviewed as part of this SEA. To facilitate reader access and understanding, the following index identifies where relevant

information can be found. The body of the Environmental Report comprises 7 main sections, a bibliography, glossary, appendices and a non-technical summary.

Table 1.3 – Organisation of the Environmental Report

Report Section	Summary	
Non-technical summary	A standalone summary of the Environmental Report, its findings and conclusions, written in non-technical language.	
Section 1: Introduction	Describes the background to the draft plan/programme and its regulatory context, along with that of the SEA and ER.	**Environmental Report**
Section 2: Overview of the draft plan/programme	Describes the details of the draft plan/programme, its objectives, possible alternatives and relationship with other relevant initiatives.	
Section 3: SEA approach	Describes the SEA process, its scope, objectives and assessment methodology.	
Section 4: Environmental Information	Describes the environmental characteristics of the area considered in the SEA. The section identifies existing environmental problems and the possible evolution of the environmental baseline and SEA objectives.	
Section 5: Summary of Assessment	Provides details of the assessment methodology and a summary of the assessment provided in Appendix 5. Considers cumulative impacts and identifies mitigation and enhancement measures to prevent, reduce or counteract any significant adverse effects identified during the assessment process.	
Section 6: Monitoring	Describes the monitoring approach.	
Section 7: Next Steps	Describes the consultation phase for the Environmental Report and proposed plan/programme and the process by which the plan/programme would be adopted.	
	Bibliography	
	Glossary and Abbreviations	
Appendix 1: Scoping Consultation Feedback	Includes a tabulation of the responses provided by consultation bodies to the initial scoping consultation.	**Appendices**
Appendix 2: Onshore oil and gas activities, controls and mitigation	Includes an overview of the main oil and gas exploration and development activities, including conventional oil and gas, virgin coal bed methane and underground gas storage, and a tabulation of the main planning and permitting controls.	
Appendix 3: Other Relative Initiatives	Includes a tabulation of other relative initiatives, their objectives/requirements and relationship with the plan/programme.	
Appendix 4: Environmental Baseline	Underpins Section 4 of the Environmental Report. The appendix is subdivided into 9 sections (a-i), each one describing the environmental baseline of each SEA topic.	
Appendix 5: Assessment	Describes the assessment process and the consideration of likely activities, their impact and mitigation.	
Appendix 6: Conservation Sites	Identifies blocks which are in whole or in part covered by Natura 2000 sites, and includes the output of a mapping exercise showing relative block sensitivity based on the number of designations within each block covered by the SEA.	

1.7 The Study Team

The Environmental Report was prepared by Hartley Anderson Limited with input from the Department of Energy and Climate Change (DECC).

1.8 Public Consultation

The Environmental Report and draft plan/programme will be issued for formal consultation in line with the requirements of the SEA Regulations. HM Government Code of Practice provides seven criteria for consultations – see extract below:

CODE OF PRACTICE ON CONSULTATION
THE SEVEN CONSULTATION CRITERIA

Criterion 1 When to consult
Formal consultation should take place at a stage when there is scope to influence the policy outcome.

Criterion 2 Duration of consultation exercises
Consultations should normally last for at least 12 weeks with consideration given to longer timescales where feasible and sensible.

Criterion 3 Clarity of scope and impact
Consultation documents should be clear about the consultation process, what is being proposed, the scope to influence and the expected costs and benefits of the proposals.

Criterion 4 Accessibility of consultation exercises
Consultation exercises should be designed to be accessible to, and clearly targeted at, those people the exercise is intended to reach.

Criterion 5 The burden of consultation
Keeping the burden of consultation to a minimum is essential if consultations are to be effective and if consultees' buy-in to the process is to be obtained.

Criterion 6 Responsiveness of consultation exercises
Consultation responses should be analysed carefully and clear feedback should be provided to participants following the consultation.

Criterion 7 Capacity to consult
Officials running consultations should seek guidance in how to run an effective consultation exercise and share what they have learned from the experience.

Extract from Code of Practice on Consultation issued July 2008

2 OVERVIEW OF THE DRAFT PLAN/PROGAMME AND ITS RELATIONSHIP WITH OTHER ACTIVITIES

2.1 The Draft Plan/Programme

The Department of Energy and Climate Change (DECC) draft plan/programme is to hold an onshore oil and gas licensing round, incorporating conventional oil and gas (including shale gas), virgin coal bed methane and gas storage activities. Depending on the outcome of the SEA process and other Government considerations, all or a proportion of the unlicensed Blocks within the SEA area may be offered for licensing.

2.1.1 Plan Objectives and Context

The UK Government 2009 White Paper, 'The UK Low Carbon Transition Plan', outlined targets and plans relating to CO_2 emissions and energy production to 2050. The legislative aspects of the previous paper, 'The Energy Challenge' passed into law in the Energy Act 2008, which makes provisions for areas including (and which are applicable to this SEA):

- Gas importation and storage (including Carbon Capture and Storage)
- Electricity from Renewable Sources (strengthens the existing renewables obligation in order to generate enhanced speed of delivery and diversity of supply technologies)
- Feed-in Tariffs which allow Government to introduce a tailor-made scheme to financially support low carbon generation of electricity in projects up to 5MW
- Miscellaneous energy issues (e.g. provision of smart meters, renewables heat incentives, transmission access powers and costs relating to network connections, gives effect in legislation to earlier administrative transfer of responsibilities for certain aspects of energy regulation, and contains provisions relating to nuclear security)

The Energy Act aims to not only help to maintain energy supply reliability, promote competitive markets and ensure affordable heating, but also contribute to the reduction in greenhouse gas emissions (most notably CO_2) which has been linked to anthropogenically augmented climate change. The Climate Change Act 2008 makes provisions for the reduction of CO_2 equivalent emissions (i.e. includes other notable greenhouse gases such as CH_4 and N_2O) through a number of measures, including the setting of a 'carbon budget'. The carbon budget set out in the Act in its original form targeted an 80% reduction in emissions on 1990 levels by 2050, with an interim reduction in emissions of 26% by 2020. The 2020 carbon budget has been subsequently altered under The Climate Change Act 2008 (2020 Target, Credit Limit and Definitions) Order 2009 to 34% below 1990 levels. The Act aims to meet this target through a range of measures, but principally through the establishment of a Committee on Climate Change[2], a system of carbon budgeting and trading, activities that reduce or remove greenhouse gases from the atmosphere and promotion through financial incentive, the production of less waste and more recycling.

The draft plan subject to this SEA needs to be considered in the context of overall UK energy supply and greenhouse gas reduction efforts. Security of supply is one of the key issues identified by the Energy White Paper and the Energy Review Report (DTI 2006). With production from UK oil and gas fields declining, the UK will become yet more reliant on imports. In 2008, 20% of the natural gas consumed in the UK was imported, and by 2010, imports could be meeting up to 40% of the UK's total gas demand. Prior to the release of

[2] see: http://www.theccc.org.uk/

the 2009 White Paper 'The UK Low Carbon Transition Plan', estimates of gas imports by 2020 were 80-90%, these have now been reduced to 45% under new proposals. This change is due to come from greater energy efficiency and greater deployment of renewables rather than an increase in indigenous gas supplies. The UK also became a consistent net importer of crude oil in 2005, with net imports amounting to 14% of the crude oil refined in the UK in 2008, reduced to 8% if exports of refined products are taken into account – imports are expected to continue to rise as indigenous production reduces (Wicks 2009). A linked factor is the need for more gas storage capacity, since until recently seasonal fluctuations in UK gas demand were met by varying production rates from UK fields. For context, UK gas storage capacity is about 4.5% of annual consumption (4.4 billion cubic metres) compared with 25% in France and 21% in Germany (DCLG 2006a, Wicks 2009). If the capacity of storage projects currently planned or in the planning process[3] is taken into account, the UK's gas storage has the potential to increase by 18.5 billion cubic metres – the National Grid (2008) proposes that around a third of these will be constructed leading to an actual increase of 5 billion cubic metres, or 10% of the expected gas demand in 2020 (National Grid 2008, as cited in Wicks 2009).

The Energy Review recognised that whilst developments in low carbon technologies and improvements in energy efficiency will act to reduce demand for and thus decrease our reliance on imported fossil fuels, fossil fuels will constitute the majority of our energy mix for the foreseeable future, particularly oil and gas. Indeed, in the wider context, the IEA (2008) World Energy Outlook anticipates that even with the adoption of a 2030 energy mix scenario based around the maintenance of atmospheric CO_2 of 450ppm (i.e. the level at which global temperature rises would likely not exceed 2°C – also see appendix 4f), oil and gas would still constitute 30 and 16.6% of the energy mix respectively. Making efficient use of the UK's own energy reserves brings obvious benefits both in the contribution it can make to a diverse UK energy mix but also to the economy in terms of jobs, investment and national income generated by the sector (DTI 2006).

Within this framework, the main objectives of the current draft plan/programme are to secure the comprehensive exploration and appraisal of UK oil and gas resources and the economic development of discovered reserves without compromising the biodiversity, ecosystem functioning and the interests of nature and heritage conservation, and other material assets and users.

2.2 Onshore Licensing Regulatory Context and Background

The Petroleum Act 1998, which consolidated a number of earlier pieces of primary legislation, vests all rights to the petroleum[4] (oil and gas) resources of Great Britain in the Crown. The Secretary of State for Energy and Climate Change, on behalf of Her Majesty, may grant licences over a limited area and period of time that confer exclusive rights to "search and bore for and get" petroleum. The oil and gas licensing system is administered by the Department of Energy and Climate Change (the Responsible Authority for this SEA).

Onshore oil and gas production licences are called Petroleum Exploration and Development Licences (PEDLs). Petroleum Exploration and Development Licences are generally offered

[3] Note that this includes all forms of gas storage (onshore and offshore), not just those in depleted hydrocarbon reservoirs.

[4] Petroleum is defined in Part I of the Petroleum Act as including "*any mineral oil or relative hydrocarbon and natural gas existing in its natural condition in strata; but does not include coal or bituminous shales or other stratified deposits from which oil can be extracted by destructive distillation*". However the Crown owns any oil and gas that "*exists in its natural condition"* in coal strata.

in Licensing Rounds. PEDLs were first issued in the 8th Licensing Round in 1996 to reduce the bureaucratic burden of issuing separate licences for each stage of an onshore field's life (previously separate Exploration, Appraisal, Development and Production Licences were issued). Onshore licence co-ordinates use the National Grid referencing system. For the DECC's Oil and Gas licensing purposes each 10km square is referred to as a block. A licence may cover a whole block, part of a block, or several blocks or part-blocks. Further information on onshore licensing can be found on the DECC onshore oil & gas website.

The award of a PEDL does not waive the requirement for the licensee to obtain access rights from landowners (e.g. a wayleave) and PEDLs do not confer any exemption from other legal/regulatory requirements. Oil and gas exploration and development activities are subject to statutory planning[5], environmental and other permitting regimes. Persons wishing to enter coal measures or coal mines to conduct exploration for oil and gas also need agreement from the Coal Authority. Under the terms of a PEDL, licensees may not conduct activities such as the drilling of wells, installation of facilities or production of hydrocarbons without the authorisation of the Secretary of State and licensees are required to provide proof to the DECC that the relevant planning and other permissions and consent(s) have been obtained.

PEDLs are valid for a sequence of periods, called Terms which are designed to follow the typical lifecycle of a field: exploration, appraisal, and production. Each Licence expires automatically at the end of each Term, unless the Licensee has made enough progress to earn the chance to move into the next Term (Table 2.1).

In England and Wales, the underground storage of gas at quantities of greater than 43 million standard cubic metres or with a flow rate exceeding 4.5 million standard cubic metres per day, is covered under Part 3 (Nationally Important Infrastructure Projects), section 14 of the Planning Act 2008 and fall within a framework provided by National Policy Statements (currently in draft form). Gas transporter and other pipelines associated with any facilities relating to this and other similar plans/programmes may also lie within the remit of this legislation, and this includes pipelines which have one end in Scotland[6].

Table 2.1 – Terms of Petroleum Exploration and Development Licences

Term	Length (years)	Phase	Expiry of Licence
Initial	6	Exploration	At end of the Initial Term unless the Licensee has completed the agreed Work Programme.
Second	5	Appraisal and development	At end of the Second Term unless Secretary of State (SoS) has approved a Development Plan.
Third	20	Production	SoS has discretion to extend Licence if production likely to continue past 20 years.

[5] See: Communities and Local Government Minerals Policy Statement 1: Planning and Minerals (DCLG 2006). This document provides a relevant policy framework for the development of oil, gas, coal bed methane and underground gas storage facilities while ensuring environmental protection.
[6] See: The Planning Act (2008): Chapter 29. Available via the Office of Public Sector Information website: www.opsi.gov.uk.

2.3 Prospectivity

The purpose of exploration activity is to identify commercially viable reserves of oil and gas. The conditions necessary for such reserves to have accumulated are complex and largely dependent on past geological history and present geological formations and structures.

For conventional hydrocarbon resources to occur in commercial quantities, a number of geological features have to coincide, including:

- The presence of suitable source rocks with an appreciable organic content
- Adequate depth of burial to allow the conversion of organic material to oil or gas through the action of temperature and pressure
- The presence of rocks with sufficient porosity to allow the accumulation of oil or gas
- Migration pathways which permit oil and gas formed from the source rocks to move to reservoir formations (permeability)
- Cap or seal rocks to prevent the oil or gas from escaping from the reservoir rocks

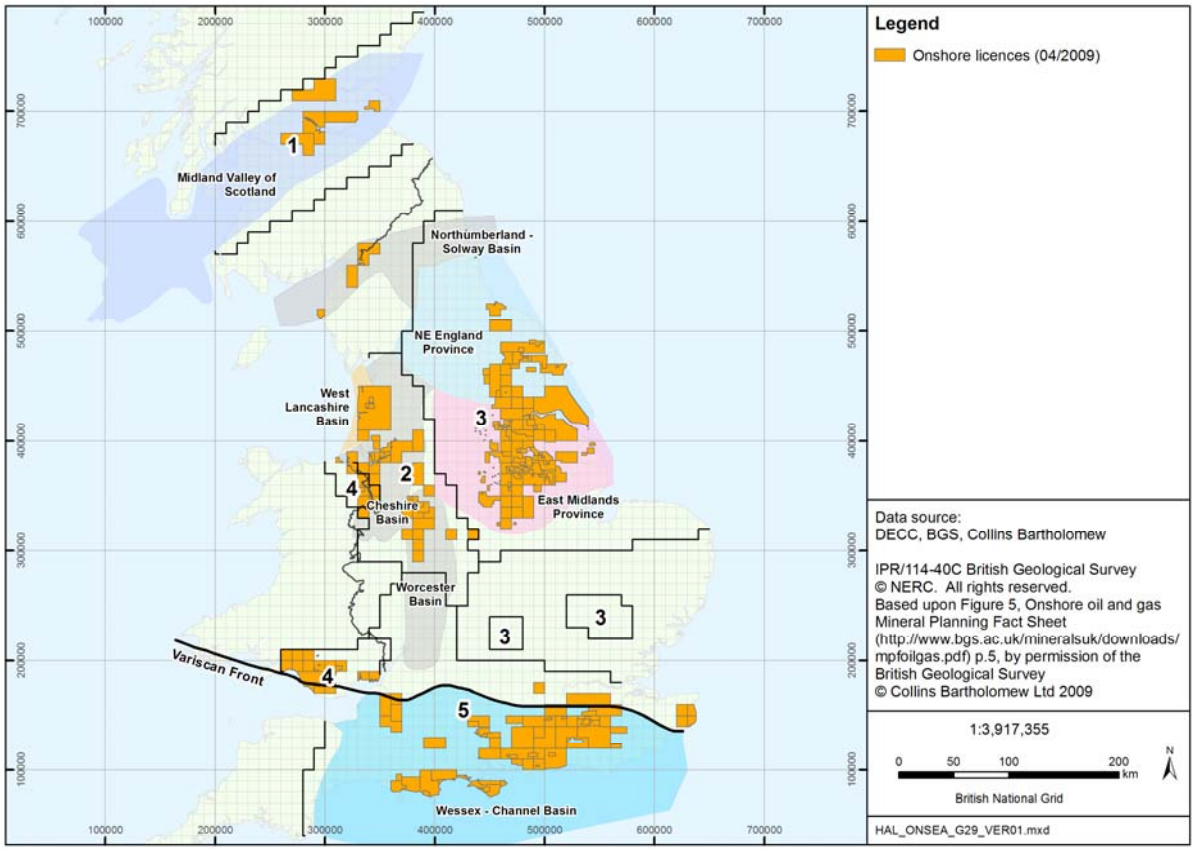
The process of coal formation generates methane (amongst other gases formed in smaller quantities) which remains trapped under pressure in the coal seam in micro-pores on the coal surface. The methane produced may exceed the adsorptive capacity of the coal and significant quantities may seep into and accumulate in the rock layers surrounding the seam of coal – the absorptive capacity of the coal increases with greater pressure. Some coal types may contain in the order of 10-20m^3 of methane per tonne of coal.

A number of prospective areas occur in the UK, due mainly to the presence of mature source rocks. The age of these mature source rocks and reservoir rocks, and the type of hydrocarbons found (oil or gas) varies, which naturally defines a series of 'provinces' (Figure 2.1).

The East Midlands oil province comprises Carboniferous source and reservoir rocks deposited in a series of major fault-bounded basins. The Midland Valley of Scotland is also prospective, with Carboniferous source and reservoir rocks. The Wessex-Channel (including the Weald) Basin arises from the presence of both Triassic and Jurassic (Mesozoic) source and reservoir rocks. Other oil and gas fields in North West and North East England arise from the presence of older (Carboniferous-Silesian) source rocks and younger Permian and Mesozoic reservoir rocks. They include the West Lancashire Basin and North East England Province (including the Cleveland Basin). Although they have not so far yielded commercial quantities of hydrocarbons, the presence of Carboniferous and Permo-Triassic reservoirs lead to other potentially productive basins/provinces including the Cheshire Basin and Northumberland-Solway Basin.

Many of these provinces are not entirely onshore, with the Wessex and Weald basins extending offshore into the English Channel. Similarly, the West Lancashire Basin is the eastern, onshore margin of the more extensive East Irish Sea Basin, and the East Midlands and Cleveland Basin link to the Southern North Sea gas basin (DCLG 2006a). These offshore areas are subject to the seaward oil and gas licensing regime unless activities are being carried out from infrastructure in the landward area of UK as set out in the Petroleum (Production) (Seaward Areas) Regulations 1988, Regulation 3(1). 2 such "watery" areas are being considered in this SEA, that of the Dee/Afon Dyfrdwy and the Forth.

Figure 2.1 – Prospective Onshore Oil and Gas Basins Showing Existing Licences



2.4 Potential Activities Following Licensing

As indicated above, the draft plan/programme does not itself permit any exploration or production activities, which will be subject to a range of planning and other controls (see Appendix 2). Based on previous Licence Rounds the uptake of blocks is expected to be limited. Levels of exploration and development activity and their timing would depend on a range of factors such as the number of blocks licensed, work programme commitments by licensees, exploration success, economic and commercial factors and approval of project development plans. The nature of oil and gas exploration and development activities together with the relevant control and mitigation mechanisms are summarised in Appendix 2.

2.4.1 Overview of Main Sources of Effect and Controls in Place

The main stages of oil and gas activity (including gas storage) are:

1. Exploration, including seismic survey and exploration drilling
2. Development, including production facility installation, generally with construction of an export pipeline, and the drilling of producer and injector wells
3. Production/operation, with routine supply, production of wastes, power generation, chemical use, produced water reinjection management and reservoir monitoring
4. Maintenance
5. Decommissioning, including cleaning and removal of facilities

These activities can interact with the natural and broader environment in a number of ways. The main potential sources of environmental effects from activities which could follow adoption of the draft plan/programme are:

- Noise from seismic survey and piling during installation
- Noise (semi-continuous or continuous) from drilling rigs, production facilities, generators and vehicles
- Physical damage to geological or physical (including geomorphological and hydrological) features, biota and features of archaeological interest from drilling rig construction, pipeline construction and cable laying
- Physical presence of structures, visual intrusion
- Chemical contamination (routine) from drilling and other discharges
- Chemical contamination (accidental) from spills
- Atmospheric emissions from fuel combustion, venting and flaring

All the major stages of onshore oil and gas operation are covered by environmental regulations (see Appendix 2) including the requirement for Environmental Impact Assessment at the development stage. The DECC's licensing system covers all oil and gas in the UK, though coal reserves are still managed by the coal authority, and access to coal formations for any purpose (including for coal bed methane developments) requires their consent. As part of the onshore licensing regime, a series of Petroleum Operation Notices (PONs) cover operations associated with conventional oil and gas (Table 2.2).

Table 2.2 – Petroleum Operation Notices (PONs) Used to Control Onshore Operations

Title	Related activities
PON4	Application for consent to drill exploration, appraisal, and development wells
PON5	Application to abandon or temporarily abandon a well
PON7	Reporting of petroleum production
PON8	Application to complete and/or workover a well
PON9b	Record and sample requirements for onshore geophysical surveys and wells
PON12	DECC well numbering system
PON14b	Notification of onshore seismic survey (also see Supplementary Seismic Survey Licences [SSSL])

Source: DECC Onshore Oil and Gas Webpage

Onshore gas storage is covered by the same legislation that controls oil and gas activities. Any depleted oil or gas field used for gas storage operations must be within an existing licensed area and have a revised development plan consent (see: DECC 2009d, field development plan guidance notes for gas storage in onshore oil and gas fields). The drilling of any gas injection/production wells is also subject to PON requirements.

2.4.2 Potential Activity Scenarios

For assessment purposes activity scenarios have been developed covering a credible range of exploration and appraisal activity. The indicative scenarios (based on past activity and trends) have been used as the basis for consideration of the environmental implications of potential licensing in Section 5.

2.4.3 Past Activity and Trends

Information on past activity and trends comes from analysis of Work Programmes committed to in previous licence rounds (Table 2.3) as well as historic onshore drilling activity data. The DECC website (http://www.og.dti.gov.uk) provides the main source of this information.

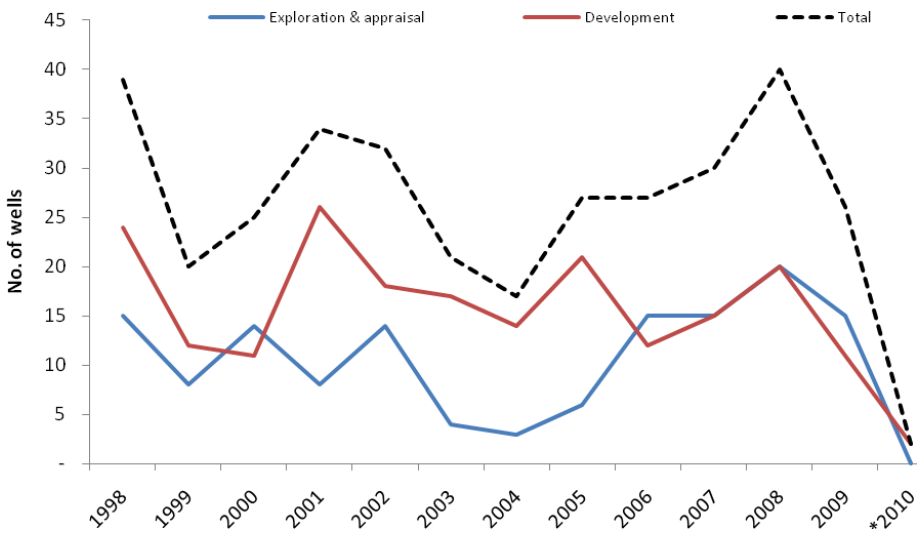
Table 2.3 – Work Programme Commitments in Previous Rounds

Licence Round	Wells to be drilled				New seismic survey
	Firm	Drill or Drop	CBM/Drill or Drop	Total	
10th (2001)	4	16	12 (+1)	33	1 (100km of 2D)
11th (2003)	-	8	-	8	1 (20km of 2D) 2 (evaluate mines gas potential)
12th (2004)	1	21	-	22	-
13th (2007)	8	41	63	112	15 (994km of 2D) 2 (80km^2 of 3D)

In the previous (13th) round of onshore licensing, 60 applications for PEDLs were made for 182 blocks by 54 companies, 20 of which were for CBM. Subsequently, on 28th May 2008, the secretary of state offered 93 PEDLs (DECC website).

To date, more than 2,000 onshore oil and gas wells have been drilled in the UK. Figure 2.2 provides details of onshore drilling activity over the last 10 years. An average of 11 exploration or appraisal wells were drilled in each year between 1998 and 2008, though significant year to year variation exists. The highest number (20) were drilled in 2008 and the lowest (3) in 2004. Provisional first quarter figures for 2010 indicate that no exploration or development wells have been drilled, though 2 development wells were started (DECC 2010).

Figure 2.2 – Number of Onshore Wells Drilled, 1998-2010



Source: DECC (2010)
*Note: *2010 figures are for quarter 1 only*

Based on the past activity and trends highlighted above, two scenarios of potential activity following a Licensing Round has been developed – one describing a low level of activity and the other a much higher level. The scenarios do not give locations of potential activity. However, given the description of basin prospectivity in Section 2.1 and our current understanding, it is likely that activity will be targeted close to existing licensed areas. The scenarios described are indicative only and are used to illustrate either end of a range of potential activities that could be committed to in Work Programmes following the 14th round.

Table 2.4 – Scenarios of Potential Activity Following the Licensing Round

Low activity scenario: Number of wells	High activity scenario: Number of wells
6 traditional oil/gas wells	28 traditional oil/gas wells
2 Coal Bed Methane wells	50 Coal Bed Methane wells
Timing of wells: *2 wells drilled in 2nd, 3rd and 4th years* *1 well in both 5th and 6th years*	*Timing of wells:* *11 wells drilled in 2nd year* *26 wells in 3rd year* *19 wells in 4th year* *11 wells in both 5th and 6th years*
Low activity scenario: New seismic survey	**High activity scenario: New seismic survey**
Shoot 40km of 2D seismic Shoot 20km of 3D seismic	Shoot up to 1,000km of 2D seismic Shoot up to 80km^2 of 3D seismic

2.5 Alternatives to the Draft Plan/Programme

Three licensing alternatives are proposed for this round of onshore oil and gas licensing. These are:

1. Not to offer any blocks for licensing
2. To proceed with the licensing programme as proposed
3. To restrict the area licensed temporally or spatially

As set out in the initial scoping document, the review of alternatives uses the following hierarchy:

Need or demand: is it necessary?
Can the need or demand be met without implementing the plan or programme at all?

↓

Mode or process: how should it be done?
Are there technologies or methods that can meet the need with less environmental damage than 'obvious' or traditional methods?

↓

Location: where should it go?

↓

Timing and detailed implementation:
When, in what form and in what sequence, should the plan be carried out?
What are the important issues? Do existing controls and measures address them? What other controls and measures are required?

The results from this review are presented in Table 2.5 below.

Table 2.5 – Consideration of Hierarchy of Alternatives

Is There a Need or Demand?
Security of supply is one of the key issues identified by the Energy White Paper, the 2006 Energy Review (DTI 2006) and in the *Low Carbon Transition Plan*. As production from UK oil and gas fields declines, the UK will become more reliant on imports. Gas imports already meet ~50% of the UK's total gas demand and in the first quarter of 2010 exceeded indigenous supply for the first time since 1968. Gas imports could reach ~60% of demand by 2020 if unabated, or 45% through greater energy efficiency measures and renewable energy deployment as proposed in the *Low Carbon Transition Plan*. DTI (2006) expected the UK to be a net importer of oil by 2010. Quarterly statistics provided by DECC show the UK presently fluctuates between net importation and export of oil and oil products. In the absence of the plan the UK would import fuel to make up the shortfall in domestic production. The Energy Review recognised that, in spite of developments in low carbon technologies and improvements in energy efficiency, fossil fuels and particularly oil and gas, will constitute the majority of the UK energy mix for the foreseeable future. Exploiting the UK's energy reserves contributes to a diverse and secure UK energy mix as well as to the economy in terms of jobs, investment and national income generated by the sector. The shift from gas self-sufficiency to net importer also means there is a need for additional gas storage capacity to accommodate seasonal variations in demand (DCLG 2006a).
Mode or Process
Exploration, drilling and production technologies are not static and improvements are introduced to increase efficiency and reduce environmental footprint and impacts. New techniques and technologies, once proven, can be expected to rapidly become accepted practice. It is concluded that there are no technologies or methods that can meet the need with less environmental damage.
Location
The presence of commercial hydrocarbon resources is a function of geological history and this dictates the broad areas included in the plan.
Timing and Detailed Implementation
The plan is needed before exploration or production can occur in currently unlicensed blocks. The early implementation of the plan would allow potential synergies in terms of use of existing infrastructure (e.g. pipelines) to be taken advantage of. The extent of such synergies will decline if the plan is delayed as infrastructure is decommissioned and removed. There are a range of environmental sensitivities present in the blocks some of which may occupy a large proportion of the block area (e.g. conurbations and some conservation designations). However, the majority of blocks are large (100km^2) which allows potential room for manoeuvre in identifying suitable areas for exploration and production activities, subject to planning and other existing controls. Block licences contain no inherent permissions or consents for activity or entry onto land. Existing controls in terms of location, timing, supply routes, noise, emissions and wastes are comprehensive with no important gaps identified. Demonstration of compliance with the planning and other regulatory requirements is a precondition of DECC activity consent. It is important that operators and potential operators of blocks demonstrate awareness of environmental sensitivities and their implications for any subsequent activity at the Block acquisition stage.

2.6 Relationship of the Draft Plan/Programme to Other Plans and Programmes

The SEA Regulations require that the Environmental Report includes:

"*an outline of the contents and main objectives of the plan or programme, and of its relationship with other relevant plans and programmes*" and that consideration is given to the degree to which the "*plan or programme influences other plans and programmes including those in a hierarchy"*

"*the environmental protection objectives, established at international, Community or Member State level, which are relevant to the plan or programme and the way those objectives and any environmental considerations have been taken into account during its preparation*".

A list of the international European and UK initiatives, including plans/programmes, together with their objectives which have been analysed in terms of their implications for the draft plan/programme and vice versa is given in Appendix 3.

3 SEA APPROACH

A visual summary of the SEA process used for onshore oil and gas licensing is presented in. The SEA process aims to aid DECC licensing decisions through the consideration of the environmental effects of the proposed plan/programme.

The key steps in the conduct of this SEA are:

1. Instigation of Draft Plan and identification of alternatives and draft objectives
2. Information gathering and collation on:
    a. Environmental baseline
    b. Existing environmental problems
    c. Potential effects of proposed plan
    d. Other relevant plans and programmes and their objectives
3. Consultation on the scope and level of detail of the Environmental Report
4. Assessment of effects including consideration of alternatives
5. Stakeholder consultation
6. Production of Environmental Report
7. Public Consultation
8. Post consultation evaluation of feedback and input to decision on the plan
9. Monitoring plan implementation

This SEA is currently at Stage 7, following on from initial consultation.

3.1 Scoping

The key purpose of scoping is to identify issues of concern at an early stage so that they can be considered in appropriate detail in the SEA. Scoping also helps to identify information sources and data gaps that may require to be filled by studies or surveys to underpin the assessment.

A formal scoping exercise with the statutory consultation bodies/authorities for Wales, England and Scotland and other stakeholders was conducted in September 2009. The scoping document was mailed to the relevant consultation bodies and authorities. The aim of the scoping document was to set out sufficient information on the draft plan/programme to enable the consultation bodies and authorities to form a view and provide feedback on the scope and level of detail appropriate for the environmental report and proposed consultation period.

The following questions were asked:

- Consultees are invited to highlight additional plans or programmes which they consider relevant to the Draft Plan.
- Consultees are invited to draw attention to and provide (where possible) additional information and data sets which they consider of potential relevance to this SEA.
- Are there any objectives that you feel should be included or removed?
- Are the indicators for each objective suitable? If not please suggest alternatives.
- Do you have any comments on the proposed approach to assessment and consultation?
- Would your organisation like to be consulted about the SEA process in any additional way?

Responses were received from 5 organisations and these are listed below:

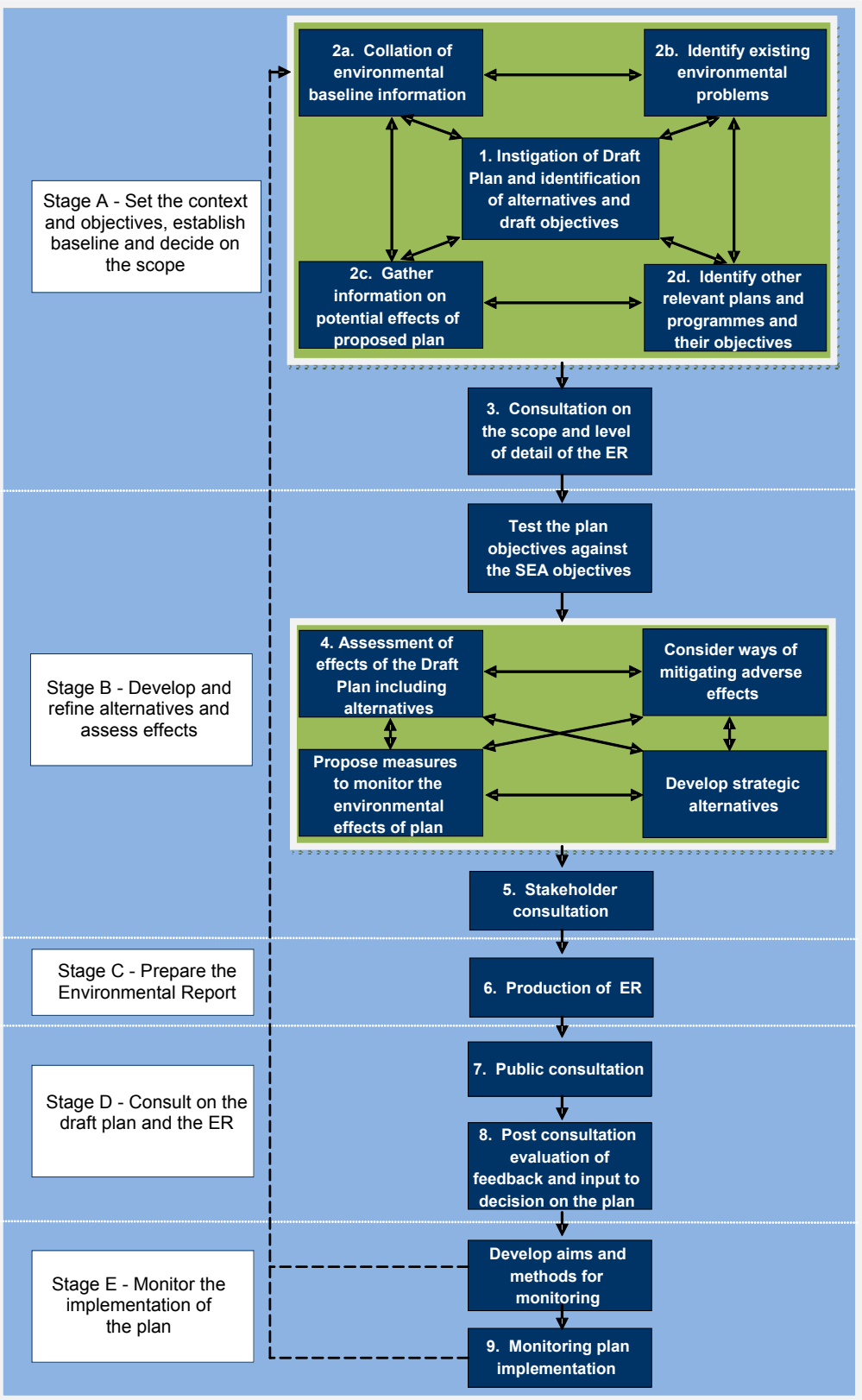
- Countryside Council for Wales
- Scottish Natural Heritage
- Natural England
- Environment Agency
- Cadw

Feedback received during the initial consultation period and how this has helped shape the Environmental Report and appendices is summarised in Appendix 1. An additional phase of scoping was initiated in April 2010 in order to consider additional blocks for inclusion in the SEA. The same statutory organisations consulted in earlier scoping were included in this exercise and responses were received from:

- Countryside Council for Wales
- Historic Scotland
- Scottish Natural Heritage
- Scottish Environment Protection Agency
- Natural England
- English Heritage

These responses are also recorded in Appendix 1.

Figure 3.1 – Overview of the SEA Process



Source: Adapted from ODPM SEA Guidance (2005)

3.2 SEA Objectives and Indicators

The SEA Objectives originally developed during the scoping phase and subsequently amended following consultation are presented in Table 3.1.

Table 3.1 – SEA Objectives and Indicators, as Amended Following Public Consultation

SEA Objectives	Indicators
Biodiversity, Habitats, Flora and Fauna	
Contributes to conservation of the wildlife and wildlife habitats of the United Kingdom.	For selected 'valued ecosystem components' no loss of diversity or decline in population (measured as % of relevant biogeographic population) attributable to onshore oil and gas activities.
Avoids significant impact to, or disturbance of, protected habitats and species of national and international importance.	Activities, individually or cumulatively, with the potential to impact upon or disturb protected habitats or species are compliant with the requirements of the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).
Geology and Soils	
Maintains the function and integrity of soil processes and services.	Continued attainment of environmental quality objectives in areas of oil and gas activities.
Avoids damage to geological conservation sites and protects important geological features.	No physical damage by oil and gas activities to features of interest in designated sites.
Water Environment (Aquifers, Groundwater, Surface Waters)	
Avoids adverse impacts on surface water (including lake and channel physical form and function) and aquifer water quality and helps achieve the objectives of the Water Framework Directive.	Continued attainment of environmental quality objectives in areas of oil and gas activities. No adverse change in the chemical and biological quality of rivers and the status of aquifers from oil and gas related activities.
Avoids, and where possible reduces, flood risk.	
Landscape	
To accord with, and deliver, the Aims and Articles of The European Landscape Convention.	Adoption of best practice guidelines in landscape assessment and mitigation for oil and gas activities.
Avoids impacts on the character of designated and non-designated landscapes.	No permanent adverse impact on the character of designated landscapes.
Air Quality	
Avoids degradation of regional air quality from oil and gas activities and helps achieve the objectives of the Ambient Air Quality and Cleaner Air for Europe Directives.	Oil and gas operations compliance with IPPC permit conditions. No adverse change in air quality, or the quality of surface water and aquifers from atmospheric deposition.
Climatic Factors	
Minimises greenhouse gas emissions.	Volume of gas flared.

SEA Objectives	Indicators
	Obligations under the Climate Change Act 2008.
Population and Human Heath	
Has no adverse impact on human health.	Continued attainment of environmental quality objectives in areas of oil and gas activities.
Avoids disruption (including the loss of access and recreational opportunities), disturbance and nuisance to communities.	Landscape and nuisance indicators.
Material Assets (Infrastructure, Other Natural Resources)	
Protects other United Kingdom resources of economic and amenity value.	Number of conflicting applications for resource use.
Promotes waste reduction, reuse and recycling.	Progress in reducing volumes of waste to landfill.
Cultural Heritage and Landscapes	
Promote awareness and identification of archaeological resources in the area.	Adoption of best practice guidelines in site evaluation and management for oil and gas activities.
Avoids significant impacts to sites of cultural, historic or archaeological importance and where possible contributes to their preservation.	No adverse impact upon the condition of heritage sites and features, including impacts on their setting and/or wider historic landscapes.

3.3 SEA Scope

The area of study included those parts of England, Wales and Scotland shown in Figure 1.1.

The oil and gas activities which are discussed within the draft plan include:

- Traditional oil and gas exploration and production, including shale gas
- Exploration and production of virgin coal bed ethane
- Use of oil and gas reservoirs for gas storage

The assessment considered the environmental effects (short, medium, long-term; temporary, permanent; positive and negative; and secondary, cumulative and synergistic) on the following receptors:

- Biodiversity, habitats, flora and fauna
- Geology and soils
- Water environment (Aquifers, groundwater, surface water)
- Landscape
- Air quality
- Climatic factors
- Population and human health
- Material assets (infrastructure, other natural resources)
- Cultural heritage, including architectural and archaeological heritage

3.4 Assessment Methodology

The assessment of this SEA incorporates inputs from:

- The understanding of the relevant receptors, existing environmental problems and evolution of the baseline conditions
- The likely activities and potential sources of impact associated with the draft plan/programme
- The current and evolving regulatory framework
- The SEA objectives
- The evidence base regarding the relative risks and potential for significant effects from activities that may potentially arise from the adoption of the draft plan/programme
- Steering Group, statutory consultee and stakeholder perspectives on important issues, information sources and gaps, and potential areas to exclude from licensing derived from scoping, assessment workshop, regional stakeholder workshops, sector workshops, meetings and other communications

The consideration of individual activities, their likely impact and duration is given in Appendix 5 and is summarised in section 5 of the environmental report. The following key was used to qualitatively categorise the nature of the predicted effects (ODPM 2005):

Magnitude of effect

++	Activity would have a major positive effect
+	Activity would have a minor positive effect
O	Activity would have a neutral effect
-	Activity would have a minor negative effect
--	Activity would have a major negative effect

Duration of effect

S	Effects would be short term
M	Effects would be medium term
L	Effects would be long term
P	Effects would be permanent

Only where an effect is scored as ‘major positive’ or ‘major negative’ is it considered to be significant.

3.5 Consultation

Formal consultation is undertaken at two stages in the SEA process:

- At scoping to ensure that the SEA fulfils the requirements of the relevant stakeholders (see: section 3.1 above)
- Public consultation on the draft plan and Environmental Report

The Environmental Report and draft plan/programme will be issued for formal consultation in line with the requirements of the SEA Regulations and the HM Government Code of Practice – see section 1.8 above.

4 ENVIRONMENTAL INFORMATION

4.1 Introduction

The following section and its associated appendices provide environmental information relevant to the area covered by the SEA as required under Schedule 2 of *The Environmental Assessment of Plans and Programmes Regulations 2004* (Regulation 12(3)).

In order to facilitate reader access to the large amount of information cited as part of the SEA, the geographical area being considered has been subdivided into 5 areas (Figure 4.1):

SEA Area 1 Scottish Midlands (including the Inner Forth)
SEA Area 2 West Midlands, North West England and Southern Scotland
SEA Area 3 East Midlands and Eastern England
SEA Area 4 North and South Wales (including the Dee/Afon Dyfrdwy)
SEA Area 5 Southern and South West England

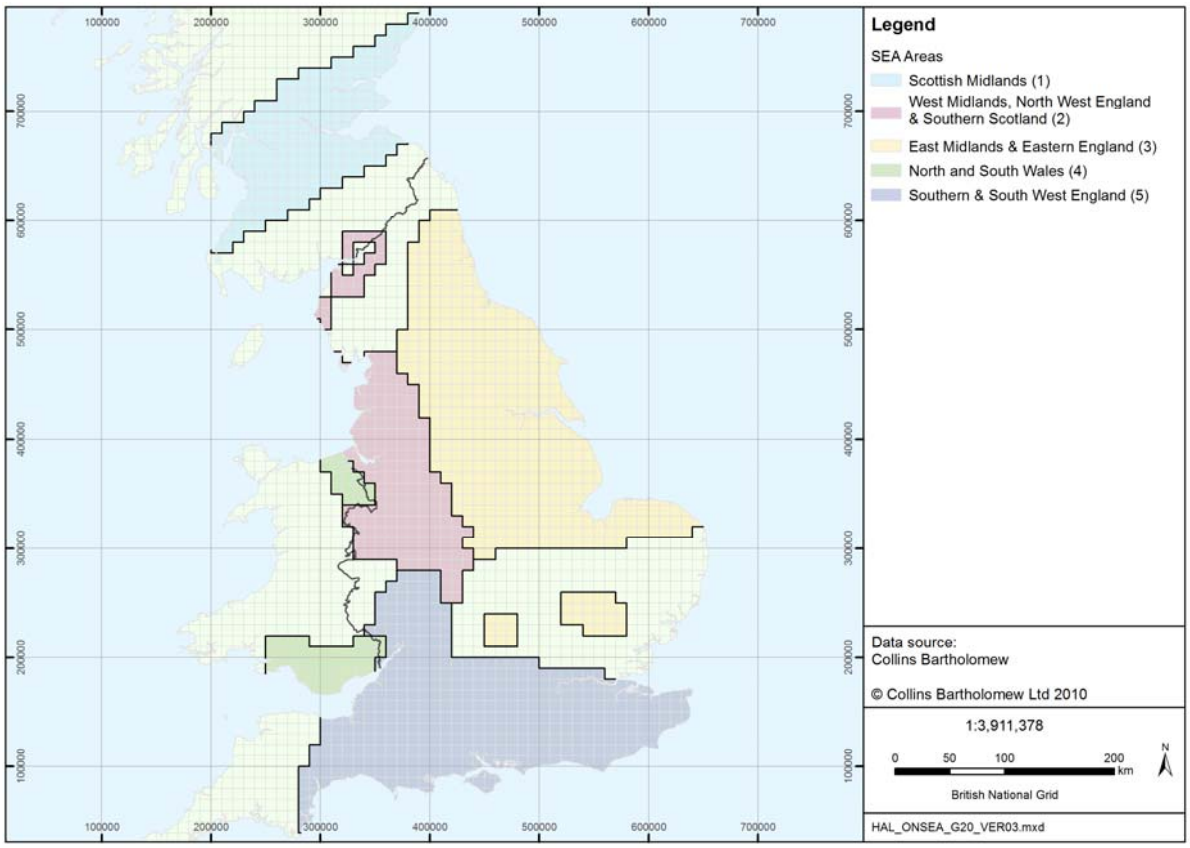
The environmental characteristics relevant to each area are discussed with reference to those topics indicated in section 3.3. Where appropriate, GIS has been used to organise the large amount of environmental information and to facilitate spatial analysis.

For more detailed information on each topic, see the relevant section of appendix 4 as detailed below (Table 4.1), and it is further recommended that the following section is read in conjunction with this appendix.

Table 4.1 – Contents of Appendix 4

Section	Topic
a	Biodiversity, Habitats, Fauna and Flora
b	Geology and Soils
c	Landscape
d	Water Environment
e	Air Quality
f	Climatic Factors
g	Population and Human Health
h	Material Assets
i	Cultural Heritage

Figure 4.1 – SEA Geographical Areas



4.2 Environmental Baseline

4.2.1 The Scottish Midlands (SEA Area 1)

Biodiversity, Habitats, Flora and Fauna

Important river systems in the Scottish Midlands SEA area include the South Esk, Tay and Tweed with the Firths of Forth and Tay, and the inner Clyde Estuary supporting important coastal habitats and species including a wide variety of seabirds and waterbirds. There are also extensive areas of upland moorland, acid grassland, woodland and blanket bog which support important species assemblages.

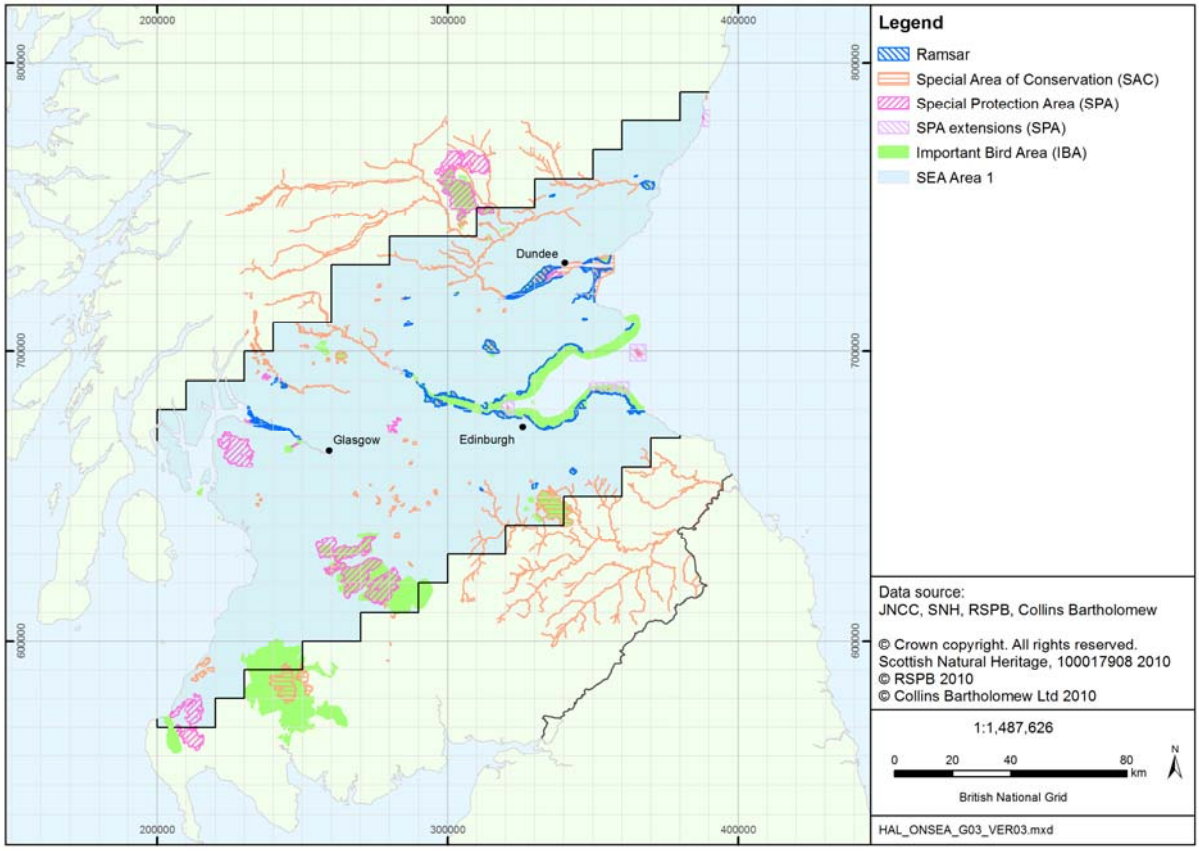
A range of priority habitats identified by the UK Biodiversity Action Plan are present within the region (see: Appendix 4a.1.4). Conservation sites of international importance include 41 SAC, 21 SPA, 12 Ramsar and 26 IBA (Figure 4.2). National and local sites include 10 NNR, 443 SSSI and 39 LNR. A number of reserves are also owned or managed by organisations such as RSPB, National Trust for Scotland and the Scottish Wildlife Trust.

The Forth Estuary has an intertidal area of 4,798 ha, covering just over half the area of the estuary as whole (Barne *et al.* 1997). The area is therefore very important for coastal bird sensitivities and a large proportion of the Forth coast supports nationally and internationally important colonies of breeding birds. This is recognised in an IBA covering the entire coast of the inner and outer firth stretching from the River Forth at Stirling, eastwards past

Edinburgh and along the coasts of Fife and east Lothian, coincident with both Ramsar and SPA designations (Figure 4.2 – also indicates current SPA extensions). Wintering waterbirds and waterbirds on passage reach substantial populations at certain times of the year. In winter the area supports over 89,000 overwintering and migratory waterbirds (e.g. bar-tailed godwit, golden plover, red-throated diver, Slavonian grebe, knot, pink-footed goose, redshank, shelduck, turnstone). In summer the area supports breeding populations of common tern (*Sterna hirundo*), and the sandwich tern (*Sterna sandvicensis*) can be found on passage between July and August.

The River Teith, a major tributary of the Forth, contains anadromous species (i.e. spawning in freshwater but completing lifecycle in the sea) including the Annex II Atlantic salmon (*Salmo salar*) and sea lamprey (*Petromyzon marinus*).

Figure 4.2 – Conservation Sites of International Importance in SEA Area 1



Geology and Soils

The Midland Valley is fault-bounded by the Highland Boundary Fault to the north and the Southern Upland Fault to the south. Although well known for coal-bearing Carboniferous strata, older Silurian and Devonian sequences include terrestrial sandstone and volcanic lava and younger Permian and Triassic rocks include lava and desert dune sandstone. Volcanic intrusions have created small areas of hilly land such as the Bathgate Hills and the Campsie Fells. The conservation importance of the region's geology is reflected in the large number of Geological Conservation Review sites (200) (see: Figure A4b.1, Appendix 4b.1).

The strata in this area have been extensively mined and quarried for minerals, particularly coal and hardrock aggregate. The overlying Quaternary deposits have provided major

resources of sand and gravel and brick clay. Legacy of both the minerals industry (coal and metals) and urban development include old mineworkings, contaminated land (Puri & Gordon 1998) and polluted groundwaters (Robins & Ball 2007) although a number of spoil bings are now protected (see: SNH 1996).

The soils of the Scottish Midlands SEA area vary from brown earths and humous-iron podzols to peaty podzols in the north, east and southern uplands, contrasting with the relative dominance of mineral gleys in the Midlands valley (Towers *et al.* 2006).

Landscape

The low-lying Midland valley runs between the Grampian Highlands to the north and the Southern Uplands to the south and contains the major population and industrial heart of Scotland. To the east, lowland coastal landscape dominates, punctuated by igneous outcrops (for instance The Ochils and Sidlaw Hills, and more locally, Arthur's Seat) which contrast with the surrounding sedimentary landscape. The landscape is made more complex by elements of estuarine intertidal flats, incised river gorges and loch basins. Landcover in the lowlands is largely arable farmland and improved grassland, but also includes woodland, grassland, heath and montane cover. Designated sites include 5 NSAs (Kyle of Bute, Loch Lomond, Trossachs, River Tay (Dunkeld) and Upper Tweeddale), the Loch Lomond and the Trossachs National Park and 2 World Heritage Sites (Edinburgh Old and New Towns, Antonine Wall).

Water Environment

The Scottish Midlands SEA area includes parts of the Scotland (incorporating parts of the Clyde, Forth and Tay Draft Management Plan Areas) and Solway-Tweed River Basin Districts. The Management Plans coordinated by SEPA and the Environment Agency in relation to these basins has both defined their environmental attributes and any physical impacts and pressures, as well as steps to achieving good status. Some of the water dependent SPAs and SACs in these areas have already been mentioned in the section on Biodiversity, Habitats, Flora and Fauna above, and in addition to these there are a number of designated bathing and drinking waters, and important freshwater and shellfish fisheries. Like many hydrological systems in the UK, water bodies in the RBDs relevant to the Scottish Midlands are experiencing pressures from undesirable physical modification, abstraction and artificial flow regimes, chemical pollution (e.g. diffuse minewater discharge), elevated concentrations of nitrate and phosphate in both surface and groundwater and the dispersion of invasive non-native species (e.g. mink, zebra mussel, signal crayfish) – see ADAS (2008). More detail on these pressures and SAC/SPA status is provided in Appendix 4d.

Surface waters are extensive; the main rivers in the Midlands being the Clyde, Forth, Tay and Tweed. Many rivers support internationally important habitats and species including otter (*Lutra lutra*, e.g. River Tweed), salmon (*Salmo salar*, e.g. Rivers Tay and Tweed), and by association freshwater pearl mussel (*Margaritifera margaritifera*, e.g. River South Esk). These and other designated conservation sites are 'water dependent', relying on a good quality freshwater supply (see: Appendix 4d).

The Carboniferous rocks which underlie much of the Midlands region are important aquifers, although of lower porosity and permeability than the main aquifers in England. The water quality of the Carboniferous sandstone aquifers in the Midland Valley tend to be worse than Devonian sandstones found elsewhere in Scotland due to the mining legacy of the area (Robins & Ball 2007). Very little of the total water supply (about 5%) comes from groundwater resources.

Air Quality

With the exception of Aberdeen City, the Scottish Midlands contain all of the declared Air Quality Management Areas (AQMAs) in Scotland, declared for 11 administrative districts. Most of these areas have been declared for PM_{10} and NO_2 emissions with the exception of Grangemouth in the Falkirk Council district, which has declared an AQMA for SO_2. The emissions maps of NAEI data produced in Appendix 4e also indicate that the central belt has higher emissions of pollutants including NO_x, CO, SO_2 and PM_{10} than areas to the north such as Stirling and much of Perth, and in Dumfries and Galloway and the Borders to the south. These emissions are associated with the large urban areas of Edinburgh and Glasgow and the major transport links in this region.

The most recent annual report on Scottish Air Quality (AEA Energy and Environment 2008) indicates that NO_x concentrations in Scotland have been steadily declining due to the implementation of UK and EU policies to reduce certain emissions. Changes in NO_2 are more complex, showing some increase partly due to the increased uptake of diesel vehicles and the retrofitting of emission control devices on buses. Urban ozone has also shown an increase which may be a function of a decrease in NO_x concentrations (AEA Energy and Environment 2008).

Climatic Factors

On average eastern Scotland received 1,135mm of rainfall a year with rainfall recorded on 159 days (1971-2000). Western Scotland received 1,732mm of rainfall a year over 189 days (1971-2000). December and January were the wettest months with about 120 and 195mm of rainfall in the east and west respectively.

UKCP09 presents climate change predictions for 2 regions which encompass the Scottish Midlands SEA area, that for West and East Scotland. The key climate change figures for mean seasonal temperature and precipitation for the medium emissions scenario[7] are given below for the 2050s (2040-2069).

Change in mean seasonal figure	Scotland West	Scotland East
summer mean temperature	+2.4°C (+1.1-3.8°C)	+2.3°C (+1.1-3.9°C)
winter mean temperature	+1.9°C (+1-3°C)	+1.7°C (+0.7-2.9°C)
summer mean precipitation	-12% (-26-1%)	-12% (-26-1%)
winter mean precipitation	+15% (+5-28%)	+10% (+2-20%)

Note: figures are central estimates relative to a baseline of 1971-2000, with the 10th and 90th percentile probability estimates indicated in brackets
Source: Murphy et al. (2009)

Population and Human Health

Within the Scottish Midlands, the Central Belt supports the highest population densities; being greatest in the cities of Glasgow (3,338 persons/km^2), Edinburgh (1,794 persons/km^2) and also to the north east in Dundee (2,310 persons/km^2). The population density in the areas between these centres (Fife, North Lanarkshire, West Lothian) still contain relatively high densities (~300-700 persons/km^2) compared with more rural areas to the north and south of the central belt (e.g. Stirling, Perth and Kinross, South Lanarkshire, Scottish Borders).

[7] Emission scenarios based on projections developed by the IPCC Special Report on Emissions Scenarios (SRES). The medium scenario is equivalent to SRES A1b (see: Nakićenović *et al.* 2000 and Appendix A4f).

Life expectancy is generally lower for both men and women in Scotland (73.3 years for men and 78.8 years for women) than in other parts of the UK. Men and women in Glasgow have the lowest life expectancy in the SEA area with a relatively high percentage (15.6%) of the population describing themselves as in "poor health".

Material Assets

The Midland Valley of Scotland is prospective for oil and gas with Silesian (Carboniferous) sandstone reservoir and mudstone and coal source rocks. Examples of fields include Dalkeith (oil) and Cousland (gas) (DCLG 2006a). Areas currently licensed for oil and gas occur in parts of Fife, Clackmannanshire, Falkirk, the Lothians and Lanarkshire.

Coal is present at the surface and down to 1,200m in a band across the Midland Valley and there is also the potential for coal bed methane (DCLG 2006b). Opencast coal mines in the Scottish Midlands had output figures for year ending March 2008 (Coal Authority 2009) of 3,380kt (East Ayrshire), 735kt (Fife), 85kt (Midlothian), 710kt (South Lanarkshire) and 260kt (West Lothian).

Fertile soils ensure that the Midland Valley contains much of Scotland's prime agricultural land (Agricultural capability classes 1 and 2), including the Valley of Strathmore, the Mearns, East Lothian, the Forth and Clyde Valleys and Ayrshire.

Cultural Heritage

Cultural heritage within the region is described in Appendix 4i. Aspects of cultural heritage receiving protection include 2 World Heritage sites (Old and New Towns of Edinburgh, and New Lanark). There are approximately 2,600 scheduled monuments in the SEA area.

4.2.2 West Midlands, North West England and Southern Scotland (SEA Area 2)

Biodiversity, Habitats, Flora and Fauna

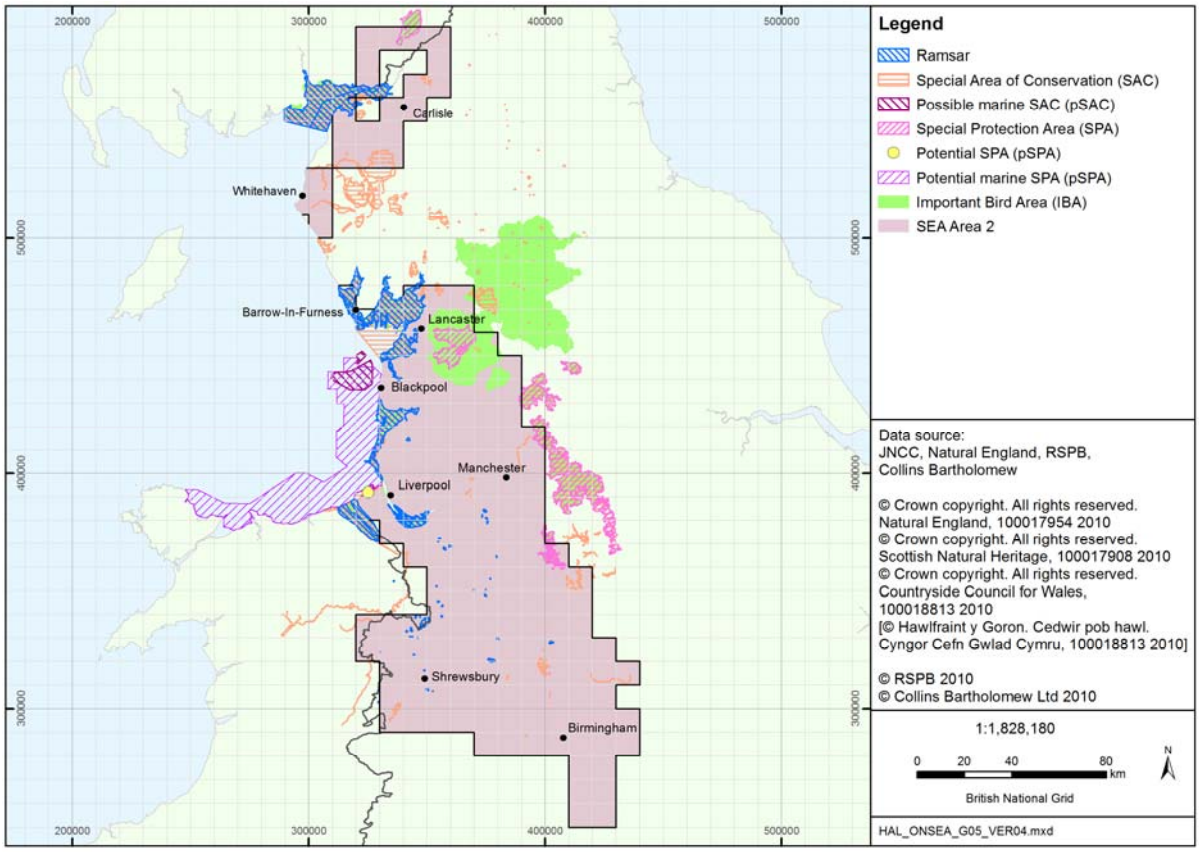
Wetland habitats including pools, rivers, clay pits, canals and mosses support important plant and animal species (e.g. great crested newt, floating water plantain, Atlantic salmon, sea and river lamprey). Other significant habitats include lowland heaths, ancient semi-natural woodlands and unimproved grassland with Cannock Chase, the Peak District Dales and the South Pennine Moors of particular importance. Blanket and raised bogs (either active or degraded/capable of regeneration) in the North West and Midlands represents over 50% of England's resource of this priority habitat and is a primary feature in a number of SAC sites in the SEA area such as the South Pennine Moors and a qualifying feature in the Ingleborough Complex. The latter site is also notable for its limestone pavements which are also a primary feature of the Morecambe Bay Pavements designation. These pavements, though widely distributed, are uncommon in the UK, covering just 2,000ha in total, though the most extensive area of pavement is present in the North of England. The vegetation of limestone pavements is unusual, and a range of calcareous rock, heath, grassland, scrub and woodland NVC types may be present.

Wetland habitats also make the region very important for wildfowl and waders, and the Solway Flats and Marshes and the Duddon Estuary support large numbers of breeding, wintering and migratory birds (e.g. redshank, barnacle goose, pink-footed goose, golden plover, bar-tailed godwit, pintail, and knot). The Morecambe Bay SAC largely coincides with the Duddon Estuary SPA and has a number of features of European importance including

mudflats and sandflats not covered by seawater at low tide, large shallow inlets and bays, *Salicornia* and other annuals colonising mud and sand, shifting dunes along the shoreline with *Ammophila arenaria* (`white dunes`), fixed dunes with herbaceous vegetation (`grey dunes`) and dune slacks. The Ribble and Alt estuaries, and the Mersey and the Dee estuaries also support large numbers of breeding, wintering and migratory birds (e.g. golden plover, redshank, ringed plover, dunlin, pintail, shelduck, and teal).

A range of priority habitats identified by the UK Biodiversity Action Plan are present within the region. International conservation sites include 26 SAC (and 1 marine pSAC), 14 SPA (and 1 pSPA, and 1 marine pSPA), 14 Ramsar and 13 IBA (Figure 4.3). National and local sites include 29 NNRs, 462 SSSIs and 243 LNRs. A number of reserves are also owned or managed by organisations such as RSPB, National Trust and Wildlife Trusts. The Mersey Narrows and North Wirral Foreshore pSPA is located adjacent to the Liverpool Bay marine pSPA. The latter site is noted for its wintering populations of red-throated diver and scoter (Article 4.1 and 4.2 respectively). Further north, the Shell Flat and Lune Deep pSAC coincides with the Liverpool Bay pSPA, and has been considered for the Annex I habitats, reefs and sandbanks which are slightly covered by sea water all the time.

Figure 4.3 – Conservation Sites of International Importance in SEA Area 2



Geology and Soils

Much of the West Midlands are underlain by predominantly soft reddish sandstone and clays. Jurassic Lias are found as an outlier to the west of Carlisle, and towards the south and east, Carboniferous limestones and shales are found. Carboniferous rocks underlie the region from Wolverhampton to Coventry, and around the Potteries and Telford. These include coal seams and other economically valuable deposits which have been responsible

for much of the earlier industrial growth of the large urban centres. To the north, Quaternary superficial deposits cover much of the region including the Carboniferous rocks of the Lancashire Coalfield and the sandstones that make up the surrounding Permo-Triassic basin. In contrast, moorland areas are dominated by Millstone Grit. The conservation importance of the region's geology is reflected in the large number of GCR sites (171). The area of Walney Island is underlain by Triassic sandstones, and backed by Carboniferous limestones similar to the Solway and Borders area, though these are largely covered in glacial drift material. The area of Walney Island is noted for its coastal geomorphology which has been greatly influenced by glacial sedimentation, and is a designated GCR site.

Urban areas including Birmingham, Manchester and Liverpool cover extensive tracts of land. Brown soils, surface-water gleys and localised podzolic soils cover much of the southern part of the region. To the north, upland areas are dominated by peat soils. Surface-water gleys cover much of the lowlands with groundwater gleys, lithomorphic and brown soils also present.

Landscape

The coastal landscape of the Solway Basin is characterised by its large intertidal areas already mentioned above, in addition to raised beaches and dunes. The area inland ranges from areas of fragmented peatland to fields enclosed by hedgerows and areas intensively managed for pasture. Further south, the Duddon Estuary provides a similar open intertidal landscape. The area is not highly industrial, though has extensive urban fringe developments at the coast, for instance industrial buildings visible at Barrow.

The relatively low-lying plain of southern Lancashire contrasts with the high open moorland of the West Lancashire Moors, Rossendale Forest and western Pennines. These moorlands are dissected by steep-sided river valleys. Large urban centres, notably Birmingham, Manchester and Liverpool and associated infrastructure, dominate much of the landscape with agricultural land outside of these areas.

Designated landscapes within the region include 3 National Parks (Lake District, Peak District and Yorkshire Dales), 6 Areas of Outstanding Natural Beauty (Shropshire Hills, Cannock Chase, Forest of Bowland, Arnside and Silverdale, Solway Coast and North Pennines), 1 Heritage Coast (St Bees Head) and 4 Environmentally Sensitive Areas (Lake District, South West Peak, North Peak and Shropshire Hills). Two NSAs (Nith Estuary and East Stewartry Coast NSAs) are also present in the Scottish section of SEA area 2. The Hadrian's Wall (Frontiers of the Roman Empire) World Heritage Site is also partly present in this SEA area, as well as in SEA area 3.

Water Environment

Around 85% of water used in the SEA area comes from reservoirs and river sources, with major upland reservoirs playing a key role (e.g. Pennine Fells and Lake District reservoirs). Groundwater used for public water supply in 2003 amounted to 11% for the North West region, representing 5% of the total groundwater abstracted in the UK for the same year (Environment Agency 2006). Valuable wetland environments include the mosses and meres of Cheshire, the Rivers Eden, Severn and Trent, and major estuaries supporting migrating birds.

The North West RBD and Solway-Tweed RBD cover parts of the SEA area. The former has a third of the poorest quality rivers in England and Wales, and only 20% of rivers at present are considered as achieving good status. There are, however, a number of excellent salmon rivers (e.g. the Derwent supports salmon, otter, lamprey and native crayfish, and the Ribble

and Mersey support salmon), and the canals of the region are an important tourist, transport and coarse fishing asset. This contrasts with the Solway-Tweed in which 45% of surface waters achieve good environmental status. Only 44% of the 18 groundwaters in the North West RBD are achieving good status at present, partly from over abstraction, saline intrusion and rebound in former mining areas. Industrial pollution and agriculture are also sources of environmental contaminants. Similarly, groundwaters in the Solway-Tweed are in better condition than in the North West, presently with 80% attaining good status.

Physical impacts and pressures which affect the RBDs and the SEA area water environment (surface and groundwater bodies) include elevated phosphorous, nitrate, ammonia and BOD levels, pesticide pollution including sheep dip, chemicals including hazardous substances, mine water diffuse pollution, abstraction, sediment changes, physical modification, barriers to fish migration and invasive non-native species. 2015 targets for the North West RBD include a 7% rise in rivers achieving good status, and a 16% increase in groundwaters achieving good status, amongst other targets relating to estuaries, coasts and lakes. In the Solway-Tweed, by 2015 the aim is that 52% of all surface waters and 82% of groundwaters will be in good condition, with a longer term plan for 92% of surface waters and 93% of groundwaters to achieve good status by 2027.

Over 200,000 properties in the North West are at risk from flooding, and around 400,000 people live within a floodplain. A low proportion of properties (<50,000) are at significant risk (more than 1:75 chance in a given year) from flooding, with the remaining properties being at moderate (1:75 to 1:200) or low (1: 200 to 1:1,000) risk (Environment Agency 2009b).

Air Quality

Poor air quality is associated mainly with urban and industrial centres such as Liverpool, Manchester and Birmingham and associated transport infrastructure. Maps of emissions for CO, NO_x, PM_{10} and SO_2 (provided in Appendix 4e) reveal these urban areas and connecting routeways as having relatively high emissions. 52 local authorities have declared Air Quality Management Areas within the SEA area, where air quality standards may not meet those required by European legislation, and that stated in the UK Air Quality Strategy. The three principal cities in the area mentioned above have declared AQMAs for NO_2 and PM_{10} emissions, consistent with most other large urban areas in the UK.

Climatic Factors

On average the Midlands received 785mm of rainfall a year with rainfall recorded on 130 days (1971-2000 average) with the North West receiving 1,290mm a year over 163 days (1971-2000 average). December and January were the wettest months with about 82mm in the Midlands and 147mm in North West. The table below indicates the changes in temperature and precipitation projected in UKCP09 for UK areas which form parts of the West Midlands and North West England SEA area for the 2050s (2040-2069), for the medium emissions scenario.

Change in mean seasonal figure	North West England
summer mean temperature	+2.6°C (1.2-4.1°C)
winter mean temperature	+2°C (+1-3°C)
summer mean precipitation	-17% (-34-1%)
winter mean precipitation	+13% (+3-26%)

Note: figures are central estimates relative to a baseline of 1971-2000, with the 10th and 90th percentile probability estimates indicated in brackets
Source: Murphy et al. (2009)

Population and Human Health

Most of the administrative areas in the West Midlands and North West England SEA area have a high population density, particularly the West Midlands (2,620 persons/km^2), Merseyside (1,348 persons/km^2) and Greater Manchester (2,574 persons/km^2), with concentrations of population centred on the urban areas of Liverpool (434,000), Blackpool (141,000), Manchester (464,000) and Birmingham (1,016,000). The high collective population density for all of the administrative areas covered in the SEA area is around 2.5 times that of the national figure, and over 1.5 times that of England (Office for National Statistics). Those areas in the Scottish Borders and Dumfries and Galloway have a comparatively low population density (23.75 and 23.12 people/km^2 respectively). South of the border Cumbria has a comparatively higher population density at 73.37 people/km^2, centred around the urban areas of Carlisle and Barrow-in-Furness.

Material Assets

The Cheshire Basin is not a proven petroleum province, but possesses similarities to both the productive offshore East Irish Sea Basin and the East Midlands hydrocarbon province. To the north, the West Lancashire Basin forms the onshore part of the East Irish Sea Basin with the onshore Formby (oil) and Elswick (gas) fields completing a line of fields in the southern part of this important hydrocarbon-producing basin. The petroleum system has a Carboniferous mudstone and coal source with Triassic sandstone reservoirs (DCLG 2006b). Large parts of Staffordshire and Leicestershire are covered by oil and gas licences. Further north, licensed areas are restricted to the north and east of the Mersey Estuary and around the Blackpool area. In the area towards the Scottish borders, the presence of Carboniferous and Permo-Triassic reservoirs is connected with the potentially productive Northumberland-Solway Basin, although it has not yet yielded commercial quantities of hydrocarbons.

Coal is present over much of the region with deep coal resources extending offshore into the eastern Irish Sea. Large areas of coal bed methane potential exist around the Mersey Estuary and north along the Cumbria coastline, with coal gasification potential around the northern rim of the Cheshire basin and in Staffordshire (DCLG 2006b). Relevant deep mining output figures for year ending December 2008 were 3,160kt for Warwickshire with opencast figures of 438kt for Leicestershire (Coal Authority 2009).

In the northern part of the region, upland areas are associated with poor agricultural land (Grades 4 and 5 in England and 6 to 7 in Scotland). Much of the rest of the area is classified as Grade 3 agricultural land with localised areas of Grade 1 or 2 lands. Extensive urban areas surround Birmingham, Liverpool and Manchester.

Cultural Heritage

Cultural heritage within the region is described in Appendix 4i. Aspects of cultural heritage receiving protection include 3 World Heritage Sites (Hadrian's Wall, Ironbridge Gorge and Liverpool – Maritime Mercantile City). There are approximately 1,660 scheduled monuments in the SEA area, and around 200 grade I, II and II* historic parks and gardens.

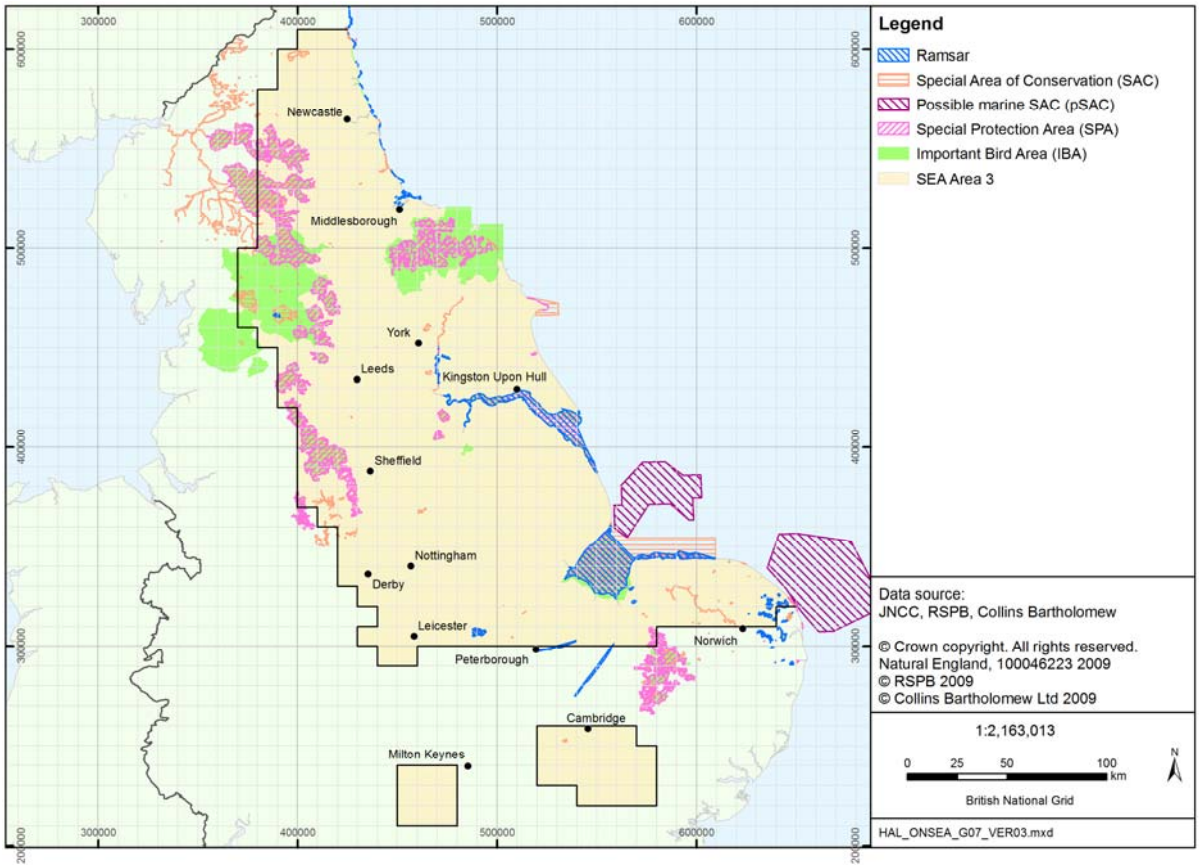
4.2.3 East Midlands and Eastern England (SEA Area 3)

Biodiversity, Habitats, Flora and Fauna

Upland and coastal habitats and species dominate nature conservation designations in the north of the region with coastal and lowland wetland habitats and associated species to the south. Features of importance include the extensive estuarine habitats of The Wash which supports huge numbers of wildfowl and waders (e.g. avocet, bar-tailed godwit, golden plover, whooper swan, ringed plover, black-tailed godwit) and the North York Moors and the Pennines which support important upland habitats and species (e.g. blanket bogs, European dry heaths and wet heaths with *Erica tetralix*). The SEA area also includes the lowland wetland habitats (fens) of East Anglia.

A range of priority habitats identified by the UK Biodiversity Action Plan are present within the region. International conservation sites include 53 SAC, 20 SPA, 14 Ramsar and 22 IBA (Figure 4.4). National and local sites include 59 NNR, 1,084 SSSI and 373 LNR. A number of reserves are also owned or managed by organisations such as RSPB, National Trust and Wildlife Trusts.

Figure 4.4 – Conservation Sites of International Importance in SEA Area 3



Geology and Soils

The main geological features include the Carboniferous Limestones, sandstones and Millstone Grit of the Pennines, Northumberland moors and Yorkshire Dales. The Coal Measures of Northumberland, Durham and West Yorkshire have been extensively exploited

and are still producing (see below). Sherwood Sandstone and mudstones occupy much of the Vale of York. Cretaceous Chalk extends through Humberside to the Wolds and Flamborough Head, and into north-east Norfolk. The conservation importance of the region's geology is reflected in the large number of GCR sites (388).

The industrial prosperity of the region was founded on the North East, Yorkshire–Nottinghamshire and Leicestershire coalfields. Current activities include some opencast and deep coal mining, extraction of limestone, hard-rock aggregate, sand and gravel, gypsum, oil and gas. Legacies of mining activities include hazards such as subsidence and contamination of ground and surface water sources by mining spoil or landfill. Other hazards include landslips, radon gas, ground 'heave' (swelling clays), and flooding.

Surface-water gley (sticky waterlogged) soils cover much of the northern part of the region with peat soils over upland areas. Brown and lithomorphic (lime-rich soils over chalk or limestone) soils cover large tracts of land from Yorkshire through the East Midlands and Lincolnshire. Groundwater gley soils are extensive around the Humber, the Lincolnshire coast and the Wash. Brown, lithomorphic and surface water gley soils dominate the Norfolk area (Environment Agency website).

Landscape

Open, expansive moorland characterises the upland areas of Northumberland, the North York Moors and the Pennines, and distinctive limestone defines the Peak District's 'White Peak', juxtaposing the gritstone of the 'Black Peak', and contrasting with the low lying and intensively farmed Humber and Fens. The area of Norfolk in the SEA area consists of large scale arable and grassland which provide a very open character to the landscape, rather than the managed feel of enclosure provided by the estates in the area. There are varied coastal landscapes such as the Humber Estuary, the chalk cliffs of Flamborough Head, the continually denuding Holderness coastline and The Wash, which has extensive tidal saltmarshes and mudflats. Urban and industrialised landscapes are restricted to the industrial centres of the North East, SW Yorkshire and the East Midlands.

Designated landscapes within the region include 5 National Parks (Northumberland, North York Moors, Yorkshire Dales, Peak District and Broads Authority), 7 Areas of Outstanding Natural Beauty (Northumberland Coast, North Pennines, Nidderdale, Forest of Bowland, Howardian Hills, Lincolnshire Wolds, and Norfolk Coast) and 5 Environmentally Sensitive Areas (Pennine Dales, North Peak, South West Peak, Breckland and Broads). There are also 6 stretches of Heritage Coast (North Northumberland, Durham, North Yorkshire and Cleveland, Flamborough Headland, Spurn, and North Norfolk) and 3 World Heritage Sites (Hadrian's Wall, Derwent Valley Mills and Saltaire).

Water Environment

Three RBDs cover the SEA area (Northumbria, the Humber and Anglian). A number of pressures on the physical and chemical quality of water bodies exist in these areas including nitrate, phosphorous and pesticide pollution, problems due to changes in sediment and physical morphology, invasive non-native species and abstraction and artificial flow pressures. Pollution from mines and mine water is a particular problem in the Northumbrian RBD, with 12% of rivers and 67% of groundwaters at risk, compared with 5.2% of all water bodies in the Humber region, reducing to negligible or no-risk levels in Anglia (Environment Agency 2009d, e, h, i, l, m).

Water resources in the northern half of the region are generally healthy, whilst in the south, water is scarcer. Important rivers include the Tyne, Tees, Derwent, Hull, Wharfe and

Bedford Ouse. The Pennines support a large number of reservoirs, particularly in the upper Tees, which both moderate flood discharges and compensate low flows. Much of the extensive wetland habitats around the Humber Estuary and within the Broads are protected as European sites including SACs and SPAs. Between 1999 and 2006 abstractions from surface water in the Anglian region declined by 13%, and those from groundwater just 0.5%, a great deal of which was used in agriculture (Environment Agency 2009a). The importance of groundwater used in public water supplies varies from about 14% of total supplies in the north to 37% in East Anglia. The Anglian region accounted for 16% of all groundwater abstractions in England in 2003, with the north east accounting for just 7% (Environment Agency 2006).

Those areas with the greatest number of properties with a significant likelihood of flooding are located in North and East Lincolnshire (5,000-7,500), East Riding of Yorkshire (7,500-10,000 properties) and Lincolnshire (>10,000 properties) authority areas (Environment Agency 2009b). Most other authorities in the SEA area have between 500 and 2,500 properties considered to have a significant likelihood of flooding.

Climatic Factors

On average the eastern and North East region received 755mm of rainfall a year with rainfall recorded on 129 days (1971-2000 average). East Anglia was drier receiving 605mm a year over 112 days (1971-2000). November and December were the wettest months in eastern and north eastern parts (about 76mm) with October and December wettest in East Anglia (about 59mm).

The table below indicates the change in temperatures and precipitation projected in UKCP09 for UK areas which form parts of the East Midlands and Eastern England SEA area for the 2050s (2040-2069) under the medium emissions scenario.

Change in mean seasonal figure	North East England	Yorkshire & Humberside	East Midlands	East of England
summer mean temperature	+2.5°C (1.2-4.1°C)	+2.3°C (+1.1-3.9°C)	+2.5°C (+1.2-4.2°C)	+2.5°C (+1.2-4.3°C)
winter mean temperature	+2°C (+1-3.1°C)	+2.1°C (+1.1-3.3°C)	+2.2°C (+1.1-3.4°C)	+2.2°C (+1.1-3.4°C)
summer mean precipitation	+14% (-29-1%)	-17% (-35-1%)	-15% (-35-6%)	-16% (-37-6%)
winter mean precipitation	+11% (+1-24%)	+11% (+2-24%)	+14% (+2-29%)	+14% (+3-31%)

Note: figures are central estimates relative to a baseline of 1971-2000, with the 10th and 90th percentile probability estimates indicated in brackets
Source: Murphy et al. (2009)

Air Quality

Air quality is generally good, particularly in rural areas, with local areas of poor air quality associated mainly with urban and industrial centres. Emissions include acidifying components such as SO_2 and CO_2 which can have direct and indirect effects on, amongst others; buildings, habitats and vegetation. Particulate matter (PM_{10}, $PM_{2.5}$) is a pollutant particularly associated with dense urban areas and the use of diesel engines, which may have detrimental effects on human health at high and persistent concentrations. There are problems of historic and current atmospheric acid deposition over some upland areas with acid soils and low buffering, or acid neutralising capacity. There are 61 Air Quality Management Areas within the region where air quality standards do not, or are unlikely to,

meet the requirements under the Air Quality Framework Directive or the Ambient Air Quality and Clean Air for Europe Directives due to be transposed into UK law by June 2010.

Population and Human Health

Northumberland, Durham, North Yorkshire, Lincolnshire and Norfolk have a relatively low population density (~300-700 persons/km^2) compared to Tyne and Wear (1,093) and administrative areas in the East Midlands, including South Yorkshire (1,306), West Yorkshire (2,200) and Nottinghamshire (776). The principal population centres in this SEA are the urban areas of Newcastle, Leeds, York and Hull in the north, and Nottingham, Leicester and Derby in the south.

Life expectancy for both men and women is generally lower in the northern part of the region (North East and Yorkshire and the Humber) with more southerly areas (East Midlands and East of England) having similar or greater life expectancies than the England average. A greater proportion of the population in the northern part described themselves as in "poor health" compared to the south and the UK as a whole.

Material Assets

Gas in the Yorkshire/NE England Province comes from a Permian limestone reservoir and Carboniferous Coal Measures source rocks (e.g. Malton, Marishes, Lockton, Eskdale). The East Midlands province covering Lincolnshire, Nottinghamshire and northern Leicestershire has been one of the most prospective areas for onshore oil and gas. The province comprises a series of major rift basins containing important source and reservoir rocks deposited during the late Carboniferous. Examples include Eakring, Welton, Rempstone, Scampton, Gainsborough (oil), Hatfield Moors and Hatfield West, Trumfleet, Saltfleetby (gas) (DCLG 2006a). Licensed areas are restricted largely to North Yorkshire, Lincolnshire, Nottinghamshire and parts of Norfolk.

Coal is present at surface and down to 1,200m (the normal limit of conventional mining) in parts of the North East (e.g. Northumberland, Tyne and Weir and Durham), Lincolnshire and Nottinghamshire. Very large resources of Carboniferous coal remain at depths below 1,200m particularly in the eastward extension of the East Pennine Coalfield, both within the UK land area and below the North Sea. There also exist further large resources of coal in Mesozoic and Palaeogene strata although much is lignite rather than bituminous coal (DCLG 2006b). Deep-mining production figures for year ending December 2008 were Doncaster (468kt), Rotherham (1,184kt), Warwickshire (3,160kt), Nottinghamshire (1,810kt), Northumberland (125kt) and North Yorkshire (2,042kt). Opencast production was smaller with Northumberland (1,223kt) and Leicestershire (438kt) the main producers (Coal Authority 2009).

Poor agricultural lands (Grades 4 and 5) are restricted to upland areas. Lowland areas particularly around the Humber and Wash are of good or excellent quality (Grades 1 and 2).

Cultural Heritage

Cultural heritage within the region is described in Appendix 4i. Aspects of cultural heritage receiving statutory protection include 5 World Heritage sites (Frontiers of the Roman Empire, Durham Castle and Cathedral, Studley Royal Park including the ruins of Fountains Abbey, Saltaire, and Derwent Valley Mills). There are also approximately 6,000 scheduled monuments and around 350 grade I, II and II* historic parks and gardens.

4.2.4 North and South Wales and the Dee Estuary (SEA Area 4)

Biodiversity, Habitats, Flora and Fauna

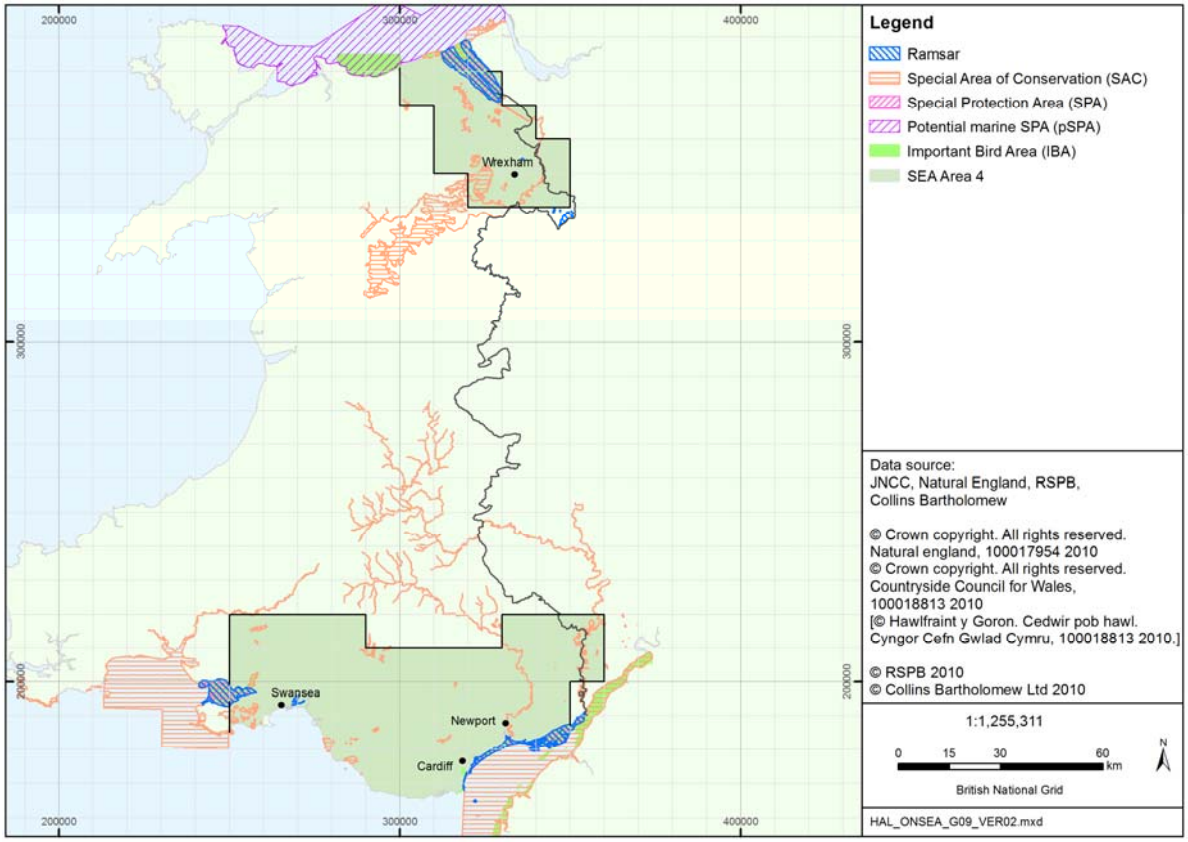
Important river systems, including the Wye and Tywi in the south and the Dee in the north, support important habitats and species including twaite and allis shads, salmon and lampreys, recognised in SAC designations for these areas. Surrounding river valleys support woodland and bat sites. Grassland, heath and woodland habitats are protected with the extensive Berwyn and South Clwyd Mountains and Halkyn Mountain sites of particular importance. There are also a number of important sites for great crested newts. The Severn and Dee estuaries are important for a wide range of waterbirds and wildfowl, and offshore, the Liverpool Bay pSPA is being considered for its over wintering populations of red-throated diver and common scoter.

A range of priority habitats identified by the UK Biodiversity Action Plan are present within the region. International conservation sites include 32 SAC, 3 SPA, 5 Ramsar and 4 IBA (Figure 4.5). National and local sites include 15 NNR, 272 SSSI and 43 LNRs. A number of reserves are also owned or managed by organisations such as RSPB, National Trust and Wildlife Trusts.

The Dee Estuary supports a number of conservation designations (SPA, SAC, Ramsar, SSSI – see Figure 4.5) alluding to the national and international importance of the area for conservation. The SAC is designated primarily due to the occurrence of Annex I habitats including mudflats and sandflats not covered by seawater at low tide (i.e. intertidal), *Salicornia* and other annuals colonising mud and sand and Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*), and Annex II species including lamprey (sea and river) and the petalwort (*Petalophyllum ralfsii*). The area of saltmarsh and mudflat also lends itself to substantial populations (>90,000) of overwintering waterfowl, making the Dee Estuary SPA of international importance. The principal species involved include bar-tailed godwit, pintail, red knot, oystercatcher, shelduck and redshank.

Further upstream, the River Dee and Bala Lake SAC has a certain dependency on the quality of the estuarine and offshore area further north and west due to the presence of anadromous species including the Atlantic salmon and sea lamprey, which require an unobstructed route upstream to spawn.

Figure 4.5 – Conservation Sites of International Importance in SEA Area 4



Geology and Soils

The region has a complex geology being underlain by rocks of Ordovician, Silurian, Devonian and Carboniferous age, in places covered by glacial and post-glacial deposits. These comprise shales, sandstones, limestone, coal, sands, gravels, boulder clay and peat, most of which have been exploited at some time. Carboniferous limestone and Coal Measures represent the most economically important mineral resources and the extensive coal fields of South Wales provided the stimulus for much of the region's industrial development. The conservation importance of the region's geology is reflected in the large number of GCR sites (80).

Brown soils cover much of the Brecon Beacons and towards the English border. Podzolic soils and surface-water gleys over much of south Wales with brown soils and extensive urban areas near the coast. In north Wales there is a mixture of podzolic, brown, surface-water and groundwater gley soils (Environment Agency website). In some areas there is a legacy of past metal and coal mining activities in the form of contaminated soils and river systems.

Landscape

In the south, the border with England is dominated by the Wye Valley, with pastoral and arable farmland landscapes together with extensive tracts of broadleaf and coniferous woodland. Further west, upland areas are dissected by valleys which were the centre of coal mining and steel production in Wales and now support industrial and urban landscapes. To the south, the coastal plain supports a pastoral landscape as well as urban and industrial areas.

The Flintshire landscape in North Wales ranges from the high open moorland of the Clwydian Range to the coastal and estuarine flats of the River Dee. Remnants of lead and zinc ore mining are an important landscape feature in some areas. Upland landscape of the Berwyns in the eastern half of Wrexham gives way to ridges and valleys and the floodplain lowlands of the River Dee in the west.

Designated landscapes within the region include 3 Areas of Outstanding Natural Beauty (Clwydian Range, Wye Valley and Gower). There is also the Glamorgan Heritage Coast, Blaenavon Industrial Landscape and Pontcysyllte Aqueduct and Canal World Heritage Sites.

A number of areas in North and South Wales appear on the Cadw/ICOMOS Register of Historic Landscapes and Register of Parks and Gardens of Special Historic Interest. These are dealt with in more detail in Appendix 4i and the Cultural Heritage section below.

Water Environment

Water resources in North and South Wales are described in more detail in Appendix 4d. Internationally important rivers include the Dee, Severn, Usk and Wye supplied by Wales' extensive uplands. Associated wetland sites are recognised in SPA and Ramsar designations and the rivers themselves also have qualifying features recognised by SAC designations, including Atlantic salmon, white-clawed crayfish, otter, shad and brook, river and sea lamprey.

Since the underlying geology is generally impermeable, there are few aquifers from which to draw large quantities of groundwater (representing only 4% of total supplies). Future climate change may lead to a winter increase in river flows of 10 to 15%, but a 50% or greater reduction in summer flows, leading to a net annual average reduction in flow of ~15% (Environment Agency Wales 2009b). This has implications for potable water supply and habitat maintenance. Without significant natural groundwater contributions to sustain them, river flows tend to fall to relatively low levels during dry periods, and react quickly to rainfall episodes. Over 150 reservoirs have been constructed in Wales to overcome the lack of natural storage in many river catchments (Environment Agency Wales 2001). The River Severn regulation scheme exemplifies the scale of reservoir building in Wales, for instance Llyn Clywedog and Lake Vyrnwy. These reservoirs have the capacity to provide significant amounts of water to the public supply, help maintain river flows during dry periods and to attenuate flood flows. In addition, the Severn is also compensated during particularly dry periods, by the Shropshire Groundwater Scheme, which supplements surface flows from its Triassic sandstone aquifer. In the Severn area of the SEA region, past and present activities have put water resources under pressure from a number of sources, including diffuse pollutants from rural land management issues, sewerage discharges, urban runoff and the legacy of mining (Environment Agency 2009n, o).

In the north, the Dee catchment covers an area of 2,251km^2. The area varies from the uplands of the Snowdonia National Park, through the Vale of Llangollen to the open Cheshire plains and the Dee estuary mudflats. The Dee is also one of Europe's most regulated rivers, supplying ~3 million people with water. Due to the strategic importance of the catchment as a whole, the lower Dee was categorised as the only Water Protection Zone in the UK in 1999.

The number of properties with significant (1 in 75 chance or greater of flooding in any given year) likelihood of flooding as identified for Local Authorities in Wales (Environment Agency Wales 2009a) is greater in the north than the south, with Denbighshire and Flintshire having 2,500-5,000 properties at risk, and Wrexham having 1,000-2,500. In the south, the greatest

numbers of properties at risk (5,500-7,500) are in Newport. Those other authorities in the South Wales section of the SEA area (e.g. Monmouthshire, Cardiff, Vale of Glamorgan, Bridgend) contain around 1,000-2,500 properties at risk of flooding. The lowest figure of less than 500 properties is found in Torfaen. These figures do not reflect those properties which are at a moderate (1 in 200 to 1 in 75 chance of flooding in any given year) or low (1 in 200 chance of flooding in any given year) risk of flooding.

Climatic Factors

Rainfall figures for North Wales were included in those for the North West region which were 1,290mm a year over 163 days (1971-2000). Similarly figures for South Wales were included in those for South West England (1,247mm a year over 154 days). December and January are the wettest months with between 147-151mm of rainfall.

The table below indicates the change in temperatures and precipitation projected in UKCP09 for UK areas which form parts of the North and South Wales SEA area for the 2050s (2040-2069) under the medium emissions scenario.

Change in Mean Seasonal Figure	Wales
summer mean temperature	+2.5°C (+1.2-4.1°C)
winter mean temperature	+2°C (+1.1-3.1°C)
summer mean precipitation	-16% (-36-6%)
winter mean precipitation	+14% (+2-30%)

Note: figures are central estimates relative to a baseline of 1971-2000, with the 10th and 90th percentile probability estimates indicated in brackets
Source: Murphy et al. (2009)

Air Quality

Poor air quality is associated mainly with urban and industrial centres such as Neath, Port Talbot, Swansea, Cardiff and Newport. Emissions from vehicles are a significant source of primary pollution throughout the UK, in particular CO, NO_2 and volatile organic compounds (VOCs) such as benzene and 1,3-butadiene and primary particles (PM_{10} and $PM_{2.5}$). It is noted that such emissions are particularly high in urban areas in Wales during peak commuting times on weekdays, at which time transport forms the major source of air pollution (WAG 2009a). Patterns of ozone in Wales, as elsewhere, are complex due to the influence of atmospheric chemistry and meteorological conditions. There appears to be some topographic dependence on ozone distribution, with higher levels tending to be recorded at greater altitude. Higher areas tend to have less diurnal variation in ozone as the air cools in the evening, flows down-slope and is replaced by relatively ozone rich air from above (see: Coyle *et al.* 2002). Ozone levels also tend to be lower in areas of Wales with higher NO_2, PM_{10} and $PM_{2.5}$ (WAG 2009a)

There are 12 administrative regions which have declared Air Quality Management Areas within the SEA area where air quality standards may not meet those required by European legislation, and that stated in the UK Air Quality Strategy. Emissions of most air pollutants (e.g. SO_2, NO_x, PM_{10}, CO) are greater over urban/industrialised areas and associated transport infrastructure (see Appendix 4e). In Wales, PM_{10} and ozone are the principle sources of pollution in urban areas.

Population and Human Health

The North and South Wales SEA area takes in those areas of Wales which are most heavily populated, namely Cardiff, Swansea and the Valleys in the south. The relatively high

population density in these areas (e.g. 2,320 persons km^2 in Cardiff, 1,927 persons km^2 in Newport, 606 persons km^2 in Swansea) can be seen by comparison with the national (Wales) total (144 persons km^2).

Life expectancy for men and women in Wales is similar to the UK average although there is considerable variety between local authority areas. For example, Monmouthshire had the highest life expectancy for men and women (men 76.2 years, women 83 years) and Merthyr Tydfil the lowest (men 72.6 years, women 77.5 years). Merthyr Tydfil also had the highest percentage of people (18.1%) describing themselves as in "poor health".

Material Assets

The Cheshire Basin is not a proven petroleum province but possesses similarities to both the productive offshore East Irish Sea Basin and the East Midlands hydrocarbon province. Carboniferous source rocks include Holywell Shales which crop out in Clwyd adjacent to its coalfield. In the Flint district, curly cannel coal yields reasonable amounts of oil. Carboniferous rocks in all the coalfields surrounding the Cheshire Basin have fair to good shows of hydrocarbons. Many of the coal seams are gassy, attracting drilling on 3 UK coalbed methane exploration licences. In the Flintshire Coalfield at Point of Ayr colliery, a methane drainage scheme was required to remove gas from underground workings (DCLG 2006b). Licensed areas are restricted to localised areas of Flintshire and Wrexham in the north but are more extensive in the south particularly to the west over Swansea, Neath, Port Talbot and Brigend.

Coal at the surface and down to 1,200m underlies the South Wales valleys area as well as parts of north Wales. In the South Wales coal field coal rank increases from the east to the northwest, where anthracite occurs, the only source in Britain (DCLG 2006b). There are a number of opencast coal mines in north and south Wales with outputs for the year ending December 2008 of 842kt (Neath Port Talbot) and 401kt (Powys). Deep coal mining is restricted to the south with outputs to the year end (December 2008) of 768kt (Rhondda Cynon Taff), 105kt (Neath Port Talbot) and 4kt (Torfaen) (Coal Authority 2009). Coal bed methane potential is extensive in both North and South Wales (DCLG 2006b).

Excellent and good quality agricultural lands are limited to the Vale of Glamorgan and localised areas of Flintshire and Wrexham. Upland areas are generally of poor agricultural quality (Grade 5). Much of South and North Wales is covered by Grade 3 agricultural land with extensive urban areas, particularly along the south coast and within the valleys.

Cultural Heritage

Cultural heritage within the region is described in Appendix 4i. Aspects of cultural heritage receiving protection include the Blaenavon Industrial Landscape and the Pontcysyllte Aqueduct and Canal World Heritage Sites, as well as approximately 1,500 scheduled monuments and numerous additional non-designated archaeological and historical features recorded on the Wales Historic Environment Record (HER). 58 historic landscapes have been described for Wales and appear on the Cadw/ICOMOS Register of Landscapes of Special Historic Interest. 18 of these landscapes are located in the areas of North and South Wales covered by this SEA (Figure A4i.4, Appendix 4i). Similarly approximately 180 historic parks and gardens (as described in the Cadw/ICOMOS Register of Parks and Gardens of Special Historic Interest) are present in the SEA area (Figure A4i.5, Appendix 4i). These are graded, similarly to listed buildings (grade I, II or II*) depending on their quality and include an area outside the main park or garden called an "essential setting", which comprises the visual area outside of the site which is necessary to maintain its character. These

landscapes, parks and gardens though not statutorily protected are material considerations in planning decisions.

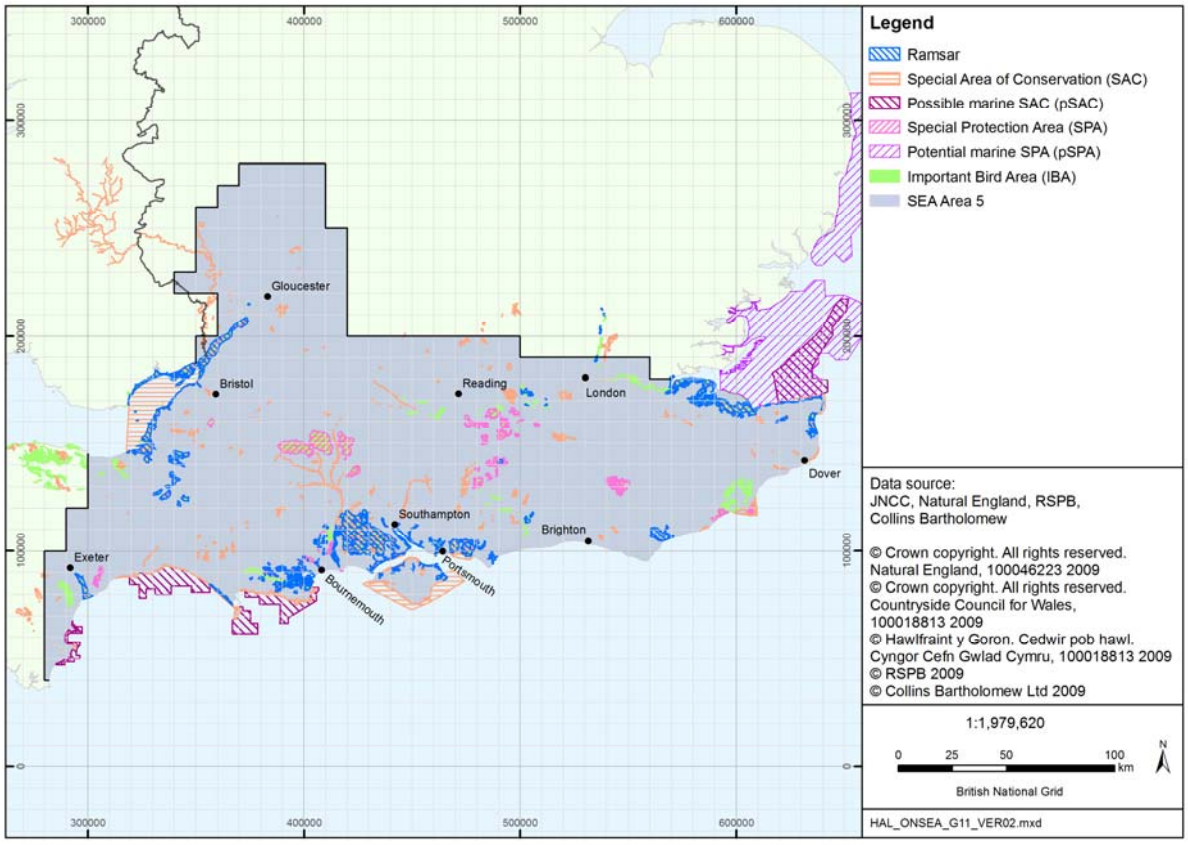
4.2.5 Southern and South West England (SEA Area 5)

Biodiversity, Habitats, Flora and Fauna

Species-rich chalk downlands and heathlands are particularly extensive and cover large parts of the south coast. River valleys and wetlands, upland areas, and a range of coastal habitats are of international importance. The area also contains densely wooded areas with extensive tracts of ancient woodland. There are a large number of important bird sites including coastal areas and wetlands for waterbirds and wildfowl.

A range of priority habitats identified by the UK Biodiversity Action Plan are present within the region. International conservation sites include 97 SAC, 30 SPA, 23 Ramsar and 32 IBA (Figure 4.6). National and local sites include 76 NNR, 1,415 SSSI (7 of which cross into Wales) and 527 LNRs. In addition to these sites, The Outer Thames marine pSPA and Margate and Long Sands marine pSAC occur adjacent to SEA area 5. These sites are being considered for the qualifying species, red-throated diver, and habitat, sandbanks which are slightly covered by sea water all the time, respectively. A number of reserves are also owned or managed by organisations such as RSPB, National Trust and Wildlife Trusts.

Figure 4.6 – Conservation Sites of International Importance in SEA Area 5



Geology and Soils

The open rolling downs and heaths which characterise much of the region are underlain largely by chalk. Wealden Greensand forms a conspicuous ridge running east to west across Surrey and Kent terminating in coastal cliffs at Folkestone Warren. Further west, chalk downlands are intersected by Greensand hills and clay vales in Dorset and Wiltshire. Granite underlies much of Devon with sedimentary rocks, especially sandstone, limestone, shale and chalk occurring to the east. Past geological history has created conditions for oil and gas generation and entrapment for example at the Wytch Farm oil field in Dorset which in 1993 had an estimated 41.1 million tonnes of recoverable oil reserves, including an offshore extension (Crumpton *et al.* 1996). The conservation importance of the region's geology is reflected in the large number of sites (640) designated as GCR sites. The Dorset and East Devon Coast World Heritage Site is designated for its important fossil sites and coastal geomorphologic features.

Some areas in the south west have a historic legacy of mine water polluted with heavy metals, contaminated land and the threat of subsidence.

Brown soils, lithomorphic, surface-water and groundwater gley soils cover much of Kent and Sussex. Lithomorphic soils dominate in central and western parts with brown, surface-water gley and podzolic (infertile acidic soil) soils also present. In Devon, brown and podzolic soils dominate with groundwater gley soils along the coastal fringe of the Severn Estuary.

Landscape

The landscape of central and eastern parts varies from open spaces of rolling arable pasture which dominate the plateaux, to river valleys and estuarine plains. The coast is heavily developed in some places and includes natural harbours (e.g. Chichester) and notable cliffs (e.g. Seven Sisters, Beachy Head). Dense ancient woodland is found in many areas, whilst chalk forms characteristic hills and escarpments, and Greensand forms a distinctive scarp/dip-slope topography. To the west, the hills and uplands of the Cotswolds, Forest of Dean, Mendips, Salisbury Plain and the moorlands of Dartmoor and Exmoor contrast with lower-lying landforms of plateaux, vales and river valleys, levels, estuaries and a wide variety of coastal landscapes.

Designated landscapes within the region include 3 National Parks (New Forest, Dartmoor and Exmoor) as well as the South Downs proposed National Park (designation now confirmed pending some boundary modifications). There are 19 Areas of Outstanding Natural Beauty (The Chilterns, North Wessex Downs, Kent Downs, High Weald, Surrey Hills, Sussex Downs, East Hampshire, Chichester Harbour, Isle of Wight, Dorset, Cranborne Chase and West Wiltshire Downs, East Devon, Blackdown Hills, South Devon, Quantock Hills, Mendip Hills, Cotswolds, Wye Valley, and Malvern Hills) and 11 Environmentally Sensitive Areas (North Kent Marshes, South Downs, Test Valley, Avon Valley, South Wessex Downs, Blackdown Hills, Dartmoor, Exmoor, Somerset Levels and Downs, Cotswold Hills and the Upper Thames Tributaries). There are also 9 stretches of Heritage Coast (South Foreland, Dover-Folkestone, Sussex, Tennyson, Hamstead, Purbeck, West Dorset, East Devon and South Devon) and 7 World Heritage Sites (Dorset and East Devon Coast, Stonehenge Avebury, City of Bath, Canterbury Cathedral, St Augstine's Abbey & St. Martin's Church, Royal Botanic Gardens of Kew, Westminster Palace, Westminster Abbey and Saint Margaret's Church, Tower of London).

Water Environment

Water is a scarce and often over-committed resource over much of the region. Important rivers in the SEA area include the Thames, Avon, Wye and Severn with chalk rivers of particular conservation importance. Groundwater, mainly from chalk aquifers, is the most important source of water representing between 30 and 74% of total public water supplies in the south west and south respectively (Environment Agency 2006).

A significant proportion of rivers and lakes in the regions three RBDs (South East, South West and Thames) are at risk from degradation resulting from physical modification. Other pressures on these areas are from invasive non-native species, nitrate in surface and ground waters, point sources of pesticides and priority hazardous substances and changes in sediment characteristics. In the South West, mines and mine waters present a risk to 107 (~12%) of rivers in the catchment and also threatens groundwater and estuarine water quality, principally from a historical legacy of tin and copper mining associated with the West Devon and Cornwall mining landscape. The risk from abandoned mines declines in the east, with only 1% of rivers at risk of failing WFD objectives by 2015. Like the other RBDs described in Appendix 4d, abstraction pressures for public water supplies are likely to increase with the projected growth in population and requirement for housing.

In the SEA area, the South East has the greatest number of properties with a significant likelihood of flooding (1 in 75 for any given year). Areas within Greater London have more than 10,000 properties at risk, and areas of Sussex have between 7,500 and 10,000 properties at risk. Areas of West Sussex, Essex, Devon and Herefordshire have between 2,500 and 5,000 properties with significant likelihood of flooding each. In the west, Gloucestershire and Bristol have more than 10,000 properties at significant risk. When figures relating to low and moderate flooding risk are taken into account, the total number of properties at risk rises to over 1,000,000 for Greater London and over 600,000 properties in the South East England region. Greater London is included in the Thames Catchment Management Plan (Environment Agency 2007) and more detail relating to flood risk can at present be found in the consultation document and summary document for this region. The documents outline the main issues relating to flooding now and in the future (e.g. inappropriate floodplain development, the inability to provide engineering solutions for all properties, possible exacerbating factors derived from future climate change), and a strategic action plan which indicates what needs to be done to alleviate flood risk. The Thames Estuary 2100 (TE2100) project set up by the Environment Agency provides a plan to manage the flood risk in the Thames for the next 100 years (see: Lowe *et al.* 2009).

Climatic Factors

The South West received 1,247mm of rain a year over 154 days (1971-2000 average) with central and eastern parts of the region receiving 776mm a year over 120 days (1971-2000 average). December and January were the wettest months in the South West (about 151mm) with October and December in more central and eastern areas (about 86mm) (Met Office website).

The table below indicates the changes in temperature and precipitation projected in UKCP09 for UK areas which form parts of the Southern and South West England SEA area for the 2050s (2040-2069) under the medium emissions scenario.

Change in Mean Seasonal Figure	South East England	South West England
summer mean temperature	+2.7°C (+1.3-4.6°C)	+2.7°C (+1.3-4.6°C)
winter mean temperature	+2.2°C (+1.1-3.4°C)	+2.1°C (+1.1-3.2°C)
summer mean precipitation	-18% (-40-7%)	-19% (-41-7%)
winter mean precipitation	+16% (+2-36%)	+17% (+4-38%)

Note: figures are central estimates relative to a baseline of 1971-2000, with the 10th and 90th percentile probability estimates indicated in brackets
Source: Murphy et al. (2009)

Air Quality

In the south east, poor air quality is most frequently found in urban areas, especially Greater London and along the main transport corridors, particularly inland where air movement is less than along the coastline. To the west, air quality is generally good. There are 96 Air Quality Management Areas within the region where air quality standards may not meet requirements.

Population and Human Health

The collective population density for all the administrative areas in this SEA area is significantly larger than the national and English averages. The area of Greater London has the largest population density of any administrative area in the UK. Southampton and Bristol also have very high population densities, having the second and sixth highest density of any administrative area in the UK. The other principal population centres in the South and South West are Reading, Bournemouth, Portsmouth, Brighton and Torbay.

Life expectancy in the region is generally higher for both men and women than the English average. In comparison to the UK as a whole, a lower proportion of the region's population describe themselves as in "poor health" (7.1% in South East and 8.5% in South West, compared to UK average of 9.3%).

Material Assets

Oil and gas in the Wessex-Channel (including the Weald) Basin arises from the presence of both Triassic and Jurassic source and reservoir rocks. Production from the large Wytch Farm oilfield discovered in Dorset in the early 1970s has dominated onshore oil output. Ten other oil and gasfields have been subsequently discovered in the Wessex-Channel Basin, some of which (e.g. Humbly Grove, now a 10 billion cubic feet storage facility operated by Star Energy) are now depleting and being considered for underground gas storage purposes (DCLG 2006a). Oil and gas licensed areas are restricted largely to the south east and central parts of southern England with a couple of blocks adjacent to the Severn Estuary.

Coal is absent over much the region with small coal deposits at surface to 1,200m in the East Kent and Gloucestershire areas (DCLG 2006b). Coal was mined in East Kent until the 1980s and was deep-mined on a small scale in the Forest of Dean in Gloucestershire although no production was recorded for the year ending March 2008 (Coal Authority 2008).

Much of the region is classified as Grade 3 agricultural land with localised areas of Grade 1 or 2. There is a large extent of urban and non-agricultural land (often for military use) in the south east and along the south coast.

Cultural Heritage

Cultural heritage within the region is described in Appendix 4i. Aspects of cultural heritage receiving protection include 8 World Heritage sites (Westminster Palace, Westminster Abbey and Saint Margaret's Church; Tower of London; Royal Botanic Gardens, Kew; Maritime Greenwich; Canterbury Cathedral, St Augustine's Abbey, and St Martin's Church; Stonehenge, Avebury and Associated Sites; Dorset and East Devon Coast, and City of Bath). There are also approximately 7,800 scheduled monuments and around 700 historic parks and gardens.

4.3 Relevant Existing Environmental Problems

The SEA directive requires consideration of any existing environmental problems which are relevant to the plan or programme, particularly those areas of environmental importance such as those pursuant to directives 79/409/EC and 92/43/EC (the Birds and Habitats Directives).

The environmental problems described in Table 4.2 were identified during the preparation of the environmental baseline (Appendix 4) and were used to inform the selection of the SEA Objectives and Indicators outlined in section 3.2. The location of relevant supporting data is signposted throughout.

Table 4.2 – Environmental Problems Relevant to Onshore Oil and Gas Licensing

Problem	Supporting Data	Implications
Loss of biodiversity	The status of UK priority habitats and species in 2008 indicates that the decline of biodiversity is a major issue. For example, only 31% of the 45 priority habitats and 44% of the 391 priority species were judged to be stable, stable and probably increasing, or increasing, and of those that are stable, some may have populations well below what is recommended. **Further Information:** Appendix 4a. JNCC biodiversity indicators webpages, Defra (2008)	Ensure potential activities do not adversely affect biodiversity.
Unfavourable condition of certain habitat features	Over the period 1999-2005, the national conservation agencies carried out a programme of monitoring the designated features of SSSI, SACs, SPAs and Ramsar sites. 57% of A/SSSI sites were reported in favourable condition, with 37% of SACs, 86% of Ramsars and 73% of SPAs reported as favourable. Conservation features which were least favourable were often impacted by factors which operated outside the sites on which they were designated (e.g. drainage conditions for some isolated wetlands, pollution) and which require concerted effort by many agencies (e.g. water quality affecting fish). **Further Information:** Appendix 4a, Williams (2006)	Ensure potential activities do not adversely affect the status of conservation features.
Legacy of mineral extraction activities	Mining activities in all of the SEA regions have left a legacy of hazards such as landslips, subsidence, contamination of ground and surface water sources from metals such as tin, copper and arsenic, and radon	Ensure oil and gas activities do not exacerbate these problems.

Problem	Supporting Data	Implications
	gas and flooding. **Further Information:** Appendix 4b and 4d.	
Changes to river form and sediment loads	River Basin Plans prepared by the Environment Agency and the Scottish Environment Protection Agency, identify that changes to the sediment load and sediment characteristics of surface waters are an issue which can reduce the viability of certain stretches of river for fish spawning, damage fish gills, suppress photosynthesis and damage river bed fauna on which fish prey. Changes to the physical morphology of rivers including straightening and the imposition of weirs can be detrimental to riverine fauna. **Further Information:** Appendix 4d, Environment Agency (2009d-w), Environment Agency & SEPA (2009), SEPA (2009a, b)	Ensure activities are not detrimental to river form or river sediment dynamics.
Flood risk	The Flood Directive (2007/60/EC) was transposed into UK law in the form of the Flood and Water Management Act 2010 (England & Wales) and the Flood Risk Management (Scotland) Act 2009. The Directive requires the production of flood hazard maps and flood management plans. The Environment Agency has completed consulting on Catchment Flood Management Plans (CFMPs) in England and Wales, with half of these complete, and the other half still in draft form. Moreover, at the local authority level, Strategic Flood Risk Assessments are completed in line with PPS25: Development and Flood Risk. In addition, those blocks occurring at or near the coast may be subject to coastal erosion issues or flooding from storm-surges. Shoreline Management Plans (In England and Wales) are taking a long term view of coastal issues by identifying sustainable management approaches for up to the next 100 years. **Further Information**: Appendix 4d, Environment Agency (2009b), Environment Agency Wales (2009a), Environment Agency CFMP webpage.	Ensure that operators are aware of flood risks in relation to any proposed sites/activities, and that activities to not generate or exacerbate flood risk.
Abstraction and artificial flow in rivers	Many rivers, surface water bodies and associated habitats rely on groundwater effluent flow to supplement water supply. In some areas abstraction and poor flow regulation has placed pressure on habitats and species, recognised as a threat to numerous SPA and SAC sites. (e.g. Rivers Tweed and Tay [SEA area 1], Pasturefields Salt Marsh [SEA area 2], River Wensum and Waveney and Little Ouse Valley Fens [SEA area 3], River Usk/Afon Wysg, River Dee and Bala Lake/ Afon Dyfrdwy a Llyn Tegid [SEA area 4], River Itchen [SEA area 5]). Abstraction pressures are recognised in Catchment Abstraction Management Strategies for England and Wales, and by water providers in their respective Water Resource Management Plans.	Ensure that any abstraction associated with activities does not detrimentally affect river flow or groundwater regimes.

Problem	Supporting Data	Implications
	Further Information: Appendix 4d, Environment Agency (2009d-w), Environment Agency & SEPA (2009), SEPA (2009a, b)	
Changes to landscape character	As part of the most recent Countryside Quality Counts (2007) survey, 29% of National Character Areas in England were identified as having a changing landscape character, many of which were altering in a direction which could be regarded as inconsistent with the traditional landscape vernacular of the area. A similar study of landscape change is not available for Scotland or Wales, though changes have undoubtedly taken place in areas relevant to the SEA in these countries also. **Further Information:** Appendix 4c, Countryside Quality Counts (2007).	Seek design solutions and appropriate siting to minimise landscape impacts of any potential developments. Ensure careful and appropriate landscaping following decommissioning.
Loss of previously undeveloped land to development	The loss of previously undeveloped areas to new developments (domestic/domestic conversions, extensions and commercial/industrial building) has reduced in England and Wales in recent years, with 61% of new developments built in 2005 being on previously developed land (77% for domestic dwellings). **Further Information:** Appendix 4c, Communities and Local Government (2009).	Ensure that land take as part of the development may be returned to its former use.
Loss of soil organic matter, erosion/structural degradation and agricultural productivity	The loss of soil organic matter and its structural degradation through compaction and erosion are issues which affect the soil resource. Some soil types are more prone to erosion than others, particularly when left without a vegetation cover. **Further Information:** Appendix 4b, Environment Agency (2004), Towers *et al.* (2006), Scottish Executive (2008b)	Avoid areas of high agricultural productivity. Ensure good site design and management minimises soil losses.
Noise Pollution	High levels of ambient noise are already found in many areas of the UK particularly in the vicinity of major roads, urban and industrial areas, and 'tranquil' areas appear to have reduced considerably over the last 30-40 years. The Environmental Noise Directive (END) 2002/49/EC, transposed into UK law in the Environmental Noise Regulations 2006, is concerned with noise from roads, rail, air traffic and industry. The directive requires that member states determine the exposure of the public to noise and its potential effects through the use of noise mapping. Using these maps, action plans are required to manage any noise issues and reduce them if necessary; the directive also requires the maintenance of good noise quality where it exists. **Further Information:** Appendix 4g, the Defra, Scottish and Welsh Assembly Noise Mapping websites, The Noise Policy Statement for England (2010).	Seek design solutions and appropriate siting to ensure that noise generated throughout the lifetime of any potential development is minimised.

Problem	Supporting Data	Implications
Light Pollution	Light pollution appears to have increased considerably over the last 30-40 years over much of the UK. The growth of urban areas, road networks and industrial areas are all major contributors to increased light levels. **Further Information:** Appendix 4c, CPRE website, ODPM (1997)	Seek design solutions and appropriate siting to ensure that light emissions are minimised without compromising safety.
Emission of greenhouse gasses and climate change	In recent years, anthropogenic and natural drivers of climatic have become an increasing focus of study due to concern over the potential impacts of any undesirable climatic change. The input of greenhouse gasses (e.g. CO_2, CH_4, N_2O, O_3) resulting from fossil fuel usage, agriculture and other land use, is of particular concern as these have been linked with atmospheric warming. Though UK CO_2 emissions have declined to ~8% below 1990 levels (at 2007), they are still the largest (544 million tonnes in 2007) at 85% of all greenhouse gas emissions. Fossil fuel dependency remains high (~90% in 2007) and is likely to remain so for some time. Legally binding EU and government targets (see: the Climate Change Act 2008 and subsequent revisions: The Climate Change Act 2008 (2020 Target, Credit Limit and Definitions) Order 2009, The Carbon Budgets Order 2009) seek to reduce emissions (based on a carbon budget of $MtCO_2$ equivalent) by 80% on 1990 levels by 2050, with an interim target of 34% by 2020. **Further Information:** Jenkins *et al.* (2009), Murphy *et al.* (2009), IPCC (2007a, b), Hulme *et al*. (2002), BERR (2008), DECC (2009e)	Minimise/recycle atmospheric emissions during extraction and production activities. Ensure the limited oil and gas production likely to result from licensing is part of a diverse range of energy sources including renewables.
Poor Air Quality and Health	Poor air quality is generally associated with urban/industrial areas and major road infrastructure. A relatively large number of Air Quality Management Areas are located in each SEA area, particularly in urban areas, many of which have been designated due to high PM_{10} levels. **Further Information:** Appendix 4e, UK Air Quality Archive, Defra (2009)	Minimise atmospheric emissions and contribute to achievement of local air quality management plans.
Environmental inequality	Initial work on an 'environmental inequality' indicator by Defra generally indicates that those most deprived areas in England may also experience one or more environmental conditions which are in relative terms 'least favourable' compared to less deprived areas for data spanning 2001-2006. Less than 0.5% of the population in the least deprived areas experience 3 or more environmental conditions that are 'least favourable', rising to ~22% in the most deprived areas. **Further Information:** Appendix 4g, Defra (2009e).	Ensure that, in addition to general considerations to do with landscape, noise and light pollution, that cumulative impacts do not allow an unacceptable level of development.
Atmospheric deposition of pollutants	High deposits of both sulphur and nitrogen are found where rainfall is highest, such as northern England and the Welsh uplands. Naturally acidic soils, (i.e. areas with a poor acid neutralising capacity), are more	Minimise atmospheric emissions of acidifying pollutants.

Problem	Supporting Data	Implications
	sensitive to acidic deposits. Around a third of the UK land area is sensitive to acid deposition, and a third to eutrophication (with some sensitive to both). In 1996, the percentage of sensitive habitat area where acid deposited exceeded critical loads was 73%. Between 2000 and 2005 this declined from 60 to 58%. The percentage of sensitive habitat area subject to critical loads of nitrogen pollution remained at 59% between 2000 and 2004, though showed an increase to 61% in 2005. **Further Information:** Appendix 4e, CEH (2007), WAG (2009a)	
Physical damage to historic monuments and their setting	English Heritage presents a 'high risk' baseline figure of 22% (a further 33% are at medium risk) in the 2008 Heritage Counts report. Figures were compiled on a regional basis as part of the *Scheduled Monuments at Risk* project, piloted in the East Midlands in 2002, revealing that 35% of the 1,500 monuments in the region were at risk (English Heritage 2005). This work builds on the previous *Monuments at Risk* (MARS) project of 1998, which revealed that since 1945 agriculture had been the largest contributor to unrecorded loss of archaeological sites (see: Appendix A4b for details on soil and cultural heritage), with agriculture currently posing risk to 19% of monuments, primarily through ploughing (English Heritage 2008a). A further 34% of monuments were at risk due to natural phenomenon such as unmanaged tree and shrub growth or animal burrowing (English Heritage 2008a). This indicator is likely to develop further in subsequent years as the condition of sites is monitored. In Wales, Cadw has monitored and collected condition data on all statutorily protected monuments on a five year programme since 1985-86, resulting in three condition reports, the fourth of which is due in 2009. The 2007 historic position statement (Cadw 2008) contains data which is used to compare figures for 1996 and 2003, which shows a slight increase in stable and improved monuments, but a persistence in the level of disturbed features, ranging from destroyed (0.13% in 2003) to superficially disturbed (7% in 2003 – mainly accounted for by the growth of invasive vegetation and scrub encroachment, probably due to less intensive agriculture). **Further Information:** Appendix 4i, Appendix 4b, English Heritage (2005, 2008a, 2009), Cadw (2007).	Ensure assessment of archaeological resource at project specific stage and subsequent monitoring during exploration, development and production stages.

4.4 Likely Evolution of the Baseline

For this SEA, the evolution of the environmental baseline in recent years has been assessed in relation to certain indicators used in the UK Government's Sustainable Development Strategy of relevance to the draft plan/programme. These indicators and the direction of

change (i.e. negative, neutral, positive) are indicated in Table 4.3, and their status and trends have been used to describe the likely evolution of the baseline in the absence of the draft plan/programme in Table 4.4.

The latest (and previous) versions of the UK Government Sustainable Development indicator updates represent the change in condition of each indicator relevant to its base year using a 'traffic light' system.

✓	-	clear improvement in status or increasing trend since base year
×	-	clear deterioration in status or decreasing trend since base year
~	-	little or no change since base year
-	-	insufficient or no comparable data

In addition to the standard suite of government sustainable development indicators, a number of additional indicators have been adopted to complement this approach which provide supplementary relevant context to the evolution of the baseline, and these are clearly indicated in Table 4.3. Where each of these indicators diverged by 3% in either a positive or negative direction from the base year, it was attributed an appropriate traffic light, which is consistent with the method used by Defra in producing its own traffic light results, though they do vary the this depending on the nature of the indicator (Defra sustainable development in government website).

These traffic lights should be read in conjunction with the appropriate environmental baseline section (Appendix 4) and narrative in Table 4.4, as they cannot, by their nature, represent the full range of trends in any dataset. In order to partly account for this, two traffic light systems are adopted in Table 4.3 as per Defra (2009e), one showing the net change over the medium-term (usually the entire range of data available) and one showing the recent change (e.g. since 2000). Where possible, results for the three relevant administrations (England, Scotland and Wales) are also presented. For some contextual indicators, there is no appropriate data with which to apply the traffic light system.

Table 4.3 – Indicators Used to Aid the Assessment of the Evolution of the Baseline

#	Indicator	Medium-term change		Recent change					Appendix
		Data range		Base year	UK	England	Scotland	Wales	
1	**Bird Populations***								A4a: Biodiversity, habitats, flora & fauna
	Farmland	1970-2008	×	2000	×	~	✓	×	
	Woodland	1970-2008	×	2000	✓	~	✓	×	
	Coastal (seabird)	1970-2008	✓	2000	×	~	×	-	
	Wintering waterbirds	1975/6-2007/8	✓	2000	×	-	✓	-	
	Breeding water and wetland birds	1975-2008	~	2000	~	✓	-	-	
2	**Butterfly populations**								
	Semi-natural habitat specialists	1976-2009	×	2000	~	-	×	-	
	Generalist species of the wider countryside	1976-2009	~	2000	~	-	~	-	
3	**Bat populations**	1978-1992‡	×	2000	✓**	-	-	-	
4	**Biodiversity**								
	BAP priority species	1999-2008	-	1999	✓	-	-	✓$_{2002}$	
	BAP priority habitats	1999-2008	-	1999	~	-	-	~$_{2002}$	
5	**Condition of species and habitats†**	-	-	-	-	-	-	-	
6	**Condition of earth science features†**	-	-	-	-	-	-	-	4b: Geology & Soils
7	**Soil condition and threats†**								
	Loss of soil organic matter (England & Wales)†	1978-2003	×	-	-	-	-	-	
	Loss of agricultural land to development (Scotland) †	1971-2003	~	1999	-	-	×	-	
	Loss of soil to development (England & Wales)†	1995-2006	✓	2000	-	✓	-	✓	

#	Indicator	Medium-term change		Recent change					Appendix
		Data range		Base year	UK	England	Scotland	Wales	
8	**Changes to landscape character (England)†**	1990-2003	✓	-	-	-	-	-	**4c: Landscape**
9	**Tranquil areas (England)†**	2007	×	-	-	×	-	-	
	Tranquil areas (Wales)†	1997-2009	×	-	-	-	-	×	
10	**Light Pollution†**	1993-2000	×	1993	×	×	×	×	
	River Quality*								**4d: Water Environment**
11	*Biological*	1990-2007	✓	2003	~	-	~2000	✓2000	
	Chemical	1990-2007	✓	2003	✓	-		~2000	
	Water Resource Use								
12	*Total abstractions from surface and groundwater*	1971-2006	✓	1999	-	-	-	✓2001	
	Leakage losses	1992-2008	✓	1999	-	-	-	✓2001	
13	**Public water yield and demand (Scotland)†**	1981-2006	✓	1999	-	-	~	-	
14	**Water stress**	-	-	-	-	-	-	-	
15	**Bathing Waters†**	1990-2008	✓	1999	-	✓	✓	✓	
	Emissions of air pollutants								**4e: Air Quality**
16	*HN_3, NO_x, SO_2*	1990-2007	✓	2003	✓				
	PM_{10}	1990-2007	✓	2003	~				
	Ecological Impacts of air pollutants								
17	*Area affected by acidity**	1996-2005	✓	2003	~	-	-	~1999	
	*Area affected by nitrogen**	1996-2005	✓	2003	~	-	-	×1999	
18	**Air quality and health**								

#	Indicator	Medium-term change		Recent change					Appendix
		Data range		Base year	UK	England	Scotland	Wales	
	PM_{10} concentrations (roadside)	1997-2008	✓	2003	✓	-	-	-	
	PM_{10} concentrations (urban)	1993-2008	✓	2003	✓	-	-	-	
	Rural ozone concentrations	1990-2008	~	2003	~	-	-	-	
	Urban ozone concentrations	1992-2008	×	2003	×	-	-	-	
19	**Greenhouse gas emissions***	1990-2008	✓	2003	✓	-	✓	✓	4f: Climatic Factors
	CO_2 emissions	1990-2008	✓	2003	✓	-	×2005	✓2000	
20	**Carbon dioxide emissions by end user***								
	Industry	1990-2007	✓	2003	~	-	-	-	
	Domestic	1990-2007	✓	2003	✓	-	-	-	
	Transport	1990-2007	×	2003	~	-	-	-	
21	**Electricity generation**								
	Electricity consumption	1990-2007	×	2003	~	-	-	-	
	fossil fuels used	1990-2007	×	2003	×				
	CO_2 emissions	1990-2007	✓	2003	✓	-	-	-	
	NO_x emissions	1990-2007	✓	2003	~	-	-	-	
	SO_2 emissions	1990-2007	✓	2003	✓	-	-	-	
22	**Renewable energy**	1989-2008	✓	2003	✓	-	-	✓2000	
23	**Demography**	-	-	-	-	-	-	-	Population & Human
24	**Life expectancy at birth (men and women)***	1981-2005	✓	2003	~	-	~	~	
25	**General health**	-	-	-	-	-	-	-	
26	**Environmental Equality***	-	-	-	-	-	-	-	

#	Indicator	Medium-term change		Recent change					Appendix
		Data range		Base year	UK	England	Scotland	Wales	
27	**Air quality and health**								
	Annual levels of particulates and ozone (see above)	-	-	-	-	-	-	-	
	Days when air pollution is moderate or higher (rural)	1989-2009	~	1999	~	-	-	✓	
	Days when air pollution is moderate or higher (urban)	1989-2009	✓	1999	~	-	-	✓	
	Noise pollution†	-	-	-	-	-	-	-	
28	**Onshore crude oil production†**	1998-2008	×	1999	×	-	-	-	4h: Material Assets
29	**Onshore gas production†**	1998-2008	×	1999	×	-	-	-	
30	**Coal production†**	1970-2009	×	1999	×	-	-	-	
31	**Fossil fuel dependency†**	1970-2007	×	1999	×	-	-	-	
32	**Energy supply**	1995-2008	×	1999	×	-	-	-	
33	**Land use**								
	Agricultural land use	-	-	-	-	-	-	-	
	Land recycling	1990-2008	✓	2003	-	✓	-	✓	
34	**Number of designated heritage assets†**								4i: Cultural Heritage
	Number of scheduled ancient monuments†	2003-2008	~	2003	-	~	-	-	
	Number of listed buildings†	2003-2008	~	2003	-	~	-	-	
35	**Historic Environment at Risk†**								
	Percentage of grade I and II buildings at risk†	1999-2009	~	1999	-	~	-	-	
	Monuments at high risk (England) †	1999-2009	✓	1999	-	✓	-	-	

Note: The species considered in the analysis of bird, butterfly and bat population change is provided in Appendix 4a.
**signifies a framework indicator – those shared by the UK Government and the devolved administrations. **This change reflects those of all the bat species (6) included in the indicator from 1999-2009. ***Figures are for 1990-2006.*
†indicates an additional indicator out with those of the UK government sustainable development strategy. ‡This data range for bat populations represents a contextual long-term estimate for pipistrelle.

Table 4.4 – Current State and Trends, and the Likely Evolution of the Environmental Baseline

Biodiversity, Habitats, Flora and Fauna
Wild Bird Populations
The sustainable development indicator data for wild bird populations extends back to 1970. The current (2008) farmland bird measure is ~53% relative to its 1970 figure, with its steepest decline recorded in the 1980s, principally associated with species which are strongly associated or restricted to farmland (specialists). There has been a slight increase in numbers for 2008. Generalist species (e.g. wood pigeon, rook) have remained largely stable, though the yellow wagtail has declined by ~50% on its 1970 level. Most of the specialist species (9 of 12) have declined by at least 50% since 1970, with tree sparrow and turtle dove recording levels at less than 10% of 1970 figures. Woodland birds have also declined since 1970 with a similar disparity between generalist and specialist species. Generalist species (great tit, long-tailed tit and wren) have almost doubled since 1970, whereas specialists (including: capercaillie, lesser spotted woodpecker, marsh and willow tit, pied and spotted flycatcher, tree pipit, lesser redpoll, nightingale and wood warbler) have declined by more than 50%. Seabird populations have, in the medium-term, had a net increase in population since 1970, peaking in 1997, though in recent years populations have declined to 27% above 1970 levels in 2008. Within this measure individual species measures vary greatly. Herring gull populations are nearly a third of those in 1970, whereas great-skuas have increased four-fold over the same period. Arctic skuas have declined by 70% in the last 14 years. The breeding waterbird population index shows sharp inter-annual fluctuations, at present being 1% higher than the 1975 baseline, though there has been little change since 2000. There has been a general decline in yellow wagtail, snipe and reed bunting since 1975, whilst Cetti's warbler, little egret and goosander saw increases in their numbers. Wintering waterbird populations increased in the 1970s, 80s and 90s to reach 68% above the 1975 baseline in 1996/97. There has been a recent decline in wintering waterbird populations in the UK (mainly ducks, geese and swans) of 7% since the winter of 2000-1. The indicator in 2007-8 is still at 88 per cent above its 1975-6 baseline. **Further Information:** Appendix 4a, JNCC biodiversity indicators webpages, WAG (2008, 2009b)
Butterfly Populations
The UK Government indicator shows wide inter-annual fluctuations in populations, which is typical of butterflies. An assessment of the trends underlying this data by Butterfly Conservation and the Centre for Ecology and Hydrology indicates little or no change in the period of 1976 to 2009. Habitat specialists have not recovered from declines due to drought conditions in the 1970s. Though the measure has declined 69% between 1976 and 2009, statistically significant change is mainly isolated to 1976-78. Similarly, generalist populations have fallen 18% between 1976 and 2009, though in the long-term, the underlying trend shows no significant overall change because of the apparent propensity for random fluctuations in the data. **Further Information:** Appendix 4a, JNCC biodiversity indicators webpages
Bat Populations
Overall, bat populations have declined in the medium-term (1978-1992), though in the last 10 years, the sustainable development indicator data shows a generally positive change, probably brought about by increased legal protection and direct conservation action. The significant increase in lesser horseshoe bat underpins the rise in the index, both attributed to conservation measures and mild winters. The 2008 increase in the indicator is influenced by high counts of noctules in the National Bat Monitoring Programme (NBMP) field survey. Bats, like many wild fauna and flora, are vulnerable to landscape change, agricultural intensification, development and habitat fragmentation.

Further Information: Appendix 4a, JNCC biodiversity indicators webpages

Biodiversity Action Plan: Habitats and Species

The UK measure of BAP species (1999-2008), indicated that the number of species assessed as stable or increasing had risen from 202 to 214 (an increase of 3.5%), while the number recorded as declining or lost fell from 137 to 125. Despite this modest improvement, the number of species assessed as 'increasing' has fallen from 48 to 45. 89 are still declining and 6 have been lost from the UK since 1994. In Scotland (2005), 50% of species are identified as stable or increasing and 14% are considered to be in decline. In Wales (2002-2005), the number of BAP species which were stable or increasing rose from 22% to 34%. The number of declining species remained at 18%.

Based on a comparison of the earliest available and most recent assessment for each BAP habitat (1999-2008), the number either 'stable' or 'increasing' in area has fallen from 21 to 20 (2.5% of the known habitats). 15 priority habitats (44%) are still declining in extent. In Scotland in 2005, 33% of those habitats considered were stable or increasing, while 30% were in decline. In Wales (2002-2005), 36% of priority habitats were stable or increasing compared to 30% in 2002. The proportion of habitats in decline has increased from 46% (2002) to 59% (2005).

Further Information: Appendix 4a, JNCC biodiversity indicators webpages, UKBAP website, WAG (2008, 2009b), Scottish Executive (2008)

Geology and Soils

Geological Earth Science Features

The JNCC Common Standards Monitoring for designated sites and features has outlined that for a number of designated geological sites (2,242), ~88% are in a favourable or unfavourable/recovering condition, with many features considered unfavourable as their features are obscured. Many categories of geological feature (rock sequences, volcanic rocks, folds, faults and rock movements) can be regarded as relatively stable, being highly robust. Others, including glacial and fluvial sedimentary and dynamic landforms are likely to be more susceptible to reworking and anthropogenic influence, or are by definition almost continually changing due to natural influences.

Further information: Appendix 4b, Williams (2006)

Soil Condition

The range of soil types that exist in the UK and their distribution are ultimately a result of differences in climate, geography/topography and geology which have existed during their accumulation in (almost exclusively) the Holocene (*ca.* last 10,000 years). A number of threats to soil integrity (i.e. the continued provision of soil services and processes) have been identified and include:

- Loss of soil organic matter and erosion
- Climate change
- Loss of soil biodiversity
- Structural degradation and compaction
- Contamination
- Loss of soil to development (e.g. soil sealing), including urbanisation and agriculture
- Threat to soil as a cultural resource (e.g. archaeological protection and UK environmental records)

Many of these issues are being dealt with through the promotion of good agricultural practise (e.g. not leaving soil bare in winter months), targets to build at least 60% of homes on previously developed land and existing environmental regulation concerning the control of certain activities likely to generate pollution.

Further information: Appendix 4b, Environment Agency (2004), Davidson & Wilson (2006), Towers *et al.* (2006)

Landscape

A comparison of results from the previous (1990-1998) and most recent (1999-2003) CQC landscape character study revealed that National Character Areas (NCAs) with a pattern of change which could be

described as maintained or enhanced has increased from 36% to 61%. Some of this change may be to do with a refinement in assessment methodology. 42 out of 100 NCAs which displayed changes inconsistent with landscape character between 1990 and 1998, showed a slowing or reversal of this degradation in the years leading up to 2003 – these areas were mainly in central and southern England. Those areas which did not show a recovery are mainly to be found in the West-Midlands, Yorkshire, the Humberside Region and North West.

Those areas of the UK landscape which are considered exceptional for their natural or cultural qualities are afforded protection and/or consideration through statutory and non statutory designations from developments which would be detrimental to their character. Out with these areas, and more generally as urbanisation and routeway expansion continues, it is reasonable to expect that light pollution may increase, with a corresponding decrease in the overall measure of 'tranquillity'.

Further information: Appendix 4c, SNH (2002e), the Landscape Character Series of Scotland, CQC (2007), Environment Agency National Character Areas, Campaign to Protect Rural England, Landscape Character Map for Wales

Water Environment

The condition of the surface water environment (biological and chemical) in the UK has been generally improving in recent years in part due to the implementation of legislation to protect the water environment (and wider environment in general in the case of emissions to air) from pollutants (point, and diffuse, e.g. sheep dip, pesticides, sediment changes) which may detrimentally affect habitats and associated species. Water environments face a number of other pressures which include over abstraction, associated with the requirement for water from surface water and groundwater sources (particularly in the south and south east) and physical modification. Other existing pressures come from invasive non-native species (e.g. signal crayfish, mink and zebra mussel) and recreation related disturbance. With the implementation of the Water Framework Directive (2000/60/EC), daughter directives (Groundwater Directive, Priority Substances Directive) and associated UK legislation, improved and holistic management of river basins is likely to continue to improve the physical, chemical and biological quality of surface and ground waters. The management of air quality (see below) will also directly affect the quality of the water environment through reduced deposition of pollutants which may lead to eutrophication and acidification.

Further information: Appendix 4d, MacDonald *et al.* (2004), SNIFFER (2004), Environment Agency (2006), Environment Agency (2009d-w)

Air Quality

Air quality is spatially variable, with quality generally increasing to the north and west where industrial development is sparser and population centres are smaller and more dispersed. Air quality is likely to improve as a corollary to a push in the reduction of emissions set out in the Ambient Air Quality and Cleaner Air for Europe Directive (2008/50/EC) and its implementation in UK law. Increased renewable energy use and improved efficiency in conventional transport methods (e.g. diesel engines) are likely to make substantial contributions to key emissions associated with environmental and human health issues.

Further information: Appendix 4e, Defra (2007), National Atmospheric Emissions Inventory, UK Air Quality Archive

Climatic Factors

The UK is presently influenced by predominantly westerly tracking storm systems throughout the year. Variations in temperature, precipitation and wind speeds may be partly accounted for by exposure, latitude and altitude. The surrounding seas also have a significant effect on the national and local weather conditions. The temperatures of air masses reaching the UK have been modified by the ocean such that the UK tends to experience lower summer temperatures than mainland Europe, but milder winters. In the recent past, the Central England Temperature has risen ~1°C since 1970 (probably anthropogenically augmented), and Scottish temperatures have risen 0.8°C since the 1980 (not necessarily anthropogenic). Future trajectories are uncertain, but UK specific scenarios based on current information are presented in the most recent (UKCP09) work by the UK Climate Impacts Programme (UKCIP).

Further information: Appendix 4f, Hulme *et al.* (2002), IPCC (2007), Met Office (2007), MCCIP (2008), Jenkins *et al.* (2009), Murphy *et al.* (2009).

Population and Human Health

The population density and human health of the UK is unlikely to change considerably in the near future. In the UK as a whole, population increased by 4.4% from 1996-2006 and is expected to increase by a further 7.3% in the years leading up to 2016, with growth being most significant in the East Midlands, East of England, Yorkshire and the Humber (SEA area 3), South West and London (SEA area 5). Scotland (SEA area 1) has the lowest projected percentage population change to 2016.

Further information: Appendix 4g, Office for National Statistics (ONS) mid-2008 population estimates, 2001 Census

Material Assets

Those areas of the UK in which oil and gas production is prospective are determined by geological history and are relatively well known. The production of onshore oil, gas and coal has declined at least over the last 10 years and now represents a small proportion of the total UK energy supply. In some areas, by the nature of oil and gas production, reserves are likely to become depleted. There are still estimated to be exploitable hydrocarbon resources in the landward UK which are commercially viable. Increased pressure is being exerted for the UK to have a greater security of supply through a lower dependence on fuel imports, though this position is threatened by the closure of a number of older nuclear and coal power plants by 2015 under European environmental legislation and a growth in gas-fired power stations. UK onshore production may help to reduce import dependence. In addition, the UK currently has only a small percentage of its gas supply in storage (~4%, equivalent to 14 days), and it is possible that that depleted onshore reservoirs will start to be increasingly used for gas storage. In order to meet CO_2 reduction targets and secure the UK energy supply, significant (up to £200 billion) investment may be required over the next 10-15 years.

Further information: Appendix 4h, DTI (2003), DCLG (2006a, b), Ofgem (2009)

Cultural Heritage

The cultural heritage of UK extends back into the Palaeolithic period (up to *ca.* 500,000 BP), though most archaeological sites are from the Mesolithic and later periods. The continuum of material which has to date been catalogued for the SEA areas and which are scheduled as ancient monuments extends to over 19,000 sites. Scheduling of monuments is the principal form of protection for archaeological sites, and for later architectural structures, listing (of differing grades) seeks to protect the integrity of notable structures from certain periods. The number of reported monuments has been increasing gradually as development and academic led investigations uncover new material.

English Heritage presents a 'high risk' baseline figure of 22% (a further 33% are at medium risk) in the 2008 Heritage Counts report. Figures were compiled on a regional basis as part of the *Scheduled Monuments at Risk* project, piloted in the East Midlands in 2002, revealing that 35% of the 1,500 monuments in the region were at risk (English Heritage 2005). This work builds on the previous *Monuments at Risk* (MARS) project of 1998, which revealed that since 1945 agriculture had been the largest contributor to unrecorded loss of archaeological sites (see: Appendix A4b for details on soil and cultural heritage), with agriculture currently posing risk to 19% of monuments, primarily through ploughing (English Heritage 2008a). A further 34% of monuments were at risk due to natural phenomenon such as unmanaged tree and shrub growth or animal burrowing (English Heritage 2008a) This indicator is likely to develop further in subsequent years as the condition of sites is monitored.

In Wales, Cadw has monitored and collected condition data on all statutorily protected monuments on a five year programme since 1985-86, resulting in three condition reports, the fourth of which is due in 2009. The 2007 historic position statement (Cadw 2008) contains data which is used to compare figures for 1996 and 2003, which shows a slight increase in stable and improved monuments, but a persistence in the level of disturbed features, ranging from destroyed (0.13% in 2003) to superficially disturbed (7% in 2003 – mainly accounted for by the growth of invasive vegetation and scrub encroachment, probably due to less intensive agriculture).

Further information: Appendix 4i, Davidson & Wilson (2006), Historic Scotland (2007), Cadw (2008), English Heritage (2008a)

5 SUMMARY OF ASSESSMENT

5.1 Introduction

The assessment is fully documented in Appendix 5 and a summary is provided below. Potential short, medium and long-term effects, permanent and temporary, positive and negative effects, and secondary, cumulative and synergistic effects of activities associated with the implementation of the draft plan are considered for: Conventional Oil and Gas (COG), Virgin Coal Bed Methane (VCBM) and Gas Storage (GS).

5.2 Potential Activities Following the Adoption of the Draft Plan/Programme

Potential activities which could follow on from the licensing round would be subject to strict regulatory control and mitigation (see: Appendix 2). Those activities which are considered to pose possible environmental issues are shown in Table 5.1.

Table 5.1 – Likely Activities and their Association with Types of Development Relevant to the Draft Plan/Programme

Broad Activity	COG	VCBM	GS	Stage in life of development
Vibroseis				**Seismic survey**
Shot hole				
Exploration wellsite construction				**Exploration and appraisal**
Exploration drilling				
Disposal of mud and cuttings				
Well test & clean-up				
Hydrofracing and de-watering				
Construction of production installations/pipelines				**Development and production**
Development drilling				
Production operations				
Storage operations				
Decommissioning				**Decommissioning**

Note: COG=Conventional Oil and Gas, VCBM=Virgin Coal bed Methane, GS=Gas Storage

The tables (Table 5.2-Table 5.5) on the following pages summarise the consideration of the relative impact magnitude and duration of activities associated with COG, VCBM and GS activities judged against the SEA objectives set out in section 3.2. The following key has been used to qualitatively categorise the nature of the predicted effects (after ODPM 2005):

Magnitude of effect

++	Activity would have a major positive effect
+	Activity would have a minor positive effect
O	Activity would have a neutral effect
-	Activity would have a minor negative effect
--	Activity would have a major negative effect

Duration of effect

S	Effects would be short term
M	Effects would be medium term
L	Effects would be long term
P	Effects would be permanent

Only where an effect is scored as 'major positive' or 'major negative' is it considered to be significant. A further summary of the SEA Assessment made against the SEA objectives is shown in Table 5.7.

5.2.1 Nearshore 'Watery' Areas

This SEA also includes the nearshore "watery" areas of the Forth and Dee as described in section 4 above – also see regulation 3(1) of Schedule 1, The Petroleum (Production) (Seaward Areas) Regulations 1988. The sensitivities (also described earlier) include a number of SPA and SAC sites concerned with the protection of intertidal habitats used by nationally and internationally important numbers of wintering, breeding and on-passage birds, and anadromous species including the salmon and sea lamprey.

There are several conditions relating to operations in these areas which limit the potential environmental impact on the marine or nearshore environment:

- These areas are only concerned with the extraction of VCBM
- Drilling rigs or other exploratory, appraisal or development equipment will be restricted to landward areas (i.e. above the low water line)
- No marine activities will be associated with any development which require directional drilling into watery areas

The impact of such developments in these nearshore areas is somewhat precluded by the lack of any marine activities. Areas close to the shore may be subject to those activities shown above, and described in more detail in Appendix 5, for VCBM exploration and production, and are subject to the same local planning controls and landward permitting regimes as any onshore development (see Appendix 2).

Table 5.2 – Relative Impact Magnitude Summary Table for COG Operations

Activity	Biodiversity, habitats, flora and fauna	Geology and soil	Landscape	Water environment	Air quality and climatic factors	Population and human health	Material assets	Cultural heritage
Impact Magnitude								
Vibroseis	o -	o	o	o	o	o	o	o
Shot hole	o -	o	o	o	o	o	o	o
Exploration wellsite construction	-	-	-	o	o -	o -	o	o
Exploration drilling	o -	o	-	o	o -	o -	o	o
Disposal of mud and cuttings	- --	o	o -	o	o -	o	o -	o
Well test and clean-up	o	o	o -	o	o -	o	o	o
Hydrofracing and de-watering	o	o	o	-	o -	o	o	o
Construction of production installations/pipelines	- --	-	-	o	o -	o -	o	o
Development drilling and production operations	-	o	-	-	o -	o -	o	o
Decommissioning	-	-	-	o	o	o	o	o

Table 5.3 – Relative Impact Duration Summary Table for COG Operations

Activity	Biodiversity, habitats, flora and fauna	Geology and soil	Landscape	Water environment	Air quality and climatic factors	Population and human health	Material assets	Cultural heritage
Impact Duration								
Vibroseis	S		S	-	-	-	-	-
Shot hole	S M		S	-	-	-	-	-
Exploration wellsite construction	S L	S M	S M	-	S M	S M	-	-
Exploration drilling	S M	-	S	-	S M	S M	-	-
Disposal of mud and cuttings	S M	-	S M	-	S M	-	S M	-
Well test and clean-up	-	-	S	-	S M	-	-	
Hydrofracing and de-watering	-	-	-	M L	S M	-	-	-
Construction of production installations/pipelines	M	S M	S M	-	S M	S M	-	-
Development drilling and production operations	M L	-	M L	M L	M L	M L	-	-
Decommissioning	M L	S M	S M	-	-	-	-	-

Table 5.4 – Relative Impact Magnitude and Duration Summary Table for VCBM Operations

Activity	Biodiversity, habitats, flora and fauna	Geology and soil	Landscape	Water environment	Air quality and climatic factors	Population and human health	Material assets	Cultural heritage
Impact Magnitude								
Exploration wellsite construction	-	-	-	O	O -	O -	O	O
Exploration drilling	O -	O	-	O	O -	O -	O	O
Hydrofracing and de-watering	O	O	O	-	O -	O	O	O
Construction of production installations/pipelines	- --	-	-	O	O -	O -	O	O
Production operations	-	O	-	-	O -	O -	O	O
Decommissioning	-	-	-	O	O	O	O	O
Impact Duration								
Exploration wellsite construction	S L	S M	S M	-	S M	S M	-	-
Exploration drilling	S M	-	-	-	S M	S M	-	-
Hydrofracing and de-watering	-	-	-	M L	S M	-		
Construction of production installations/pipelines	M	S M	S M	-	M L	S M	-	-
Production operations	M L	-	S M	S L	M L	M L	-	-
Decommissioning	M L	S M	S M	-	-	-	-	-

Table 5.5 – Relative Impact Magnitude and Duration Summary Table for GS Operations

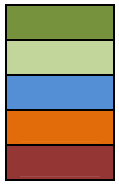
Activity	Biodiversity, habitats, flora and fauna	Geology and soil	Landscape	Water environment	Air quality and climatic factors	Population and human health	Material assets	Cultural heritage
Impact Magnitude								
Construction of production installations/pipelines	- / --	-	-	O	O / -	O / -	O	O
Storage operations	-	O	-	O	O / -	-	O	O
Decommissioning	-	-	-	O	O	O	O	O
Impact Duration								
Construction of production installations/pipelines	M	S / M	S / M	-	M / L	S / M	-	-
Storage operations	M / L	-	M / L	-	M / L	M / L	-	-
Decommissioning	M / L	S / M	S / M	-	-	-	-	-

5.3 Alternatives

The plan/programme alternatives were described in section 2.5 and include:

1. Not to offer any blocks for licensing
2. To proceed with the licensing programme as proposed
3. To restrict the area licensed temporally or spatially

The results of the assessment utilise the following key to categorise the nature of the predicted impact:



Activity would have a major positive effect on indicator
Activity would have a minor positive effect on indicator
Activity would have a neutral effect on indicator
Activity would have a minor negative effect on indicator
Activity would have a major negative effect on indicator

Alternative 1, not to lease or licence areas for development, is not viable as it would not allow any contribution to the UK wider energy and climate change policy objectives. Unconstrained development (Alternative 2) poses the risk of significant environmental effects on ecological and other receptors, including European conservation sites. The conclusion of the SEA is that a modified alternative 2 should be adopted, that is to proceed with the licensing programme but with some with licensing conditions.

Table 5.6 below shows the relationship between each indicator used to describe the evolution of the baseline in appendix 4 and the potential resultant magnitude of any possible impacts given the adoption of each alternative.

Table 5.6 – The Relationship of SEA Indicators to Plan Alternatives

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
Biodiversity, Habitats, Flora and Fauna (Appendix 4a)						
1	**Bird Populations**					
	Farmland	Farmland bird populations fell by 53% between 1970 and 2008. Most of this decline took place between the mid-1970s and mid-1990s. In the last three years, the farmland bird index has fallen to its lowest recorded level.				Alternatives 2 and 3 may cause disturbance to birds or bats, although the scale of disturbance (noise, vibration and light etc.) will depend on the size and type of facility, location, duration of activities, and effective mitigation. At a strategic level, minor negative impacts are likely with the potential of positive impacts through good site restoration and remediation.
	Woodland	Between 1970 and 2008, there was a 25% decrease in UK abundances of woodland birds. The most severe decline occurred in the late 1980s and early 1990s, but the index has been broadly stable in recent years.				
	Coastal	Seabird populations have increased by 27% between 1970 and 2008. Populations peaked in the late 1980s, with a small decline occurring since then. Despite a sustained rise in the measure, kittiwake, shag and fulmar have all suffered significant declines in recent years, contributing to a dip in the indicator between 2003 and 2004.				
	Wintering and waders	Across the UK, the wintering wetland bird index was 88% higher in 2008 than in 1975-6, with populations peaking in 1996-7.				

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
2	**Butterfly populations**	Long term butterfly population trends are difficult to interpret due to large interannual fluctuations in the data. Since 1976 the measure for specialist species (see Appendix 4a) has fallen significantly, but that for generalist species has shown little to no overall change. There seems to be no statistically significant change in the underlying data for any of the recorded species in recent years.				
3	**Bat populations**	Since 2000, bat populations have increased by a collective total of 20%, mainly due to a significant increase in the lesser horseshoe bat. Prior to this bats had experienced a major population decline which has recently stabilised (and is now increasing) due to protection and direct conservation action, though they remain under threat from landscape change and development pressure				

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
4	**Biodiversity**					
	BAP priority species	UK: 1999-2008. The number of species assessed as stable or increasing has risen from 202 to 214 (an increase of 3.5%), while the number recorded as declining or lost fell from 137 to 125. Despite this modest improvement, the number of species assessed as 'increasing' has fallen from 48 to 45. 89 are still declining and 6 have been lost from the UK since 1994. Scotland: 2005, 50% of species identified as stable or increasing. 14% considered to be in decline. Wales: 2002-2005. BAP species stable or increasing rose from 22% to 34%. Declining species remained at 18%.				Potential disturbance to priority species may result from alternatives 2 and 3. Detailed site-specific assessment and mitigation proposals would be required prior to planning approval under national EIA regulations, with specific reference to conservation status of surrounding areas (including statutory sites and UKBAP and LBAP habitats and species). Subject to this assessment, activities resulting from proposed licensing will not significantly impact BAP species and habitats at a strategic level.
	BAP priority habitats	UK: 1999-2008. Based on a comparison of the earliest available and most recent assessment for each habitat, the number either 'stable' or 'increasing' in area has fallen from 21 to 20 (2.5% of the known habitats). 15 priority habitats (44%) are still declining in extent. Scotland: 2005, 33% of those considered were stable or increasing, while 30% were in decline. Wales: 2002-2005: 36% of priority habitats in Wales were stable or increasing compared to 30% in 2002. The proportion of habitats in decline has increased from 46% (2002) to 59% (2005).				A large proportion of the 65 priority habitat types identified by the UKBAP are represented in the areas that may be offered for licence and these have varying degrees of sensitivity to physical disturbance.

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
5	**Condition of species and habitats†**	74.6% of species features are in a favourable or recovering condition. 65.6% of habitat features are in a favourable or recovering condition. Not a SD indicator and no targets published.				Existing large-scale onshore developments (e.g. Wytch Farm) have demonstrated that significant interactions with designated and other sites of conservation value can be mitigated and that features of high conservation value can be maintained in close proximity to production operations.
Geology and Soils (Appendix 4b)						
6	**Condition of earth science features†**	88.1% of earth science features are in a favourable or recovering condition. Not a SD indicator and no targets published.				The robust nature of many earth science sites means that they are unlikely to be significantly disturbed by activities resulting from licensing. Potential positive effect of uncovering obscured features. See also *Condition of species & habitat features (SSSI, SAC, SPA & Ramsar)* above.
7	**Soil condition and threats†**					
	Loss of soil organic matter†	There is limited data for Scotland, but recent surveys in England and Wales indicate that there has been an average loss of organic matter of 15% in arable soils and rotational grass soils, 16% in soils under permanently managed grassland and 23% in agriculturally managed soils and semi-natural land.				Careful site design and management, and consideration of local hydrology and soil characteristics should prevent the loss of soil during any vegetation clearance and road construction. Site reinstatement should also consider best practices to stabilise land.
	Loss of soil to development (England and Wales)†	The amount of soil lost to development has gradually decreased from nearly 8,000ha in 1995 to 4,200ha in 2006. In 2008, 79% of new homes were developed on brown-field sites, an increase of 23 percentage points since 1997.				The loss of land to development would be very small, the typical area of any development being 1-4ha, though more extensive tracts of land may be expected to be disturbed as a result of exploration, appraisal and pipelay. Site reinstatement and the underground burying of any pipes should minimise loss of land.

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
Landscape (Appendix 4c)						
8	**Changes to landscape character†**	A comparison of results from the previous (1990-1998) and most recent (1999-2003) CQC study reveal that NCAs which have a pattern of change which can be described as maintained or enhanced have increased from 36% to 61%. Some of these changes may be to do with a refinement in assessment methodology.				Impacts should only be for the duration of the life of the development. Landscapes considered to be of particular value and/or sensitivity identified under a range of designations are afforded a degree of protection through the statutory consenting and planning systems. Mitigation may be implemented through siting and operational controls; residual visual impact may occur over limited spatial and temporal scales – not considered to be significant at a strategic level.
9	**Tranquil areas†**	A total loss of tranquillity amounting to 21% has taken place in England (1960-1990). In Wales, between 1997 and 2009 there was an overall loss of 1,500km^2 of undisturbed area (~6% of the land area of Wales). A pilot study suggests that disturbance in the Scottish Midlands may also have increased.				Disruption, disturbance and nuisance effects on human communities are associated principally with traffic congestion, noise and dust; consistent with a range of other construction and development projects of a similar scale. These effects may be more significant in rural and non-industrialised areas.
10	**Light pollution†**	About 24% of the UK land area had shifted up a brightness band between 1993 and 2000. There was a similar increase in brightness for England (26%) with smaller increases for Scotland (17%) and Wales (19%).				Potential activities resulting from alternatives 2 and 3 will have a minor impact on light pollution (e.g. site safety lighting, vehicle lights, flaring operations). The extent of the impact will depend on location, duration and timing. Mitigation may be implemented through operational controls; residual visual impact over limited spatial and temporal scales is not considered to be significant at a strategic level.

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
Water Environment (Appendix 4d)						
11	**Biological and Chemical Quality of Rivers**	This indicator will in due course be changed to reflect assessments of ecological status as required by the Water Framework Directive. See Appendix A4d for details. At present, the chemical/biological quality of rivers is measured differently in Scotland than in England and Wales and so results between these areas are not directly comparable, though in Scotland the percentage of rivers of good quality has remained stable at around 87% between 2000 and 2006, based on a combined chemical, biological and aesthetic assessment.				Alternatives 2 and 3 could result in activities that may pose a risk to surface and ground waters (e.g. lost circulation of drilling fluids, site drainage, accidental spillages, liquid storage). These issues are not unique to the oil and gas industry and best practice management and mitigation practices are well established. A high level of regulatory control by the EA and SEPA is implemented through PPC, including requirements under the Groundwater and Water Framework Directives.
	*Biological River Quality**	Between 1990 and 2007 the percentage of rivers of good biological quality in England rose from 60 to 72% (excluding London office region). In 2007, 87% of rivers in Wales were of good biological quality.				
	*Chemical River Quality**	In 2007, 76% of English rivers (excluding London office region) were of good chemical quality, compared with 43% in 1990. In all years since 1993, over 90% of rivers in Wales have been of good chemical quality.				
12	**Water Resource Use**					

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
	Total abstractions from surface and groundwater	In 2006, 35 billion litres of water were abstracted per day from non-tidal surface and ground water sources in England and Wales.				Water abstraction is not expected to be significant for most operations, though larger quantities of water may be expected to be used for hydrofracing operations in relation to shale gas extraction.
	Leakage losses	In 2007/08, 3,291 Ml/d of water put into the supply in England and Wales was lost through leakage, which as a percentage of total input, is 7% less loss (22 vs. 29%) than in the peak year of 1994/5.				Plan alternatives will have no significant impact.
13	**Public water yield and demand (Scotland)**	There was a net increase of ~3.5% in water demand between 1981 and 2006.				Plan alternatives will have no significant impact.
14	**Water stress (England and Wales)**	Abstractions from surface waters are already at their limit in the summer for much of England and also in the winter for parts of the South and East.				Operators should ensure that aquifer and local surface water bodies are not affected by activities, as in relation to indicator 12 above.
15	**Bathing Waters†**	Overall, the number of mandatory (95.8%) and stricter guideline (63.9%) passes in the UK was less in 2008 than in 2007, though there has been a general trend of increasing standards, offset in 2008 by exceptionally high rainfall. In Scotland, 7 bathing waters failed to meet basic standards, as did 1 in Wales.				Provided that surface and groundwater bodies are suitably protected the plan alternatives should have no significant impact on bathing waters.

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
Air Quality (Appendix 4e)						
16	**Emissions of air pollutants**	The national emission of air pollutants (NH_3, SO_2, NO_x, and PM_{10}) reduced between 1990 and 2007. Ammonia (NH_3) reduced by ~20%, nitrogen oxides (NO_x) by ~45%, particulates (PM_{10}) by ~50% and sulphur dioxide (SO_2) by ~80%.				The scale of pollutant gas emissions from plan related activities is minor in the context of overall UK emissions and relative to those from UK oil & gas production, though they will contribute to the overall emission of pollutants which are regarded as having negative environmental and human health implications.
17	**Ecological impact of air pollutants**					
	*Area affected by acidity**	Between 2000 and 2005 the area where acid deposited exceeded critical loads declined from 60 to 58%.				Given the scale and nature of likely activities, mandatory mitigation and the location of sensitive habitat, there are likely to be at most very minor negative impacts to the land area affected on adoption of alternatives 2 and 3.
	*Area affected by nitrogen**	Between 2000 and 2004 the area where nutrient nitrogen exceeded critical loads remained at 59%, down from 65% in 1996. The value increased to 61% in 2005.				
18	**Air Quality and Health (see indicator 27)**					

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
Climatic Factors (Appendix 4f)						
19	*Greenhouse gas emissions*	Emissions of the six primary greenhouse gases that the UK is committed to reduce under the Kyoto Protocol were provisionally estimated to be 623.8 million tonnes in 2008, 20% below 1990 levels. Emissions of the principle greenhouse gas, CO_2, were estimated to be ~10% lower than 1990 levels for 2008. Net greenhouse gas emissions in Scotland have reduced by 15.4% between 1990 and 2005, equalling 54.6 million tonnes in 2005. For Wales, emissions of the basket of greenhouse gases declined by 7.9% between 1990 and 2006.				The scale of greenhouse gas emissions from plan related activities is minor in the context of overall UK emissions and relative to those from UK oil & gas production. Regardless, such emissions will be included in future UK wide climate change response control initiatives.
20	**Carbon dioxide emissions by end user***					
	Industry	2007: CO_2 reduced by 16% on 1990 levels.				Plan alternatives will have no significant impact on CO_2 emissions by end user.
	Domestic	2007: CO_2 reduced by 9% on 1990 levels.				
	Transport	2007: CO_2 increased by 9% on 1990 levels.				
21	**Electricity generation**					
	Electricity consumption, fossil fuels used	Electricity consumption increased by 24% between 1990 and 2007, with an accompanying increase in fossil fuel use of 12%.				Plan alternatives will have no significant impact on fossil fuel usage by electricity generation.

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
	CO_2 and NO_x emissions	Since 1999, both NO_x and CO_2 have shown an increase of ~4% and ~24% respectively to 2007, though are ~50% and ~10% lower than 1990 figures respectively.				
	SO_2 emissions	SO_2 emissions declined by ~90% between 1990 and 2007.				
22	**Renewable energy**	In 2008, renewable sources of electricity represented 5.5% of the total energy mix, increasing from 1.8% in 1990. The increase in renewable energy has principally been from biomass and wind sources.				Plan alternatives will have no significant impact.
Population and Human Health (Appendix 4g)						
23	***Demography***	Population was estimated to be 61.3 million in mid-2008, up from 58.8 million in 2001, 57.2 million in 1990 and 55.6 million in 1970. The UK population is expected to expand by ~7% in the period between 2006 and 2016.				Wider population and health issues will be effectively controlled by regulation of discharges, emissions and noise. Health and safety of local workforce and surrounding communities are stringently regulated under existing statutory controls and operator management systems.
24	***Life expectancy at birth****					
	Men	In 2004, UK average male life expectancy was 76.6 years for men, with a healthy life expectancy of 67.9. From the 2001 Census, overall average life expectancies in England, Wales and Scotland were 76, 75.4 and 73.3 years respectively.				

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
	Women	In 2004, UK average female life expectancy was 81 years, with a healthy life expectancy of 70.3. From the 2001 Census, overall average life expectancies in England, Wales and Scotland were 80.6, 80.6 and 78.8 years respectively.				
25	**General health**	In the UK, 9.3% of people described their health for the 12 months prior to Census day (29 April 2001) as "not good". This compared with 9.0% (England), 10.2% (Scotland) and 12.5% (Wales).				
26	**Environmental Equality***	Less than 0.5% of the population in the least deprived areas experience 3 or more environmental conditions that are 'least favourable', rising to ~22% in the most deprived areas.				Site location and design should consider possible cumulative impacts, particularly in areas already experiencing a high level of deprivation or environmental inequality.
27	**Air quality and health**	The number of days when air pollution was assessed as being moderate or higher at urban sites has reduced significantly since 1993 (with the exception of a peak in 2003) while the number of days affected in rural areas, caused largely by ozone, shows no overall trend.				Wider population and health issues will be effectively controlled by regulation of discharges, emissions and noise. Health and safety of local workforce and surrounding communities are stringently regulated under existing statutory controls and operator management systems.

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
	Noise pollution†	There is no specific indicator data or targets relating to this topic. See section A4g.3.6 for details.				It may be expected that the adoption of alternatives 2 or 3 may increase ambient noise levels. Wider population and health issues will be effectively controlled by regulation noise. Health and safety of local workforce and surrounding communities are stringently regulated under existing statutory controls and operator management systems.
Material Assets (Appendix 4h)						
28	**Onshore crude oil production**	UK onshore crude oil production decreased steadily from 5.2 million tonnes in 1998 to 1.25 million tonnes in 2008.				Potential crude oil production arising from licensing would have a positive impact on onshore production on adoption of alternatives 2 or 3.
29	**Onshore gas production**	UK onshore gas production has fallen steadily from 289 million cubic metres in 1999 to 97 million cubic metres in 2008.				Potential gas production arising from licensing would have a positive impact on onshore production on adoption of alternatives 2 or 3.
30	**Coal production**	UK total coal production has fallen from 147.2 million tonnes in 1970 to 17.9 million tonnes in 2009.				Given the small scale and nature of likely activities and mandatory mitigation (including planning controls), potential activities resulting from licensing are unlikely to sterilise coal reserves or affect coal production.
31	**Fossil fuel dependency**	The mix of primary fuels consumed for energy purposes in the UK has become increasingly diverse since 1970, when it was heavily dominated by coal and petroleum. Fossil fuel dependency has been falling gradually since 1970, though has risen slightly since 1997 due to a decrease in nuclear electricity generation				Plan alternatives will have no significant impact on fossil fuel dependency.

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
32	**Energy supply**	The UK's indigenous energy production broadly met or exceeded gross inland energy consumption during the 1990s. Since 1999 indigenous energy production has fallen from being 22% above consumption to 19% less than consumption in 2006, with the UK a net importer of energy.				Potential oil and gas production arising from licensing may have a positive impact on UK indigenous energy production on adoption of alternatives 2 or 3.
33	**Land use**	In 2006, 52% of land in the UK was either grass or rough grazing land, and 18% of land was covered by crops or left bare fallow. Other forms of agriculture accounted for 3% of UK land. 12% of UK land area was forest and woodland whilst 14% of land area was urban land or 'land not otherwise specified'. Inland water covered 1% of UK land area.				Given the small scale and nature of likely activities and mandatory mitigation (including planning controls), potential activities are unlikely to impact negatively on other land users. Land remediation as part of the decommissioning process may also have a positive impact for subsequent land use.
	Agricultural land use (Scotland)	Between 1982 and 2000, the total land used for agriculture in Scotland decreased by 5% to 6.08mha, followed by a slight rise to 6.2mha in 2007. The area of rough grazing decreased by 0.63mha (14%) between 1982 and 2003, rising slightly by 2007. In 2007, the area of woodland and other land was more than three times greater than in 1982.				

#	Indicator	Current Status/Trends	Plan alternatives			Commentary
			1	2	3	
	Land recycling	The percentage of new dwellings arising from building on previously developed land or through the conversion of existing buildings increased from 54% in 1990 to 75% in 2007 (provisional estimate).				Land remediation as part of the decommissioning process may have a positive impact for subsequent land recycling.
Cultural Heritage (Appendix 4i)						
34	**Number of designated heritage assets**					
	Number of scheduled ancient monuments	The number of scheduled monuments in England has increased by ~1.4% between 2003 and 2009.				Plan alternatives will have no significant impact.
	Number of listed buildings	The number of listed buildings in England has not changed significantly between 2003 and 2009 (<0.5%).				Plan alternatives will have no significant impact.
35	**Historic Environment at Risk**					
	Percentage of grade I and II buildings at risk	The number of listed building at risk in England has reduced by ~0.5% between 1999 and 2009.				Plan alternatives will have no significant impact.
	Monuments at high risk	In England, the Heritage at Risk Register recorded a ~15% fall in monuments at risk between 1999 and 2008. Those areas with the greatest proportion of assets at risk are the South West, West Midlands and Yorkshire and Humberside.				Plan alternatives will have no significant impact.

*Note: *signifies a framework indicator – those shared by the UK Government and the devolved administrations; †indicates an additional indicator out with those of the UK government sustainable development strategy.*

Table 5.7 – Summary of SEA Assessment

Biodiversity, Habitats, Flora and Fauna	
1. Contributes to conservation of the wildlife and wildlife habitats of the United Kingdom. 2. Avoids significant impact to, or disturbance of, protected habitats and species of national and international importance.	
Summary of Consideration	**Mitigation**
Exploration activities are typically of short duration whilst production and export facilities are in place for longer. EIA under the operator's EMS and regulatory requirements will provide effective mitigation through consultation and site and timing selection to obviate or minimise effects. Similarly, where a proposed activity location is within or adjacent to a Natura 2000 site.	Through the SEA process awareness of the existence of designated sites and protected species will be raised at the application stage, which will be carried through to the operational phase through DECC and other requirements.
Geology and Soils	
1. Maintains the function and integrity of soil processes and services. 2. Avoids damage to geological conservation sites and protects important geological features.	
Summary of Consideration	**Mitigation**
Facility siting under the existing planning regime would normally be required to avoid localised geological features of interest, flood plains, highly graded agricultural land etc. Entry onto land requires landowner approval. Controls on the segregation and storage of soils during construction are normal.	No additional mitigation necessary.
Landscape	
1. To accord with, and deliver, the Aims and Articles of The European Landscape Convention. 2. Avoids impacts on the character of designated and non-designated landscapes.	
Summary of Consideration	**Mitigation**
Valued landscapes include designated (statutory and non-statutory) and non-designated areas. In general, similar considerations apply to the siting of temporary and longer-term hydrocarbon related facilities, which aim to reduce visibility and promote effective restoration of disturbed ground. The planning consent process is effective in controlling adverse impact on the landscape and allowing for public input through the statutory consultation process.	No additional mitigation viewed as necessary.
Water Environment	

1. Avoids adverse impacts on surface water (including lake and channel physical form and function) and aquifer water quality and helps achieve the objectives of the Water Framework Directive. 2. Avoids, and where possible reduces, flood risk.	
Summary of Consideration	**Mitigation**
The location of surface waters and aquifers (especially those of potable water), their sensitivity and susceptibility to pollution are well known and their protection is effectively addressed through the approvals processes for exploration, production and export facilities.	Placement of exploration or production facilities in flood plains or areas prone to flooding, including those areas at the coast and subject to coastal erosion, should be avoided.
Air Quality	
1. Avoids degradation of regional air quality from oil and gas activities and helps achieve the objectives of the Ambient Air Quality and Cleaner Air for Europe Directives.	
Summary of Consideration	**Mitigation**
The existing regulatory controls on transport, power generation and gas flaring are regarded as adequate. EIA to support planning and other consents would be expected to give due consideration to the potential implications of the planned activity on attainment of local and regional air quality plans. Atmospheric emissions and contributions to climate change typically form key performance indicators for operators leading to internally driven pressure to control and reduce such emissions.	No additional mitigation necessary.
Climatic Factors	
1. Minimises greenhouse gas emissions.	
Summary of Consideration	**Mitigation**
The existing regulatory controls on transport, power generation and gas flaring are regarded as adequate. Atmospheric emissions and contributions to climate change typically form key performance indicators for operators leading to internally driven pressure to control and reduce such emissions. During the period of plan application, further measures to promote energy efficiency and the reduction of greenhouses gas emissions can be expected as part of UK and other initiatives in response to climate change concerns.	No additional mitigation necessary.
Population and Human Health	

1. Has no adverse impact on human health. 2. Avoids disruption (including the loss of access and recreational opportunities), disturbance and nuisance to communities.	
Summary of Consideration	**Mitigation**
Existing regulatory controls on the location and design of facilities, the timing of operations, resultant wastes and emissions, accidental events, export routes and facilities etc. are regarded as effective in minimising potential effects on human health and communities.	No additional mitigation identified as being necessary.
Material Assets (infrastructure, other natural resources)	
1. Protects other United Kingdom resources of economic and amenity value. 2. Promotes waste reduction, reuse and recycling.	
Summary of Consideration	**Mitigation**
Existing planning and other controls e.g. through the Mineral Planning Authorities and equivalent bodies, are viewed as effective in reducing the potential effects of hydrocarbon exploration and production activities to non-significant levels. Waste minimisation is being promoted through fiscal mechanisms as well as by the implementation of operator EMS processes.	No additional mitigation seen as necessary, as consultation is required early in the planning stages of an activity.
Cultural Heritage, including Architectural and Archaeological Heritage	
1. Promote awareness and identification of archaeological resources in the area. 2. Avoids significant impacts to sites of cultural, historic or archaeological importance and where possible contributes to their preservation.	
Summary of Consideration	**Mitigation**
Planning control mechanisms require archaeological desk studies, field investigations, and watching briefs for exploration and production facility site works. In addition planning controls require that due regard is taken of buildings and other features of architectural value.	No additional mitigation is considered necessary.

5.4 Interrelationships, Cumulative and Transboundary Effects

The consideration of the range of potential effects from the hydrocarbon exploration and production activities that could follow implementation of the draft plan has not identified any significant interrelationship between the potential sources of effects. Potential interrelationships with other industrial and other activities are typically addressed through the planning approval and pollution control processes and quality of life initiatives. Cumulative effects can arise from:

- Accumulation of the individual footprints of a local effect, e.g. habitat loss or disturbance associated with multiple developments in local area, particularly where the footprints overlap
- Collective demand for resources, both material (e.g. building materials) and services (e.g. landfill)
- Collective effects of emissions or discharges, where these influence a common receptor (e.g. atmospheric greenhouse gas concentrations)

Other cumulative effects may be qualitative, e.g. loss of amenity value for recreational purposes, or loss of tranquillity may be associated with any industrial development in a rural environment. Government initiatives to progress renewable energy and Carbon Capture and Storage (CCS) are unlikely to have significant cumulative effects. Cumulative visual effects may be possible between onshore wind and any oil and gas infrastructure, though since the location (and to a certain extent the scale) of activities that could follow the adoption of the draft plan/programme are uncertain, these cannot be assessed with any certainty.

The UK Government CCS programme, the Framework for the Development of Clean Coal (FDCC), seeks to have four demonstrator projects operational by 2020 associated with coal fired electricity generating plants. It is unlikely that significant cumulative effects could take place in the time horizon for this SEA with regards to the FDCC programme, as the largest effects of the FDCC are likely to be following the requirement to retrofit CCS technology following the establishment of a technologically and commercially feasible method being identified (post-2020). In any case, it is highly likely the programme will make use of offshore reservoirs and therefore onshore pressures are likely to be derived from pipelay and any additional plant used in capture. Areas that could potentially be centres for CCS development include the Humber (see Yorkshire Forward 2008), Teesside, Thames Gateway, the Firth of Forth and Merseyside, which are areas that both coincide with clusters of industry with high CO_2 emissions, and a number of blocks currently licensed for onshore oil and gas. In the medium-term there may be some scope for incremental effects between these programmes.

As discussed above, the scale of activities resulting from the proposed plan/programme, and therefore the scale of associated effect, is relatively small in comparison to other mineral extraction and energy developments on a national scale. The proposed plan will not make a substantial contribution to the overall cumulative effect in any of the categories under consideration; and is therefore not considered to present a significant risk of cumulative effect in a strategic context.

Similarly, no potentially significant cumulative or transboundary effects were identified that would not be expected to be adequately controlled by existing regulatory or other mechanisms. Activities that could follow adoption of the draft plan and the use of any fossil fuels exploited would contribute in a minor way to greenhouse gas emissions which although are recognised as a key concern, are being addressed through local, UK government, EU

and international initiatives on energy efficiency, emission reductions, renewable sources of energy supply and carbon capture and storage technologies.

5.5 Conclusion

The SEA has considered the potential implications of relevant activities associated with the draft plan/programme for each environmental topic outlined in appendix 4, and within any appropriate regulatory context. The conclusion of the SEA is that a modified alternative 2 should be adopted, that is to proceed with the licensing programme but with some with licensing conditions. It is recommended that the DECC place an explicit expectation on licence applicants to demonstrate an excellent understanding of the environmental sensitivities and potential constraints on blocks both at the application stage and during any subsequent operations.

6 MONITORING

6.1 Legislative Requirements

The SEA Regulations require the DECC, as Responsible Authority for oil and gas licensing, to:

"….monitor the significant environmental effects of the implementation of each plan or programme with the purpose of identifying unforeseen adverse effects at an early stage and being able to undertake appropriate remedial action."

In so doing the Regulations allow for the responsible authority's monitoring arrangements to comprise or include arrangements established otherwise than for the express purpose of complying with the Regulations e.g. monitoring conducted for other regulatory purposes.

6.2 Approach

Ongoing monitoring for the Draft Plan will be as follows:

- Against the activity scenarios given in Section 2.4.2
- Review of research and emerging technology
- Indicators developed for the SEA Objectives informed by consultation with the Consultation Bodies and Planning Authorities

Where unforeseen adverse effects are identified, the DECC will seek to establish the cause in consultation with the Consultation Bodies and other stakeholders. Remedial action will be developed and agreed with relevant parties and implemented as appropriate.

The monitoring programme will be further developed in the Post Consultation Statement.

7 NEXT STEPS

The Onshore SEA Environmental Report, complete with appendices, are available for review and public comment for a period of 12 weeks from the date of publication. The documents are being made available from the DECC website, on CD and hard copy. Comments[8] and feedback should be marked "Onshore Oil & Gas SEA Consultation" and may be sent by letter or email, addressed to:

Mr RB Kiff
Department of Energy and Climate Change
Energy Development Unit
3 Whitehall Place
London SW1A 2HH

E-mail: Ricki.Kiff@decc.gsi.gov.uk

On completion of the public consultation phase, a Post Consultation Report will be prepared and made available through the Onshore SEA website. This report will collate the recipients' comments and responses from DECC, and any technical clarifications required.

Any comments received during public consultation will be considered in decision making regarding the draft plan/programme.

On adoption of the plan/programme a statement will be published detailing:

g) how environmental considerations have been integrated into the plan/programme
h) how the Environmental Report has been taken into account
i) how opinions expressed by the consultation bodies and public consultees on the relevant documents have been taken into account
j) how the results of any consultations entered into with other Member States have been taken into account (if required)

[8] **Confidentiality:** Your comments may be made public by DECC in relation to this consultation exercise. If you do not want your name or all or part of your response made public, please state this clearly in the response. Any confidentiality disclaimer that may be generated by your organisation's IT system or included as a general statement in your fax cover sheet will be taken to apply only to information in your response for which confidentiality has been requested.
However, please also note that DECC may disclose information it holds pursuant to a statutory, legal or parliamentary obligation, including without limitation, requirements for disclosure under the Freedom of Information Act 2000 and/or the Environmental Information Regulations 2004. In considering any request for disclosure of such information under the Freedom of Information Act 2000 or the Environmental Information Regulations 2004, DECC will consider and make use of relevant exemptions or exceptions where they properly apply and, where relevant, will consider whether the public interest in withholding the information outweighs the public interest in disclosing the information. It is DECC's normal practice to consult and consider the views of third parties where necessary although decisions on disclosure are ultimately taken by DECC. However, any decision by DECC against the release of information can be appealed to the Information Commissioner and ultimately the Information Tribunal.
We will handle any personal data you provide appropriately in accordance with the Data Protection Act 1998 and the Freedom of Information Act 2000.

k) the reasons for choosing the plan/programme as adopted, in the light of the other reasonable alternatives dealt with
l) the measures that are to be taken to monitor for potential significant environmental effects of the implementation of the plan/programme.

GLOSSARY AND ABBREVIATIONS

Term	Definition
Aarhus Convention	Grants the public rights regarding access to information and public participation and access to justice. It focuses on interactions between the public and public authorities.
Alluvial	Layer of broken rocky matter or sediment, formed from material that has been carried in suspension by a river or stream and dropped as the velocity of the current decreases.
ANC	Acid Neutralising Capacity. The ability of a given area to neutralise acid deposition, determined by a number of geological and hydrological factors.
Ancient semi-natural woodland	Native tree stands that have not obviously been planted and date back to at least 1600.
Anthropogenic	Resulting from human activity.
AONB	Area of Outstanding Natural Beauty (statutory designation)
AQMA	Air Quality Management Area.
Aquifer	Body of rock that holds water and/or through which water flows.
Arable land	Able to be ploughed and used for the cultivation of crops.
BAP	Biodiversity Action Plan.
BAT	Best Available Technique.
BERR	Department of Business, Enterprise and Regulatory Reform, formerly DTI.
BGS	British Geological Survey.
BIS	Department for Business, Innovation and Skills. Formed in 2009 through the merger of BERR and the Department for Innovation, Universities and Skills (DIUS).
Biodiversity	Diversity of species.
Blanket bog	A globally restricted peatland habitat confined to cool, wet, typically oceanic climates.
Blowout	An unexpected violent eruption of oil and gas from a well during the drilling phase of operation.
BOD	Biochemical Oxygen Demand – (with reference to water bodies) a measure of the amount of biodegradable organic matter present – see also DO (Dissolved Oxygen).
Borehole	Deep and narrow shaft in the ground used for extraction of fluid or gas reserves below the earth's surface.
Brown earth	Type of soil.
Bryophyte	Plants of the division Bryophyta (mosses and liverworts).
BTO	British Trust for Ornithology.
Calcareous	Containing calcium carbonate, chalky.
Cap or seal rock	Relatively impermeable rock, commonly shale, anhydrite or salt, that forms a barrier or seal above and around reservoir rock so that fluids cannot migrate beyond the reservoir.
Carboniferous	Relating to the fifth period of the Palaeozoic era (between the Devonian and Permian periods, about 363 to 290 million years ago), a time when extensive coal-bearing strata were formed.
Carseland	Low flat, peat or marsh covered plain.
CBM	Coal Bed Methane.
CCW	Countryside Council for Wales.
CCS	Carbon Capture and Storage.
CHP	Combined Heat and Power.

Term	Definition
Clough	Ravine in a hill.
CO	Carbon monoxide.
CO_2	Carbon dioxide.
COG	Conventional Oil and Gas
Coalbed methane	Methane deposits which reside in the pores of coal seams.
Coke	Solid fuel made by heating coal in the absence of air so that the volatile components are driven off.
COMAH	Control of Major Accident Hazards.
Coniferous woodland	Defined as wooded land on which more than 75% of the tree crown cover consists of coniferous species.
CPRE	Campaign to Protect Rural England.
Dark Ages	The period in Europe between the fall of the Roman Empire and the Middle Ages, *c*.500-1100, regarded as unenlightened.
DECC	Department of Energy and Climate Change. Formed in late 2008, combines the former energy and climate change mitigation responsibilities of BERR and Defra respectively.
Defra	Department for Environment, Food and Rural Affairs.
Demography	Scientific study of biological populations.
Derelict	In a very poor condition as a result of disuse and neglect.
Devonian	Geologic period of the Palaeozoic era spanning from roughly 415 to 360 million years ago.
DO	Dissolved Oxygen. A measure of the total available oxygen in a water body available for use by biota.
Drilling mud	Mixture of clays, water and chemicals used to cool and lubricate the drill bit, return rock cuttings to the surface and to exert hydrostatic pressure to maintain well control.
DrWPAs	Drinking Water Protection Areas – a body of water which drinking water is abstracted. The WFD aims to prevent deterioration in quality and reduce unnecessary treatment.
DTI	Department of Trade and Industry (see: BERR, DECC)
EA	Environment Agency.
EAP	Environmental Action Plan.
Earthwork	Large artificial bank of soil, especially one made as a defence in ancient times.
EC	European Community.
Ecosystem	An ecological community together with its environment, functioning as a unit.
EEC	European Economic Community.
EIA	Environmental Impact Assessment.
EMS	Environmental Management System.
EN	English Nature (now Natural England).
END	Environmental Noise Directive 2002/49/EC. Transposed into UK law through the Environmental Noise Regulations 2006. Concerned with the identification, mapping and effects of noise, its mitigation and the maintenance of good noise quality where is exists.

Term	Definition
EPR	Environmental Permitting (England and Wales) Regulations (2007). Regulations introduced under the Integrated Pollution Prevention and Control Directive. Now integrates the former PPC regulations (England and Wales only) and streamlines many permits granted for waste management through the use of generic risk assessments for certain activities.
EPS	European Protected Species.
EQS	Environmental Quality Standards. Levels of the 33 priority substances identified under council decision 2455/2001/EC, which are not to be exceeded in surface waters of member states.
ER	Environmental Report.
ESA	Environmentally Sensitive Area. Also see Environmental Stewardship.
Escarpment	Long, steep slope at the edge of a plateau or separating areas of land at different heights.
Espoo Convention	The Convention on Environmental Impact Assessment in a Transboundary Context (1991).
Estuarine	Of, relating to, or found in an estuary.
Estuary	Wide part of a river where it nears the sea; normally where fresh and salt water mix.
ETS	Emissions Trading Scheme.
EU	European Union.
Eutrophic	Rich in dissolved nutrients, photosynthetically productive and often deficient in oxygen during warm weather.
Exploration well	Well drilled to determine whether hydrocarbons are present in a particular area.
Fault	A fracture in the continuity of a rock formation caused by a shifting or dislodging of the earth's crust, in which adjacent surfaces are displaced relative to one another and parallel to the plane of fracture.
Fauna	Animals of an area or period.
FDP	Field Development Plan.
Flora	All the plant life in a particular region.
Fossil fuel	Hydrocarbons, primarily coal, fuel oil or natural gas, formed from the remains of dead plants and animals.
Funerary	Relating to a funeral or the commemoration of the dead.
GCR	Geological Conservation Review.
GDP	Gross Domestic Product.
Geomorphology	The study of the underlying form, and weathering processes, of rocks and land surfaces.
GG	Greenhouse Gas.
Gill	Deep ravine, especially a wooded one.
GIS	Geographical Information System.
Glacial	Relating to the current and past action of glacier presence, movement and process in the landscape. Term may extend to processes at the periphery of glacial activity, e.g. frost shattering, ice wedging etc.
Gley soil	Type of soil which exhibits a greenish-blue-grey soil colour due to wetland conditions.
GOR	Government Office Region.
Greenhouse gas	A gas, such as carbon dioxide, that contributes to the greenhouse effect by absorbing infrared radiation.
GROS	General Register Office for Scotland.

Term	Definition
Groundwater	Water held underground in the soil or in pores and crevices in rock.
GS	Gas Storage
GwD	Groundwater Directive (2006/118/EC).
Ha	Hectare.
Habitat	Place where a particular species lives and grows.
Habitats (and Species) Directive	Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna requires EU member states to protect scheduled species and to designate and manage special areas of conservation (SAC).
Henge	Prehistoric monument consisting of a circle of stone or wooden uprights.
HMSO	Her Majesty's Stationery Office.
Holocene	The latest period in the Quaternary following the Pleistocene, encompassing the period of geological time since the end of the last glaciation and including the present day, from *ca.* 10,000yr BP.
Hydrocarbon	Compounds containing only the elements carbon and hydrogen, (such as oil and natural gas).
IBA	Important Bird Areas.
Invertebrate	Animals without backbones.
IPC	Integrated Pollution Control.
IPCC	Intergovernmental Panel on Climate Change.
IPPC	Integrated Pollution Prevention and Control.
Iron Age	A period that followed the Bronze Age, when weapons and tools came to be made of iron.
JCA	Joint Character Area (now National Character Area [NCA]).
Karst	Landscape underlain by limestone which has been eroded by dissolution, producing towers, fissures, sinkholes, etc.
km	Kilometre.
Knoll	Small hill or mound.
Kt	Kilo-tonnes.
LA21	Local Agenda 21.
Lacustrine	Relating to lakes.
LAPC	Local Air Pollution Control – a regulatory regime in Northern Ireland and Scotland that controls emissions to the air from certain business processes – now replaced by PPC Part B permits under PPC.
LBAP	Local Biodiversity Action Plan.
LDF	Local Development Frameworks.
LDP	Local Development Plan.
Limestone	Sedimentary rock composed largely of the mineral calcite.
Lithomorphic	Soil whose characteristics are derived from events or conditions of a former period.
LNR	Local Nature Reserve.
Ma	Million years.
MAFF	Ministry of Agriculture, Fisheries and Food.
Marl	Unconsolidated sedimentary rock or soil consisting of clay and lime formerly used as fertiliser.
MARS	Monument at Risk Survey of England.
Mediaeval	Relating to the Middle Ages.
Menhir	Tall upright prehistoric stone erected as a monument.

Term	Definition
Mesozoic	Relating to the era between the Palaeozoic and Cenozoic eras, about 245 to 65 million years ago.
Mire	Stretch of swampy or boggy ground.
Ml/d	Million litres per day.
MoD	Ministry of Defence.
Morphological	Concerned solely with physical shape.
MPA	Minerals Planning Authorities.
MPG	Minerals Planning Guidance.
MPPW	Minerals Planning Policy Wales.
MPS	Minerals Planning System.
MTAN	Minerals Technical Advice Note.
Mudstone	Fine-grained sedimentary rock whose original constituents were clays or muds.
MWDF	Minerals and Waste Development Framework.
Mya	Million years ago.
NANS	National Ambient Noise Strategy.
Natura 2000 Network	Sites of conservational value designated under the EU Habitats or Birds Directives.
NATMAPVector	A national (England and Wales) map of soil classification with ~300 different soil associations.
NCA	National Character Area (formerly Joint Character Area [JCA]). A geographical area defined by Natural England with support from English Heritage as having particular landscape (including landcover, buildings and settlement) character.
NERC	Natural Environment Research Council.
NNR	National Nature Reserves.
NO_x	Nitrogen oxides.
NO_2	Nitrogen dioxide.
NP	National Park. (Statutory Designation).
NPPG	National Planning Policy Guidelines.
NRSI	National Soils Research Institute.
NSA	National Scenic Area.
NSA	Nutrient Sensitive Area.
NTS	National Transmission System.
NVZ	Nitrate Vulnerable Zone.
ODPM	Office of the Deputy Prime Minister.
Oil shale	Fine-grained sedimentary rock from which oil can be extracted.
ONS	Office for National Statistics.
Ore	Volume of rock containing components or minerals in a mode of occurrence which renders it valuable for mining.
Palaeosol	A buried or relict, exposed soil preserving some characteristics of former pedogenic (soil forming) regimes, albeit natural or anthropogenic.
Pastoral	Relating to the farming or grazing of sheep or cattle.
PEDL	Petroleum Exploration and Development Licence.
Permian	Geological period extending between *ca.* 300 and 200Mya.
Permo-Triassic	Division between the Permian Period and the Triassic Period.
Plateau	Area of fairly level high ground.

Term	Definition
PM	Particulate matter. Emitted primarily from combustion processes, these particles are usually described in terms of their size (e.g. PM_{10} indicates a particle size of 10µm)
Podzols	Light-coloured soil found predominantly under coniferous forests and on moorlands in cool regions where rainfall exceeds evaporation.
Pollard	Trees that have had their top and branches cut to encourage new growth.
Potable	Drinkable (i.e. fit for human consumption).
PPC	Pollution Prevention and Control.
Quaternary	Geologic time period from the end of the Pliocene Epoch up to and including, the present. Incorporates the Pleistocene period which has its base at 2.59Ma.
Ramsar	International Convention on the Protection of Wetlands.
RBD	River Basin District. A geographic area encompassing one or more river catchments which form a management area – there are 12 such districts in the UK.
RBMP	River Basin Management Plan. A holistic management plan relating to the water environment of a RBD.
Renewable energy	Energy derived from resources that are regenerative or for all practical purposes cannot be depleted.
Reservoir rock	Reservoir that oil migrates to and is held underground.
RSPB	Royal Society for the Protection of Birds.
RSS	Regional Spatial Strategies.
SAC (Special Area of Conservation)	Area designated as European Sites (Natura 2000) under the Habitats and Species Directive.
Saline	Containing or impregnated with salt.
Saltmarsh	Low coastal grassland normally overflowed by the tide.
Sandstone	Sedimentary rock composed mainly of sand-size mineral or rock grains.
Scarp	Very steep bank or slope; an escarpment.
Scree	Mass of small loose stones that form or cover a slope on a mountain.
SD	Sustainable Development.
SEA (Strategic Environmental Assessment)	An appraisal process through which environmental protection and sustainable development is considered in advance of decisions on policy, plans and programmes.
Seismic survey	Survey technique used to determine the structure of underlying rocks by passing acoustic shock waves into the strata and detecting and measuring the reflected signals. Depending on the spacing of survey lines, data processing method and temporal elements, the seismic is referred to as either 2-D, 3-D or 4-D.
SEPA	Scottish Environment Protection Agency.
SHEP	Scottish Historic Environment Policy. Initially a series of policy documents surrounding Scottish heritage protection, consolidated into a single document in 2008.
Shoreline Management Plan	A document that sets out a strategy for coastal defence for a specified length of coast, taking account of natural coastal processes and human and environmental influences and needs.
SNH	Scottish Natural Heritage.
SO_2	Sulphur dioxide.
SoS	Secretary of State.
Source rock	A rock rich in organic matter which, if heated sufficiently, will generate oil or gas.

Term	Definition
SPA (Special Protection Areas)	Areas designated as European Sites under the Wild Birds Directive.
SPZ	Source Protection Zone – an area designated for the purpose of protecting groundwater.
SRES	Special Report on Emissions Scenarios.
SSSI	Site of Special Scientific Interest.
SSSL	Supplementary Seismic Survey Licence. Application for a SSSL can be made where an onshore operator requires to survey an area up the edge and into adjacent land out with the area covered by the PEDL. The licence has the duration of 1 year and covers an area up to 1km outside the PEDL area.
Tributary	River or stream connecting into an equivalently sized, or larger, river.
Tumuli	Ancient burial mounds; barrows.
UDP	Unitary Development Plan.
UK	United Kingdom.
UKBAP	United Kingdom Biodiversity Action Plan.
UKCIP	UK Climate Impact Programme.
UKSIC	UK Soil Indicators Consortium.
UN	United Nations.
UNESCO	United Nations Educational, Scientific and Cultural Organisation.
VCBM	Virgin Coal Bed Methane.
Vernacular	Concerned with domestic and functional rather than monumental buildings. The rubric of “vernacular” architecture is concerned with a style of building inherent to a certain time or place which has not been imported from elsewhere, and which typically makes use of local building materials, a type of (though not to be confused with) tradition of building which does not extend beyond the functional.
VOC	Volatile Organic Compound.
Waders	Any of many long-legged birds that can wade in water in search of food (includes oystercatcher, whimbrel, snipe, avocets, stilts, plovers, sandpipers, godwits, curlews, snipe and phalarope).
WAG	Welsh Assembly Government.
WES	Wildlife Enhancement Scheme.
Wetland	An environment at the interface between truly terrestrial ecosystems and truly aquatic systems making them inherently different from each other yet highly dependent on both.
WFD	Water Framework Directive.
WFD UK TAG	Water Framework Directive United Kingdom Technical Advisory Group.
Wildfowl	Collective term for all ducks, shelducks, geese and swans.

REFERENCES

ADAS (2008). Alien Species and the Water Framework Directive: Using Alien Species Forums to Address Problems in Scottish Catchments. Scottish Natural Heritage Commissioned Report No.299 (ROAME No. R07AC614), 47pp.

AEA Energy and Environment (2008). Scottish Air Quality Database Annual Report 2007: A report to the Scottish Government, 41pp.

Antonine Wall World Heritage Site Website (accessed: April 2009). http://www.antoninewall.org/

Bell M and Walker MJC (2005). Late Quaternary Environmental Change: Physical and Human Perspectives (2nd edition). Pearson, London, 348pp.

Bellamy PH, Loveland PJ, Bradley RI, Lark RM and Kirk GJD (2005). Carbon Losses from all Soils Across England and Wales 1978-2003. *Nature* **437**: 245-248.

Blaauw M, van Geel B and van der Plicht J (2004). Solar Forcing of Climatic Change During the Mid-Holocene: Indications from Raised Bogs in The Netherlands. *The Holocene* **14**: 35-44.

Black H, Bellamy P, Creamer R, Elston D, Emmett B, Frogbrook Z, Hudson G, Jordan C, Lark M, Lilly A, Merchant B, Plum S, Potts J, Reynolds B, Thompson R and Booth P (2008). Design and Operation of a UK Soil Monitoring Network. Science Report – SC060073, Environment Agency, Bristol, 208pp.

Blum WEH (1993). Soil Protection Concept of the Council of Europe and Integrated Soil Research. In: Eijsackers HJP and Hamers T (eds.) Soil and Environment Vol 1. Integrated Soil and Sediment Research: a Basis for Proper Production. Kluwer Academic Publisher. Dordrecht, pp. 37-47

British Geological Survey (2004). The Case for Underground Gas Storage (UGS). Memorandum by BGS to Select Committee on European Union. UK Parliament website - *http://www.publications.parliament.uk/pa/ld200304/ldselect/ldeucom/105/105we04.htm.*

Buston RM and Clarkson CR (1998). Geological Controls on Coalbed Methane Reservoir Capacity and Gas Content. *International Journal of Coal Geology* **38**: 3-26.

Cadw (1998a). Register of Landscapes of Outstanding Historic Interest in Wales. Cadw, Cardiff, 176pp.

Cadw (1998b). Register of Landscapes of Special Historic Interest in Wales. Part 2.2: Landscapes of Special Historic Interest. CCW, Cadw, ICOMOS, 96pp.

Cadw (2007a). Register of Landscapes, Parks and Gardens of Special Historic Interest in Wales, Part I: Parks and Gardens, Additional and Revised Entries, Volume 1 (with text in Welsh and English). Cadw, Cardiff, pp. xv + 76, 15 site plans.

Cadw (2007b). Guide to Good Practice on Using the Register of Landscapes of Historic Interest in Wales in the Planning and Development Process. Cadw, Cardiff, 32pp.

Cadw (2008). The Welsh Historic Environment: Position Statement 2007. Cadw, 72pp.

Cadw (2009a). The Welsh Historic Environment: Position Statement 2008. Cadw, 76pp.

Cadw (2009b). Conservation Principles, Policies and Guidance for the sustainable management of the historic environment in Wales: Consultation Draft. Cadw and the Welsh Assembly Government, 34pp.

Campaign to Protect Rural England Website (accessed: March 2009). http://www.cpre.org.uk/

Carey PD, Wallis SM, Emmett BE, Maskell LC, Murphy J, Norton LR, Simpson IC and Smart SS (2007). Countryside Survey: UK Headline Messages from 2007. Centre for Ecology and Hydrology, 30pp.

Centre for Ecology and Hydrology (2004). Trends in Critical Load Exceedances for Acidity and Nutrient Nitrogen for the Years 1995-97, 1998-2000, 1999-2001 and 2010. Centre for Ecology and Hydrology, 33pp.

Centre for Ecology and Hydrology (2007). Critical Loads and Dynamic Modelling: Final Report. Natural Environment Research Council CEH Contract No: C02661, 53pp.

Centre for Ecology and Hydrology Pollutant Deposition website (accessed: March 2009) http://www.uk-pollutantdeposition.ceh.ac.uk/

Chaudhry AU (2003). Oil Well Testing Handbook. Elsevier, 670pp.

Clwyd-Powys Archaeological Trust website (accessed: 4th September 2009) http://www.cpat.org.uk/projects/longer/histland/histland.htm

Coal Authority (2009). Production and Manpower Returns for 12 month period January-December 2008. (http://www.coal.gov.uk/media/C93/AB/CSum_2008.pdf)

Coyle M, Smith RI, Stedman JR, Weston KJ and Fowler D (2002). Quantifying the Spatial Distribution of Surface Ozone Concentrations in the UK. *Atmospheric Environment*. **36**: 1013-1024.

Creedy D (1999). Coalbed Methane: The R&D Needs of the UK. Report No. COAL R163, Department for Trade and Industry.

Creedy D and Tilley H (2003). Coalbed Methane Extraction and Utilization. *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy* **217**: 19-25.

Creedy D, Garner K, Holloway S and Ren TX (2001). A Review of the Worldwide Status of Coalbed Methane Extraction and Utilisation. Report No. COAL R210, DTI/Pub URN 01/1040, 78pp.

Crosdale PJ, Beamish BB and Valix M (1998). Coalbed Methane Sorption Related to Coal Composition. *International Journal of Coal Geology* **35**: 147-158.

Crumpton CA, Goodwin MJ and Barne JH (1996). Oil and Gas Developments. In: Barne JH, Robson CF, Kaznowska SS, Doody JP and Davidson NC. Coasts and Seas of the United Kingdom. Region 9 Southern England: Hayling Island to Lyme Regis. Joint Nature Conservation Committee, Peterborough, pp. 210-211.

Davidson DA and Wilson CA (2006). An assessment of Potential Soil Indicators for the Preservation of Cultural Heritage. School of Biological and Environmental Science, University of Stirling, Stirling, 49pp.

Department for Business, Enterprise and Regulatory Reform (2008). Digest of United Kingdom Energy Statistics 2008. A National Statistics Publication, 394pp.

Department for Communities and Local Government (2006a). Mineral Planning Factsheet: Onshore Oil and Gas. British Geological Survey and Natural Environment Research Council, 16pp.

Department for Communities and Local Government (2006b). Mineral Planning Factsheet: Coal and Coalbed Methane. British Geological Survey and Natural Environment Research Council, 18pp.

Department for Communities and Local Government (2006c). Minerals Policy Statement 1: Planning and Minerals. Department for Communities and Local Government, 35pp.

Department for Communities and Local Government (2006d). Planning and Minerals:

Practice Guide. Department for Communities and Local Government, 40pp.

Department for Communities and Local Government (2009). Land Use Change Statistics (England) 2007 – Provisional Estimates January 2009. Communities and Local Government, 12pp.

Department for Culture, Media and Sport UK World Heritage Site Portal (accessed: April 2009). http://www.ukworldheritage.org.uk

Department for Environment, Food and Rural Affairs (2002). Sewage Treatment in the UK. UK Implementation of the EC Urban Waste Water Treatment Directive. Department for Environment, Food and Rural Affairs, London, 16pp.

Department for Environment, Food and Rural Affairs (2005). Regulatory Impact Assessment: Council of Europe European Landscape Convention. Department for Environment, Food and Rural Affairs, 12pp.

Department for Environment, Food and Rural Affairs (2006a). Sustainable Farming and Food Strategy – Indicator Data Sheet. Headline Indicator H5: Soil Quality – Soil Organic Matter. Department for Food and Rural Affairs, 2pp.

Department for Environment, Food and Rural Affairs (2006b). Farm Practices Survey – England 2006, 45pp.

Department for Environment, Food and Rural Affairs (2007a). European Landscape Convention: A Framework for Implementation. Department for Environment, Food and Rural Affairs, 11pp.
(http://www.defra.gov.uk/wildlife-countryside/issues/landscap/).

Department for Environment, Food and Rural Affairs (2007b). The Rural Development Programme for England: 2007-2013 – Chapter 3 Analysis of the Situation, the Strategy and the Ex Ante Evaluation. Department for Environment, Food and Rural Affairs, 167pp.

Department for Environment, Food and Rural Affairs (2007c). Farm Practices Survey 2007, 57pp.

Department for Environment, Food and Rural Affairs (2008a). Farm Practices Survey – England 2008, 87pp.

Department for Environment, Food and Rural Affairs (2008b). Guidance on the Legal Definition of Contaminated Land. Department for Environment, Food and Rural Affairs, 13pp.

Department for Environment, Food and Rural Affairs (2008c). Local Authority CO_2 Emission Estimates 2006: Methodology Summary. Department for Food and Rural Affairs, London, 12pp.

Department for Environment, Food and Rural Affairs (2008d). Sustainable Development Indicators in your Pocket 2008. An update of the UK Government Strategy Indicators. Department for Food and Rural Affairs, London, 138pp.

Department for Environment, Food and Rural Affairs (2009a). Local Air Quality Management Practice Guidance 1: Economic Principles for the Assessment of Local Measures to Improve Air Quality. Department for Environment, Food and Rural Affairs, London, 55pp.

Department for Environment, Food and Rural Affairs (2009b). Local Air Quality Management Practice Guidance 2: Practice Guidance to Local Authorities on Low Emissions Zones. Department for Environment, Food and Rural Affairs, London, 53pp.

Department for Environment, Food and Rural Affairs (2009c). Local Air Quality Management Practice Guidance 3: Practice Guidance to Local Authorities on Measures to Encourage the

Uptake of Low Emission Vehicles. Department for Environment, Food and Rural Affairs, London, 71pp

Department for Environment, Food and Rural Affairs (2009d). Local Air Quality Management Practice Guidance 4: Practice Guidance to Local Authorities on Measures to Encourage the Uptake of Retro-Fitted Abatement Equipment on Vehicles. Department for Environment, Food and Rural Affairs, London, 64pp.

Department for Environment, Food and Rural Affairs (2009e). Sustainable Development Indicators in your Pocket 2009. An update of the UK Government Strategy Indicators. Department for Food and Rural Affairs, London, 160pp.

Department for Environment, Food and Rural Affairs (2009f). Technical report to accompany UK PM_{10} Time Extensions Notification forms: April 2009. Published by Defra, 140pp.

Department for Environment, Food and Rural Affairs (2009g). Safeguarding our Soils: A Strategy for England. Department for Food and Rural Affairs, London, 42pp.

Department for Environment, Food and Rural Affairs (2010). Wild Bird Populations 2008: The Sustainable Development Strategy Indicator, Wintering Waterbirds. Defra, 11th March 2010, 7pp.

Department for Environment, Food and Rural Affairs Sustainable Development webpages (accessed: March 2009). http://www.defra.gov.uk/sustainable/government/

Department for Food, Environment and Rural Affairs (2007d). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1). The Stationery Office, 54pp.

Department for Trade and Industry (1999). Cleaner Coal Technologies: Future Plans for Research and Development, Technology Transfer and Export Promotion. Energy Paper 67. Department for Trade and Industry, 81pp.

Department for Trade and Industry (2001a). Coalbed Methane: A Fossil Fuel Resource with the Potential for Zero Greenhouse Gas Emissions - Phase IIIA. Cleaner Coal Technology Programme, Project Summary 258, 4pp.

Department for Trade and Industry (2001b). Coalbed Methane Extraction and Utilisation: Technology Status Report. Cleaner Coal Technology Programme. Technology Status Report 016, 10pp.

Department for Trade and Industry (2003). The Hydrocarbon Prospectivity of Britain's Onshore Basins, DTI, 86pp.

Department of Energy and Climate Change digest of UK Energy Statistics Webpages (accessed: July 2010)
(http://www.decc.gov.uk/en/content/cms/statistics/source/source.aspx)

Department of Energy and Climate Change (2008). UK Energy Sector Indicators 2007: Background Indicators. Department for Energy and Climate Change, 110pp.

Department of Energy and Climate Change (2009a). Energy Trends: September 2009. A National Statistics Publication, 68pp.

Department of Energy and Climate Change (2009b). Digest of United Kingdom Energy Statistics 2009. A National Statistics Publication, 210pp+Annexes.

Department of Energy and Climate Change (2009c). Energy Statistics: Statistical Press Release 25th March 2010. Department of Energy and Climate Change, 6pp.

Department of Energy and Climate Change (2009d). Field Development Plan Guidance Notes for Gas Storage in Onshore Oil and Gas Fields. Department of Energy and Climate

Change June 2009, 15pp.

Department of Energy and Climate Change (2009e). The UK Low Carbon Transition Plan: National strategy for climate and energy. Department of Energy and Climate Change, 220pp.

Department of Energy and Climate Change (2010). Energy Trends June 2010. Department of Energy and Climate Change, 56pp.

Donaldson MP, Edwards KJ, Meharg AA, Deacon C and Davidson D (2009). Land Use History of Village Bay, Hirta, St Kilda World Heritage Site: A Palynological Investigation of Plaggen Soils. *Review of Palaeobotany and Palynology* **153**: 46-61.

Downing RA (1998). Groundwater: Our Hidden Asset. British Geological Survey, 59pp.

E&P Forum and UNEP (1997). Environmental Management in Oil and Gas Exploration and Production: An Overview of Issues and Management Approaches. UNEP IE/PAC Technical Report 37, 68pp.

English Heritage (2003). Heritage Counts 2003. English Heritage, London, 98pp.

English Heritage (2004). Heritage Counts 2004. English Heritage, London, 120pp.

English Heritage (2005). Heritage Counts 2005. English Heritage, London, 84pp.

English Heritage (2007). Heritage Counts 2007. English Heritage, London, 53pp.

English Heritage (2008a). Heritage Counts 2008. English Heritage, London, 56pp.

English Heritage (2008b). Conservation Policies, Principles and Guidance for the sustainable management of the historic environment. English Heritage, 73pp.

English Heritage (2009). Heritage Counts 2009. English Heritage, London, 25pp.

Entec (2006a). Chapter 12 Onshore gas storage. As part of an overall project for DTI on EU Emissions Trading Scheme (ETS) Phase II – UK New Entrants Spreadsheet revisions, 17pp. (http://www.dti.gov.uk/files/file28596.pdf)

Entec (2006b). Chapter 13 Onshore terminals. As part of an overall project for DTI on EU Emissions Trading Scheme (ETS) Phase II – UK New Entrants Spreadsheet revisions, 22pp. (http://www.berr.gov.uk/files/file28601.pdf)

Environment Agency (2004). The State of Soils in England and Wales. Environment Agency, Bristol, 28pp.

Environment Agency (2006). Underground, Under Threat: The State of Groundwater in England and Wales. Environment Agency, 23pp.

Environment Agency (2007). Thames Region Catchment Flood Management Plan, Summary Document. Consultation, January 2007. 22pp.

Environment Agency (2008a). A Consultation on the Draft River Basin Management Plan: Anglian River Basin District. Environment Agency, 67pp+Annexes.

Environment Agency (2008b). A Consultation on the Draft River Basin Management Plan: Dee River Basin District. Environment Agency, 52pp+Annexes.

Environment Agency (2008c). A Consultation on the Draft River Basin Management Plan: Humber River Basin District. Environment Agency, 68pp+Annexes.

Environment Agency (2008d). A Consultation on the Draft River Basin Management Plan: North West River Basin District. Environment Agency, 77pp+Annexes.

Environment Agency (2008e). A Consultation on the Draft River Basin Management Plan: Northumbria River Basin District. Environment Agency, 55pp+Annexes.

Environment Agency (2008f). A Consultation on the Draft River Basin Management Plan: Severn River Basin District. Environment Agency, 61pp+Annexes.

Environment Agency (2008g). A Consultation on the Draft River Basin Management Plan: South East River Basin District. Environment Agency, 62pp+Annexes.

Environment Agency (2008h). A Consultation on the Draft River Basin Management Plan: South West River Basin District. Environment Agency, 54pp+Annexes.

Environment Agency (2008i). A Consultation on the Draft River Basin Management Plan: Thames River Basin District. Environment Agency, 73pp+Annexes.

Environment Agency (2008j). A Consultation on the Draft River Basin Management Plan: Western Wales River Basin District. Environment Agency, 54pp+Annexes.

Environment Agency (2009a). State of Environment – East of England. Environment Agency, 108pp.

Environment Agency (2009b). Flooding in England: A National Assessment of Flood Risk. Environment Agency, 33pp.

Environment Agency (2009c). Water for People and the Environment: Water Resources Strategy for England and Wales. Environment Agency, 88pp.

Environment Agency (2009d). River Basin Management Plan, Anglian River Basin District – Main Document. Environment Agency, 67pp.

Environment Agency (2009e). River Basin Management Plan, Anglian River Basin District. Annex G: Pressures and Risks to Waters. Environment Agency, 41pp.

Environment Agency (2009f). River Basin Management Plan, Dee River Basin District – Main Document. Environment Agency, 56pp.

Environment Agency (2009g). River Basin Management Plan, Dee River Basin District – Main Document. Environment Agency, 46pp.

Environment Agency (2009h). River Basin Management Plan, Humber River Basin District – Main Document. Environment Agency, 85pp.

Environment Agency (2009i). River Basin Management Plan, Humber River Basin District. Annex G: Pressures and risks to waters. Environment Agency, 37pp.

Environment Agency (2009j). River Basin Management Plan, North West River Basin District – Main Document. Environment Agency, 84pp.

Environment Agency (2009k). River Basin Management Plan, North West River Basin District. Annex G: Pressures and risks to waters. Environment Agency, 69pp.

Environment Agency (2009l). River Basin Management Plan, Northumbria River Basin District – Main Document. Environment Agency, 59pp.

Environment Agency (2009m). River Basin Management Plan, Northumbria River Basin District. Annex G: Pressures and risks to waters. Environment Agency, 36pp.

Environment Agency (2009n). River Basin Management Plan, Severn River Basin District – Main Document. Environment Agency, 66pp.

Environment Agency (2009o). River Basin Management Plan, Severn River Basin District. Annex G: Pressures and risks to waters. Environment Agency, 51pp.

Environment Agency (2009p). River Basin Management Plan, South East River Basin District – Main Document. Environment Agency, 66pp.

Environment Agency (2009q). River Basin Management Plan, South East River Basin District. Annex G: Pressures and risks to waters. Environment Agency, 51pp.

Environment Agency (2009r). River Basin Management Plan, South West River Basin District – Main Document. Environment Agency, 71pp.

Environment Agency (2009s). River Basin Management Plans, South West River Basin District. Annex G: Pressures and risks to water. Environment Agency, 48pp.

Environment Agency (2009t). River Basin Management Plan, Thames River Basin District – Main Document. Environment Agency, 90pp.

Environment Agency (2009u). River Basin Management Plan, Thames River Basin District. Annex G: Pressures and Risks to waters. Environment Agency, 31pp.

Environment Agency (2009v). River Basin Management Plan, Western Wales River Basin District – Main Document. Environment Agency, 58pp.

Environment Agency (2009w). River Basin Management Plan Western Wales River Basin District. Annex G: Pressures and risks to waters. Environment Agency, 52pp.

Environment Agency and Scottish Environment Protection Agency (2008). Draft River Basin Management Plan for the Solway Tweed River Basin District. Environmental Report, 63pp.

Environment Agency and Scottish Environment Protection Agency (2009). The river basin management plan for the Solway Tweed river basin district 2009–2015, 14pp+Chapters and Appendices.

Environment Agency Wales (2001). Water Resources for the Future: A Summary of the Strategy for Wales. Environment Agency Wales, 5pp.

Environment Agency Wales (2009a). Flooding in Wales: A National Assessment of Flood Risk. Environment Agency Wales, 32pp.

Environment Agency Wales (2009b). Water Resources Strategy for Wales. Environment Agency Wales, 77pp.

European Commission (2006). A Vision for Zero Emission Fossil Fuel Power Plants. Report by the Zero Emission Fossil Fuel Power Plants Technology Platform, European Commission, Brussels, 30pp.

Fowler D, McDonald AG, Crossley A, Nemitz E, Leaver D, Cape JN, Smith RI, Anderson D, Rowland P, Ainsworth G, Lawlor AJ, Guyatt H and Harmens H (2006). UK Heavy Metal Monitoring Network. Project Number EPG 1/3/204. Centre for Ecology and Hydrology, 120pp.

Glamorgan-Gwent Archaeological Trust website (accessed: 4th September 2009) http://www.ggat.org.uk/cadw/cadw_mainpage.html

Gordon J, Lees RG, Leys KF, MacFadyen CCJ, Puri G, Threadgould R and Kirkbride V (2002). Natural Heritage Zones: Earth Sciences. Scottish Natural Heritage, 259pp.

Haffey D (2008). Local Geodiversity Action Plans: A Review of Progress in England. Natural England Research Reports, Number 027, 82pp.

Haines-Young RH (2007). Tracking Change in the Character of the English Landscape, 1999-2003. Natural England, Catalogue Number NE42, 35pp.

Hall J, Ullyet J, Heywood E, Broughton R and Fawehinmi J (2004). The National Critical Loads Mapping Programme: Phase IV. Centre for Ecology and Hydrology, Huntingdon. 64pp.

Halliday S. (2003), Rig-and-furrow in Scotland. In: Govan S (ed.) Medieval or Later Rural Settlement in Scotland: 10 years on. Historic Scotland, pp.69-81.

Hamelinck CN, Faaij APC, Turkenburg WC, van Bergen F, Pagnier HJM, Barzandji OHM, Wolf K-HAA and Ruijg GJ (2002). CO_2 Enhanced Coalbed Methane Production in the

Netherlands. *Energy* **27**: 647-674.

Historic Scotland (2007). Scotland's Historic Environment Audit: A Review of Existing Information. *Historic Scotland,* 127pp.

Historic Scotland (2008). Scottish Historic Environment Policy. Historic Scotland, 70pp.

Honguuan Y, Yuan J, Guo W, Cheng J and Hu Q (2008). A Preliminary Laboratory Experiment on Coalbed Methane Displacement with Carbon Dioxide Injection. *International Journal of Coal Geology* **73**: 156-166.

Honguuan Y, Zhou G, Fan W and Ye J (2007). Predicted CO_2 Enhanced Coalbed Methane Recovery and CO_2 Sequestration in China. *International Journal of Coal Geology* **71**: 345-357.

Hulme M, Jenkins GJ, Lu X, Turnpenny JR, Mitchell TD, Jones RG, Lowe J, Murphy JM, Hassel D, Boorman P, McDonald R and Hill S (2002). Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report. Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Norwich, 120pp. http://www.ukcip.org.uk/resources/publications/documents/14.pdf

Ilex Energy Consulting (2006). Strategic Storage and Other Options to Ensure Long-Term Gas Security. A Report to the DTI, 99pp.

International Energy Agency (2008). World Energy Outlook 2008. International Energy Agency 578pp.

IPCC (2007a). Climate Change 2007: The Physical Science Basis. In: S Solomon, D Qin, M Manning, Z Chen, M Marquis, KB Averyt, M Tignor and HL Miller (Eds.). Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996pp.

IPCC (2007b). Summary for Policymakers. Climate Change 2007: The Physical Science Basis. In: S Solomon, D Qin, M Manning, Z Chen, M Marquis, KB Averyt, M Tignor and HL Miller (Eds.). Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 18pp.

Jenkins GJ, Perry MC, and Prior MJO (2009). The Climate of the United Kingdom and Recent Trends. Met Office Hadley Centre, Exeter, 117pp.

Joint Nature Conservation Committee (2007). Second Report by the UK under Article 17 on the Implementation of the Habitats Directive from January 2001 to December 2006. *Peterborough*: JNCC, 15pp.

Joint Nature Conservation Committee biodiversity indicators webpages (accessed: July 2010)
http://www.jncc.gov.uk/page-4229

Jones JAA (1997). Global Hydrology: Processes, Resources and Environmental Management. Longman, 399pp.

MacDonald AM, Ball DF and Dochartaigh BÉÓ (2004). A GIS of Aquifer Productivity in Scotland: Explanatory Notes. British Geological Survey Commissioned Report CR/04/047N, 21pp.

Maddock A (ed.) (2008). UK Biodiversity Action Plan; Priority Habitat Descriptions. UK Biodiversity Action Plan, 94pp.

Maggs R, Harrison D, Carslow D and Stevenson K (2008). Analysis of Trends in Gravimetric Particulate Mass Measurements in the United Kingdom. Bureau Veritas

HSandE Limited for Defra, 66pp.

Meharg AA, Deacon C, Edwards KJ, Donaldson M, Davidson DA, Spring C, Schrimshaw C, Feldmann J, Raab A, Ellam R (2005). Ancient Manuring Practices Pollutes Arable Soil at the St Kilda World Heritage Site, Scottish North Atlantic. *Chemosphere* **64**: 1818-1828.

Met Office (2007). National Meteorological Library and Archive. Fact Sheet 4: Climate of the United Kingdom, 17pp.

Met Office (2009). National Meteorological Library and Archive. Subject Guide 3: Weather and Climate of the British Isles. A Selection of Books Available from the Library and Archive, 6pp.

Murphy J, Sexton D, Jenkins G, Boorman P, Booth B, Clark R, Collins M, Harris G and Kendon L (2009). Climate Change Projections. Met Office Hadley Centre, Exeter, 190pp.

Nakićenović N and Swart R (Eds.) (2000). IPCC Special Report on Emissions Scenarios. A Special Report of IPCC Working Group III. Cambridge University Press, 570pp.

National Grid (2008). Gas Transportation: Ten Year Statement. National Grid, 139pp.

Natural England Natural Areas Webpages (accessed: March 2009). (http://www.naturalareas.naturalengland.org.uk/)

Nature Conservancy Council (1986). Nature Conservation Guidelines for Onshore Oil and Gas Development. The Nature Conservancy Council, 51pp.

Nilsson J and Grennfelt P (Eds.) (1988). Critical Loads For Sulphur and Nitrogen. UNECE/Nordic Council Workshop Report, Skokloster, Sweden.

Office for National Statistics Webpages (accessed: March 2009). http://www.statistics.gov.uk/

Office of the Deputy Prime Minister (1997). Lighting in the Countryside: Towards Good Practice: Main document. Office of the Deputy Prime Minister and Countryside Commission, 96pp.

Office of the Deputy Prime Minister (2004a). Land Use Change Statistics (LUCS) Guidance. The Office of the Deputy Prime Minister, London, 16pp.

Office of the Deputy Prime Minister (2004b). Planning Policy Statement 7: Sustainable Development in Rural Areas. Office of the Deputy Prime Minister, London, 24pp.

Office of the Deputy Prime Minister (2005). A Practical Guide to the Strategic Environmental Assessment Directive: Practical guidance on applying European Directive 2001/42/EC "on the assessment of the effects of certain plans and programmes on the environment". Office of the Deputy Prime Minister, London, 105pp.

Ofgem (2009). Project Discovery: Energy Market Scenarios Consultation Document. Office of Gas and Electricity Markets, 110pp.

Parfitt SA, Barendregt RW, Breda M, Candy I, Collins MJ, Coope GR, Durbidge P, Field MH, Lee JR, Lister AM, Mutch R, Penkman KEH, Preece RC, Rose J, Stringer CB, Symmons R, Whittaker JE, Wymer JJ and Stuart AJ (2005). The Earliest Record of Human Activity in Northern Europe. *Nature* **438**: 1008-1012.

Perry M and Hollis D (2005). The Development of a New Set of Long-Term Climate Averages for the United Kingdom. *Journal of Climatology,* **25**: 1023-1039.

Puri G and Gordon JE (1998). Soils and sustainability – a Natural Heritage Perspective. Contaminated Soil '98. Volume 1. Proceedings of the Sixth International FZK/TNO Conference on Contaminated Soil, Edinburgh, UK, 17-21 May 1998.

Quine TA Van Oost K, Walling DE and Owens PN (2006). Development and Application of

GIS-Based Models to Estimate National Rates of Soil Erosion by Tillage, Wind and Root Crop Harvest. University of Exeter Report to Defra, Project SP08007, University of Exeter, UK, 59pp.

Roberts MB and Parfitt SA (1999). Boxgrove. A Middle Pleistocene Hominid site at Eartham Quarry, Boxgrove, West Sussex. English Heritage Archaeological Report 17, 456pp.

Robins NS and Ball DF (2007). Groundwater Exploitation and Development: Some Current Issues in Scotland. *Water and Environment Journal* **12**: 440-444.

Scotland and Northern Ireland Forum for Environmental Research (2004). Development of a Groundwater Vulnerability Screening Methodology for the Water Framework Directive: Final Report. Project WFD28, 44pp.

Scott A and Shannon P (2007). Local Landscape Designations in Scotland: Opportunity or Barrier to Effective Landscape Management? *Landscape and Urban Planning* **81**: 257-269.

Scottish Environment Protection Agency (2007). National Air Quality Report 2007. Scottish Environment Protection Agency, 53pp.

Scottish Environment Protection Agency (2008a). Strategic Environmental Assessment of the Draft Scottish river Basin Management Plan: Environmental Report. Report No. RT-HWY-237-0D Final, 54pp.

Scottish Environment Protection Agency (2008b). Clyde Draft Area Management Plan 2009-2015. Scottish Environment Protection Agency, 52pp.

Scottish Environment Protection Agency (2008c). Forth Draft Area Management Plan 2009-2015. Scottish Environment Protection Agency, 61pp.

Scottish Environment Protection Agency (2008d). Tay Draft Area Management Plan 2009-2015. Scottish Environment Protection Agency, 43pp.

Scottish Environment Protection Agency (2009a). The river basin management plan for the Scotland river basin district 2009–2015 Chapter 1: State of the water environment. Scottish Environment Protection Agency, 44pp.

Scottish Environment Protection Agency and Environment Agency (2009b). The river basin management plan for the Solway Tweed river basin district 2009–2015 Chapter 1: State of the water environment. Scottish Environment Protection Agency and Environment Agency, 30pp.

Scottish Executive Environment Statistics Online Webpages (accessed: July 2010) (http://www.scotland.gov.uk/Topics/Statistics/Browse/Environment/seso)

Scottish Executive (2008a). Key Scottish Environment Statistics. A National Statistics Publication for Scotland, 53pp.

Scottish Executive (2008b). The Scottish Soil Framework: A Consultation Document June 2008. Scottish Executive, Edinburgh, 75pp.

Scottish Natural Heritage (1996). Information and Advisory Note Number 50. The Natural Heritage Interest of Bings (Waste Tips) in Scotland. *Scottish Natural Heritage. http://www.snh.org.uk/publications/on-line/advisorynotes/50/50.htm*

Scottish Natural Heritage (2002a). Natural Heritage Futures: West Central Belt. Scottish Natural Heritage, 40pp.

Scottish Natural Heritage (2002b). Natural Heritage Futures: Border Hills. Scottish Natural Heritage, 40pp.

Scottish Natural Heritage (2002b). Natural Heritage Futures: Western Southern Uplands

and Inner Solway. Scottish Natural Heritage, 40pp.

Scottish Natural Heritage (2002c). Natural Heritage Futures: Eastern Lowlands. Scottish Natural Heritage, 36pp.

Scottish Natural Heritage (2002d). Natural Heritage Zones: A National Assessment of Physical Characteristics. Scottish Natural Heritage, 248pp.

Scottish Natural Heritage (2002e). Natural Heritage Zones: A National Assessment of Scotland's Landscapes. Scottish Natural Heritage, 445pp.

Silcock P, Swales V, Manley W, Jones J and Smith G (2003). A Long Term Policy Perspective for Sustainable Agriculture: The Potential Environmental Impacts of CAP Mid-Term Review Proposals. GFA-RACE Partners Limited in association with IEEP, final report for Defra, 65pp.

Steadman EJ, Mitchell P, Highley DE, Harrison DJ, Linley KA, Macfarlane M and McEvoy F (2004). Strategic Environmental Assessment (SEA) and Future Aggregate Extraction in the East Midlands Region. *British Geological Survey Commissioned Report* CR/04/003N, 105pp.

Stern N (2006). The Economics of Climate Change. Cambridge University Press, 712pp.

Sustainable Development in Government Webpage (accessed: March 2009) http://www.defra.gov.uk/sustainable/government/

Sustainable Farming and Food Strategy Indicators Webpage (accessed: March 2009). http://statistics.defra.gov.uk/esg/indicators/

Towers W, Grieve IC, Hudson G, Campbell CD, Lilly A, Davidson DA, Bacon JR, Langan SJ and Hopkins DA (2006). Scotland's Soil Resource – Current State and Threats. The Macaulay Institute and University of Stirling. Environmental Research Report 2006/01, 181pp.

UK Biodiversity Steering Group (1995). Biodiversity: The UK Steering Group Report - Volume I: Meeting the Rio Challenge. HMSO, 103pp.

United Nations Educational, Scientific and Cultural Organisation (2008). Operational Guidelines for the Implementation of the World Heritage Convention. Intergovernmental Committee For The Protection of the World Cultural and Natural Heritage. UNESCO, 163pp.

Welsh Assembly Government (2008). Sustainable Development Indicators for Wales: 2008. Welsh Assembly Government, 56pp.

Welsh Assembly Government (2009a). Air Pollution in Wales 2008: A Report of the Welsh Air Quality Forum. A report by AEA on behalf of the Welsh Assembly Government and Welsh Air Quality Forum, 16pp.

Welsh Assembly Government (2009b). State of the Environment: July 2009. Statistics for Wales. (http://www.statswales.wales.gov.uk/tableviewer/document.aspx?ReportId=5830)

Wicks M (2009). Energy Security: A National Challenge in a Changing World. An independent review supported by officials from the Department of Energy & Climate Change. Department of Energy & Climate Change, 123pp.

Widdicombe R (2008). Orchard Biodiversity Project: A Project Report on the Threats to Traditional Orchards from Development, Landscape and Environmental Change in Herefordshire and Worcestershire. A Report for Herefordshire Unitary Authority and Worcestershire County Council, 16pp.

Williams, JM (ed.) (2006). Common Standards Monitoring for Designated Sites: First Six Year Report. Peterborough, JNCC.

Yorkshire Forward (2008). A Carbon Capture and Storage Network for Yorkshire and Humber. An introduction to understanding the transportation of CO_2 from Yorkshire and Humber emitters into offshore storage sites. *Yorkshire Forward*, 58pp.