

**Final Report - Literature Review / Scoping Study on  
Cumulative Effects Assessment and the Strategic  
Environmental Assessment Directive**

**by, Emma James, Paul Tomlinson Vicky McColl and Chris Fry**

**PR SE/730/03**



**UNPUBLISHED PROJECT REPORT**

## **PROJECT REPORT PR SE/730/03**

# **LITERATURE REVIEW / SCOPING STUDY ON CUMULATIVE EFFECTS ASSESSMENT AND THE STRATEGIC ENVIRONMENTAL ASSESSMENT DIRECTIVE**

Version: Final

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## **EXECUTIVE SUMMARY**

This report draws together the results of a literature review / scoping study on cumulative effects assessment (CEA) and the Strategic Environmental Assessment (SEA) Directive (EC Directive 2001/EC/42/EC on the assessment of the effects of certain plans and programmes on the environment) carried out on behalf of the Environment Agency (the Agency) by the Centre for Sustainability (C4S) at TRL Limited. CEA is becoming an important issue because of the implementation of the SEA Directive and because of increasing evidence that the most significant environmental changes may not result from the direct effects of an individual action, but from the combination of multiple minor effects over the accumulation of time (US Council on Environmental Quality, 1997).

The SEA Directive will require an SEA of a plan or programme to consider the plan or programme's cumulative and synergistic effects. For the purposes of this report cumulative effects have been defined as effects that result from changes caused by a plan, programme or policy in association with other past, present or reasonably foreseeable future actions. A CEA will be carried out as part of the overall SEA process. The SEA Directive does not outline how such an assessment should be carried out. Draft guidance on the SEA Directive has been published by the Office of the Deputy Prime Minister (ODPM, 2002). This sets out some guidance on how to report the cumulative effects of plans and programmes. More guidance is expected in 2003 on how to carry out a CEA.

The Agency recognises that the Directive's requirement to consider cumulative effects presents an opportunity to assess and manage those effects which have to date been poorly considered. If cumulative effects are to be addressed they need to be considered as part of strategic decision making. At project level it is often too late. The Agency aims to push forward good practice both for its own work and that undertaken by others. However, the application of CEA to SEA within the UK is at an early stage and an agreed methodology does not exist. In order for the Agency to comply with the requirements of the Directive and maximise the opportunities it offers, research is required on CEA methodologies that can be used or adapted. This research was commissioned in recognition of this. The aims of the research set out in the project brief were to:

1. Identify tools and techniques that are available for undertaking CEA in relation to the requirements of the SEA Directive;
2. Identify what experience of undertaking CEA is available within and outside the Agency;
3. For the above two objectives identify project and multi-project level approaches that might be transferable to strategic level assessments as well as existing strategic level approaches;
4. Identify the wider applicability of CEA to existing tools, techniques and guidelines to the Agency. This should take account of factors including robustness; breadth of applicability; flexibility; ease of use; transparency; resources and data / information required for use and compatibility with other tools and techniques;

5. Identify gaps and make recommendations for future work to develop new and existing tools, techniques and guidelines to ensure the Agency can realise the opportunities and manage the risks associated with the implementation of the SEA Directive; and
6. The study should take into account the need to address cumulative impacts throughout the SEA process not just at the impact assessment stage.

The review was carried out between February and March 2003 and has focused on the following:

- The Agency's need for tools and techniques through consultation with Agency officers (a full list of consultees has been provided in Appendix D);
- The tools and techniques available for undertaking CEA at different stages of plan / programme making through a literature review and consultation with external practitioners; and
- Gaps in the available tools and techniques based on the literature review and the techniques currently used for environmental assessment within the Agency.

Consultations with Agency officers formed an important part of the study. The consultations found that:

- SEA is carried out within the Agency, but takes many different forms and follows different guidance;
- CEA is considered as part of the assessment of some plans and programmes but it is not done in a formalised or consistent way;
- There is a high level of interest amongst Agency officers on how CEA can help the Agency to meet its objectives;
- The Agency has not carried out any assessments that have been specifically identified as a CEA, although cumulative effects are considered in an informal way in some SEAs. Guidance is needed in the short term, focusing particularly on a procedural framework for CEA;
- Guidance is also needed on what the data requirements might be for CEA and what tool / techniques can be used in CEA such as cause – pathway – effects, network diagrams etc. Agency staff need to be shown how these may be useable;
- Clarification is needed on how to set the boundaries of the assessment (time boundaries and geographical boundaries); and
- The environment is constantly changing often due to small incremental changes – guidance is also needed on how to take this constant environmental change into account in the assessment.

The literature analysed as part of the study has been broken down into four types:

- UK and international governmental agency guidance – generally dealing with broad principles;
- Academic articles on broad principles;
- Topic based guidance – dealing with specific cumulative impacts e.g. erosion in a river basin;
- Case studies.

An analysis has also been made of traditional EIA and SEA tools that can be adapted for use in CEA.

The literature review confirmed that the majority of CEAs that had been carried out in the past were as part of project level assessments. However, these project level assessments in the main can be modified for use in strategic level assessment. The Agency itself has used many approaches to EIA and SEA in the past that can be modified to examine cumulative effects. These include scoping approaches such as quality of life capital, risk based approaches to environmental assessment, approaches to strategic coastal monitoring that could be adapted for use to monitor other types of resources and modelling approaches to assess projects, plans and programmes under the Habitats and Birds Directives.

Useful approaches were identified from the other sections of literature focusing on methods for identifying other plans and programmes and future actions within the plan / programme area and how to decide which to assess, checklists for use in scoping and impact prediction methods such as consensus building tools, causal chain analysis, matrices and impact pathway methods.

The study then matched the Agency's need for guidance as highlighted by the consultation with Agency officers, with the available guidance as evidenced by the literature review. It is recommended that the first step is to set up a CEA procedure possibly as part of the Agency Management System (AMS). This will then need to be augmented by more specific guidance relating to tools that can be used for CEA (checklists, matrices etc) and specific guidance related to certain types of plan and programme.

The study recommendations consist of a programme of research and development on CEA. After an analysis of the approach to cumulative effects contained in the draft ODPM guidance it has become clear the Agency is well placed to initiate its own research into how cumulative effects can best be predicted and presented. The programme of research and development suggested by this report will help the Agency maximise the opportunities afforded by CEA.

The forward programme is set in terms of three different timescales based upon the amount of work that would be required to bring them into effect.

- Short-term recommendations (2003 – 2004) for application before the Directive becomes a statutory requirement in 2004. These deal with the delivery of tools and techniques that are available now but may not be fully applied in the different spheres of Agency tasks.

- Medium term recommendations (2003 – 2006) for application by 2006. These will require some trial application of tools and techniques or the building of databases to allow their use.
- Longer term recommendations focus upon R&D activities that would be expected to be delivered over a 5-10 year period (2006 – 2013) before the results were in widespread use.



## CONTENTS

<b>EXECUTIVE SUMMARY .....</b>	<b>I</b>
<b>1. INTRODUCTION .....</b>	<b>1</b>
1.1. NEED FOR THE STUDY.....	1
1.2. THE STUDY BRIEF.....	2
1.3. THE SEA DIRECTIVE'S LINKS WITH OTHER REGULATIONS .....	3
1.4. STUDY METHOD .....	4
<b>2. CUMULATIVE EFFECTS.....</b>	<b>5</b>
2.1. INTRODUCTION .....	5
2.2. TYPES OF CUMULATIVE EFFECT .....	5
2.3. THE PRINCIPLES OF CEA .....	7
2.4. TECHNICAL CHALLENGES IN CARRYING OUT CEA.....	9
2.5. THE AGENCY'S ROLE IN CEA.....	9
<b>3. THE ROLE OF CEA IN SEA.....</b>	<b>11</b>
3.1. INTRODUCTION .....	11
3.2. PROJECT LEVEL CUMULATIVE EFFECTS .....	11
3.3. WHY CEA IS CENTRAL TO SEA .....	13
3.4. SCREENING .....	14
3.5. SCOPING .....	15
3.6. FORECASTING CUMULATIVE EFFECTS .....	16
3.7. MITIGATION AND ENHANCEMENT.....	18
3.8. MONITORING OF CUMULATIVE EFFECTS.....	19
3.9. REPORTING AND CONSULTATION.....	20
<b>4. GUIDANCE ON CUMULATIVE EFFECTS ASSESSMENT .....</b>	<b>23</b>
4.1. INTRODUCTION .....	23
4.2. UK AND INTERNATIONAL GOVERNMENT AGENCY GUIDANCE .....	23
4.2.1. <i>The Canadian Responsible Authorities Guide to CEA (1994)</i> .....	25
4.2.2. <i>The Canadian Cumulative Effects Assessment Practitioners Guide (1998)</i> .....	27
4.2.3. <i>US guidance - Considering Cumulative Effects under the NEPA (1997)</i> .....	29
4.3. GUIDANCE USED BY THE AGENCY .....	32
4.4. ACADEMIC LITERATURE .....	33
4.5. TOPIC BASED LITERATURE .....	34
4.6. CASE STUDIES .....	35
4.7. OIL SANDS PROJECTS IN NORTHERN ALBERTA: A REGIONAL STUDY APPROACH (ADAPTED FROM CANADIAN ENVIRONMENTAL ASSESSMENT AGENCY, 1998).....	35
4.7.1. <i>Introduction</i> .....	35
4.7.2. <i>Scoping</i> .....	36
4.7.3. <i>Impact Identification and Assessment</i> .....	36
4.7.4. <i>Determining the Significance of the Impacts</i> .....	37
4.7.5. <i>Lessons to be Learnt</i> .....	38
4.8. LIVERPOOL BAY (ADAPTED FROM OAKWOOD ENVIRONMENTAL LTD, 2002).....	39
4.8.1. <i>Introduction</i> .....	39
4.8.2. <i>The Assessment framework</i> .....	40
4.8.3. <i>Lessons to be Learnt</i> .....	41
4.9. INTEGRATED APPRAISAL FOR RIVER BASIN MANAGEMENT PLANS – RIVER RIBBLE CASE STUDY (ADAPTED FROM ANDREWS ET AL, 2003). .....	41
4.9.1. <i>Introduction</i> .....	41
4.9.2. <i>Stages of the Appraisal</i> .....	41
4.9.3. <i>Strengths and Weaknesses of the Approach</i> .....	43
4.9.4. <i>Lessons to be Learnt</i> .....	43
4.10. LONDON TIDAL FLOOD DEFENCES STRATEGIC ENVIRONMENTAL FRAMEWORK .....	44
4.10.1. <i>Introduction</i> .....	44
4.10.2. <i>Assessment Framework</i> .....	44

4.10.3. Lessons to be Learnt .....	45
<b>5. THE AGENCY’S NEED FOR TOOLS AND TECHNIQUES .....</b>	<b>47</b>
5.1. INTRODUCTION .....	47
5.2. VIEWS EXPRESSED BY AGENCY OFFICERS .....	47
5.3. OTHER ENVIRONMENTAL ASSESSMENT TOOLS.....	51
5.4. PRODUCING CEA GUIDANCE FOR THE AGENCY .....	61
5.4.1. Production of a Generic CEA Framework .....	61
5.4.2. Developing Plan and Programme Specific Guidance .....	61
5.4.3. Outstanding Procedural Issues.....	69
<b>6. RECOMMENDATIONS.....</b>	<b>72</b>
<b>7. CONCLUSIONS .....</b>	<b>76</b>
<b>REFERENCES .....</b>	<b>78</b>
<b>GLOSSARY .....</b>	<b>84</b>
<b>APPENDICES.....</b>	<b>88</b>
<b>APPENDIX A: AGENCY GUIDANCE.....</b>	<b>88</b>
<b>APPENDIX B: ACADEMIC LITERATURE ON CEA.....</b>	<b>94</b>
<b>APPENDIX C: TOPIC BASED GUIDANCE .....</b>	<b>99</b>
<b>APPENDIX D: AGENCY STAFF AND OTHER CONSULTEES .....</b>	<b>107</b>
<b>APPENDIX E: QUESTIONS FOR INTERVIEWS WITH AGENCY OFFICERS.....</b>	<b>109</b>

## 1. INTRODUCTION

### 1.1. Need for the Study

The Strategic Environmental Assessment (SEA) Directive (Directive 2001/42/EC on the assessment of certain plans and programmes on the environment) will impose new duties and responsibilities on the Environment Agency (the Agency) as a statutory consultee, a data provider and producer of plans and programmes.

The SEA Directive will require an SEA of a plan or programme to consider the plan or programme's cumulative and synergistic effects. For the purposes of this report cumulative effects have been defined as effects that result from changes caused by a plan, programme or policy in association with other past, present or reasonably foreseeable future actions. A CEA will be carried out and reported as part of an SEA within an environmental report but is likely to be a distinct procedure that the plan or programme maker needs to go through as part of the overall SEA process. However, the SEA Directive does not give any further guidance on cumulative effects assessment (CEA) that may help organisations judge the likely implications of this requirement.

The Directive does, however, provide guidance on other issues that will have a bearing on how a CEA is carried out as part of an overall SEA process. The SEA Directive requires the following information to be provided:

- An outline of the contents of a plan or programme and relationship with other plans and programmes. (*This identification of other plans and programmes is likely to be useful when deciding the other plans and programmes the CEA should take into account*);
- Baseline studies - the relevant aspects of the state of the environment and the likely evolution without the plan or programme, the environmental characteristics of areas likely to be significantly affected and any existing environmental problems. (*To assist with the CEA element of the SEA this will need to identify the actions (apart from the plan under review) that are causing changes to the environment*));
- Environmental protection objectives relevant to the plan or programme;
- Likely significant effects on the environment including on issues such as biodiversity, population, human health, flora, fauna, soil, water, air, climatic factors, material assets, cultural heritage including architectural archaeological heritage, landscape. The inter-relationship between the environmental factors must also be assessed. Effects should include secondary, cumulative, synergistic, short, medium and long term, permanent and temporary, positive and negative. (*Significant cumulative effects must be assessed for these same environmental issues and impact types*).
- The mitigation measures envisaged to prevent and reduce the environmental effects. (If a CEA identifies that the plan or programme will have unacceptable issues in association with the plan or programme of another organisation, strategic mitigation may have to be undertaken);
- Assessment of reasonable alternatives and the reason for selecting the alternative dealt with. (*The CEA must also consider alternatives*); and

- An outline of the monitoring undertaken. (*This monitoring must also include cumulative effects, which are likely to be difficult to monitor*).

The assessment must take into account the views of stakeholders during the process.

The definition of significant effects within the Directive is also important. The Directive states that the cumulative nature of the effects of the plan are an important criteria when taking the decision on whether the impacts of a plan or programme is significant and, therefore, should be subject to an assessment. This means that CEA is likely to take an important part in overall SEA screening.

Draft guidance on the SEA Directive has been published by the Office of the Deputy Prime Minister (ODPM, 2002). This sets out some guidance on how to report the cumulative effects of plans and programmes. More guidance is expected in 2003 on how to predict the cumulative effects of a plan or programme. However, whilst the ODPM guidance expands on the SEA Directive's requirements, it is guidance for land use plans and programmes and generic in its consideration of CEA. Additional guidance and training is required for Agency staff to ensure the CEA requirements of the Directive are met.

The Agency has recognised that the Directive's requirement to consider cumulative effects present an important opportunity to assess and manage those effects which to date have been poorly considered. This is despite the fact that they are an important component of the environmental impact of strategic decisions. If cumulative effects are to be addressed they need to be considered as part of strategic decision making. At project level it is often too late. The Agency aims to push forward good practice both for its own work and that undertaken by others. However, the application of CEA to SEA within the UK is at an early stage and an agreed methodology does not exist. In order for the Agency to comply with the requirements of the Directive and maximise the opportunities it offers, research on CEA methodologies that can be used or adapted by the Agency is required. This activity needs to be linked to all stages of the SEA process as outlined in draft ODPM guidance (ODPM, 2002) not just the issue of impact prediction. Plan and programme makers need to think about cumulative effects at all stages of the plan / programme making process.

## **1.2. The Study Brief**

This report draws together the results of a literature review / scoping study on cumulative effects assessment (CEA) and the Strategic Environmental Assessment (SEA) Directive carried out on behalf of the Agency by the Centre for Sustainability (C4S) at TRL Limited.

The aims of the research set out in the project brief were to:

1. Identify tools and techniques that are available for undertaking CEA in relation to the requirements of the SEA Directive;
2. Identify what experience of undertaking CEA is available within and outside the Agency;
3. For the above two objectives identify project and multi-project level approaches that might be transferable to strategic level assessments as well as existing strategic level approaches;
4. Identify the wider applicability of SEA to existing tools, techniques and guidelines to the Agency. This should take account of factors including robustness; breadth of

applicability; flexibility; ease of use; transparency; resources and data / information required for use and compatibility with other tools and techniques;

5. Identify gaps and make recommendations for future work to develop new and existing tools, techniques and guidelines to ensure the Agency can realise the opportunities and manage the risks associated with the implementation of the SEA Directive; and
6. The study should take into account the need to address cumulative impacts throughout the SEA process not just at the impact assessment stage.

This literature review and scoping study is not intended to provide a definitive answer to what the Agency needs to do to address cumulative effects assessment within SEA, but will highlight the gaps that need addressing in future research and development. The effective identification and assessment of cumulative effects will help to provide more effective protection for the environment as a whole and, if carried out properly, may reduce the workload of assessment at the project stage, increasing efficiency and ensuring Agency interests are sufficiently addressed within the plans and programmes of other agencies.

### **1.3. The SEA Directive's Links with Other Regulations**

There are important links to be made with both the Conservation (Natural Habitats &c) Regulations, the Birds Directive and the Water Framework Directive.

The Habitats and Birds Directive and Conservation (Natural Habitats &c) Regulations require a review of both new and existing consents granted by the Agency that may affect or potentially affect a European Natura 2000 site. The Regulations require that where an application for consent is likely to have a significant effect on the site (either alone or in combination with other plans / programmes and projects) the competent authority should make an appropriate assessment of the implication for the site in view of that site's conservation objectives.

The Water Framework Directive introduces an integrated approach to water management that is based on catchment management. River Basin Management Plans will be the vehicle for delivering the requirements associated with integrated management, the main stages of which are:

- An assessment of the current state of the catchment, the human and natural pressures and their impacts on the water;
- An assessment of whether the objectives of the Directive are likely to be met looking at both biological and chemical parameters;
- Scientific, technical and economic appraisals of different improvement options; and
- Establishment of a programme of measures.

Both of these regulations potentially involve consideration of cumulative impacts or cumulative changes to the environment. The Agency will have to consider carefully how the forward programme of research on CEA can be utilised to assist particularly in the assessment of River Basin Management Plans and Programmes of Measures required under

the Water Framework Directive. The existing methods used in in-combination assessments for the Habitats Directive may be useful in the development of CEA methodologies.

#### **1.4. Study Method**

This review has focused on the following:

- The Agency's need for tools and techniques through consultation with Agency officers (a full list of Agency officers consulted has been provided in Appendix D);
- The tools and techniques available for undertaking CEA at different stages of plan / programme making through consultation with external practitioners (a full list of practitioners consulted has been provided in Appendix D) and a literature review focusing on the following:
  - Governmental or Agency Guidance – generally dealing with the broad principles;
  - Academic articles on broad principles;
  - Issue specific guidance – dealing with specific cumulative impacts e.g. erosion in a river basis; and
  - Case studies.

The report concludes by analysing the gaps in the available tools and techniques and making recommendations on what guidance, research, training and awareness-raising is needed to ensure that the Agency complies with the CEA requirements of the SEA Directive.

## 2. CUMULATIVE EFFECTS

### 2.1. Introduction

The assessment of cumulative impacts reflects a broadened perspective on the nature of human-environment interactions. This perspective acknowledges that:

- Environmental change originates not only from single projects but also from interactions of multiple projects (sometimes contained within a plan or programme). These interactions need to be considered in planning to ensure that environmental limits are not breached; and
- Environmental change accumulates through additive or interactive processes. The impact of two actions on the environment can be complex and may result in environmental degradation that is worse than originally thought because of interactions between projects. These can be chemical, biological or physical interactions (Wood et al, 1997).

Although the SEA Directive does not define CEA and it is not yet a common practice within the UK, CEA has been practised in some countries for a number of years (in the case of the USA, since the 1960's). It does, therefore, use some common terms and concepts that require some clarification. A glossary of terms has been included at the end of this report after the references, and this chapter will further explain some of these terms and present them within a context that is relevant to the Agency.

Cumulative impacts, cumulative effects and cumulative environmental change are terms which are often used interchangeably (Spaling, 1995). For the purposes of this report these terms are taken to mean the same thing although for the most part, the term 'cumulative effects' is used. The concept of cumulative change is based on the premise that the impacts of individual independent actions are not mutually exclusive to each other, rather they may accumulate, interactively or additively to bring about significant environmental change (Bonnell, 1997).

A recent practitioner guide prepared for the Canadian Environmental Assessment Agency (CEAA) (Hegmann et al. 1999) defined cumulative effects as:

*...changes to the environment that are caused by an action in combination with other past, present and future human actions.*

Also pertinent to this study, is the definition in European Union guidance on CEA (Commission of the European Communities, 1993), which defines cumulative impacts as:

*The accumulation of human induced changes in valued environmental components across space and over time; such impacts occur in an additive or interactive manner.*

### 2.2. Types of Cumulative Effect

Cumulative effects can occur in various ways. Table 2.1 sets out the main forms of cumulative environmental effects.

Table 2.1: Examples of cumulative effects (Adapted from US Council on Environmental Quality, 1997)

Type	Main characteristics	Example
<i>It is important to note that cumulative effects can be positive as well as negative</i>		
Time crowding	Frequent and repetitive effects on an environmental system	Fishing rate exceeds breeding / replacement rate
Time lags	Delayed effects	Exposure to carcinogens
Space crowding	High spatial density of effects on environmental system	Pollution discharges into streams from non-point sources
Cross-boundary	Effects occur away from the source	Acidic precipitation Upland afforestation and grazing control improving water quality and reducing flooding down stream.
Fragmentation	Change in landscape pattern	Fragmentation of historic districts or habitats
Compounding effects	Effects arising from multiple sources or pathways	Synergism among pesticides
Indirect effects	Secondary effects	Induced development following construction of infrastructure Water quality improvements in regeneration areas eg dock areas contributing to property value increases.
Triggers and thresholds	Fundamental changes in system behaviour or structure	Global climate change

The model of source, pathway and receptor is useful when considering the varied ways that impacts accumulate. The table above demonstrates some of the different sources and pathways of cumulative effects. Effects also impact upon receptors in different ways. Effects can impact upon receptors through additive or interactive processes. Additive effects are those where the impacts may be combined in a straight forward manner, while interactive or synergistic effects lead to a net decrease in environmental quality that differs from the simple summation of the impacts, i.e. the result may be greater than the sum of the parts. The SEA Directive specially requires the assessment of a plan or programme's synergistic effects. Table 2.2 sets this out more clearly by giving examples.



Table 2.2: Additive and interactive effects

	<b>Additive Process</b>	<b>Interactive / Synergistic Process</b>
<b>Single Action</b>	Repeated effects from a single proposal e.g. effects of highway de-icer on aquatic systems.	Effects from a single action that interact with the resource in a complex manner e.g. bio-accumulation of PCBs from various industrial sources in the food chain.
<b>Multiple Actions</b>	Repeated effects from multiple sources e.g. Effects of various de-icers from different roads draining into the same catchment	Effects from multiple sources affecting resources in a non-linear manner, e.g. discharge of nutrients from point discharges (sewage works) and non point discharges leading to algal blooms and lowering of dissolved oxygen.

### 2.3. The Principles of CEA

The concept of cumulative effects has existed since the inception of formal environmental assessment systems around the world due to a recognition of the complexity of environmental systems and the effects that development can have on them. Evidence is increasing that the most important environmental changes may not result from the direct effects of an individual action, but from the combination of multiple minor effects over the accumulation of time (US Council on Environmental Quality, 1997).

Table 2.3 is adapted from the US Council on Environmental Quality (1997) and sets out the principles of cumulative effects analysis.

Table 2.3: The principles of cumulative effects assessment

<p><b><i>Cumulative effects are caused by the aggregate of past, present, and reasonably foreseeable future actions</i></b></p> <p>The effects of a proposed action on a given resource include the present and future effects added to the effects that have taken place in the past. If an environment is already degraded the effects of new plans or programmes on this environment may be more serious. Consideration of quality of the environment before the project, plan or programme is implemented is vital to predict what the quality of the environment will be after the project, plan or programme is implemented.</p>
<p><b><i>Cumulative effects are the total effect, including both direct and indirect effects, on a given resource, ecosystem, and human community of all actions taken, no matter who has taken the action</i></b></p> <p>Individual effects from disparate activities may add up to or interact to cause additional effects not apparent when looking at the individual effects one at a time. The practicalities of this are complicated in terms of whose responsibility the assessment is.</p>
<p><b><i>It is not practical to analyse the cumulative effects of an action on every environmental receptor, the list of environmental effects must focus on those that are truly meaningful</i></b></p> <p>For cumulative effects analysis to help the decision-maker and inform interested parties, it must be limited to effects that can be evaluated meaningfully. Boundaries must be set so analysts are not attempting to measure effects on everything. The significant effects of the action should be chosen through careful scoping.</p>
<p><b><i>Cumulative effects on a given resource, ecosystem, and human community are rarely aligned with political or administrative boundaries</i></b></p>

Cumulative effects analysis on natural systems must use natural ecological boundaries and analysis of human communities must use actual sociocultural boundaries to insure including all effects. Analysis of effects cannot stop at a county boundary. However, this causes problems with mitigation and monitoring of effects if the plan / programme makers have no jurisdiction to implement mitigation outside of their administrative area.

***Cumulative effects may result from the accumulation of similar effects or the synergistic interaction of different effects***

Repeated actions may cause effects to build up through simple addition (more and more of the same type of effect), and the same or different actions may produce effects that interact to produce cumulative effects greater than the sum of the effects.

***Cumulative effects may last for years beyond the life of the action that caused the effects***

Some actions cause damage lasting far longer than the life of the action itself (e.g., acid mine drainage, radioactive waste contamination, species extinction). Cumulative effects analysis needs to apply the best science and forecasting techniques to assess potential catastrophic consequences in the future.

***Each affected resource, ecosystem, and human community must be analysed in terms of its capacity to accommodate additional effects, based on its own time and space parameters***

Analysts tend to think in terms of how the resource, ecosystem, and human community will be modified given the actions development needs. The most effective cumulative effects analysis focuses on what is needed to ensure long-term productivity or sustainability of the resource.

The Canadian Environmental Assessment Agency in their Cumulative Effects Assessment Practitioners Guide (Hegmann et al, 1999) has set out what cumulative effects assessments are expected to do. The guidance states that:

*CEA is environmental assessment as it should always have been: an Environmental Impact Assessment (EIA) done well. In practice, the assessment of cumulative effects requires consideration of some concepts that are not always found in conventional approaches followed in EIAs. Specifically, a CEA is typically expected to:*

- *Assess effects over a larger (i.e., "regional") area that may cross jurisdictional boundaries; [Includes effects due to natural perturbations affecting environmental components and human actions.]*
- *Assess effects during a longer period of time into the past and future;*
- *Consider effects on Valued Ecosystem Components (VECs) due to interactions with other actions, and not just the effects of the single action under review;*
- *Include other past, existing and future (e.g., reasonably foreseeable) actions; and*
- *Evaluate significance in consideration of other than just local, direct effects.*

## 2.4. Technical Challenges in Carrying out CEA

There are numerous technical challenges associated with CEA both as applied to project level assessments and plan / programme level assessments. These challenges have been set out in Table 2.4. Section 3 of this report outlines these in more detail as they apply to project / programme level CEA.

Table 2.4: Technical challenges in CEA

<b>Challenges specific to the different stages in an assessment (stages adapted from ODPM, 2002 and Environment Agency, 2003b)</b>	
<b>CEA Stage</b>	<b>Challenges</b>
<b>Screening (does the plan / programme require SEA)</b>	Will the plan / programme require an SEA? CEA is required as part of an SEA. The cumulative nature of the impacts of a plan or programme may help to define whether an impact is considered significant. Therefore, when assessing the significance of the plan or programme, CEA may become important.
<b>Identify other plans / programmes, objectives and problems</b>	How far can analysts go in looking at the combined effect of their plan / programme with other plans / programmes.
<b>Select the baseline including forward and backcasting (data on trends)</b>	How can trends in the baseline environment be identified? How can the effects of future issues such as climate change be built into the assessment? What will the environment be like in 20-30 years time if the plan / programme is not implemented?
<b>Scoping</b>	To what extent should cumulative effects inform the setting of objectives? How should the temporal and spatial boundaries of the assessment be chosen? Which aspects of the environment need to be looked at? If cumulative effects are likely to be important, more aspects of the environment may need to be analysed than is first apparent.
<b>Option and policy identification and assessment</b>	How can analysts ensure that indicators are sufficiently focused to be able to identify and assess cumulative effects? Outcome focused indicators are likely to identify more impacts than action focused indicators. How can the relative contribution made by particular actions be judged, recognising that the last action although small may be sufficient to breach an environmental threshold?
<b>Impact assessment</b>	What tools can be used to judge the magnitude and significance of cumulative and synergistic impacts and hence the significance of multiple impacts?
<b>Mitigation</b>	How can the different parties' responsibility for mitigation be identified? Should mitigation aim to offset the effects of the plan / programme or aim to seek environmental enhancement?
<b>Consultation</b>	How can input from other interested parties be assured?
<b>Monitoring</b>	How practical is it to define monitoring programmes to address cumulative effects? Is state of the environment reporting adequate?

## 2.5. The Agency's Role in CEA

The Agency is the most important environmental protection body in England and Wales although not responsible for all activities that cause environmental change. The Agency's roles in SEA and CEA are:

***Regulator including enforcement / compliance assessor and prosecutor***

The Agency regulates various activities and processes. As part of this role the Agency may require an applicant to provide certain information and/or undertake assessments of activities. An important Agency work area is the Review of Consents under the Conservation (Natural Habitats &c) Regulations. An assessment must be carried out on all Agency permissions to determine whether each permission/activity either on its own or in combination with others is having an adverse effect on a Natura 2000 site.

***Developer and operating authority***

The Agency undertakes capital and revenue works (such as flood defence and navigation schemes as part of Catchment Flood Management Plans and Flood Defence Strategies) and as part of this role the Agency uses appraisal to inform plans, programmes and strategies to guide future work.

***Plan and programme maker***

The Agency produces a number of plans and programmes that are likely to require SEA and CEA such as National and Regional Water Resources Strategies, Catchment Abstraction Management Plans (CAMS) and Waterways Plans. A legal review is underway within the Agency in order to ascertain which of the Agency's plans and programmes may be subject to the requirements of the SEA Directive.

***Consultee and advisor***

The Agency advises central, regional and local government and other government agencies on the likely significant environmental effects of their plans and programmes. As part of this role the Agency will become involved in assessments where it is not the competent authority but rather a provider of information, data and expert judgement.

### **3. THE ROLE OF CEA IN SEA**

#### **3.1. Introduction**

This Chapter explores why the successful application of CEA is crucial to the outcome of a successful SEA process. Reflecting upon the application of cumulative effects assessment within project level EIAs, the Chapter sets out the key arguments that have been used to promote the application of CEA within SEA.

#### **3.2. Project Level Cumulative Effects**

Much of the CEA literature highlights the inadequacies of project by project CEA. It is difficult to address cumulative impacts within a project level assessment because traditional project level EIA does not normally address concerns associated with gradual environmental change from a range of activities and multiple stresses (Fuller and Sadler, 1999).

A recent review was carried out on the assessment of cumulative effects within UK environmental statements (Cooper and Sheate, 2002). The review examined 50 UK environmental statements submitted between 1989 and 2000 and recognised that although the assessment of cumulative effects has been required since the EC Directive (85/337/EEC) was issued, they are still inadequately addressed in most environmental statements.

Table 3.1 outlines the results of the study (taken from Cooper and Sheate, 2002)

Table 3.1: The results of the Cooper and Sheate study (2002)

Sample of environmental statements = 50			
Mentioned cumulative effects	24	No mention of cumulative effects	26
Provided a definition of cumulative effects	8		
Referred indirectly to cumulative effects by using the terms combined effects, in-combination effects or interaction of effects	4		
Identified potential cumulative effects	15	Concluded that there were no cumulative effects without an assessment	1
Considered cumulative effects	13	Concluded that cumulative effects were insignificant without assessment	4
Addressed cumulative effects by providing some analysis	9		
Discussed cumulative effects for all affected resources:	5	Discussed cumulative effects for some affected resources:	4
		Identified other developments	3
Identified other developments	1	Identified only similar developments	1
Identified only similar developments or actions	2	Identified no other actions	0
Identified one other action	2		

NB. The environmental statements may fall into more than one category. i.e. a plan may have mentioned cumulative effects and provided a definition of cumulative effects. Therefore, the numbers do not add up to 50.

The environmental statements that did assess cumulative effects did so using a number of concepts (Cooper and Sheate, 2002):

- Cumulative effects as residual effects from earlier projects (Thames Gas Pipeline and Belvedere Combined Heat and Power Plant EISs);
- Cumulative effects as a combined effect of two projects (the Channel Tunnel Rail Link (CTRL) and M2 EISs);
- Interactions of impacts of the project (Stonecastle Farm Quarry EIS and Westhay Heath EIS);
- Impacts from the proposed project and from other past, present and future projects / actions (Ebbsfleet Development); and
- Impacts of the different elements of a scheme (i.e. the combined impact of a housing scheme and its associated infrastructure as in the Swale Gateway EIS and Otterburn EIS).

Table 3.2. (also adapted from Cooper and Sheate, 2002) examines the issues that were considered and approaches taken as part of some of these impact statements. The study found that the systematic consideration of cumulative effects was only found in three environmental statements – the CTRL and M2 widening which considered combined effects and the Swale EIS and the Otterburn EIS which considered the cumulative effects of the development

within their scheme. The review reaffirmed that CEA carried out as part of a project level assessment is difficult because of uncertainties over temporal and spatial boundaries. It is difficult for an EIA to assess outside the geographical and temporal boundaries of the proposed project. Setting wider boundaries is vital to CEA and is the main reason why CEA is better carried out at the strategic level.

Table 3.2: Issues considered and approaches taken to CEA in environmental statements in the UK

Projects	VECs	Approaches	Comments
CTRL and M2. High speed railway and road widening	Landscape character, ancient woodland	Professional judgement	Qualitative assessment of all affected resources, quantified assessment of noise from operations; considered the combined effects of the two projects
Swale Gateway. Integrated assessment of four potential property development sites	Landscape character and visual amenity	Professional judgement	Qualitative assessment of changes in landscape character and views; considered the combined effects of the four projects within the development
Otterburn Training Area. Road strengthening and widening, new facilities for gun spurs and new accommodation blocks	Landscape character, visual amenity, recreation and heritage sites	Professional judgement	Qualitative assessment of all affected resources, assessed alongside direct and indirect impacts; considered the effects of different actions within a programme
Ebbsfleet Development. Mixed use developments including commercial, residential and leisure and commercial developments	Landscape character, visual amenity, Ebbsfleet marshes, water resources and quality	Professional judgement and use of findings from previous studies	Qualitative assessment of all affected resources; considered other projects

### 3.3. Why CEA is central to SEA

Analysts have been arguing for many years that cumulative environmental effects are best considered at the policy, plan and programme level (for example, Clarke, 1994). The temporal and geographical scales of analysis used at the project level are insufficient to comprehensively assess cumulative effects. There are numerous data, jurisdictional and methodological obstacles inhibit cumulative environmental assessment (CEA) at the project level (Canter and Kamath, 1995).

It is helpful to distinguish between different types of plans and programmes as the contribution of CEA will differ according to the plan or programme type. Fry et al (2002) identified three types of plans or programmes that may be subject to the SEA Directive. These are:

**Policy-orientated** – overarching plan for considering proposals that are not location-specific (e.g. Regional Planning Guidance);

**Area-wide plans** - broad characterisation of the entire study area to consider location-specific proposals within a wide geographic extent (e.g. Tourism plans);

**Specific Zones** – where more detailed assessment may be required to consider local proposals (e.g. corridors within Local Transport Plans). These proposals may be identifiable as projects which, if they proceed, will subsequently require project level EIA.

The application of CEA is likely to be different for each of these. Policy orientated proposals (such as Regional Planning Guidance, Structure Plans and Shoreline Management Plans) do not, as such set out likely developments (or zones for development) that could be assessed in combination with the effects of other developments in an area. Rather they set out policies that guide development in the area such as the policies on development on greenfield land. Professional judgement is likely to be required in order to assess what the cumulative impact of these policies are in concert with the policies of other organisations. Many policy orientated plans carry out, as part of their sustainability appraisal, a consistency analysis that analyses how consistent the plan is with other organisation's policies. It may be possible to extend this analysis to consider what the combined effects of the policies may be. It has been recognised that in broad terms the objectives and indicators-led approach (which is more reliant on professional judgement than quantitative analysis) is most suitable for the assessment of policy orientated plans (Fry et al, 2002). This makes it likely that CEA carried out on policy orientated proposals will be based on professional judgement.

Area wide plans / programmes and zonal proposals within plans or programmes contain a number of location specific projects. CEA for such proposals is likely to be vital, as the judgement of what the environmental impact of the plan / programme may be will rely on analysing the cumulative effects of the individual projects.

In practice, most plans and programmes tend to be a combination of these different elements – i.e. a Development plan will contain both zones of development and policies. The exact form of CEA undertaken for different plans or programmes is likely to be different for each type of plan / programme and the methods used for CEA are likely to develop in the future.

The following sections will review the main stages of a strategic environmental assessment and explain how cumulative effects have previously been addressed within these.

### **3.4. Screening**

Screening involves determining whether there is a requirement to undertake an SEA of a plan or programme and whether CEA is required as a part of this. There are two elements to this consideration. Firstly, whether the plan / programme requires an SEA. It is unclear at the time of writing which plans and programmes within the UK will require SEA. The second consideration is whether plans / programmes will require CEA as part of the SEA. As stated by the Directive, where certain plans or programmes are likely to give rise to significant effects then they are to be subject to a SEA. Such effects should include consideration of their cumulative effects.



The cumulative nature of effects becomes important in the screening process itself. The cumulative nature of the effects is one criteria that can be used to judge their significance and whether the plan or programme should be subject to the requirements of the Directive.

### **3.5. Scoping**

Scoping has two purposes. Firstly it helps identify appropriate boundaries and issues of concern on which to focus an assessment. Secondly it ensures that data collection and assessment is limited to only those issues required to address the impacts (Kingsley, 1997). There is further complexity when assessing cumulative effects because it is important to avoid assessing more than necessary. This can be difficult because the scope of a CEA can be very wide.

Essentially there are five tasks which must be carried out within the scoping stage of a CEA that is being carried out as part of an SEA. These are common themes and were reflected in the majority of literature reviewed for this study (for example, see Davies (1992), Kingsley (1997), Kotze (2001) and the US Council of Environmental Quality (1997)). The key activities are as follows:

#### **Identification of Potential Issues and Problems**

Kingsley (1997) suggests that identifying potential cumulative impacts of plans and programmes requires taking account of natural dynamics and the current state of a natural system. Several mechanisms for undertaking an initial review have been suggested. For example Canter and Kamath (1995) proposed a questionnaire checklist questionnaire approach. The questionnaire checklist approach involves identifying which issues are important and documenting how they are selected for further technical analysis. It is important within CEA to identify problems in terms of those environmental components that are in decline and are near to their threshold. These environmental components may not be able to cope with the multiple stresses of the cumulative effects of different plans and programmes.

#### **Selection of Valued Environmental and Community Resources and Future Objectives**

An examination of cumulative impacts requires the considerations of impacts on both valued environment and community resources. It is not possible to assess the plan or programme's impact on every receptor. Therefore, it is necessary to define those resources that are particularly valued by the community or vital to the healthy functioning of the environment. SEA (as outlined in the ODPM guidance) requires the selection of environmental / sustainability objectives. The choice of objectives used in CEA will generally be those selected for the overall SEA process. However, in certain circumstances where there are parts of a plan or programme where there is a strong project element or spatial definition i.e. in a Local Development Document Action Plan, and where it is known that the effects of many plans and programmes will impact upon one area (i.e. there may be combined effects of a housing development, a flood development scheme and a transport plan) a CEA analysis may need to select more locally defined objectives. These objectives will need to define what is important within that particular area.

### **Establish Spatial Boundaries**

The setting of spatial boundaries involves finding a balance between the constraints of time, budget and data availability, and the need to adequately address environmental effects that could extend for considerable distances away and into the future. Establishing spatial boundaries includes both an examination of the effects resulting from the plan or programme and spatial boundaries of the valued resources.

### **Establish Temporal Boundaries**

Cumulative effects need to be considered in terms of a specified time period. *How far back in time* and *how far ahead in time* the assessment considers is dependent upon the environmental and community resource. It is also dependent upon the time frames of the effects any individual actions / policies within a plan or programme. Different actions and policies within a plan / programme may be implemented over different time scales or the effects may become apparent over different time scales. This needs to be addressed within scoping whilst recognising that uncertainties increase with projections further into the future.

### **Identification of Past, Present and Reasonably Foreseeable Future Actions**

To identify cumulative effects, there is a need to consider the state of the environment, past and likely future environmental trends and the valued qualities that are being actively managed. Identifying past, present and future activities can often be difficult, as empirical evidence can be scarce as noted by Rumrill and Canter (1997). However, the assessment should only concentrate on those impacts that have had a major influence on future quality of the resource.

The classification of future actions can be considered in the following ways:

- Hypothetically: *There is a considerable uncertainty whether the action will ever proceed;*
- Reasonably foreseeable: *The action may proceed but there is some uncertainty;*
- Certain: *The action will proceed or there is a high probability the action will proceed.*

### **3.6. Forecasting Cumulative Effects**

While several approaches are available to assist in the assessment of cumulative effects, there is no single approach applicable to all situations. Table 3.3 presents some of the assessment methods that are available.

Table 3.3: Some of the methods available to assess cumulative effects (adapted from Canadian Environmental Assessment Agency, 1998).

Tool	Examples of Use
Impact Models	Detailed assessment of cause-effect relationships between an action and valued resources.
Spatial Analysis using a GIS	Quantifying physical properties of actions (e.g., length of roads, area of cleared land) and changes to landscape features (e.g., loss of wildlife habitat)
Landscape Level Indicators of Change	Providing numerical values that represent large-scale disturbances or change
Numerical Modelling	Quantifying physical-chemical constituents (e.g. air and water quality)

Selection of the most appropriate tools can be based on consideration of the following:

- Ability to organise, analyse and present information;
- Stage of the assessment (e.g. scoping, baseline data collection, analysis, reporting);
- Types of issues;
- Types of disturbances and effects;
- Types of valued resources being examined;
- Quality and extent of baseline data;
- Level of expertise available; and
- Resources available to meet the needs of decision-makers.

Where uncertainties remain about future actions a review of environmental trends may be more appropriate. Hegmann and Yarranton (1994) propose the following issues on which to base the data assembly activities for a review of environmental trends:

- What valued resources may be affected?
- What parameters are best used to measure the effects?
- What determines the present condition?
- How will the proposed action in combination with existing and approved actions affect their condition?
- What are the probabilities of occurrences and probable duration of such effects?
- What ability does the resource have to absorb further effects before changes become irreversible?
- What degree of certainty can be attached to the estimates of occurrences and magnitude of these predicted effects?

Uncertainty in predicting effects and determining significance can arise due to the variation in natural systems, a lack of information, knowledge or scientific agreement regarding cause-effect relationships, or the inability of predictive models to accurately represent complex systems. However, the level of risk and uncertainty associated with cumulative effects increase at the planning level because generally, scales are broader and issues are larger.

There are many systems to manage risk and uncertainty. One system that may prove to be useful in managing risk and uncertainty in CEA is the Italian Flag Method. This is a policy

appraisal concept that attempts to assign issues into three different risk and uncertainty zones. If an issue is in the green zone it means that the policy-maker has all the information needed to make a judgement on what the impact of that policy, plan, programme or project may be and has classified it as an insignificant risk. If the issue is in the red zone, it means again that the information is available but that it has been classified as a significant risk. Issues in the white zone are issues where there is inadequate information to make a judgement. The attention of the policy maker should be focused on reducing these uncertainties to reduce the amount of issues classified as white. The method is currently being investigated by the Highways Agency for use in environmental assessment.

The assessment of alternatives is important in SEA and in CEA. The SEA Directive requires the assessment of reasonable alternatives taking into account the objectives and the geographical scope of the plan or programme. The main consideration of CEA is to ensure that different alternative options that are selected for testing as part of the SEA are also assessed for their cumulative impacts. The assessment of cumulative impacts of different options could become an important way to screen out unacceptable options, as the use of CEA becomes more widespread.

### **3.7. Mitigation and Enhancement**

Mitigation of environmental effects is vital if the SEA Directive is to meet its objective of providing for a high level of protection of the environment. The SEA Directive states that an environmental report should provide information on “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”. Mitigation of cumulative impacts is not specifically considered within the Directive or within the ODPM draft guidance on SEA (ODPM, 2002).

Mitigation is a more difficult concept to put into practice for strategic level CEA especially if the CEA addresses past, present and future plans / programmes of other organisations. In this situation there may be an absence of clear and precise allocation of responsibilities among the plan or programme makers or project developers regarding the implementation of enhancement/mitigation and also monitoring measures. It is also probable that some mitigation measures may only be capable of being delivered by parties other than the proponent of the plan / programme. Several administrative jurisdictions and stakeholders will be involved and hence the co-operation of these other interests is needed to ensure that the mitigation/enhancement or monitoring measure is successfully implemented.

One way of tackling the issues raised above is through the concept of ‘no net loss’ which is a mitigating measure for cumulative effects of regional plans and programmes (Davies, 1996). ‘No net loss’ is advanced in response to area-wide cumulative effects and requires that any resource disturbed from its pre action condition be replaced with an area of equivalent capability to ensure that sustainable use of the resource is maintained. However, in order to create more land any existing land must be converted and by implication this may be to the detriment of other species. In addition there may be no land within reasonable distance of the action to be modified.

### **3.8. Monitoring of Cumulative Effects**

Monitoring helps to ensure that impact predictions were accurate and that mitigation methods are implemented as required. Article 10 of the SEA Directive states that member states should monitor the effects of the implementation of plans and programmes to identify unforeseen effects at an early stage and to be able to undertake appropriate remedial action. The ODPM draft guidance on SEA (ODPM, 2002) states that monitoring should be carried out using the indicators that the plan or programme was measured against and that this should take account of cumulative effects as well as direct effects. What the guidance does not explicitly highlight, however, is that an in depth knowledge of cause and effect pathways is required in order to determine the elements of the plan / programme that are having an undesirable effect. The plan or programme may also be operating against a background of general environmental degradation / improvement or may be producing unforeseen interactions with other plans and programmes (both key issues in CEA). Therefore, it is difficult to separate out the effects of one plan / programme with another and the effects of plans /programmes against general environmental trends.

In the face of these difficulties it may only be possible to carry out more general state of the environment monitoring for cumulative effects. This monitoring should then inform the objectives of the next plan / programme. However, there are problems with this approach. If the monitoring does not assign responsibility to a specific plan or programme and therefore a specific party, it will be very difficult to use the monitoring as the SEA Directive in order to undertake appropriate remedial action. The issue of monitoring strategic level impacts is a difficult one and it is beyond the scope of this project to set out a definitive answer.

The ODPM guidance for land use plans and programmes sets out a format it requires monitoring results to be reported in. This format seems to be guiding analysts towards state of the environment monitoring. Table 3.4 sets out this format.

Table 3.4: Format for an SEA monitoring programme as set out in Draft ODPM guidance (ODPM, 2002).

<b>Possible format for a monitoring programme</b>					
<b>Objective/ target</b> (* = important objective; see Stage B1)	<b>what to monitor</b>	<b>Where do the monitoring data come from?</b>	<b>How often</b>	<b>at what point should additional action be considered?</b>	<b>what could be done if a problem is identified?</b>
*protect biodiversity at ecosystem, species and genetic levels	condition of designated sites and other sites of nature conservation importance	Planners	Every 2 years	Condition gets worse	consider ways of improving biodiversity protection and enhancement, e.g. provision of wildlife corridors
Protect human health and amenity	number of accidents per person-km travelled by car, foot, bike	Local authority	Annual	any of these gets 10% worse	improvements to pedestrian and cycling facilities, traffic calming, new road layout to reduce accidents
*promote positive health related behaviour	% children walking or cycling to school	Environmental health authority	Every 2 years	% decreases	liaise with cycling officer; establishing walking and cycling routes

Other key components of a monitoring programme focusing upon cumulative effects are:

- Measurable indicators of the magnitude and direction of change;
- Appropriate temporal and spatial scales
- Appropriate measurement methodologies; and
- Cost effectiveness.

Discussions with SEA practitioners during this study have shown that some local authorities are starting to examine collaboratively how they currently monitor indicator sets of various different plans and programmes. The approach is called a co-ordinated corporate approach. In particular, Oldham Borough Council and Vale Royal Borough Council have started to examine the collective monitoring requirements of the sustainability appraisal of their community strategy and their best value indicators. This could be transposed to the monitoring of cumulative effects.

### 3.9. Reporting and Consultation

Documentation of the SEA of plans and programmes is an important part of the assessment process, particularly where a large part of the assessment involves participating as part of a committee to assess options as they are considered. It is of critical importance to the effective implementation of the SEA Directive that CEA is reported in a transparent way. The ODPM

draft guidance on SEA has specified a table format in which to report the cumulative environmental effects of a plan or programme. This is shown in Table 3.5.

Table 3.5: Cumulative effects table from the ODPM draft guidance on the SEA Directive

Summary of preferred option assessments to identify cumulative effects										
SEA objective (*= important objectives; see Stage B1)	short term					Medium to long term				
	effect of preferred option for issue...					Effect of preferred option for issue...				Cumulative effect of preferred options for A+B+C+D
	accessibility	Housing demand	Water and wastewater	...	cumulative effect of preferred options for A+B+C+D	accessibility	Housing demand	Water and wastewater	...	
*protect biodiversity at ecosystem, species and genetic levels					Significant negative effect					
Protect human health and amenity										
*promote positive health related behaviour										significant negative effect
...										
Comments; changes to the preferred options:										

This table could be included in a separate chapter in the SEA report that specifically addresses cumulative effects in order to make it clear how and which cumulative effects have been assessed. The reporting of the cumulative effects assessment should provide a traceable record of the identification and management of these effects, in a form suitable for distribution to stakeholders, peers and other parties in comparable situations. An environmental report could:

- Define cumulative effects in sufficient detail so that the reader/public is aware of the analyst's understanding and comprehension of this term;
- Describe various forms of cumulative effects and identify those that are most likely to occur in the plan or programme;
- Identify various limitations such as inadequacy of available data/information, non-availability of proven methodologies for accurately predicting cumulative effects and other limiting factors;
- Describe in sufficient detail selected impact prediction methodologies and the proposed mitigation and monitoring measures including rationale for their selection;
- Present and justify the criteria used for determining the relative significance of the cumulative effects upon valued resources;
- Report linkages among the bio-physical, socio-economic, human and ecosystem health effects and their relevance to human population and wildlife well being;
- Describe appropriate mitigation measures and plans for monitoring. Identify the roles and responsibilities of various agencies, the proponent and the public in implementing the proposed measures;

- Describe the scientific, technical and administrative roles and responsibilities for collecting, storing and interpreting the data/information. Also describe the mechanism for public access to such data; and
- Identify the agency/authority responsible for making the necessary adjustments in remedial measures and for taking required action based on the monitoring results.

Consultation is a vital element throughout the SEA process. However, it is important when assessing cumulative effects for many reasons:

- Consultees can provide vital information to the assessment in terms of the evolving state of the environment. It will be important within CEA to identify those environmental components that are in decline and are near to their threshold. These environmental components may not be able to cope with the multiple stresses of the cumulative effects of different plans and programmes;
- CEA involves the identification of valued environmental components – if stakeholders are not involved it can become the sole opinion of the assessment team on what is valuable; and
- Successful CEA involved identifying other plans and programmes, the likelihood of them going ahead and their likely environmental impacts. This is very difficult to do without the active involvement of other plan and programme makers.



## **4. GUIDANCE ON CUMULATIVE EFFECTS ASSESSMENT**

### **4.1. Introduction**

This Chapter provides a review of the literature that has been reviewed during this study. The literature has been classified into the following categories:

- UK and international government agency guidance – generally dealing with broad principles;
- Academic articles on broad principles;
- Topic based guidance – dealing with specific cumulative impacts e.g. erosion in a river basis;
- Case studies.

As this is a scoping study this literature review cannot be considered as a complete review of all international literature on CEA. The references have been selected through an application of the study team's knowledge, a targeted search on the internet and consultation with SEA and CEA practitioners selected at the start of the project.

### **4.2. UK and International Government Agency Guidance**

It is evident from the literature review and consultation that CEA guidance mainly emanates from North America (see Table 4.1). Internet searches and consultation have focused on identifying whether other European countries or countries such as Australia and New Zealand have published cumulative effects guidance but no guidance was found. EU research on cumulative effects has been reviewed in section five of this report. Examination of government guidance has proved the most fruitful area of enquiry so this section of the report is more detailed than the other sections setting out the results of the literature review. An important point to note is that CEA has grown in a response to the lack of strategic plan and programme making within the North American system. The fact that Canada and the USA have been practising CEA well before many European countries does not imply that they are ahead of Europe in terms of strategic level CEA. Most of the guidance included below is project level guidance although many of the principles are transferable to strategic level CEA.

Table 4.1: Selected Government / Agency guidance documents

Title	Comment
<p>Alberta Environment (no date given): Cumulative Effects Assessment and Environmental Impact Assessment Reports Required under the Alberta Environmental Protection and Enhancement Act.</p>	<p>This advises on how to examine the additive ecological effect of energy and utilities projects. The stages in the assessment are:</p> <ul style="list-style-type: none"> <li>• Scoping;</li> <li>• Identifying future activities;</li> <li>• Analysing effects; and</li> <li>• Adaptive management.</li> </ul> <p>The guidance has a section on ‘dealing with uncertainty’. It notes that uncertainties are greater with CEA than other aspects of EIA. Uncertainties include ‘imperfect knowledge of baseline and present activities, limited understanding of primary and indirect impacts of activities and uncertainties about future developments’. Regulators expect:</p> <ul style="list-style-type: none"> <li>• Description of efforts to obtain data;</li> <li>• Exploratory analysis of outcomes and assumptions;</li> <li>• Description of how to monitor uncertainties; and</li> <li>• Plans to respond to unfavourable outcomes.</li> </ul> <p>In other words proponents must describe how they plan to monitor outcomes of CEA.</p> <p>The guidance does consider the monitoring needed and asks the following questions of proponents: Are monitoring and research needed to detect adverse outcomes and reduce critical uncertainties? How will feedback from monitoring be incorporated into long term project operations? What documentation is envisioned or required during life of the project? What reporting mechanisms are anticipated?</p>
<p>Canadian Environmental Assessment Agency (1994): Responsible Authorities Guide – Reference Guide: Addressing Cumulative Environmental Effects.</p>	<p>Sets out a procedural framework and generic approaches for each step of the assessment process.</p> <p>The guidance is robust, has a wide breadth of applicability, flexibility, is easy to use and is transparent.</p> <p>Elements of this guidance would be useful within an Agency procedural framework if adapted to strategic level CEA.</p>
<p>Canadian Environmental Assessment Agency (1998): Cumulative Effects Assessment Practitioners Guide (<i>this is a supplement to the 1994 guidance listed above</i>)</p>	<p>This is a supplement to the guide above and offers a best practice perspective on CEA with emphasis on the assessment of cumulative biophysical effects. It is intended to be broadly applicable to projects of varying size and complexity in different industrial and development sectors. It could be adapted for Agency use.</p>
<p>Canadian Environmental Assessment Agency (1999): Operational Policy Statement: Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act</p>	<p>The statement is related to consideration of paragraph 16(1)(a) of the Canadian Environmental Assessment Act, which states:</p> <p><i>Every screening or comprehensive study of a project and every mediation or assessment by a review panel shall include a consideration of the environmental effects of the project, including...any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out.</i></p> <p>The purpose of the guide is to explain the relationship between the Act and the two pieces of guidance listed above. It is an administrative document and is included for the sake of completeness.</p>
<p>Addressing cumulative effects</p>	<p>This guidance is the forerunner of the 1994 and 1998 guidance. It is</p>

Title	Comment
under the Canadian Environmental Assessment Act: A Reference Guide. Canadian Environmental Assessment Agency. See Davies, K (1992).	included here for the sake of completeness.
Griffiths, A and McCoy, E (date unknown) Cumulative Effects Assessment: Generic Framework. Carried out by the Macleod Institute, Calgary, Alberta for the Canadian Arctic Resources Committee.	The generic framework provides a conceptual basis for designing a CEA. The guidance sets out a generic framework that is similar to the Canadian and US procedural framework. It is a flexible and easy to use framework which can be adapted but is very similar to the Canadian and US frameworks so may not be of further interest to the study.
US Council on Environmental Quality (1997): Considering cumulative effects under the NEPA.	The guidance follows similar procedural steps to the Canadian guidance. These steps are: <ul style="list-style-type: none"> <li>• Scoping;</li> <li>• Describing the effected environment; and</li> <li>• Cumulative effects assessment.</li> </ul>

The next section sets out in more detail the requirements of the Canadian and the US system of CEA.

#### 4.2.1. The Canadian Responsible Authorities Guide to CEA (1994)

The reference guide describes an approach for addressing cumulative environmental effects at project level under the *Canadian Environmental Assessment Act*. Specifically, the guide:

- Reviews the concept of cumulative environmental effects;
- Discusses the relevant requirements of the *Act*;
- Outlines some general considerations;
- Proposes a framework for addressing cumulative environment effects under the *Act*; and
- Provides a list of key references on the subject.

The framework given is described in Table 4.2

Table 4.2: Canadian CEA framework

<p><b>Scoping</b></p> <p><i>According to the guidance this is focused on setting the boundaries of the assessment and focus of the analysis.</i></p>
<ol style="list-style-type: none"> <li>1. Identifying environmental effects to be considered;</li> <li>2. Identifying likely cumulative environmental effects within those limits (effects resulting from the project, effects of past and existing projects and human activities, likely future projects and human activities – at a minimum this is projects that have been approved).</li> <li>3. Setting the spatial and temporal boundaries for the assessment. This is established using a number of criteria including: <ul style="list-style-type: none"> <li>• The size and nature of the project and its potential effects;</li> <li>• The availability of existing data and knowledge about the project and its environmental effects and the feasibility of collecting new data and knowledge if there are data or knowledge gaps;</li> <li>• The size, nature and location of past and future projects and activities in the area, and the significance of their adverse environmental effects;</li> <li>• Relevant ecological boundaries, including physiography, vegetation, land use, habitat, soil and surface materials and climate;</li> <li>• Relevant aquatic boundaries, including watersheds, sub-watersheds, drainage basins, and hydrogeological discontinuities; and</li> <li>• Relevant jurisdictional boundaries, including municipal, county, township or regional boundaries.</li> </ul> </li> </ol>
<p><b>Analysis</b></p> <p><i>The objective of the analysis is to identify the environmental effects of a project and determine the significance of these effects.</i></p>
<p>Analysis should include an assessment of:</p> <ul style="list-style-type: none"> <li>• The status of the receiving environment, including its important characteristics and other stresses (e.g. how have past projects and activities affected or stressed the environment)?</li> <li>• The cumulative environmental effects of the project, including: <ul style="list-style-type: none"> <li>• Interactions among effects the project may cause in the environment, such as those between effects on water quality and effects on fish resulting from sedimentation and destruction of the shoreline vegetation cover;</li> <li>• Interactions among any effects on: <ul style="list-style-type: none"> <li>• Health and socio-economic conditions;</li> <li>• Physical and cultural heritage;</li> <li>• Current use of lands and resources for traditional purposes by aboriginal persons;</li> <li>• Any structure, site or thing that is of historical, archaeological, paleontological or architectural significance, caused by changes in the environment; and</li> </ul> </li> <li>• Interactions among changes to the project caused by the environment.</li> </ul> </li> </ul> <p><b><i>Methods – Modelling, expert systems and geographic information systems are being increasingly used. However, where information is lacking, qualitative approaches and best professional judgement are used</i></b></p>

<p><b>Mitigation</b></p> <p><i>Prior to determining the significance of any cumulative environmental effects, the need for technically and economically feasible mitigation measures that could reduce or eliminate the effects should be considered.</i></p>
<p>Mitigation measures could include:</p> <ul style="list-style-type: none"> <li>• avoiding sensitive areas such as fish spawning areas or areas known to contain rare or endangered species;</li> <li>• adjusting work schedules to minimise disturbance;</li> <li>• engineered structures such as berms and noise attenuation barriers;</li> <li>• pollution control devices, such as scrubbers and electrostatic precipitators; and</li> <li>• changes in manufacturing, process, technology, use, or waste management practices, such as substituting a hazardous chemical with a non-hazardous one, or the re-cycling or re-use of waste materials.</li> </ul>
<p><b>Determining the significance of the effect</b></p> <p><i>After taking into account any appropriate mitigation measures, the likelihood and significance of the cumulative environmental effects must be determined..</i></p>
<p>The determination of significance consists of three general steps:</p> <ul style="list-style-type: none"> <li>• Step 1: Deciding Whether the Environmental Effects are Adverse</li> <li>• Step 2: Deciding Whether the Adverse Environmental Effects are Significant</li> <li>• Step 3: Deciding Whether the Significant Adverse Environmental Effects are Likely</li> </ul> <p>Relevant standards (i.e. water quality standards should be use in determining significance.</p>
<p><b>Follow up (monitoring)</b></p> <p><i>To monitor the accuracy of the environmental assessment and/or the effectiveness of any mitigation measures taking into account using and/or supplementing existing programs that monitor cumulative environmental effects.</i></p>
<p>A follow-up program to monitor cumulative environmental effects may be appropriate when:</p> <ul style="list-style-type: none"> <li>• The project is likely to cause new or different cumulative environmental effects;</li> <li>• The project involves new or unproven mitigation measures whose ability to reduce cumulative environmental effects is uncertain;</li> <li>• An otherwise familiar or routine project is proposed for a new or unfamiliar environmental setting;</li> <li>• Where there is some uncertainty about the conclusions of the assessment of cumulative environmental effects;</li> <li>• Project scheduling or operational details are subject to change such that the cumulative environmental effects could be different from those described in the EA.</li> </ul>

#### 4.2.2. The Canadian Cumulative Effects Assessment Practitioners Guide (1998)

Canadian guidance on CEA was augmented by the introduction of this additional guidance in 1998. The guide sets out how the CEA process may be applied to regional planning and land use studies, thus shifting the assessment onto a more strategic footing.

Although these regional studies share some elements of project-specific CEA, they may also:

- Involve larger spatial boundaries;
- Take many years to complete, often due to the considerable amount of data collection and analysis required;
- Occur *before* many actions begin in a region as opposed to *after* an action is first proposed (i.e., they are proactive as opposed to reactive), in some cases to provide input to area management plans (such as for a park); and

- Be used to establish acceptable thresholds of change, which can then be used for subsequent project-specific assessments in the same geographic region.

The guide uses the same five steps as included in the earlier Canadian guidance provides more detailed advice on how an analyst might carry out the assessment. Particularly useful sections of the guidance in terms of carrying out strategic level CEA are:

- Scoping;
- Evaluation of significance;
- Handling uncertainty within the assessment; and
- Monitoring and review.

**Scoping** - A first step is to focus only on those effects that originate from the action under review rather than focusing on the aspirational goals of the region – i.e. increasing wildlife habitat.

Setting boundaries relies less on special CEA techniques than on the time-honoured basics of EIA practice of:

- Making conservative assumptions about the magnitude and probability of the effect in the face of uncertainty (i.e. assume that effects will be greater rather than smaller);
- Relying on professional judgement;
- Practising risk management; and
- Using an adaptive approach.

Extra points to note are:

- For terrestrial VECs such as vegetation and wildlife, ensure boundaries are ecologically defensible; and
- Expand boundaries sufficiently to address the cause-effect relationships between actions and VECs including the likely pathways.

**Evaluation of significance** - According to the guidance, there are several factors that would influence the interpretation of significance:

- Exceedance of a threshold;
- Effectiveness of mitigation;
- Size of study area;
- Incremental contribution of effects from action under review;
- Relative contribution of effects of other actions;
- Relative rarity of species;
- Magnitude of change relative to natural background variability;
- Creation of induced actions; and
- Degree of existing disturbance.

**Handling uncertainty within the assessment** - The guidance also provides advice on handling uncertainty:

- Make conservative conclusions (i.e., assume that an effect is more rather than less adverse). This is referred to as the Precautionary Principle;
- Provide a record or audit trail of all assumptions, data gaps, and confidence in data quality and analysis to justify conclusions;
- Recommend mitigation measures to reduce adverse effects and monitoring, followed by evaluation and management of effects, to ensure effectiveness of these measures; and
- Implement mechanisms to evaluate the results of the monitoring and provide for subsequent mitigation or project modification, as necessary.

**Monitoring and review (labelled as follow up within the guidance)** - The situations in which a follow-up is required include those where (Davies 1996):

- There is some uncertainty about the environmental effects of other actions, especially imminent ones;
- The assessment of the action's cumulative effects is based on a new or innovative method or approach;
- There is some uncertainty about the effectiveness of the mitigation measures for cumulative effects.

These are useful guidelines but it is important to note that under the SEA Directive, monitoring and review will always be required.

#### **4.2.3 US guidance - Considering Cumulative Effects under the NEPA (1997)**

The US guidance also sets out the various steps that are expected within a CEA. The steps are shown in Table 4.3.

Table 4.3: US procedural framework

EIA Components	CEA Steps
<b>Scoping</b>	Identify the significant cumulative effects issues associated with the present action and define the assessment goals; Establish the geographic scope for the analysis; Establish the time frame for the analysis; and Identify other actions affecting the resources, ecosystems and human communities of concern.
<b>Describing the Affected Environment</b>	Characterise the resources, ecosystems and human communities identified in scoping in terms of their response to change and capacity to withstand stresses; Characterise the stresses affecting these resources, ecosystems and human communities and their relation to regulatory thresholds; and Define a baseline condition for the resources, ecosystems and human communities.
<b>Determining the Environmental Consequences</b>	Identify the important cause and effect relationships between human activities and resources, ecosystems and human communities; Determine the magnitude and significance of cumulative effects; Modify or add alternatives to avoid, minimise, or mitigate significant cumulative effects; and Monitor the cumulative effects of the selected alternative and adapt management.

While the guidance is relatively prescriptive in the steps that should be followed in the impact assessment, most of these are similar to the steps advocated within Canadian CEA guidance. The US guidance uses the concept of impact zones as a geographical basis for analysis. Table 4.4 shows suggestions of what impact zones could be for different receptors. This could be useful in determining spatial boundaries in scoping.



Table 4.4: Impact zones and receptors

Resource	Possible geographic areas for analysis
Air quality	Metropolitan area, airshed, global atmosphere
Water quality	Stream, watershed, river basin, estuary, aquifer
Vegetative resources	Watershed, forest range or ecosystem
Resident wildlife	Species habitat or ecosystem
Migratory wildlife	Breeding grounds, migration route, wintering areas, or total range of affected population units
Fishery resources	Stream, river basin, estuary, or parts thereof; spawning area and migration route
Historic resources	Neighbourhood, rural community, city, state, tribal territory, known or possible historic district
Socio-cultural resources	Neighbourhood, community, distribution of low-income or minority population, or culturally valued landscape
Land use	Community, metropolitan area, county, state, or region
Coastal zone	Coastal region or watershed
Recreation	River, lake, geographic area, or land management unit
Socio-economics	Community, metropolitan area, county, state, or country

The guidance is also quite detailed in terms of guiding assessors on the types of impacts that are possible on different receptors. Usefully, it includes an indicative list on the main types of impacts on air quality, surface water, ground water, land and soils, wetlands, ecological systems, historic and archaeological resources, socio-economics and human community structure. These indicative impact lists for groundwater and wetlands have been provided here as an example.

- Impacts on ground water;
  - Water quality degradation from non-point and multiple point sources of pollution that infiltrate aquifers; and
  - Aquifer depletion or salt water intrusion following the overdraft of groundwater for numerous uncoordinated sources;
- Impacts on wetlands;
  - Habitat loss and diminished flood control capacity resulting from dredging and filling individual tracts of wetlands; and
  - Toxic sediment contamination and reduced wetlands functioning resulting from irrigation and urban run-off.

The US guidance also introduces the concept of stress factors. This is a way of identifying the main causes of environmental stress and setting out how these are currently affecting environmental quality. The goal of characterising stress is to determine whether the resources, ecosystems and human communities of concern are approaching conditions where additional stresses will have a cumulative effect. The guidance suggests that activities should

be listed in a table and their impacts assessed against environmental receptors. The likely locations of the impacts should also be ascertained and shown on a map. This is a relatively simple way of showing which environmental receptors and locations will be subject to cumulative stresses.

The US guidance sets out different methods that can be used to predict cumulative impacts on environmental resources. These are as follows:

- Questionnaires, interviews and panels;
- Checklists;
- Matrices;
- Network and systems diagrams;
- Modelling;
- Trends analysis;
- Overlay mapping and GIS;
- Carrying capacity analysis;
- Ecosystem analysis;
- Economic impact analysis; and
- Social impact analysis.

Mitigation and monitoring are addressed in the guidance, although not as extensively as in the Canadian guidance. However, the US guidance does suggest a list of what components a monitoring system should include:

- Measurable indicators of the magnitude and direction of ecological and social change;
- Appropriate timeframe;
- Appropriate spatial scale;
- Means of assessing causality;
- Means of measuring mitigation efficacy; and
- Provisions for adaptive management.

### **4.3. Guidance used by the Agency**

UK government guidance on EIA does not provide information on the assessment of cumulative effects that could usefully be transferred to strategic level.

However, the Agency has already produced various guidance documents related to environmental assessment and strategic environmental assessment (some of which are in draft) that could be used to guide CEA. This guidance has been reviewed as part of this research project to identify what additional guidance is needed and where within the Agency guidance “framework” this should be located. Appendix A lists and summarises the Agency guidance that has been reviewed as part of this project. It also includes some MAFF (Ministry of Agriculture, Fisheries and Food) / DEFRA (Department of the Environment,

Food and Rural Affairs) guidance that has been produced on certain types of plan such as Shoreline Management Plans.

The review found that the Agency has already produced a lot of general guidance on EIA and SEA as part of the Agency Management System although this is in draft form. The purpose of the AMS guidance is to provide a consistent framework for policy, process and guidance that the Agency seeks to implement. CEA guidance should be developed within the AMS framework.

The Agency also uses a lot of guidance for environmental assessment of its plans, programmes and projects. Some of this is produced by the Agency and some is produced by DEFRA (or its predecessor MAFF). These include guidance on:

- Flood and coastal defence projects;
- Shoreline Management Plans;
- Coastal Habitat Management Plans;
- Habitats and Birds Directive guidance on in combination assessment;
- Catchment Abstraction Management Plans;
- Water Level Management Plans; and

Through reviewing these documents it became clear that the Agency already uses many environmental assessment frameworks that could be modified for use in CEA. These include:

- Scoping approaches such as quality of life capital;
- Risk based approaches to environmental assessment;
- Approaches to strategic coastal monitoring. The framework for responsibilities of different parties could be adapted for use to monitor other types of resources; and
- Modelling approaches to assess projects, plans and programmes under the Habitats and Birds Directive.

#### **4.4. Academic Literature**

A wealth of academic literature exists on CEA but it has only been possible to explore a small portion during this study. Literature was identified through consultation with experts and through a web-based search. An attempt has been made to review the most up to date papers found although some older papers are included where they are felt to be particularly relevant. Appendix B lists and summarises the academic literature that has been reviewed as part of this project.

The academic literature reviewed can be broken down into three categories:

- Generic literature on CEA. This literature does not provide guidance or suggest an approach but discusses general issues related to CEA – i.e. a review of a certain country's progress in implementing CEA;

- Literature that sets out generic CEA frameworks and the general steps that an authority should take when undertaking CEA. These general steps apply equally to project and strategic level approaches; and
- Advice on how to carry out a particular stage of CEA – i.e. scoping.

The most useful papers are of the third category. Many useful methods have been identified that could be modified for Agency purposes. This included:

- Methods for identifying other plans, programmes and future actions within the plan / programme area and how to decide which to assess;
- Checklists for use in scoping;
- Impact prediction methods such as consensus building tools, causal chain analysis, matrices and pathway methods.

#### **4.5. Topic Based Literature**

Topic based literature has also been reviewed as part of the project. This encompasses literature dealing with specific topics or impacts such as river basin management or resource conservation. Appendix C lists and summarises the academic literature that has been reviewed as part of this project. However, given the scale of the subject matter it is only possible to identify where particular approaches may be useful and be worthy of further investigation. Where possible specific guidance documents have been sought. However, there are very few guidance documents on some of the issues and consequently a lot of the information presented is taken from academic studies. A lot of references have been found but where they are not available on the internet, they have not been reviewed because of time constraints within this scoping study. References have, however, been identified at the bottom of each table.

This section of the literature review aimed to assess whether specific methods have been devised to assess the cumulative effects of certain types of plans or programmes. The following plans were chosen to reflect the interests of the Agency and also the main type of plans that the Agency may be involved with as consultee, planning and transport plans. The plan types chosen were:

- Plans affecting catchment and river systems;
- Plans affecting coastal regions;
- Ecological plans; and
- Planning and transport plans.

The review found that there is very little topic specific CEA guidance that could be used for strategic level assessment. The literature tended to be of two different types:

- Project level assessments that use data hungry modelling approaches that would be difficult to transfer to the strategic level; and

- State of the environment inventory systems that aim to identify environmental change and make links to human activity or scientific studies that aim to test some of these assumptions.

The first type of literature is of limited use at a strategic level. However, the second study type may be useful in terms of strategic monitoring and ensuring that Agency officers have the latest information on which to judge what the impacts of plans and programmes may be on different environmental receptors.

#### **4.6. Case Studies**

Four case studies have been presented in order to illustrate different aspects of cumulative effects assessment within SEA and to explore the CEA experience available in the UK (including some of the work carried out by parts of the Agency) and the rest of the world.

Case studies were identified through consultation with the experts listed in Appendix D. This consultation has identified that the CEAs that have been carried out within the UK (and worldwide) in the past have typically been part of an EIA process rather than an SEA process. Because there are not many examples of CEA carried out as part of an SEA, two project level case studies have been chosen and two strategic level case studies have been chosen.

CEA is starting to be carried out as part of SEA such as in the River Basin Management Plan case study. However, Agency officers consulted as part of the project identified that there is a need to develop new methodologies and there is a need for further guidance that focuses on general procedural issues and further guidance related to certain types of plan or programme.

The following case studies are presented:

- Oil Sands Development, Alberta (project level);
- Liverpool Bay (project level);
- Integrated appraisal for River Basin Management Plans, carried out for the Agency by WRc (strategic level); and
- London Tidal Flood Defences strategic environmental framework (strategic level);

#### **4.7. Oil Sands Projects in Northern Alberta: A Regional Study Approach (adapted from Canadian Environmental Assessment Agency, 1998)**

##### **4.7.1. Introduction**

This assessment examined an increase in the number and size of projects connected with extraction of heavy oil from bitumen sand deposits in Alberta. Concerns about the cumulative effects of these actions, and acknowledgement of the limitations of a project-by-project review process, resulted in provincial and federal agencies calling for a regional study approach to address these concerns. Industry responded with a framework through which the effects of new facilities could be related to a baseline of existing regional effects. As new proposals reach the application review stage, their incremental effects would be referenced to the regional review information compiled earlier. The effects on 14 components were predicted: air quality, hydrology, surface water quality, surface water hydrology, aquatic

resources, ecological land classification, terrain and soils, terrestrial vegetation, wetlands, wildlife, human health, historical resources, resource use, and traditional land use.

#### 4.7.2. Scoping

The study sought to identify the priority issues of concern within the study area. These are shown Table 4.5.

Table 4.5: Priority issues of concern

Environmental Component	Regional Issues of Concern	Regional Valued Components	Examples of Indicators
Air Systems	Acidic deposition, odours, greenhouse gas emissions (global issue)	Air Quality	Emitted gases transported over long distances (NOx, SO2)
Surface Water	Lowering of lake water levels, contamination of water	Water Quality and Quantity	Combined water volume withdrawals, water quality constituents affecting drinking water standards
Groundwater	Depletion of aquifers	Potable well water	Combined water volume withdrawals
Aquatic Resources	Contamination of fish, increased harvest pressures	Sport fish species	Northern pike
Vegetation	Loss of vegetation through land clearing, effects of airborne deposition	Vegetation ecosites	Low bush cranberry, Aspen, White spruce
Wildlife	Loss, sensory alienation and fragmentation of habitat, direct mortality due to increased traffic and hunting harvest	Hunted and trapped species	Moose, black bear, lynx, fisher
Resource Use	Decreased opportunities for resource harvesting (fish, traditional plants, hunting, timber, trapping), increased road access, visual effects	Timber harvest areas, furbearers, game species, new road access, recreational enjoyment	Aspen stands, beaver, moose, campsites

An Interaction Matrix was also used during an early scoping workshop to aid identification of possible relationships between various project actions and environmental components. This was carried out for all project phases (preliminary activities or exploration, construction, operations and abandonment).

#### 4.7.3. Impact Identification and Assessment

A total of 35 impact models were produced for the regional assessment. Figure 4.1 provides an example of an impact model developed to assess the effects of the Cold Lake Oil Sands Project on surface water quality.

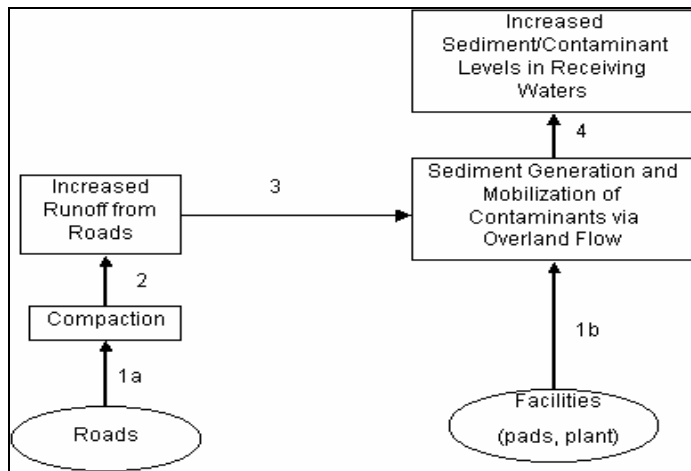


Figure 4.1: Impact model used in the Cold Lake Oil Sands CEA

The model was accompanied by linkage statements such as:

- 1a. The operation and maintenance of roads will lead to compaction of the roadbed.
- 1b. Operation and maintenance of pads and plant facilities will result in the generation of sediment and mobilisation of contaminants via overland flow from these facilities.
2. Compaction will cause an increase in surface runoff from the road.
3. Increased runoff from roads will result in erosion of exposed soils, resulting in an increase in sediment generation and transport. Soluble contaminants from the road and the road bed will be transported along with the sediment.
4. Increased sediment and contaminant transport will result in higher levels of these parameters in receiving waters, which will result in a decline in surface water quality.

A confidence statement of low, medium or high was attached to each of these statements. After the compilation of these diagrams, a simple impact statement was compiled. For example, for the diagram above it would be *operation and maintenance of roads and facilities will result in the generation of sediment and transport of contaminants to receiving waters.*

#### 4.7.4. Determining the Significance of the Impacts

Determining the significance of effects associated with the project was based on seven significance attributes. These attributes have generally gained common acceptance amongst EIA practitioners (although the definitions may vary) as a means of identifying and measuring various aspects of an effect that collectively assist in the evaluation of significance. These significance attributes are shown in Table 4.6.

Table 4.6: Significance attributes

Attribute	Options	Definition
Direction	Positive	Beneficial effect on VEC
	Neutral	No change to VEC
	Negative	Adverse effect on VEC
Scope	Site	Effect restricted to a small site
	Local	Effect restricted to the project footprint
	Sub-regional	Effect extends to area within a few kilometres of the project footprint
	Regional	Effect extends throughout regional assessment area
Duration	Short-term	Effects are significant for <1 year before recovery returns conditions to the pre-project level; or, for species, for less than one generation
	Medium-term	Effects are significant for 1-10 years; or, for species, for one generation
	Long-term	Effects are significant for >10 years; or, for species, for more than one generation
Frequency	Once	Occurs once only
	Continuous	Occurs on a regular basis and regular intervals
	Sporadic	Occurs rarely and at irregular intervals
Magnitude	Low	Minimal or no impairment of component's function or process (e.g., for wildlife, a species' reproductive capacity, survival or habitat suitability; or, for soil, ability of organic soil to fix nitrogen)
	Moderate	Measurable change in component's function or process in the short and medium duration; however, recovery is expected at pre-project level
	High	Measurable change in component's function or process during the life of the project or beyond (e.g., for wildlife, serious impairment to species productivity or habitat suitability)
Significance	Insignificant Significant Unknown	Based on the analysis, use of Significance Query, and best professional judgement, is the effect on the VEC significant?
Confidence	Low Moderate High	In general, what is the confidence level in the conclusion?

#### 4.7.5. Lessons to be Learnt

The approach used by the project uses expert judgement within a framework, which means that this judgement is recorded in a comprehensive and consistent way. This allows all subsequent assessments to be compared on a similar basis. The use of linkage models and



significance attributes could be very useful to the Agency especially in terms of proving that the most significant impacts are being addressed. The tool is flexible and robust in that it can be adapted and is fairly simple and easy to use. The data and information required for use can be tailored to how much detailed data is available. Further use of this tool should be investigated as part of a toolkit of CEA methods for the Agency. The tool should be easy to adapt for use on strategic level CEA although impact models may be more complex and take into account interactions with other plans, programmes and projects.

#### **4.8. Liverpool Bay (Adapted from Oakwood Environmental Ltd, 2002)**

##### **4.8.1. Introduction**

The Countryside Council for Wales (CCW) commissioned Oakwood Environmental Limited in December 2001 to undertake the development of a methodology for CEA for offshore industries in Liverpool Bay.

The principal study objectives were:

- To review current understandings of potential cumulative effects from offshore industries and develop a proposed methodology for cumulative effects assessment of offshore industries from a nature conservation and landscape / seascape perspective;
- To produce a GIS database and analysis tool for offshore CEA;
- To identify current and predict likely future cumulative effects from offshore industries in Liverpool Bay on habitats and species of importance; and
- To identify data gaps and recommend further data and research requirements for undertaking CEA for offshore activities.

#### 4.8.2. The Assessment framework

Figure 4.2 shows the essential elements of the assessment framework;

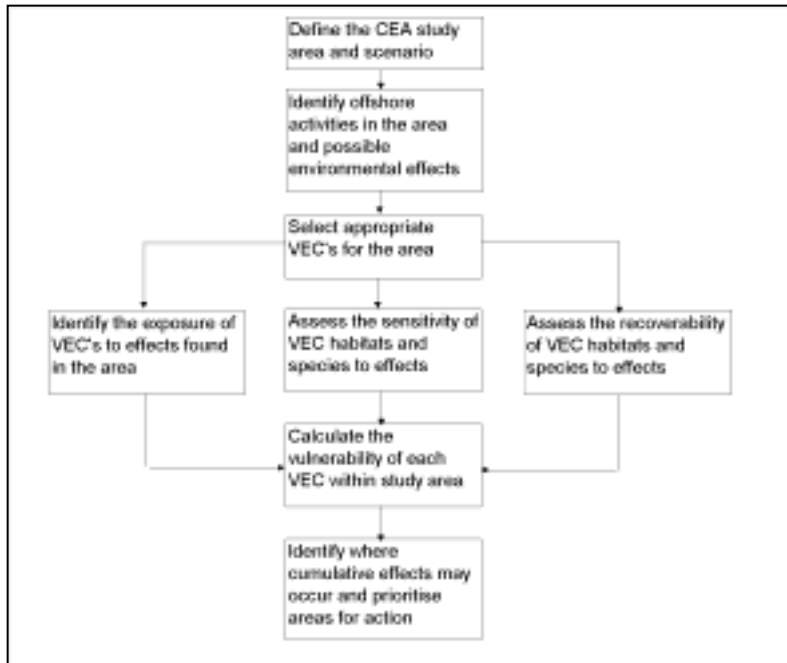


Figure 4.2 Liverpool Bay – the essential elements of the assessment framework

It is not made clear in the report what methods are used to guide the judgements needed in the various steps outlined above e.g. whether expert judgement or some element of modelling has been used. However, the study did make extensive use of GIS data – using the overlay technique to overlay data related to baseline environment and projected activities. This may have been used to inform expert predictions. The case study is useful, however because it identifies what problems may need to be overcome in the future to ensure effective coastal CEA. The report makes the following recommendations:

- The study highlighted that there are many gaps in the knowledge of the types and distributions of offshore biotopes and species in the Welsh seas (this is expected to apply to UK coastal waters generally);
- There is a current lack of digital data sources from all sectors, which needs to be addressed to achieve compatible and successful data transfer. The lack of digital data available for the study also highlighted the need for relatively large resources required to develop underlying GIS data layers for a CEA.
- Knowledge of the ecological requirements and sensitivities of marine species and habitats to human activities is still developing, as are confidence limits and reliability when undertaking cumulative effect assessments. There is also an urgent need for research into surface effects of activities (e.g. noise and visual disturbance) on key environmental resources such as seabirds, so that these can be included in future CEA studies.
- Links between this study and ongoing sensitivity and mapping work should be investigated further. The integration of data for human activities, vulnerability rankings for VECs, and sensitivity maps could provide a central GIS database tool for storing;

analysing; and mapping sensitivities, vulnerability to activities and cumulative effects queries.

#### **4.8.3. Lessons to be Learnt**

The report is somewhat confusing on the methods used to make impact predictions. The methodology also appears data and resource hungry. The report acknowledges that the method is resource hungry and will need a large resource if done properly. If the methodology is further developed it may prove useful to the Agency but research would need to be carried out on the likely data needs of the approach and how transferable it may be to strategic level assessments. Because of the lack of detail on method, this has not been possible to ascertain.

### **4.9. Integrated Appraisal for River Basin Management Plans – River Ribble Case Study (adapted from Andrews et al, 2003).**

#### **4.9.1. Introduction**

The Agency commissioned WRc and the Environment & Society Research Unit (ESRU, University College London) to carry out a study on an *Integrated Appraisal for River Basin Management Plans*. (Andrews et al, 2003). River Basin Management Plans are required as part of the implementation of the Water Framework Directive (Directive 2000/60/EC).

This study set out an outline integrated appraisal system that combines scientific and economic assessment and public consultation and involvement. The report provides a practical worked example exploring how the elements of this appraisal system might be applied to the Ribble River Basin. The objectives of the study were to explore ways of carrying out an integrated appraisal of measures for achieving good water status in a river basin, and to identify and investigate the main issues and problems that would be encountered in carrying out such appraisals. The study focused on the Ribble river basin in the Northwest of England.

#### **4.9.2. Stages of the Appraisal**

**Objective specification** – this initial element specifies the form of the objective in terms of (moving towards) achieving good status. It also establishes an agreed appraisal framework that recognises national and local objectives and the requirements of the Directive.

**Characterisation of River Basin: Assessment of pressures and risks of non-compliance under a business-as-usual case** – a risk based assessment of the likelihood of water bodies failing to achieve good water status in future planning periods. This is based on a business-as-usual scenario of likely future changes in pressures in the absence of any additional policy measures, over and above existing firm commitments. Table 4.7 shows example of the risk assessment framework used.

Table 4.7: Risk assessment framework

Ribble	Significant?	Likely Development in Pressure			Likelihood of limiting achievement of quality states in future plan periods								
		2000 to 2015	2015 to 2021	2021 to 2027	2015			2021			2027		
					G	M	B	G	M	B	G	M	B
Water Industry STW discharges	Yes	↓	→	→	H	M	L	H	M	L	H	M	L
Landfill	No	↓	↓	↓	L	L	L	L	L	L	L	L	L
Land drainage	No	→	↓	↓	M	L	L	L	L	L	L	L	L
Dangerous substances	Yes	→	→	→	L	L	L	M	M	L	M	M	L
Agricultural diffuse pollution	Yes	↑	↑	↑	H	H	L	H	H	L	H	H	L
Abstraction	Yes	→	→	↑	L	L	L	L	L	L	H	M	L
Overall (inc. synergies/cumulative effects)					H	H	L	H	H	L	H	H	L

G-Good, M-Moderate, B-Poor Status. H-High (75%), M-Medium (50%), L-Low (25%) risk of failure

**Option screening** – to identify feasible and effective measures aimed at reducing the risk of failing to achieve different (specified) water states in different planning periods.

**Option appraisal** – the identification and appraisal of cost-effective measures, and an assessment of the costs and economic and non-water environmental impacts of these measures. The method uses a combination of qualitative descriptions of the development of pressures, supplemented by quantitative assessments for some common quantifiable pressures using, for example, simple indicator-based pressure forecasts. This is presented in an *Appraisal Summary Table (AST)* to detail the problem being addressed, the feasible measures and the effectiveness, costs and ancillary impacts of options for achieving different water states.

**Objective refinement** – the assessment of the most appropriate objective for particular water bodies, given the feasibility of identified measures in achieving different water states, as well as the costs and ancillary impacts of the cost-effective packages of options for achieving these. This assessment focuses on examining whether the costs of these packages of options are disproportionately expensive. It will also aid decision-making, concerning the possible need for derogations to allow an extended deadline for achieving good quality (time derogation) and/or to achieve a less stringent objective (objective derogation).

**Plan agreement** – the development of an agreed set of actions for the Agency, its partners, sectors and specific geographic areas, and involving the results of national, regional and local stakeholder participation.

#### 4.9.3. Strengths and Weaknesses of the Approach

The main strengths of the approach are:

- The development of a business-as-usual case requires the assessment of the significance of pressures and their likely future development. This will help to set the baseline of the assessment as required under the ODPM guidance and the projection of a future baseline.
- The approach involved the establishment of a *stakeholder working group* to work with the appraisal process and a *stakeholder network* to channel views and concerns into, and receive outputs and feedback from, the appraisal process. This was seen as a useful approach and one that could be adapted as and when the actual appraisal process is more clearly defined.

However, it was recognised that the following issues required more research:

- It is unclear whether the approach could be applied to other types of water body (especially groundwaters);
- Some of the key concepts need to be operationalised, for example by defining terms, such as “significant pressure” and “(risks of) non-compliance”;
- In addition, there remains a need for more fundamental work on the relationship between the impacts of pressures and water states, and on the relationship between physico-chemical, hydro-morphological and biological elements of good water status;
- Research into cause and effect relationships was also seen as central to the assessment of the feasibility and effectiveness of measures. In particular, there is a need to determine whether the approach could learn from other practical examples of decision-making under uncertainty. Further research would be needed into establishing how the feasibility and effectiveness assessments could deal with instances of multiple impacts (e.g. on different elements of good status) and synergies between measures; and
- In terms of the assessment of costs, cost effectiveness and ancillary impacts, a need was perceived to define different levels of appraisal (broad-brush and more detailed assessments) and what might constitute good practice in each case.

#### 4.9.4. Lessons to be Learnt

The study is in the early stages of development and does not explicitly address cumulative impacts. Consultation with the officer in charge of the Water Framework Directive work within the Agency suggests that the development of guidance is ongoing but that at the moment is likely to be simple and matrix based with more complex methods slotting into the framework as development is carried out on tools. The case study was included because the framework suggested could in time be modified for wider Agency use. It does currently have some useful approaches such as the use of an appraisal summary table and the use of a risk assessment framework. The appraisal summary table is a tried and tested means of comparing multiple impacts of an option and as such will easily be understood by many practitioners.

It is suggested that the development of this methodology be tracked, as much of the future research will yield useful information that can be applied to wider cumulative effects assessment within the Agency.

#### **4.10. London Tidal Flood Defences Strategic Environmental Framework**

##### **4.10.1. Introduction**

Management and renewal of tidal flood defences in London is the primary responsibility of land-owners and developers (enforced by the Agency through the Land Drainage Regulations), with the Agency itself undertaking works in situations where a land-owner is unable to do so. The tidal flood defences protect an area of 125km<sup>2</sup> in London and are formed of 195km of river walls, embankments and control structures.

The renewal of the tidal flood defences is undertaken in the context of high land values and considerable development pressures in the capital. This has for many years resulted in the loss of river capacity and caused adverse effects on the hydrological capacity and environmental quality of the tidal Thames. A major cause of this is through “encroachment” where river walls being replaced in front of the original alignment. This is not a new phenomenon - encroachment has resulted in the incremental loss of extensive areas of intertidal habitats over many centuries (with the current river wall alignment lying some 100m in advance of the Roman waterfront).

Operating in line with DEFRA's guidance, the Agency takes a strategic approach to managing the environmental impacts associated with the renewal of the flood defences on the tidal Thames. This approach was first introduced in the overarching “London Tidal Flood Defences - Strategic Environmental Framework” (Environment Agency, 1999) and has more recently been updated through a series of embayment-level strategic environmental assessments. The approach has been applied through the implementation of individual tidal defence projects within the Thames Region capital works programme as well as through the Land Drainage consent process (for third party developments).

##### **4.10.2. Assessment Framework**

The effective assessment and management of cumulative effects is at the heart of the approach outlined in the Strategic Environmental Framework. In particular, the initiative aims to achieve no further net loss of environmental assets, and where opportunities exist, secure gains. The approach is summarised in Figure 4.3 and its key features include:

- Focusing upon a limited number of key environmental assets (i.e. hydrology and geomorphology, fisheries, aquatic biology, nature conservation, archaeology and heritage, river transport and wharfage, recreation, landscape, water quality);
- Adopting readily recordable measures of physical change as indicators of the actual effects on ecology and other features (e.g. change in area of intertidal habitat in the subtidal zone);
- Maintaining an “Environmental Balance Sheet” for each embayment area to monitor the net losses and gains against each indicator;
- Promoting the use of a “mitigation and compensation hierarchy” and recognising that the environmental assets are not entirely tradable across different locations; and

- Applying the approach to third party developments alongside Agency schemes.

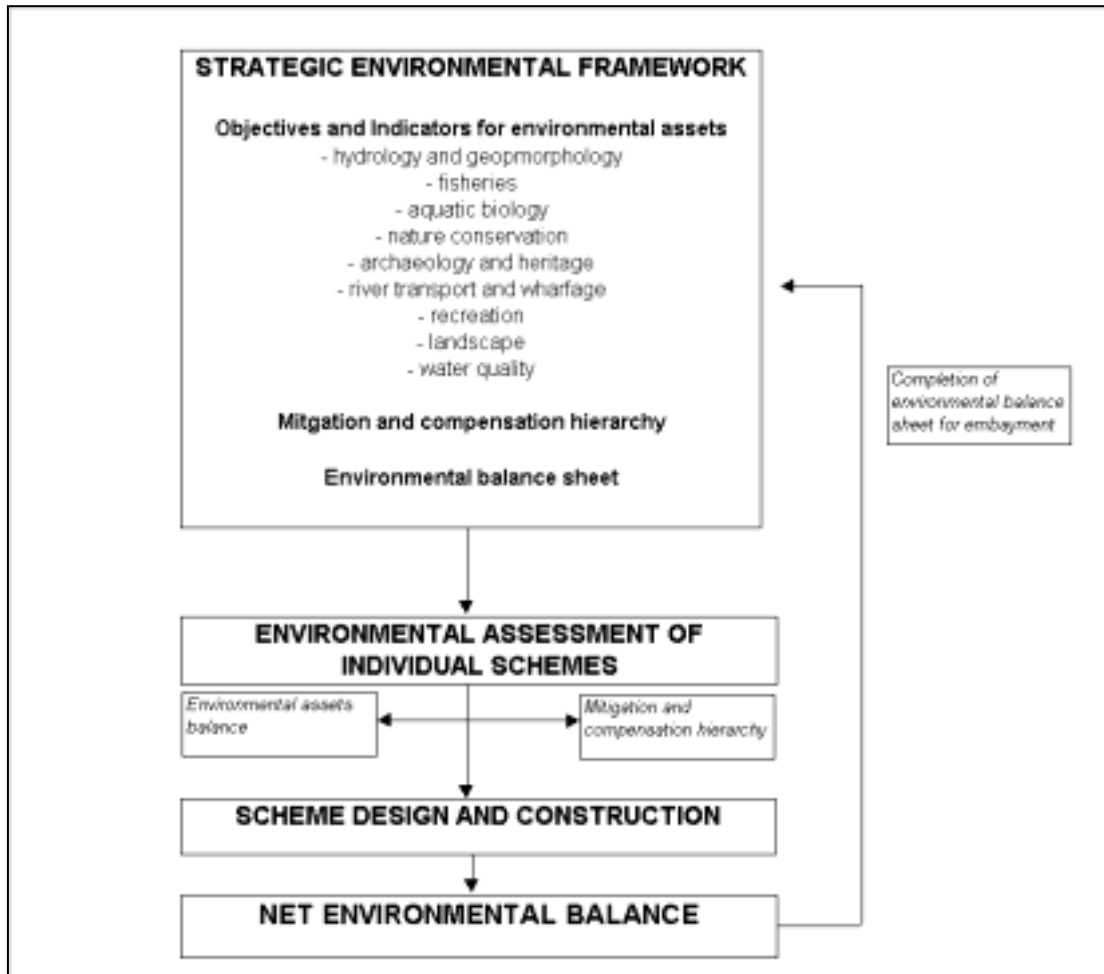


Figure 4.3: The approach to monitoring cumulative effects in the SEA framework (Environment Agency, 1999)

#### 4.10.3. Lessons to be Learnt

In developing the cumulative effects assessment techniques embodied in the Strategic Environmental Framework, it was clear that certain factors would have a particular bearing upon the potential success of the approach. These factors include:

- The nature of many of the important impacts is relatively simple, recordable and quantifiable – most of the effects are additive rather than synergistic in nature;
- Whether the Agency has some control over all of the works undertaken, both as a developer and a regulator via the land drainage consenting process. It also has the opportunity set a good example for other developers in its own works (e.g. achieving net gains in intertidal habitat creation at the high profile Greenwich Peninsula site);
- The incomplete scientific understanding of some environmental effects and critical thresholds may lead to uncertainty in impact prediction; and

- Difficulties in incorporating measures of quality as well as quantity of environmental features when adding cumulative effects (Fry, 1999).

The approach outlined in the Strategic Environmental Framework has now been operating for three years. Whilst the framework itself has now been supplemented through the development of embayment-specific strategic environmental assessments (to provide a more detailed environmental baseline and strategic environmental objectives), the approach to monitoring cumulative effects based on environmental balance sheets remains as originally set out. In practice however, the data collection and analysis required to support the approach has proved somewhat onerous (Whittle, 2003). This has particularly been the case for the land drainage officers who deal with the majority of sites. The experience may not be unique to this context and may be repeated elsewhere where new approaches to cumulative effects assessment are required, at least until the approaches become well-established.



## **5. The Agency's Need for Tools and Techniques**

### **5.1. Introduction**

Building upon the literature review, this chapter:

- Sets out results of the consultation with Agency officers. This clarifies the perceived need for CEA frameworks and tools and also highlights the level of knowledge Agency officers have on CEA;
- Widens this literature search by examining other environmental assessment tools that could be modified for use in CEA;
- Sets out what guidance is available to produce an Agency CEA framework; and
- Reviews the possibility of producing issue / plan or programme specific guidance for the Agency.

### **5.2. Views Expressed by Agency Officers**

Appendix D of the report sets out a list of Agency officers who were consulted as part of the project. Officers were identified by the Agency project team as being a representative cross section of people involved in strategic and SEA related work. A standard list of questions was presented to each of the Agency officers relating to a number of different elements of environmental assessment practice. This was done by means of a telephone interview (see Appendix E). This section brings together the results of this survey.

#### **The level of current SEA activity within the Agency**

It was acknowledged that there is some current strategic assessment activity carried out by the Agency but that assessments are not always referred to as an SEA. It is important to note that although strategic planning and assessment is happening within the Agency, this does not mean that this assessment adheres to the requirements of the SEA Directive. One officer, responsible for environmental assessment believed that a published SEA was only carried out on flood defence strategies, although work has been completed on assessments of Catchment Abstraction Management Strategies and Shoreline Management Plans. Assessments are quite often referred to and carried out as sustainability appraisals. An example of this is the sustainability appraisal that was carried out on the Water Resources Strategy produced in 2001 (Water Resources for the Future: A Strategy for England and Wales). This appraisal examined the impacts of options and the impacts of the plan as a whole on aspects of sustainability. It examined a broad range of impacts under the four government sustainable development headings of environment, economy, society and natural resources. Each option within the plan was appraised within a matrix that examined:

- Risk;
- Uncertainty;
- Policy constraints; and
- Opportunities for environmental enhancement.

The Thames Waterway Plan is another example of where SEA is being pushed forward within the Agency. In the early stages of the Thames Ahead initiative, a decision was made that SEA was essential to achieve a balance between increased navigation and recreation on the Thames and the environment. The objective of the SEA is to inform and appraise a range of strategic marketing options against a sustainable development framework. Once this has been completed it is intended that plan makers will assess the impact from a social, economic and environmental perspective, against available baseline data and objectives. Environmental specialists are working proactively with marketing professionals to develop the most sustainable options, which will be taken forward to form the basis of the Thames Waterway Plan.

The SEA has been divided into two phases. In Phase I the methodology was developed to carry out the assessment, the environmental objectives and indicators for the River Thames were defined and collected. Available data were stored in order to record the baseline situation in a Geographical Information System (GIS). The final report included a high level appraisal of potential options and a database and maps detailing available baseline data.

Phase II was commissioned in February 2002 to review and update the methodology, apply it to possible development options within Thames Ahead under the themes visitors, boating, facilities and land development, consider alternatives and identify cumulative impacts. Agency officers hope that the SIAM approach (Environment Agency, 2003b) will be utilised as part of this methodology.

### **The level of current CEA activity within the Agency**

The level of CEA activity was found to be low within the Agency. One area of development within the Agency was found to be work on the Humber Estuary Shoreline Management Plan. Major efforts are currently underway to include the effects of other developments (port developments, industrial development etc) in the assessment of the plan. No particular guidance is being used for this but advice is currently being sought from a range of internal and external advisors.

Informal assessment work on cumulative effects was completed as part of the Water Resources Strategy. Systems of working were developed in particular connected with abstraction control that means that the impacts on other parts of the Agency were assessed (for example, the interaction between water quality and water resources is controlled by both parts of the organisation planning to protect summer flows). Because the strategy took these issues into account and because a sustainability appraisal was carried out at different scales, the strategy acknowledged some of the cumulative impacts that could occur and tried to minimise them, although not explicitly.

The scenario approach that was taken examined the impact of different policy decisions by producing a narrative about how society and the environment will change, so in a sense it allowed the plan makers to understand how the environment responded to cumulative effects. This could have been further developed into an explicit CEA. The officer in charge felt that the strategy would have benefited from a more explicit CEA but at the time the strategy was being developed (between 1998 and 2001) it was not a consideration.

Other comments were made to the effect that CEA was carried out but that it was very localised, within environmental assessment of individual schemes and only in relation to the

function of the scheme. An example would be assessment of a coastal protection scheme taking into account the effects of other coastal protection schemes but not including the effects of other developments on environmental receptors.

One officer in charge of environmental assessment felt that where cumulative impacts are likely that some consideration would be given, mainly at the scoping stage and at the draft reporting phase when outputs become available. It is clear, however, that CEA is not carried out in a systematic and consistent way.

Several respondents felt that the closest the Agency gets to CEA is through the 'in combination' assessment required in Regulation 48 of the Conservation (Natural Habitats &c) Regulations. The other aspect of 'in combination' the Agency has considered is the acceptability of a perhaps incremental and otherwise insignificant change to an already degraded site.

The London Tidal Flood Defences strategic environmental framework was also suggested as an example of CEA and this has been included as a case study (see section 4.10).

No other examples of CEA within the Agency have been suggested to the project team.

### **Input into other plans and programmes**

Other (non Agency) plans and programmes that were discussed during the interviews were local and regional land use plans and the Agency's input into these. The Agency has had an in depth input into the Regional Planning Guidance for the South East and the London Plan. An Agency member of staff has been seconded to the South East Regional Assembly writing policies on flood risk / management, water resources and water quality. The main link with the sustainability appraisal of the strategy has been to provide baseline data.

According to the Agency respondent, CEA is not carried out on land use plans at the moment and there is no guidance that land use planners can readily use. The Agency has a concern about this because of the cumulative effect of developments on floodplains and water resources. A concern was also expressed that given the variable standard of environmental and sustainability appraisals within local authorities, that standards of CEA application are not likely to be consistent. It was suggested that this may be an area where the Agency has to provide some guidance or standards. General guidance was thought to be an important first step to establish principles followed by specific guidance on topics, which would be regionally specific to reflect the different pressures in different regions. Advice is needed on where the trade offs lie in different regions.

### **Guidance currently used for environmental assessment within the Agency**

The government guidance on *Sustainability Appraisal of Regional Planning Guidance* (ODPM, 2001) was used for some of the assessments that specifically addressed sustainability issues. An example of this was the sustainability appraisal carried out on the Water Resources Strategy. Current Agency guidance was also used within assessment of individual projects including *The Handbook for Scoping Projects: EIA* (Environment Agency, 2002). The Agency Management System Guidance (AMS Guidance) (Environment Agency, development ongoing) was also mentioned as being used.

Elements of methodologies were also specially designed for specific tasks within assessment of Agency plans and programmes. The most transferable of these was the risk and

uncertainty framework designed for the sustainability appraisal of the Water Resources Strategy. Other guidance used within the Agency includes the English Nature Regulations Guidance note 4 which is used for “alone or in combination assessments” for Regulation 48 of the Conservation (Natural Habitats &c) Regulations. However, no Agency guidance specifically on CEA of plans or programmes was suggested to the project team.

Consultation was also carried out with an officer within the economic appraisal section of the Agency. This department provides guidance on monetary valuation of actions by the Agency. An example of this was guidance on monetary valuation of recreational improvements. It was felt that the multi criteria framework used within this could be a transferable framework for cumulative effects assessment.

Reference was also made within the consultation of the collaborative work carried out with the Agency and the UK Climate Impacts Programme on handling risk and uncertainty in decision-making for climate change. This project will be developed within the Agency through proposed work with the European Union for a four-year project examining the effects of climate change on spatial plans and programmes.

### **Guidance needed for effective CEA**

It was reported by one officer that SEA procedures within the Agency Management System (AMS) Guidance are not considered practical or useable and that Agency staff feel that there is not enough data to carry out what is suggested and the procedures add too much time to the plan and programme making process. There was only one mention of the AMS guidance within the interviews related to SEA so this may support this view that the AMS Guidance is not extensively used.

It was felt that guidance was needed in order to ensure consistency of standards, especially where the Agency is giving advice to aid the assessment of other organisation’s plans and programmes i.e. Local Planning Authorities.

Most of the interviewees felt that if CEA guidance was provided it needed firstly to consist of a simple procedural framework that was not too onerous in terms of adding time and cost to plan and programme making. Some example frameworks were suggested such as the multi criteria analysis framework used for economic assessment and the generic framework used for sustainability appraisals. The view was expressed by one officer that any guidance should cover all sustainability issues not just the environment. It was also felt that the risk and uncertainty framework developed for the Water Resources Strategy might be usefully transposed for use in other contexts.

One respondent also felt that very prescriptive guidance that guided officers towards one answer would not be helpful. The opinion was expressed that CEA is likely to remain something that depends in the end on professional judgement and this should not be stifled by guidance that was too restrictive.

Most of the respondents did not have a definite view on whether guidance should be provided that helped to assess each plan or programme type the Agency produce or assess the impacts on each environmental receptor. One respondent felt that guidance should split into the different categories of plan or programme:

- Plans or programmes detailing infrastructure that the Agency needs to build; and

- Strategy dealing with long term options (this is where the respondent thought CEA was most applicable).

However, another respondent felt that once general framework guidance is in place this should then be added to with guidance relating to particular assessment methods.

This view was also held by staff members in charge of providing the AMS guidance. They feel that the early stages of guidance development needs to focus on the procedural elements by examining the procedures that the Agency and other agencies already have and see what works and what doesn't. However, some respondents also felt that the technical side also needs development after the procedural framework is in place. The officer in charge of the Humber Estuary Shoreline Management Plan felt this as the models being used there are not specifically designed to deal with cumulative effects. In general it was felt that guidance on the following is lacking at the moment and would hinder the Agency when examining cumulative effects:

- What data requirements might be for CEA;
- What tool / techniques can be used in CEA such as cause – pathway – effects, network diagrams etc. Agency staff need to be shown how these may be useable;

Others felt that as part of the generic procedural guidance some clarification should be given on the following issues:

- How to assess against an evolving baseline / how to project the baseline forward;
- Should the Agency be examining the cumulative impact of every project within a capital programme? What would be the boundaries of the assessment? Where does CEA stop?
- Should the Agency examine the cumulative effects of their own plans, programmes and projects added to the plans, programmes and projects of other agencies? How can these important plans, programmes and projects be identified?
- How can lack of data be dealt with in an assessment?

Staff responsible for providing environmental assessment guidance within the Agency also thought that in terms of increasing the accuracy of predictions that in the future the Agency may want to start drawing together scientific literature on different receptors to ensure officers are up to date on the likely effects of different actions. However, it was felt that this should not prevent the earlier production of guidance. Guidance needs to be given to officers to enable them to make an assessment of cumulative effects of a plan or programme no matter how much data may be available to them.

### **5.3. Other Environmental Assessment Tools**

The review of literature carried out as part of this CEA project has identified two main categories of literature on CEA. The first category of literature that has been found is the simpler checklist or procedural framework type guidance that sets out the general steps that should be followed as part of a CEA. The second type are academic studies examining the

cumulative effects of certain types of development or certain types of environmental receptors. An example would be the study that examined the effects of several linear developments on different forest bird species. These studies although not guidance in themselves can be used as the background to more detailed predictive techniques if these are developed for the Agency. They attempt to set out what the detailed impact pathways may be for different developments and receptors.

The project brief also required the study to examine whether existing project and strategic level tools could be adapted for use in CEA. This section of the report will do this.

The Agency has recently completed a study into Strategic Integrated Assessment Methods (SIAM) (Environment Agency, 2003b) which sought to develop the integration of appraisal tools and environmental, social and economic information and issues. As part of this project generic appraisal stages were identified and good practice approaches recommended. The SIAM report constitutes a comprehensive review of the appraisal tools used by the Agency and others to examine the environmental impacts of project and strategic level decisions and as such has strong links to this project. According to the SIAM report the main transferable appraisal tools can be broken down into six categories:

- Cost benefit analysis;
- Multi-criteria analysis;
- Life cycle assessment;
- Risk assessment;
- Environmental assessment and related tools;
- Sustainability appraisal and related tools.

For this project the attributes of these appraisal tools has been assessed under a number of criteria. These criteria are:

### **Robustness**

One of the key problems in dealing with cumulative effects is that they are particularly variable with respect to geographic area and time as the aggregation of impacts is a result of many complex factors. However, the desire to be rigorous and robust in the tools and techniques becomes more demanding as the focus moves from the site- specific, to regional and national level plans and programmes. This is compounded by the often long timescales for effects to be come apparent.

Robustness may also be seen in terms of repeatability of the assessment - whether others would arrive at the same conclusion even given the difficulties of scale and duration as identified above. Essentially, would others be as equally accurate in the forecast?

### **Breadth of applicability**

Tools can be divided into two types – generic tools that can be used to gauge the impacts of all types / levels of plan, programme and impact; and tools which are specific to one type of plan or programme / one type of impact or one geographic area. Generic tools include checklists, matrices, causal chain diagrams (cause and effect diagrams). Tools which are

specific to one type of plan / programme or issue are those which rely on a level of modelling / data collection that has been adapted to make it specific to that kind of impact, plan / programme or area. An example would be the SIMCAT river modelling system used by the Agency.

### **Flexibility / ease of use**

This issue is closely related amount of data required for the assessment method. If a technique requires a large amount of data, for example on past environmental trends, it will be less flexible and adaptable than a tool requiring less data. Flexibility also relates to whether tools can be used for more than one type of plan / programme or one type of area.

### **Resources and data / information needs**

It can generally be said that methods that are relatively robust will need large amounts of data and resource. Some of the methods this report have large data and other resource requirements. It is important that the data required for the method is proportionate to the robustness of the assessment method.

### **Compatibility with other tools and techniques.**

One important issue for the Agency is that tools are compatible with the tools that other organisations will be using to carry out CEA as part of SEA. This is a difficult issue to consider at this stage as other organisations do not seem to have started planning for the CEA element of the SEA Directive. By examining how commonly used tools can be adapted for use in CEA it is unlikely that any tools chosen by the Agency will be incompatible with tools used by other organisations.

### **Transferability of project level techniques**

Many of the tools have applications at both a project and a strategic level in environmental assessment. Some of the more data hungry tools, however, such as modelling will always be more appropriately used at a project level. What is clear is that different types of plan or programme will be more able to use detailed project level assessment tools such as modelling. Plans or programmes that are essentially of the area – wide and zonal type may be more able to use these approaches. However, due to the complexities of CEA it will be difficult to ascertain whether a project level tool can be adapted for use in strategic level CEA until the tool is tested. Plans that are more policy based are likely to use tools that are used both for project and strategic levels already such as checklists and matrices.

### **Transparency and inclusiveness**

An important attribute of tools is how transparent they are to the user. Some computer or mathematical models work as a “black-box” where the internal workings of a model are not known. A parallel in environmental assessment is pseudo – quantitative methods such as scoring and weighting systems for impacts. These tools can be attractive because they substantiate numerically the benefits of one option over another (Glasson et al, 1994). However, tools such as these can make it difficult for stakeholders to get involved in the

assessment process as they can have difficulties seeing how their input is turned into meaningful appraisal results. Conversely tools such as matrices and checklists can be transparent and inclusive eg when used to record the results of an appraisal process that utilises stakeholder debate.

Table 5.1. shows how these commonly used environmental assessment tools may be adapted for use in a CEA framework.



Table 5.1. Relevance of environmental assessment tools to CEA

Tool description	Definition	Application to CEA and attributes of tool
<b>Cost benefit analysis</b>		
<p>Various different methods – hedonic pricing, willingness to pay, contingent valuation, cost effectiveness analysis</p>	<p>CBA assigns a value to costs and benefits on the basis of individual’s preferences.</p> <p>CBA cannot operate in isolation. It is primarily an evaluation tool not an impact identification tool (Petts, 1999) and depends for its analysis on separate impact identification.</p>	<p><b>Scoping</b></p> <p>Could be used in SEA scoping with the community assigning values to certain environmental resources. This would be a way of assessing the relative values of different environmental resources and which should be assessed in detail in the assessment. This should be investigated further.</p> <p><b>Impact prediction</b></p> <p>CBA is a specialised tool that would require a lot of resources to undertake for a strategic level CEA. It is not particularly flexible or easy to use for impact prediction and is not a transparent or inclusive process as it requires the input of a professional. The uncertainty likely in judging the impacts of a plan or programme may mean that the results of any CBA are meaningless. For example, an assessor may have assigned a value to each hectare of SSSI. However, if the assessment cannot make a relatively certain judgement on how much SSSI may be lost as a consequence of a plan or programme, valuation becomes pointless.</p>
<b>Multi criteria analysis</b>		
<p>Examples include Appraisal Summary Tables used in Local Transport Plan appraisal</p> <p>Has also been used to forge consensus in the New Forest LEAP (Local Environment Agency Plan)</p>	<p>Any structured approach to determining overall preferences among alternative options, where options accomplish several objectives (DETR, 2001).</p>	<p><b>Impact Prediction particularly options assessment</b></p> <p>This could be a useful tool to use when assessing the impacts of a number of different options. When used in its simplest form MCA requires the production of a relatively simple and transparent performance matrix (similar to the Appraisal Summary Tables produced as part of Local Transport Plan Appraisal) which presents the results of the impact assessment for plan or programme makers to judge. This is a very simple and flexible way of presenting results for an option assessment and has a large breadth of analysis because it can be used to present qualitative and quantitative data. MCA is a commonly used tool so its use in CEA is likely to be compatible with tools that are likely to be used in evolving SEA frameworks. For CEA it is most likely to be used as a way of presenting appraisal results for different environmental receptors.</p>

<b>Life cycle assessment</b>		
Examples include the Agency's WISARD tool (Waste Integrated Systems Assessment for Recovery and Disposal)	This is a cradle to grave analysis of the environmental impacts of a product or process.	LCA can be time and resource intensive and the data required for the assessment are often not available or of insufficient quality. LCA cannot deal with effects that cannot easily be quantified. CEA of strategic plans and programmes is unlikely to be able to reach the level of quantification needed for LCA and LCA does not deal with location specific impacts. E.g. an increase in sediment is treated the same wherever it is experienced. Because of these reasons, LCA is unlikely to be a valuable tool in CEA at the strategic level.
<b>Risk assessment</b>		
The Agency has used risk assessment at the project level on flood and coastal projects	Risk assessment involves the estimation of the probability and severity of hazards to human health, ecological systems and / or safety.	<p><b>Impact prediction</b></p> <p>Risk assessment may be useful to CEA because it offers a formalised manner of dealing with uncertainty. There are likely to be large uncertainties associated with plans and programmes especially as CEA demands that the assessment look at the cumulative environmental impacts of the plan or programme in question and plans or programmes of other agencies. Risk assessment is a flexible tool that can be used at several different levels from a simple risk statement to a full quantitative risk assessment (Petts, 1999). Impact prediction in CEA would be useful if it explicitly considered both impact probability and impact severity. This tool can be used in association with stakeholders as the process can be broken down into a relatively transparent process of appraising people's perceptions of acceptability of risk. This should be investigated. Risk assessment is a commonly used tool in the Agency so its use in CEA is compatible with tools already in use by the relevant officers..</p>

<b>Tools used with environmental assessment processes (both project level and strategic)</b>		
<p>Matrices and checklists</p>	<p>Checklists are simple lists to remind the appraisal team of impacts they should consider during the appraisal</p> <p>Matrices are more complex tables that enable an appraisal team to identify what part of a plan, programme or project may have an effect on which environmental receptor.</p>	<p><b>Scoping and Impact Prediction</b></p> <p>Checklists and matrices are a simple, transparent and inclusive way to identify what the likely environmental effects of a plan or programme might be. They are tried and tested tools (making their use compatible with tools likely to be used generally for SEA) and are flexible. The amount of evidence provided to back up the information given in the checklist or matrix can be adapted so the robustness of the tool changes according to how much evidence is collected. This also makes them flexible in terms of the stage they are used in the assessment. They can very usefully used at the scoping stage by a panel debating what the impacts are likely to be. At the impact prediction stage they can be used along with other methods such as causal chain analysis or modelling.</p>
<p>Professional judgement (possibly using questionnaires, interviews and panels)</p>	<p>Professionals come to a view on what the impact of a plan or programme may be using their professional knowledge. This can be achieved by a single professional but it is valuable for a number of opinions to be sought from experienced practitioners. These approaches seek to do this either through debate, where consensus can be found or through questionnaires which can help to guide the assessor.</p>	<p><b>Impact Prediction</b></p> <p>Professional judgement is still the main way that assessment of the impacts of plans and programmes is carried out. This is also likely to be the case with CEA. It has many benefits because it is simple to use, is flexible, transparent and can be used with any amount of data / information that is available. Standard matrices could be modified so they can specifically consider the effects of a number of different plan and programme together. The method in the past has not been particularly robust because of the way it has been used. Appraisals have tended to be carried out by one officer (sometimes fairly junior and inexperienced) and have not involved professional debate. The inclusiveness of the process could be much improved by including a wider range of professionals and stakeholders in the debate.</p>

LITERATURE REVIEW / SCOPING STUDY ON CUMULATIVE EFFECTS ASSESSMENT AND THE STRATEGIC ENVIRONMENTAL ASSESSMENT  
DIRECTIVE

<p>Stakeholder involvement – quality of life capital</p>	<p>The core idea of the quality of life capital tool is that the environment, the economy and society provide people with a range of benefits and that it is these benefits that we need to protect and enhance.</p>	<p>The quality of life capital idea could be used at several levels in a CEA.</p> <p><b>Scoping</b></p> <p>Its main purpose is defining what is important to people so it is a good way of identifying what are valued resources and what should be considered in an assessment.</p> <p><b>Impact evaluation</b></p> <p>The method can be used to judge how significant impacts may be once they have been predicted.</p> <p>The tool is relatively easy to use, transparent and inclusive but to get a robust answer that is representative of the majority of peoples opinions it may take a lot of time and resources. The valued resources chosen at the beginning of the CEA exercise should be subject to a reality check to ensure that all valued resources have been chosen. Resources that people choose may not include resources that are important in ecological terms.</p>
<p>Ecological footprinting</p>	<p>Ecological footprinting is a way of expressing environmental impact (mainly on resources) by showing what area of land would be needed to sustain a certain population or the production of a product, service or project.</p>	<p>Because of the uncertainty involved in plans and programmes it would not be possible to map out a footprint at any level of detail that would be useful to plan or programme makers. Ecological footprinting also only examines the resource impacts of an action. It does not cover the breadth of issues that CEA would require.</p>
<p>Numerical / computer modelling</p>	<p>Modelling utilises computers to build a simulation of an environment. An example would be modelling the environment of a river catchment. Inputs to the environment can then be modelled to find out what their impact may be. I.e. the impact of a new discharge can be modelled to ascertain what effect it will have on water quality</p>	<p>Modelling has been utilised within the Agency as part of the in combination assessments carried out as part of the Habitats Directive. Catchment models have been produced for 27 rivers in the UK designated as a Special Area of Conservation (SAC). These models are called SIMCATs.</p> <p><b>Impact Prediction</b></p> <p>Models can be useful to assess the cumulative impacts of several projects. Where a CEA is being carried out on a plan or programme that is, in effect, a collection of projects, modelling should be investigated as a method that is considered to be robust. However, modelling is a specialised area and will need specialised resources and is likely to be very resource intensive. The decision to use computer modelling is one that should be considered carefully. Modelling approaches are not very transparent processes. Because of this, they may make it difficult to involve stakeholders and may not serve to increase stakeholders general understanding of the impacts that different activities can have on different environmental systems.</p>

Causal chain analysis	A causal chain analysis maps the complex and knock on effects of an environmental change. Impacts are very rarely simple (especially in CEA) and a causal chain diagram can map these impacts.	<p><b>Impact prediction</b></p> <p>Causal chain analysis can be very useful in setting out how different plans or programmes and different impacts can interact with one another. It is likely to be a very useful tool for use in CEA and the effects of different plans and programmes can be mapped to see whether they would have the same end point i.e. whether they will affect the same environmental resource. It is a flexible and easy to use tool as it can be used with as much or as little data that is available to the project team. The robustness of the tool is measurable because the path from cause to effect is set out very clearly and each link in the chain can be monitored. Because of this it is a very transparent tool.</p>
GIS	GIS is a mapping tool that can be used for several different purposes in the environmental assessment process.	<p><b>Scoping</b></p> <p>Mapping is an important tool to express and help set the spatial boundaries of an assessment by looking at the geographical extent of valued resources.</p> <p><b>Impact prediction</b></p> <p>In assessment of projects GIS can be helpful by overlaying maps of the extent of an environmental resource with a map of the physical extent of the project. This could be useful in CEA by mapping the extent of different plans, programmes and policies and identifying possible areas of overlap that may need further investigation. This may be more difficult for a plan or programme if the implications of the action on the ground cannot be ascertained to any great level of detail. However, its use as a tool should be investigated further. GIS helps to make the whole process of assessment more inclusive as it clarifies the likely extent of impacts.</p>

<b>Sustainability appraisal and other related tools</b>		
Objective led sustainability appraisal	Environmental (or sustainability) objectives for an area / resource are agreed and a plan or programme's ability to reach those objectives is scored usually using professional judgement in a matrix.	<p>The ODPM draft guidance on SEA (ODPM, 2002) is based on a model of objective led assessment.</p> <p><b>Objective setting</b></p> <p>It is important to assess in CEA firstly what the baseline environment is like and then also assess what objectives will need to be reached by the plan or programme. There are many important objectives that the Agency would want plans or programmes to help to achieve such as river quality objectives and air quality objectives. It is important that as part of the CEA process, the assessment identifies other plans and programmes that are important. This is a common step in sustainability appraisal.</p> <p><b>Impact Prediction</b></p> <p>Impact prediction within sustainability appraisal has tended to be of a qualitative nature using professional judgement. This is likely to be the most useful method in plans that are essentially policy based. This is a flexible, transparent and easy to use method but the robustness needs to be improved by properly documenting the professional debate or by setting out more clearly the assumptions that were made in reaching the conclusion. Assumptions relating to how effects are expected to interact will be especially important to document for a CEA.</p>

## **5.4. Producing CEA Guidance for the Agency**

Consultation with Agency officers included the consideration of whether generic CEA guidance was needed for the Agency or whether energy should be focused on producing guidance on how to carry out CEAs of specific plans and programmes. The consensus was that generic framework guidance was needed firstly and that once this was in place, plan and programme specific guidance could be produced.

In response to this view, this chapter of the report firstly draws together the literature in a way that could be used as a basis for setting up generic procedural guidance. The chapter then goes on to outline considerations that may need to be borne in mind in the production of plan and programme specific guidance.

### **5.4.1. Production of a Generic CEA Framework**

Table 5.2 brings together the results of the literature review and review of tools. It summarises the findings of the literature review by summarising (by ODPM SEA stage) the promising approaches and tools that have been identified and would need to be developed / modified in the production of a generic Agency CEA framework and suite of tools. The purpose of this framework is to outline the steps that Agency officers should go through when carrying out a CEA and the general considerations that should be borne in mind under each step. An example of such a consideration may be under the step of scoping to set out how to identify whether the future actions of other organisations are important to assess.

The setting up of this generic framework is paramount. It could be based upon the stages set out in Table 5.2 and should be kept fairly general outlining the steps that CEA should follow. Once the framework is outlined, considerations and a suite of predictive tools can be developed that fit into it.

A colour-coded system has been used within the table. Green denotes that current Agency guidance is adequate to comply with the likely CEA requirements for SEA. Yellow denotes that a combination of Agency guidance and external guidance can be used to produce new Agency guidance. Red denotes an issue on which the CEA community does not currently have a solution and which may need further research (possibly in conjunction with other agencies).

### **5.4.2. Developing Plan and Programme Specific Guidance**

The list below shows which Agency plans and programmes are likely to require an SEA and are therefore likely to require consideration of cumulative effects. This list has been taken from the draft AMS guidance on which plans, programmes and strategies are likely to require an SEA under the provisions of the directive.

- Catchment Flood Management Plans (CFMPs);
- Flood & Coastal Defence Strategies;
- Shoreline Management Plans (SMPs);
- Catchment Habitat Management Plans (CHaMPs);
- Water Level Management Plans;

- Flood & Coastal Defence Capital Programme;
- Flood & Coastal Defence Operational Maintenance Programmes (watercourse & asset maintenance);
- Water Resources National and Regional Strategies;
- River Basin Management Plans (RBMPs) and programmes of measures (required under the Water Framework Directive);
- Catchment Abstraction Management Strategies (CAMS);
- Fisheries Action Plans;
- Recreation Strategies and Action Plans; and
- Navigation (Waterways) Plans.

Topic based literature has been analysed concentrating on different Agency issues and also planning and transport issues. This section of the literature review found that there were very few guidance documents that specifically dealt with CEA of different plan or programme types (i.e. a habitat plan). Most of the literature was academic in nature and either set out general principles of assessment (similar to those already examined) or were studies that sought to test impact assumptions and linkages i.e. a study examining how deforestation affects the temperature of streams. These studies do help us to understand the nature of how activities impact on the environment but are not predictive tools as such.

In terms of relationship with the ODPM stages of SEA assessment, the literature either relates to all stages of the assessment because it sets out general requirements of the CEA, or they relate to the impact prediction stage of assessment. An example of setting out general requirements of a CEA is Berg et al (1996) which sets out desirable attributes of a watershed level assessment.

Although general procedural guidance is recommended as a priority it may also become necessary to develop guidance specific to certain types of plan or programme. Although the topic specific literature search has been relatively limited the impression was also gained from the external consultation that guidance on methods for specific plan and programme types / issues is generally lacking. Therefore, it is suggested that the Agency will need to carry on with its early but developing work on CEA methods for certain types of plan or programme. An example of this is the work on the River Ribble for the Water Framework Directive.

This is potentially a large task. Therefore, it is suggested that a staged approach is the best way forward building on the good work that has already been started in various sections of the Agency. This staged approach should involve setting out priorities in terms of plans and programmes that are felt to be the most important to address in terms of cumulative effects (this needs to address plans and programmes where work is already underway on SEA methods and also address plans and programmes that are in preparation but not adopted before 2006, as these will be subject to the requirements of the Directive).



Table 5.2: Matching Agency needs with available guidance

Likely stages (based on ODPM guidance)	Current Agency Guidance	Issues	Possible Guidance / Tools	Implementation issues
<b>Screening (does the plan or programme require SEA or CEA?). this is not an explicit stage within the ODPM guidance.</b>				
Decision on whether cumulative effects are likely to be significant within the assessment.	The AMS includes a work instruction for screening and scoping for SEA.	There is no current guidance to ascertain whether CEA will be an important aspect of the SEA.	No possible tools have been identified for examining whether cumulative effects will be important.	Draft AMS guidance on SEA is appropriate for use. If a plan or programme needs to have an SEA carried out on it, this will need to include cumulative effects by virtue of the Directive.
<b>A. Identify other plan and programme's objectives, visions and problems</b>				
Assess the likelihood of other activities going ahead.	There is no current Agency guidance on this.	Agency officers have expressed a concern that they need guidance how to identify which other plans and programmes should be assessed.	Conservative determination method for determining whether an action is reasonably foreseeable.	This is a simple and flexible checklist of issues which could be turned into a procedure for the Agency on determining which plans should be considered and how to determine whether the actions within them are reasonably likely to go ahead.

<b>B. Select the baseline including forward and backcasting (data on trends)</b>				
Assess the current status of the receiving environment – concentrating on valued ecosystem components.	Agency EIA scoping guidance (Environment Agency, 2002) gives a list of data sources and stakeholders and sets out the type of baseline data that might be needed for an assessment. Although this is project level it could be adapted.	Agency officers feel the guidance is needed on the data requirements of CEA.	State of the environment approaches including a broad understanding of sensitivity and processes.  Use of GIS but will probably not involve primary data collection.  Cost benefit analysis could be used along with quality of life capital to chose the valued environmental resources for use in the assessment	The AMS guidance on SEA is a useful framework. More research is needed on the baseline data requirements of cumulative effects assessment.
Assess the future status of the environment (without the plan or programme).	AMS SEA guidance states that future trends in the baseline will need to be reported.	Agency officers have expressed need for guidance to on how to assess an evolving baseline.	The scenario approach may be an important tool.	Unclear how the scenario approach could be used within the Agency. More research needed on possible approaches and possibly broad overarching scenarios that can be set related to future level of development, climate change etc.
<b>D. Scoping</b>				
Identify likely environmental effects.	The Agency has published a list of impact types within the EIA scoping guidance (Environment Agency, 2002).	What level of detail is needed at this stage?	Various government agencies provide indicative lists of impact type to guide decision-making.  Checklists and matrices have been used extensively for this.	Indicative lists are easy to use, flexible as they can apply to all types of plans and programmes and are easily adaptable especially as some Agency work has already been carried out on this. Decide how best to produce these indicative lists.
Identify likely cumulative effects.	There is no specific guidance on how to identify cumulative effects. Agency guidance on scoping for EIA (Environment Agency, 2002) identifies quality of life capital as a useful scoping approach.	How different would this be to identifying simple direct effects? Which agency's responsibility is it to do this?	See above for checklists.	The checklists could be adapted so all relevant actions could be scored against these. Needs more thought on how to involve other parties when doing this.

LITERATURE REVIEW / SCOPING STUDY ON CUMULATIVE EFFECTS ASSESSMENT AND THE STRATEGIC ENVIRONMENTAL ASSESSMENT  
DIRECTIVE

<p>Set appropriate geographical and temporal boundaries.</p>	<p>There is no guidance on this.</p>	<p>Ensure boundaries are ecologically defensible. How can the Agency cope with the difficulties of planning over administrative boundaries?</p>	<p>Several guidance documents including US and Canadian guidance set out criteria on how to decide temporal and spatial boundaries.</p> <p>US guidance sets out geographical areas for analysis based on environmental resource.</p> <p>GIS is likely to be a very useful tool to help set spatial boundaries.</p>	<p>There are some lists and criteria on how to set boundaries. Although some of these relate to planning systems in other countries they could be adapted to take into account Agency issues.</p>
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<b>C and E. Option and policy identification and assessment</b>				
Assess the cumulative effects of the plan or programme.	The Agency has a work instruction for risk management.	Agency officers feel that they need more guidance on how possible methodologies can be useable within the Agency context and how to deal with lack of data.	<p><u>Various methods:</u></p> <p>Methods to address uncertainty / risk;</p> <p>Spatial analysis using GIS;</p> <p>Indicators of change;</p> <p>Numerical modelling;</p> <p>Questionnaires, interviews and panels (expert judgement);</p> <p>Matrices and checklists;</p> <p>Multi-criteria analysis (e.g. the AST used for the Ribble case study (although this mainly a presentational device); and</p> <p>Causal chain analysis</p> <p>(see Table 5.1. for a more in depth analysis of the attributes of these tools).</p>	<p>Tools are divided into those that are flexible, easy to use and adaptable (checklists, matrices, networks and systems diagrams, indicators and panels / interviews) and those that are arguably more robust but require large amounts of data / resource such as GIS analysis and numerical modelling).</p> <p>The important issue in this is prediction – how do you come to a view on what the effect is going to be. There are different levels of this:</p> <ul style="list-style-type: none"> <li>• Expert judgement in an unstructured way (as used in a lot of sustainability appraisals)</li> <li>• Expert judgement using tools such as network diagrams, checklists and matrices and GIS)</li> <li>• Numerical modelling.</li> </ul> <p>Research is needed within the Agency on how these tools can be applied. Some simple examples should be given in the meantime to slot into the procedural framework guidance as it is being developed – these should focus on expert judgement with supporting tools.</p>
Assess the environmental effects in combination with other activities.	<p>Risk and uncertainty framework developed as part of the sustainability appraisal for the National Water Resource Strategy</p> <p>Sustainability appraisal framework used as part of several Agency assessments</p> <p>Various different methods mainly incorporating expert judgement but some modelling programmes (air quality and river quality mainly).</p>			

LITERATURE REVIEW / SCOPING STUDY ON CUMULATIVE EFFECTS ASSESSMENT AND THE STRATEGIC ENVIRONMENTAL ASSESSMENT  
DIRECTIVE

Determine significance.	There are no tools.	Uncertainties relating to impact prediction also relate to how the significance of impacts can be assessed.	Significance thresholds as used in the oil sands case study.	Significance thresholds are used for a variety of SEA methods such as work on multi modal study appraisal, which examines the significance thresholds for issues such as biodiversity and water quality. These could be adapted for Agency use.
<b>F. Mitigation</b>				
Identify mitigation measures Decide on strategic mitigation.	No Agency guidance was identified.	Level of mitigation response may be beyond one Agency to cope with. Effective CEA mitigation often implies the need for co-operation.	No particular guidance has been highlighted that examines CEA mitigation.	This issue is likely to be a difficult one. Is the aim of mitigation to reach overall policy aims or compensate for the damage done by one particular plan or programme? The resolution of this issue is beyond the scope of this report. Research should be conducted that analyses the links between objective setting and mitigation and how strategic mitigation may be carried out involving different parties. Legal and institutional mechanisms will be important.

<b>H and I Consultation</b>				
<p>Consultation comes at a variety of different stages in the assessment process.</p>	<p>Agency scoping guidance on EIA (Environment Agency, 2002) has a review of public consultation methods and a list of stakeholders. AMS guidance on SEA (Work instruction for SEA screening and scoping) examines principles of stakeholder participation.</p>	<p>CEA relies on information and data provided by others. Consultation (and involvement) are vitally important.</p>	<p>Consensus building approach. Quality of life capital.</p>	<p>The social policy team within the Agency will be important in determining what methods may be useful for CEA. Most methods used in planning are flexible and can be adapted. As CEA guidance within the Agency is developed the development of consultation tools needs to be an important element of it and needs to be very much related to the methods chosen.</p>
<b>I. Monitoring</b>				
<p>Evaluate the effectiveness of mitigation measures. Determine the changing state of the environment.</p>	<p>The Agency monitors the environment as part of most of its activity.</p>	<p>Monitoring has been highlighted within the academic literature as a difficult issue.</p> <p>What is being monitored? The effects of the plan or programme, all plans, programmes and activities or the general state of the environment?</p> <p>How can the links between the state of the environment and actions be made clear (how can impact pathways be monitored?)</p>	<p>Alberta guidance and the US guidance lists a number of aspects of monitoring systems.</p>	<p>This is likely to be another difficult issue. Research should be conducted that analyses the links between objective setting and monitoring (as outlined by ODPM draft SEA guidance) and how monitoring may be carried out involving different parties. Legal and institutional mechanisms will be important.</p>

### 5.4.3. Outstanding Procedural Issues

Having explored the literature and the views of Agency officers to assemble a view of the need for tools and techniques, this Chapter provides a perspective on the wider issues associated with cumulative effects assessment.

#### **Involvement in other Agencies Plans and Programmes**

The Agency is also involved in the assessment of other organisation's plans and programmes as:

- A provider of data;
- A consultee giving opinions on the accuracy of impact predictions;
- Provider of advice on methods to assess the impacts of development on water resources and flooding.

The list below shows some of the plans and programmes which the Agency may be involved in as an advisor or consultee:

- Regional Planning Guidance;
- Regional Economic Strategies;
- Regional Waste Strategies;
- Regional Sustainable Development Frameworks;
- Statutory Development Plans including Waste and Minerals Local Plans (both the old and the new system of Local Development Frameworks)
- Biodiversity Action Plans;
- Community Strategies;
- Forward plans and programmes produced by water companies;
- Local Transport Plans; and
- Regional Transport Plans.

*It should be noted that there may be other plans and programmes that will be subject to the SEA Directive's requirements. These are likely to fall in the tourism, forestry and agriculture sectors. It is very difficult to set out a definitive list before the ODPM has carried out the necessary reviews.*

Consultation on this project has made it clear the Agency is ahead of most local authorities in their consideration of the requirements of the SEA Directive and the methods available to carry out CEA and SEA. Therefore, the Agency may find itself in an informal role of providing more general advice on CEA methods and frameworks.

Important issues in this context are:

**Data** – there is uncertainty over how much data are needed for various stages of CEA and SEA. Research may be needed (in concert with other organisations) on the data needed for different levels of CEA. This needs to be linked to the type of methodology chosen for impact prediction. A sustainability appraisal approach would require less data than a numerical modelling approach. This consideration of data needs to be extended to take into account the likely methods that local authorities (and other bodies) will need for their SEA / CEA. The Agency may need to organise its data in a manner that highlight environmental trends and to indicate where thresholds and environmental capacities may be threatened.

**Predictions** – there is a lack of knowledge of how development activities impact on the environment, especially in terms of cumulative effects on water resources and flooding. It may become the role of the Agency to gather together the data on these issues in order to be able to advise other agencies.

**Methods** - there is concern amongst Agency staff that there are variable standards within local authorities at the moment related to SEA. This is also a similar concern related to CEA and advice from the Agency may become important.

### **Understanding and Interest in CEA**

It is clear that the level of understanding of what cumulative effects are and how they can be assessed is low, both within and outside of the Agency. Levels of expertise in carrying out CEA (especially as part of SEA) is limited. However, there is a high level of interest within the Agency (amongst the officers consulted) in how CEA can help the Agency fulfil its goals. This should be built upon through awareness raising, research and training.

### **Impact Linkages**

Even agencies which are charged with looking after a particular resource are seldom fully aware of how development of different kinds impacts upon that resource and how this interacts with natural environmental changes. This is a fundamental issue in CEA because practitioners need to look at the impacts of not just one development but many. Work is needed on how we can identify the relative contributions of different stresses acting upon different resources and the overall carrying capacity of environmental systems. The most valued environmental resources are the most vital to examine first.

There is academic research being carried out on linking activities to environmental states. A lot of this has not been translated into broad principles that can be used for assessment practice. This needs to be done and ways of using this data once assembled need to be formulated. This kind of data is very useful because it can be used in a number of ways. It can be merely made available to experts having to weigh up the likelihood of different impacts to give a more concrete basis to assumptions. At the other end of the spectrum it can be used as input into numerical modelling packages.



This approach relies heavily on practitioners setting out the assumptions they make in early CEAs. In this way these assumptions can be tested as part of a CEA research agenda. i.e. if a practitioner assumes that deforestation in a catchment combined with increasing development will result in a certain increase in run off this will need to be monitored and a link established. An exploration is needed of whether post-development audit of this kind can contribute towards an improved understanding of the causes of cumulative effects or can enhance predictive capabilities and development of appropriate management strategies.

## 6. RECOMMENDATIONS

An important output of this study is to set out a forward programme of research and development on CEA for the Agency.

Further action is necessary in order to minimise the risks of not implementing the SEA Directive fully in terms of the CEA requirements. It will also help to ensure that the opportunities afforded by CEA are fully realised.

The forward programme of research and development is set in terms of three different timescales based upon the amount of work that would be required to bring them into effect and what can realistically be achieved.

Short-term recommendations (2003 – 2004) are for application before the Directive becomes a statutory requirement in 2004. These deal with the delivery of tools and techniques that are available now but may not be fully applied in the different spheres of Agency tasks. Other short term recommendations relate to the outward facing activities of the Agency and include such ideas as the provision of advice notes to other plan and programme making authorities in areas that the Agency considers to be highly sensitive to cumulative effects.

Medium term recommendations (2003 – 2006) are for application by 2006. Among the medium timescale recommendations are those that will require some trial application of tools and techniques or the building of databases to allow their use.

Longer timescale recommendations focus upon R&D activities that would be expected to be delivered over a 5-10 year period (2006 – 2013) before the results were in widespread use.

On the basis of this scoping study it is possible to identify the following themes that the Agency may wish to explore in its desire to promote wide consideration of cumulative effects within both its plan and programme making activities and in its role as a statutory consultee:

- Raising general awareness of cumulative effects assessment;
- Guidance and procedural mechanisms;
- Training;
- Research.

Table 7.1: Recommendations

Activity		Commentary	Timescale
<b>A: Raising General Awareness</b>			
A1	Internal Workshop	An internal workshop on the theme of cumulative effects, potentially organised by specific themes could provide a more effective appreciation of officer existing tools, interests and needs than can be delivered through this Scoping Study.	Short-Term (2003/04)
A2	Internal Advice Note	An interim advice note on what cumulative effects assessment is and why it is important for officers to consider this issue serving as a reminder of the legal obligations.	Short-Term (2003/04)
A3	External Advice Note	Aimed at external plan / programme makers initially as an overview of the issue and how the Agency can contribute towards helping the plan / programme making authorities meet the obligations under the SEA Directive.	Short-Term (2003/04)
A4	Locally Targeted Advice	The Agency could offer advice on cumulative effects which should be considered as part of plan / programme making activities. Where appropriate this could be on a river basin catchment basis.	Medium-Term (2003/06)
<b>B: Guidance and Procedural Mechanisms</b>			
B1	Procedural Framework Guidance	Build into the AMS a general procedure for CEA. This could be based on the ODPM SEA steps.	Short-Term (2003/04)
B2	CEA Methods	Build into the AMS procedure, general methods that can be applied to guide practitioners. These could be written as work instructions and be drawn from methods discussed as part of the SIAM project.	Short-Term (2003/04)
B3	Plan / Programme Specific Guidance	In addition to the procedure and general methods that could be developed (see above), a certain amount of plan / programme specific guidance may be necessary. The Agency will need to prioritise this according to the plan / programme making timetable.	Medium-Term (2003/06)
B4	Procedural Mechanisms	The SIAM report recommends greater integration of assessment activities across the Agency. Procedural mechanisms need to be explored to deliver such integration. Consideration of cumulative effects should form part of this review of mechanisms.	Medium-Term (2003/06)
<b>C: Training</b>			
C1	Training	Training packages that are based upon examples could be developed for use internally or externally.	Medium-Term (2003/06)
<b>D: Research</b>			
D1	Screening and Scoping	Plan / programme specific guidance is needed to define the spatial and temporal scope of cumulative effects assessment. This may involve the use of thresholds to focus cumulative effects assessments and mechanisms by which the valued environmental features that are susceptible to cumulative effects are identified.	Short-Term (2003/06)

LITERATURE REVIEW / SCOPING STUDY ON CUMULATIVE EFFECTS ASSESSMENT AND THE STRATEGIC ENVIRONMENTAL ASSESSMENT DIRECTIVE

Activity		Commentary	Timescale
D2	Critical Impacts on Valued Environmental Resources	Research on how different activities are impacting upon certain environments to identify their relative contribution on the state of the environment. This could possibly be a modification of the work on pollutant inventories being carried out due to the Water Framework Directive. Natura 2000 sites should be a priority area for this work. Further research would be required to set out the scope for this work.	Medium-Term (2003/06)
D3	Translating research into awareness	Many research activities have been undertaken on aspects of how actions lead to environmental impacts and change, however these are frequently highly academic and have not been translated into broad principles that can be used for assessment practice. This activity would aim to collect and assimilate research within specific topics such as wetland ecosystems or water resource management to devise new principles and methods. This could include a review of the Agency's other research and development programmes.	Long-Term (2006 - 2013)
D4	Cumulative Impact of Non-Agency Plan / Programme-Making Activities	An assessment of the extent to which the plan / programme making activities of others consider cumulative effects and mechanisms by which the Agency can provide effective input to these plan / programme making processes.	Short-Term (2003/04)
D5	Forecasting Cumulative Effects	Examination of the extent to which quantified techniques e.g. risk assessment and environmental modelling can be applied to particular issues and how best to use subjective judgement.	Medium-Term (2003/06)
D6	The Precautionary Principle, BPEO, Habitats and Birds Directive and the Water Framework Directive	Consideration of how these principles interact with cumulative effects assessment in terms of the decisions taken and the advice that the Agency provides.	Short-Term (2003/04)
D7	Monitoring	A review of the extent to which existing monitoring programmes can provide early warning of unforeseen cumulative effects. Also the manner that monitoring should be delivered by either development projects or other agencies.	Long-Term (2006 – 2013)
D8	Determining the Success of Mitigation	Exploration of mechanisms to determine whether the degradation caused by cumulative effects has been arrested. Also, is mitigation a return to the pre-impact state or to some different desired state?	Long-Term (2006 – 2013)
D9	Regulatory Instruments	Consideration of how permissions, planning and financial instruments can be used to respond to cumulative effects.	Short to Medium Term (2003/06)
D10	Environmental economics	Exploration of the extent to which cumulative effects can be expressed in monetary terms.	Medium to Long Term (2003/2010)

Activity		Commentary	Timescale
D11	Data Sets	The Agency holds many data sets and also contribute towards other meta-data sets such as Magic (Multi Agency Geographic Information for the Countryside see <a href="http://www.magic.gov.uk">www.magic.gov.uk</a> ) and those organised by the Regional Observatories. The Agency could organise its data in a manner that highlights environmental trends and to indicate where thresholds and environmental capacities may be threatened.	Long-Term (2006 – 2013)
D12	Information Sources for Cumulative Effects	An exploration of the potential role of State of Environment Reporting in supporting cumulative effects assessments.	Short-Term (2003/04)
D13	Monitoring, Mitigation and Enhancement	Exploration of the opportunities associated with the monitoring, mitigation and enhancement of cumulative effects in terms of the institutional and legal mechanisms that need to be put in place to set these up strategically.	Short-Term (2003/04)
D14	Post-Development Audits	Exploration of whether post-development audits can contribute towards an improved understanding of the causes of cumulative effects or can enhance predictive capabilities and development of appropriate management strategies. This is equally applicable to the identification of positive cumulative effects.	Medium-Term (2003/06)

## 7. CONCLUSIONS

The aims of this research were to:

1. Identify tools and techniques that are available for undertaking CEA in relation to the requirements of the SEA Directive;
2. Identify what experience of undertaking CEA is available within and outside the Agency;
3. For the above two objectives identify project and multi-project level approaches that might be transferable to strategic level assessments as well as existing strategic level approaches; and
4. Identify the wider applicability of SEA to existing tools, techniques and guidelines to the Agency. This should take account of factors including robustness; breadth of applicability; flexibility; ease of use; transparency; resources and data / information required for use and compatibility with other tools and techniques;
5. Identify gaps and make recommendations for future work to develop new and existing tools, techniques and guidelines to ensure the Agency can realise the opportunities and manage the risks associated with the implementation of the SEA Directive; and
6. The study should take into account the need to address cumulative impacts throughout the SEA process not just at the impact assessment stages;

These aims have been met through a consultation with practitioners and Agency officers and a literature review focusing on the following:

- Generic guidance issued on CEA in other countries;
- Academic literature (both generic and focusing on different plan and programme types); and
- Environmental assessment tools that can be modified for use in CEA of plans and programmes.

The study found that the expertise available within the Agency is varied. Some officers have experience of carrying out SEAs and sustainability appraisals of plans and programmes. However, very few have specific CEA experience. Exceptions to this are officers who worked on the Humber Estuary Shoreline Management Plan and the Water Resources Strategy. What is clear, however, was that CEA is not considered within the Agency in a systematic and consistent way.

In terms of expertise available outside the Agency, most of the CEAs that have been carried out within the UK (and worldwide) are as part of an EIA process rather than an SEA process. Where CEAs are being carried out as part of SEA, many questions are being raised which still need addressing. The next few years are likely to see an intense period of development of CEA methodologies as part of SEA. The practitioners consulted as part of the project confirmed this and stated that much more guidance is needed in the future if CEAs are to be effective.

Approaches have been identified that could be modified for use in CEA for the Agency. These approaches have been analysed according to the stages of SEA as set out in the ODPM draft guidance on SEA (ODPM, 2002). Implementation issues have been highlighted for each of these stages and categorised according to whether current guidance is adequate, or there is guidance that can be modified or it is an issue on which the environmental assessment community does not have a solution and may require new research.

Many stages of CEA will require new guidance. These include baseline setting, cumulative impact identification and issues of strategic mitigation and monitoring. Where such gaps in knowledge and guidance have been identified a programme of research and development has been set out. This focuses on:

- Raising general awareness;
- Guidance and procedural mechanisms;
- Training; and
- Research.

Due to a lack of prescriptive guidance to date and the fact that this study has identified a paucity of CEA practice and CEA tools it is felt that the Agency is well placed to initiate its own research into how cumulative effects can best be predicted and presented. Such a programme of research and development has been presented within the report.

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## GLOSSARY

**Action:** Any project or activity of human origin.

**Assessment Framework:** A description of a process that organises actions and ideas, usually in a step-by-step fashion. Frameworks help to guide practitioners in carrying out an assessment.

**Baseline Information:** A description of existing environmental, social and economic conditions.

**Cause-effect Relationship:** The connection between an action's disturbance (cause) and its effect on the environment.

**Combined Effects:** The effects caused by various components of the same action.

**Connectivity:** A landscape characteristic that facilitates the movement of biota between blocks of habitat (i.e., this is removed in a fragmented landscape).

**Cumulative Effects Assessment:** An assessment of the incremental effects of an action on the environment when the effects are combined with those of past, existing and future actions.

**Direct Effect / Impact:** An effect in which the cause-effect relationship has no intermediary effects.

**Duration:** The period of time in which an effect on a valued ecosystem component may exist or remain detectable (i.e., the recovery time for a resource, species or human use).

**Environmental Components:** Fundamental elements of the natural and human environment. Examples of components include: social, air, water, soils, terrain, vegetation, wildlife, fish and land use.

**Fragmentation of Habitats:** The breaking up of contiguous blocks of habitat into increasingly smaller blocks as a result of direct loss and/or sensory disturbance (i.e., habitat alienation). Eventually, remaining blocks may be too small to provide usable or effective habitat for a species.

**Frequency:** The number of occurrences of an effect within a specific period of time.

**Impact Model:** A formal description of a cause-effect relationship that allows the assessment of various components of that relationship through the use of an Impact Statement, a Pathways Diagram, and the validation of linkages and pathways.

**Indicators:** Data that is used to measure the condition of something of interest. Indicators are often used as variables in the modelling of changes in complex environmental systems.

**Indirect effect / impact:** An effect in which the cause-effect relationship (e.g., between the action's impacts and the ultimate effect on the environment) has intermediary effects. As an interaction with another action's effects is required to have a cumulative effect (hence, creating intermediary effects), cumulative effects may be considered as indirect.

**Induced Action:** An action that occurs as a consequence of another action. The induced action is not an intended component of the initiating action.

**Interactions:** An action or influence resulting from the mutual relationship between two or more actions or an action and an environmental receptor.

**Monitoring:** A continuing assessment of conditions at and surrounding the action. This determines if effects occur as predicted or if operations remain within acceptable limits, and if mitigation measures are as effective as predicted. With strategic environmental assessment, background state of the environment monitoring may become more important.

**Natura 2000 network:** Article 3 of the Habitats Directive requires the establishment of a European network of important high-quality conservation sites that will make a significant contribution to conserving the 169 habitat types and 623 species identified in the Directive. The network of sites identified is referred to as the Natura 2000 network.

**Network Diagram:** An illustration of cause-effect relationships between an action's impact and an effect.

**Precautionary Principle:** A general rule of public policy action to be used in situations of potentially serious or irreversible threats to health or the environment, where there is a need to act to reduce potential hazards *before* there is strong proof of harm, taking into account the likely costs and benefits of action and inaction (Gee, 2000).

**Recovery:** The return of environmental conditions to the state they were prior to the action.

**Residual Effects:** Effects that remain after mitigation has been applied.

**Scenario:** A description of environmental and development conditions at a certain time to allow comparisons of change (e.g., pre-development, current, and reasonably foreseeable).

**Scoping:** A consultative process for identifying and possibly reducing the number of items (e.g., issues, environmental components) to be examined until only the most important items remain for detailed assessment. Scoping ensures that assessment effort will not be expended in the examination of trivial effects.

**Screening:** The process of determining whether a plan / programme requires assessment

**Significance:** A measure of how adverse or beneficial an effect may be on an environmental component.

**Spatial Boundary:** The area examined in the assessment (i.e., study area).

**Spatial Overlap:** An overlap of zones of influence from different actions.

**Study Area:** The geographic limits within which an impact to an environmental component is assessed.

**Synergistic:** Where two or more impacts work in concert causing an overall impact where the whole is greater than the sum of the parts

**Temporal Boundary:** The period of time examined in the assessment.

**Threshold:** A limit of tolerance of an environmental component to an effect, which if exceeded, results in an adverse response by that component.

**Valued Ecosystem Component (VEC):** Any part of the natural environment that is considered important by the proponent, public, scientists or government involved in the assessment process. Importance may be determined on the basis of cultural values or scientific concern. This term is sometimes used interchangeably with the term valued environmental resource which may be applied to the built environment.



**Zone of Influence:** A geographic area, extending from an action, in which an effect is non-trivial.

## APPENDICES

### APPENDIX A: AGENCY GUIDANCE

Title	Comment
<b>Generic environmental assessment guidance</b>	
Agency Management System: SEA Policy and Procedures.	<p>Within the Agency Management System Guidance the Agency has sought to set out a common language – a framework through which information and instructions are issued to Agency staff about environmental assessment. This framework consists of:</p> <ul style="list-style-type: none"> <li>• Policy – a statement of organisational intent, supported by corporate objectives and targets;</li> <li>• Standards – statement of the levels of performance to which the organisation is committed to achieving;</li> <li>• Process overviews – a high level map that describes a sequence of activities that together will enable the organisation to achieve its own objectives and targets;</li> <li>• Procedures – an approved method for carrying out an activity;</li> <li>• Work instruction – an approved method for carrying out a specific task within an activity.</li> </ul> <p><i>It is clear that CEA policies, standards, procedures and work instructions will need to be developed that integrate well with the overall guidelines for SEA.</i></p>
Environment Agency (2000) EIA: A Handbook for Scoping Projects.	<p>The guidance gives advice to developers, consultants, local authorities and Agency officers on their role in EIA as a consultee, as a developer and as a regulator. Whilst not directly related to CEA, the handbook contains a lot of valuable information on:</p> <ul style="list-style-type: none"> <li>• Potential stakeholders and sources of data;</li> <li>• Possible approaches for scoping effects such as quality of life capital, prompt lists and matrices;</li> <li>• Potential sources of environmental impact on different environmental receptors; and</li> <li>• Different public consultation methods for environmental assessment and their advantages / disadvantages.</li> </ul> <p><i>Some of the approaches advocated in the guidance for scoping could certainly be adapted for use in cumulative effects assessment, especially quality of life capital approaches. Scoping is a vital stage in CEA and robust guidance is needed.</i></p>

Title	Comment
<b>Flooding and coastal defence guidance</b>	
MAFF (2000): Flood and Coastal Defence Project Appraisal Guidance - PAG4 – Approaches to Risk	<p>The report sets out specialist methods of approaching risk analysis and sets out where risk assessment should come in an overall assessment. In terms of environmental risk the guidance states:</p> <p>“Risk assessment can be used as appropriate to identify hazards to the environment and to assess the significance of possible damage in terms of likelihood and consequences. While in many cases environmental risks cannot be expressed in monetary terms, this does not mean that they should be excluded from the risk analysis and management process. The risks can still be assessed, and scheme options compared, using qualitative approaches. The multi-criteria approach can be useful in documenting and assessing environmental risks.”</p> <p><i>This guidance aims not to be prescriptive and is fairly flexible. It could be adapted to form a risk-based approach to CEA.</i></p>
MAFF (2000) Flood and Coastal Defence Project Appraisal Guidance - PAG 5 – Environmental Appraisal	<p>This has many suggested appraisal stages:</p> <ul style="list-style-type: none"> <li>• Description of need and opportunity;</li> <li>• Project objectives;</li> <li>• Existing situation and constraints;</li> <li>• Options appraisal; and</li> <li>• Conclusions and recommendations.</li> </ul> <p>This document sets out a cost benefit analysis for examining environmental issues. It touches on appraisal and EIA techniques and discusses the strategic iterative framework of appraisal. It does not examine cumulative impacts.</p> <p><i>The guidance could be helpful in the following ways:</i></p> <ul style="list-style-type: none"> <li>• <i>Screening - could be useful as it considers legislation affecting various plans and programmes;</i></li> <li>• <i>Identifying other plans and programmes - the document would help identify similar plans, programmes and objectives;</i></li> <li>• <i>Baseline and impact assessment - the document considers specific sites such as SSSI and Ramsar sites and how to identify impacts on them.</i></li> </ul>
DEFRA (2001): Shoreline Management Plans. A guide for coastal defence authorities  <i>N.B. New guidance is due to be published later in 2003</i>	<p>Shoreline management plans are policy-based plans. They set out policies for managing the risk to people and the environment from flooding and coastal erosion. The appraisal then assesses these policies for their environmental effects. Cumulative effects are not explicitly considered. If a Coastal Habitat Management Plan has been carried out, an appraisal of the SMP should not be necessary.</p> <p>The appraisal system concentrates on identifying opportunities and constraints and then choosing and appraising options. The guidance sets out criteria for policy appraisal (issues that should be covered) but does not go into detail about predictive methods. The guidance does, however, set out a programme for strategic coastal monitoring. This includes keeping a record of all shoreline management activities. This monitoring is mainly to keep track of the state of the environment but also helps to ascertain the nature of the natural processes. The links to human induced change are not as strong.</p> <p><i>The approach is based on a policy based appraisal and does not include much guidance on predictive methods. The monitoring section is useful and possibly could be adapted to other types of plans and programmes.</i></p>

Title	Comment
<p>Environment Agency, and English Nature (2002). Coastal Habitat Management Plans: an Interim Guide to Content and Structure.</p> <p><i>N.B. New guidance is due to be published in October 2003</i></p>	<p>CHaMPs will consider the responsibilities of the flood and coastal defence operating authorities in relation to the Habitats and Birds Directives only. The recommendations in CHaMPs will be fed into the next generation of SMPs and into flood and coastal defence strategies and schemes.</p> <p>An assessment of the effects of the strategy must be carried out on a site's integrity. Cumulative effects are not mentioned within the guidance.</p> <p><i>The assessment process is relatively narrow and could not be adapted to assist in the wider assessment of cumulative impacts.</i></p>

Title	Comment
<b>Habitats Directive Guidance</b>	
<p>Environment Agency (2003). EU Habitats and Birds Directives Handbook for Agency Permissions and Activities.</p>	<p>The handbook covers generic policy and also technical guidance. An assessment must be carried out on any new (covered by Regulation 48) or existing permissions (covered by Regulation 50) that affect Natura 2000 sites.</p> <p>This is broken into 4 stages according to risk:</p> <ul style="list-style-type: none"> <li>• Stage 1: Screening of the activity;</li> <li>• Stage 2: An assessment of the likely significant effects;</li> <li>• Stage 3: An appropriate assessment to ascertain adverse effect; and</li> <li>• Stage 4: If there is an adverse effect on the integrity of the site, amend or revoke permission (unless there are reasons of overriding public interest).</li> </ul> <p>Cumulative effects are vitally important for these assessments because activities are assessed whether they will have an effect “alone or in combination with another activity”. Work instructions set out the assessment procedure for the different functions of the Agency:</p> <ul style="list-style-type: none"> <li>• Fisheries;</li> <li>• Water resources;</li> <li>• Water quality</li> <li>• Flood Defence;</li> <li>• Groundwater;</li> <li>• Waste management;</li> <li>• Process industry regulation;</li> <li>• Radioactive substances;</li> <li>• Navigation; and</li> <li>• Recreation and estates.</li> </ul> <p>There is no guidance given on methods of combining effects, and Agency officers have confirmed that no guidance is planned. The work instruction for the water quality function is the most detailed on this point but the extent of the guidance is that a catchment model may be the best way to model cumulative impacts. Catchment models have been produced for 27 rivers in the UK designated as a Special Area of Conservation (SAC). These models are called SIMCATs. SIMCAT warrants further investigation as an example of a computer modelling package used to predict cumulative impacts.</p>

Title	Comment
	<i>The Habitats Guidance cannot be used directly as a model for assessing cumulative effects. The guidance gives as much guidance as it needs for its staff to assess “in combination” effects but each site has its own features and combination of hazards and permissions – it would be impossible to produce guidance for every combination of eventualities. However, modelling approaches could be useful for certain plans and programmes that set out quite definite programmes of activity.</i>

Title	Comment
<b>Water resources</b>	
<p>Sustainability appraisal developed for the National Water Resources Strategy.</p> <p>Environment Agency (2001). Water Resources for the Future. A strategy for England and Wales</p>	<p>This was an appraisal methodology developed to assess the National Water Resources Strategy. It draws on the approach used by regional planning bodies to assess Regional Planning Guidance. Alongside this it includes a risk and uncertainty framework that examines risks, uncertainties, opportunities and constraints of different options. A tabular approach has been adopted that provides a framework for the inevitably subjective analysis. The approach considers:</p> <ul style="list-style-type: none"> <li>• Uncertainty in the technology, investigation, time cost and resource value of an option;</li> <li>• Opportunities to meet wider objectives, for environmental enhancement, resilience to climate change and to provide amenity and recreational benefits; and</li> <li>• Constraints that may limit the success of the option including attitudes and aspirations, and legal or institutional barriers.</li> </ul> <p><i>The approach is felt to be an extremely useful way of formalising an approach that may be subjective and introducing the idea of risk based appraisal. This approach would be useful for SEA overall and could be adapted for CEA although this would need further investigation</i></p>

Title	Comment
<b>Abstraction / catchment management</b>	
<p>Catchment Abstraction Management Plans (guidance on sustainability appraisal).</p> <p>This is contained within Environment Agency (2002): Managing Water Abstraction: the Catchment Abstraction Management Strategy process.</p> <p><i>NB. These will be replaced by River Basin Management Plans – see Case Study on River Ribble</i></p>	<p>This “sustainability appraisal” process uses a largely qualitative approach to consider what the resource availability status for each water resource management unit should or could be after each six-year cycle. In catchments that are “over abstracted” or “over-licensed”, this may involve recovering some resources. In units where there is some water available, the process defines the resource availability status that could be reached, but should not be exceeded. It also allows the appraisal of options for managing abstraction within the catchment including recovering water resources, by taking into account the implications of different options on all aspects of sustainability. Options are screened and refined to identify those that will achieve the greatest environmental benefits with the lowest social and economic impacts.</p> <p>Where it is clear that a qualitative approach is inadequate, for example, where it is proposed that licences need to be varied or revoked, there will be some quantification of costs to abstractors included in the appraisal process.</p> <p><i>The largely qualitative approach, although flexible is reproduced in other appraisal guidance and as such will not add much to the CEA process.</i></p>

Title	Comment
<b>Water Level Management</b>	
MAFF (1994) Water Level Management Plans plus additional guidance issued in 2002.	<p>The appraisal uses cost benefit analysis to place a monetary value on environmental benefits. This is expressed as £ per hectare of designated site that would benefit.</p> <p><i>The issue of placing a cost on environmental impacts is a difficult one. It has been possible to do this when considering water levels because of the small amount of resources considered under the guidance. It would not be possible to take this approach for cumulative effects assessment</i></p>

## APPENDIX B: ACADEMIC LITERATURE ON CEA

Each reference has been classified (see highlighted text at the top of each comments box) according to whether it applies to a certain stage of CEA, all stages of CEA or is generic. Generic refers to the fact that a certain reference does not give guidance on particular stages of CEA but focuses on more general issues such as the progress of a particular country in including CEA in assessment procedures. Where the literature is felt to be useful in devising an Agency CEA methodology, comments have been provided on this in italics. The table is set out by stage in the assessment and then by date.

Title and Author	Comment
<p>Senner, RGB, Colonell, JM, Isaacs, JD, Davis, SK, Ban, SM, Bowers, JP and Erikson, DE (2002): A systematic but not too complicated approach to cumulative effects assessment.</p>	<p><b>Stages – all stages</b></p> <p>This paper closely follows the US guidance. This sets out a general approach to facilitate consistency rather than being too restrictive. It relies on the use of impact matrices to identify impacts. The framework is shown below:</p> <ol style="list-style-type: none"> <li>1. At the start of the project, hold scoping meetings and interviews with stakeholders, concerned individuals, and the public at large.</li> <li>2. Review the literature to identify and characterise past, current, and reasonably foreseeable future actions that have affected or could affect the identified resource components, using the scoping input to guide the inquiry.</li> <li>3. Identify the relevant resource components for the physical, biological, and socioeconomic environments.</li> <li>4. Define the geographic scopes for the physical, biological, and socioeconomic environments.</li> <li>5. Establish a time frame for the CEA that covers the past, present, and reasonably foreseeable future.</li> <li>6. Prepare the Affected Environment chapter. Summarise how the resource components have historically been shaped and altered by human actions and natural events from the environmental reference point up to the present. Note residual effects from the past that continue to influence present conditions.</li> <li>7. Review the predicted direct and indirect effects of the proposed action and its alternatives. Note which are considered significant, beneficial, or adverse, and criteria and thresholds.</li> <li>8. One alternative at a time, prepare a cumulative effects assessment (CEA) matrix for each resource component.</li> <li>9. Enter past, current, and reasonably foreseeable future external influences into the CEA matrix.</li> <li>10. Enter the appropriate information for each cell in summary form so that potential cumulative effects will become evident</li> <li>11. Apply significance criteria and thresholds.</li> </ol> <p><i>Comment – the information in this document could be utilised within a CEA procedure for the Agency</i></p>



Title and Author	Comment
<p>Kotze, I (2001): Integrating the assessment of cumulative effects into Environmental Impact Assessment and Strategic Environmental Assessment in South Africa.</p>	<p><b>Stage – all stages / generic</b></p> <p>The paper sets out evaluation criteria to assess whether CEA has adequately been integrated with SEA in South Africa.</p> <p><i>Comment – this could be used / adapted to examine the adequacy of any Agency methodologies that may be devised after implementation.</i></p> <p><i>It could also be used by the Agency to examine the adequacy of approaches used by others.</i></p>
<p>Parr, S (1999): Study on the Assessment of Indirect and Cumulative Impacts as well as impact interactions.</p>	<p><b>Stage – generic (review of other methods)</b></p> <p>This study is a collection of information taken from studies throughout the world examining cumulative effects. It also examines how each member state is attempting to address cumulative effects in legislation. In effect, this is nothing more than a scoping study.</p> <p><i>Comment - once areas have been identified where the Agency needs guidance, the methods referred to in this study could be modified for Agency purposes. One advantage of the study is that it sets out various methodologies and critiques them. This could be transferred.</i></p>
<p>Burris, RK and Canter, LW (1997): A practitioner survey of cumulative impact assessment.</p>	<p><b>Stage – generic</b></p> <p>This paper examined questionnaire responses from 54 environmental assessment practitioners from the US and abroad to ascertain the current level of practice at the time. It examined reporting practices, technical issues (such as the difficulties of setting boundaries); and transboundary and global issues. Problems that practitioners reported were the absence of standardised monitoring methods correlating monitoring results from actual conditions with predicted impacts associated with specific assumed conditions and defining where the boundaries of an assessment should be.</p> <p><i>Comment - this paper is useful for general background information but not helpful in assisting in the formulation of guidance</i></p>
<p>Clark, R (1994): Cumulative effects assessment: A tool for sustainable development.</p>	<p><b>Stage – all stages</b></p> <p>This examines a study approach with seven critical steps. These are mainly the same as the US guidance but stress the importance of setting goals within the assessment. The paper concludes that CEA is best carried out at a plan, programme or policy level because examination of alternatives is still possible at this stage particularly in terms of setting society’s objectives and testing what the impacts of these may be and whether they will breach any environmental limits.</p> <p><i>Comment – this paper is useful for general background information but not helpful in assisting in the formulation of guidance</i></p>

Title and Author	Comment
<p>McCold, LM and Saulsbury, JW (1996) Including past and present impacts in cumulative impact assessment.</p>	<p><b>Stage – identifying other plans, programmes, objectives, visions and problems and setting the baseline (ODPM Stage A)</b></p> <p>This paper seeks to clarify how past and present impacts can be included in a cumulative effects assessment under NEPA.</p> <p><i>Comment – this could be used to help clarify how to approach this issue in the UK context.</i></p>
<p>Rumrill, JN and Canter, LW (1997): Addressing future actions in cumulative effects assessment.</p>	<p><b>Stages – Identifying other plans, programmes, objectives, visions and problems and setting a future baseline (ODPM Stage A)</b></p> <p>This paper examines court cases that have taken place in the US regarding this issue of CEA. The paper concludes with a set of criteria (conservative determination method) to determine when something becomes a reasonably foreseeable future action. This method is outlined below.</p> <p><b>The conservative determination method for determining future actions</b></p> <ol style="list-style-type: none"> <li>1. Determine reasonable temporal and spatial boundaries with respect to the availability of information, the realm of influence or control exerted by the agency and the nature of the environmental impacts of the project;</li> <li>2. Within those boundaries, if the agency has additional formal proposals, (approved or pending approval) these should be included;</li> <li>3. Conduct forecasting to determine possible, plausible and probable future activities both internal or external to the agency that fall within the spatial and temporal bounds set in step 1. Evidence to support the likelihood of each forecast activity should be included;</li> <li>4. Evaluate the list in step 3 to determine possible connectedness to the original proposal. Consider geographic relationships, common resources or environmental media impacted, causal links or catalytic effects. If connections are determined, include those activities in the analysis;</li> <li>5. Evaluate the list in step 3, determine if significant amounts of effort, resources, time and money have been invested into future activities. If so, include them in the analysis;</li> <li>6. Within the area of concern, determine the existence of any planning documents such as development plans that relate future activities to the original proposal through a common goal or objective; and</li> <li>7. Evaluate the significance of each activity thus far categorised as reasonably foreseeable. Include considerations such as whether the information is available, whether the information will have any impact on project alternative evaluation and selection. This is a scoping exercise to ensure that the list of actions is only limited to those with measurable effects on the resource.</li> </ol> <p><i>Comment – this could also be modified for use when determining likely future actions to include in a CEA</i></p>

Title and Author	Comment
<p>Canter, L.W and Kamath, J, 1995: Questionnaire checklist for cumulative impacts.</p>	<p><b>Stage – scoping (ODPM Stage D)</b></p> <p>This sets out a checklist that can be used to scope cumulative impacts. The user first answers questions regarding the impacts of the proposed action on specific features of certain categories. The same series of questions are then considered regarding the cumulative impacts of the proposed action and past, present, and reasonable foreseeable future actions. The 21 topical categories include physical components (landform, air/climatology, water, solid waste, noise, and hazardous waste), biological components (flora and fauna), and socioeconomic components (land use, recreation, aesthetics, archaeological sites, health and safety, cultural patterns, local services, public utilities, population, economic factors, transportation, natural resources, and energy).</p> <p><i>Comment – the checklist is widely applicable, is flexible and easy to use. The use of questionnaire checklists with a full list of issues would be useful to the Agency in the scoping process to identify which issues are important and documenting how they were selected for further technical analysis. Because questionnaire checklists are directed to impact identification, other methods would be needed to quantify cumulative impacts, to incorporate their consideration in trade-off analyses of alternatives, and to develop appropriate mitigation measures.</i></p>
<p>Therivel, R (2002): Implementing the SEA Directive: Analysis of existing practice. Report for the South West Regional Assembly.</p> <p>Therivel, R (2003): Implementing the SEA Directive: Five pilot studies. Report for the South West Regional Assembly</p>	<p><b>Stages – all stages / impact prediction (ODPM Stage E)</b></p> <p>These reports acknowledged that assessment of cumulative impacts needs improving before the SEA Directive is implemented. The purpose of the reports was not to suggest methods. However, the report does acknowledge that causal chain analysis could be useful for assessing cumulative effects. Causal chain analysis is a way of documenting assumptions made during an assessment of the impact of an action. It charts the impact from original cause to the end effect.</p> <p><i>Comment – consider the use of causal chain analysis as a method for identifying cumulative effects</i></p>
<p>Landscape Design Associates (2000). Cumulative effects of wind turbines. The preparation of a planning tool by means of consensus building.</p>	<p><b>Stage – impact prediction and consultation(ODPM Stages E)</b></p> <p>The project sought to devise a methodological tool based on consensus building that could be replicated for other projects where cumulative effects may be difficult to judge.</p> <p><i>Comment - the method is simple and flexible and could be adapted as an approach to consultation at a strategic level especially where contentious issues are being considered.</i></p>
<p>Morgan, RK (1999): Environmental Impact Assessment: A methodological perspective.</p>	<p><b>Stage – all stages but essentially prediction methodologies(ODPM Stage E)</b></p> <p>This book has an extensive chapter on CEA. It sets out in detail the different technical methodologies that can be used to predict cumulative impacts. These have been split into:</p> <ul style="list-style-type: none"> <li>• Quantitative / matrix methods</li> <li>• Effects orientated methods</li> </ul> <p><i>Comment – these approaches could be modified for the strategic</i></p>

Title and Author	Comment
	<i>level. This should be investigated as part of assembling a toolkit of methods.</i>
<p>Damman, D, Cressman, DR and Sadar, MH (1995). Cumulative effects assessment – the development of practical frameworks.</p>	<p><b>Stage – all stages but concentrates on impact prediction (ODPM Stage E)</b></p> <p>The framework was developed for uranium-mining activities based on a review of available literature. The framework is very similar to others developed by the Canadian and the US governments. The main difference is that this framework recommends that impact pathways be identified as a specific step within the method by the production of a network diagram.</p> <p><i>Comment – the addition of impact pathways is a useful step in identifying effects.</i></p>

## APPENDIX C: TOPIC BASED GUIDANCE

Title	Comment
<b>Catchment and River Systems</b>	
<p>Woolhouse, C and McKeever E (2003). Thames Ahead Implementation – SEA Phase II. Environment Agency Thames region.</p> <p>UK</p>	<p><b>Stage – all stages</b></p> <p>Stages in the assessment:</p> <ul style="list-style-type: none"> <li>• Select theme and split into subsets</li> <li>• Define and agree options</li> <li>• Establish scope and appraisal criteria</li> <li>• Carry out analysis of sustainability</li> <li>• Conduct internal and external consultation</li> <li>• Complete appraisal</li> <li>• Assess cumulative impacts</li> </ul> <p><i>Comment – Needs to include more details about methods that are going to be used to examine cumulative effects. Currently uses an additive approach – it could be expanded to examine other types of cumulative effects?</i></p>
<p>HR Wallingford (development ongoing) HarmonIT catchment modelling interface.</p> <p>UK</p>	<p><b>Stage – all stages</b></p> <p>HarmonIT is a research project funded by the European Commission aiming at the development and implementation of a European Open Modelling Interface and Environment (OMI) that will simplify the linking of hydrology related models. The establishment of the OMI will support and assist the strategic planning and integrated catchment management required by the Water Framework Directive.</p> <p><i>Comment - The development of this tool could be an important step if in the future quantitative predictions are to be made of cumulative effects on a catchment basis. It is too early in the development of this tool to draw any conclusions.</i></p>
<p>Berg, N.H., K. B. Roby, and B. J. McGurk. 1996. Cumulative watershed effects: applicability of available methodologies to the Sierra Nevada.</p> <p>United States</p>	<p><b>Stage – all stages</b></p> <p>Sets out the desirable attributes of a cumulative watershed effects assessment:</p> <ul style="list-style-type: none"> <li>• Be scientifically rigorous and specifically link natural or human-induced causes for system changes on the hill slope or in the channel with implications to downstream beneficial uses (e.g., fisheries, domestic water supply),</li> <li>• Prescribe direct, specific management actions keyed to information collected in the affected basin,</li> <li>• tie management prescriptions to conditions in the stream, causes for those conditions, and hazards in the watershed,</li> <li>• include physical and/or biological measures that prompt change in management,</li> <li>• include all major land uses (e.g., recreation, urbanisation, mining, timber harvest, grazing),</li> <li>• include a monitoring component to determine if prescriptions are implemented as specified,</li> <li>• assess and track the temporal and spatial distribution of impacts from past actions,</li> <li>• be structured so that results of the analysis are repeatable and readily verifiable,</li> <li>• screen levels of disturbance so that the level of the analysis effort</li> </ul>

Title	Comment
<b>Catchment and River Systems</b>	
	<p>matches the severity of disturbances and/or condition of basin,</p> <ul style="list-style-type: none"> <li>• incorporate a landscape scale (versus "project" scale), and</li> <li>• involve all major stakeholders as full partners from the beginning of the process.</li> </ul> <p><i>Comment – assessment on a catchment level will become more important as the Water Framework Directive is implemented. The method may be useful in assessing the cumulative impacts of River Basin Management Plans.</i></p>
<p>Bartholow, J (2000): Estimating cumulative effects of clearcutting on stream temperatures.</p> <p>United States</p>	<p><b>Stage – impact prediction (ODPM Stage E)</b></p> <p>The paper uses the phrase cumulative to mean indirect impact. It aims to show how changes in forest cover can affect stream temperature by using a stream segment temperature model. The model showed that changes in stream shading were the most influential factor governing increases in maximum daily water temperature, accounting for 40% of the total increase. Altered stream width was found also to be influential. Temperature increases due to clearcutting persisted 10km downstream into an unimpacted forest segment of the hypothetical stream. The model revealed that it is a complex set of factors that govern temperature stream dynamics rather than single factors such as shade or air temperature.</p> <p><i>Comment - This can help to predict changes in water temperature but this is not particularly useful in itself. Need to be able to predict the biodiversity consequences of this. The paper itself states that more work is needed on the model. It is useful background on the effects of deforestation on water temperature. May be useful if very detailed guidance is developed on biodiversity.</i></p>
<p>Citizens for Better Forestry (2000) Cumulative Watershed Effects Assessment.</p> <p>United States</p>	<p><b>Stage – impact prediction (ODPM Stage E)</b></p> <p>This report is an overview report of the problems associated with the assessment of watershed effects, concentrating on water quality, watershed hydrology, channel morphology, and aquatic habitat. It examines the types of cumulative effects that may be encountered, reviews the US legislation and sets out some principles of cumulative watershed effects assessment. It also reviews some methodologies such as</p> <ul style="list-style-type: none"> <li>• Modelling programmes such as equivalent clearcut area (ECA), equivalent roaded area (ERA), USDA sediment fish model and water resources evaluation of non-point silvicultural resources.</li> </ul> <p><i>Comment - these models are fairly complex and would be difficult to transfer to the UK situation.</i></p> <ul style="list-style-type: none"> <li>• Watershed Analysis Methods – this is planning at a watershed (catchment level) level and sometimes involves the production of an analysis manual. Manuals are designed specifically for a catchment and are not transferable.</li> </ul> <p><i>Comment - the approach may be worthy of further analysis.</i></p>
<p>Maryland Department of Natural Resources (1997). Maryland Biological Stream Survey.</p>	<p><b>Stage – setting the baseline, impact prediction and monitoring (ODPM stages B, E and G)</b></p> <p>The tool was created to provide comprehensive information on the status of biological resources in Maryland Streams and how they are affected by acid deposition and other cumulative effects of</p>

Title	Comment
<b>Catchment and River Systems</b>	
United States	<p>anthropogenic stresses. The methodology uses a variety of analytical methods to evaluate the relative contributions of different anthropogenic stresses.</p> <p><i>Comment – this is an inventory examining the state of the resource and the stresses upon it. State of the environment reports may be useful in monitoring SEAs and CEAs</i></p>
<p><i>There are several references that could not be obtained because of time restrictions and would be useful to review in any later stages of research.</i></p> <p><i>Osowski, S.L. et al. 2001: A watershed-based cumulative risk impact analysis: 35 Environmental vulnerability and impact criteria. Environmental Monitoring and Assessment 36 66:159-185 37.</i></p> <p><i>Schnackenberg, ES and Macdonald, LH (1998). Detecting Cumulative Effects on Headwater Streams in the Routt National Forest, Colorado. Journal of the American Water Resources Association. Volume 35 (5) October 1998. Pp 1163-1177.</i></p> <p><i>Charbonneau, R., and G.M. Kondolf. 1993. Land use change in California: Nonpoint source water quality impacts. Environmental Management, 17:453-460.</i></p> <p><i>Kondolf, G.M. 1995. Surface-groundwater interactions: some implications for sustainability of groundwater resources. In Proceedings of the 19<sup>th</sup> Biennial Groundwater Conference, Sacramento, California. Water Resources Center Report No.84, University of California, Davis. p.133-142.</i></p> <p><i>Kondolf, G.M. 1995. Planning approaches to mitigating adverse human impacts on land-inland-water ecotones. In Proceedings of the UNESCO/MAB Conference, "Fish and Land/Inland Water Ecotones", Zakopane, Poland, May 1995. (in press).</i></p> <p><i>Kondolf, G.M. 2001. Planning approaches to mitigating adverse human impacts on land-inland-water ecotones. Ecohydrology and Hydrobiology 1:111-116.</i></p> <p><i>In addition to this, the University of California at Berkeley has a useful webpage on cumulative effects and catchment management. These are small-scale studies relating to particular US river catchments but may be of some use for research purposes.</i></p> <p><i><a href="http://www-laep.ced.berkeley.edu/people/kondolf/research/catchment/catchment.html">Http://www-laep.ced.berkeley.edu/people/kondolf/research/catchment/catchment.html</a></i></p>	

Title	Comment
<b>Coastal Impacts</b>	
<p>Jones, P.J.S. (2001) Marine ecosystem impacts of coastal squeeze.</p> <p>UK</p>	<p><b>Stage – generic / review of issues</b></p> <p>As vulnerability and adaptation assessments move closer to actual decision- making processes, from a regional-national strategic to local project level, there is a need for complimentary studies to assess the potential impacts on shallow subtidal and intertidal habitats under different scenarios. Such assessments are particularly important where a 'hold the line' approach to coastal defence is being maintained, as intertidal habitats are then likely to be vulnerable to impacts through 'coastal squeeze'.</p> <p>The paper concludes that it may be necessary to assess such impacts at a regional level in order to address the cumulative impacts of individual projects on marine ecosystems were a 'hold the line' approach to be widely adopted. Individual projects may be judged to have insignificant effects, but the loss of intertidal and shallow sub-tidal habitats through coastal squeeze at a regional sea scale may be significant.</p> <p><i>Comment - this paper is useful for general background information but not helpful in assisting in the formulation of guidance</i></p>
<p>North Carolina Department of</p>	<p><b>Stage – all stages</b></p> <p>The Division of Coastal Management (DCM) is developing a</p>

Title	Comment
<b>Coastal Impacts</b>	
<p>Environment and Natural Resources (date unknown): Pilot Study on cumulative effects on the coast.</p> <p>United States</p>	<p>methodology for conducting regional (small watershed level) cumulative impact assessments throughout the coastal area. The proposed pilot project will identify local coastal development trends and cumulative impacts to the major coastal resources that are not otherwise evident through the normal "permit by permit" development review conducted under current CAMA permitting. The assessment study areas will encompass small watershed areas to gain a holistic view of the landscape, resource issues and environmental quality, and render the scope of the project more meaningful and manageable. Public opinion, local issues and economic concerns will generate resource issues. This regional analysis can provide a basis for working with local governments to develop policies in their specific land-use plans and programmes.</p> <p><i>Comment - contact has been made with the DCM Cumulative and Secondary Impacts Analyst who has offered to provide detailed information for the next stage of this project. Because of timing the information could not be included within this pilot stage. The usefulness could be judged at this later stage.</i></p>
<p>Maryland Department of Natural Resources (2000) Coastal 2000.</p> <p>United States</p>	<p><b>Stage – setting the baseline and monitoring (ODPM Stages B and G)</b></p> <p>This programme monitors the condition of ecological resources to evaluate the cumulative success of current policies and programs and to identify emerging problems before they become widespread or irreversible. The programme will provide an estimate of the condition of significant estuarine and coastal resources, allowing Maryland’s coastal waters to be ranked and compared to waters from other geographical areas. The pilot is also intended to build the partnerships and provide the tools needed to address resource monitoring issues of regional and state interest.</p> <p><i>Comment – this is an inventory examining the state of the resource and the stresses upon it. State of the environment reports may be useful in monitoring SEAs and CEAs</i></p>
<p>Oakwood Environmental Ltd (2002): Development of a methodology for the assessment of Cumulative effects of marine activities using Liverpool Bay as a case study.</p> <p>UK</p>	<p><b>Stage – all stages but mostly impact prediction (ODPM Stage E)</b></p> <p>This is a methodology for cumulative effects assessment of offshore industries from a nature conservation and landscape / seascape perspective. Aims of the study were to produce a GIS database and analysis tool for offshore CEA; to identify current and predict likely future cumulative effects from offshore industries in Liverpool Bay on habitats and species of importance; to identify data gaps and recommend further data and research requirements for undertaking CEA for offshore activities.</p> <p><i>Comment - The use of a geographical information system (GIS) was identified as a key tool for storing, analysing, disseminating, and mapping data. Matrices were used to store information relating to the effects assessment and the results displayed as a layer on a map of the study area. These could be useful tools for the Agency.</i></p>
<p>Sklar, FH and Brosder, JA (1998) Coastal environmental impacts brought about by alterations to freshwater flow in the Gulf of Mexico.</p>	<p><b>Stage – Impact prediction (ODPM Stage E)</b></p> <p>This study examined possible coastal impacts of changes in freshwater flow. Multi-objective statistical models and dynamic simulations were used to predict cumulative impacts of changes in freshwater flow on the Gulf of Mexico.</p> <p><i>Comment – this study was very specific to one location and involves</i></p>



Title	Comment
<b>Coastal Impacts</b>	
United States	<i>complex modelling procedures. These approaches could be investigated for certain types of plan or programme. More work is needed to identify which plans and programmes would be most suited to this type of analysis</i>
Nestler, JM and Long, KS (1994): Cumulative Impact Analysis of Wetlands using hydrological indices.  United States	<b>Stage – monitoring to enable impact prediction (ODPM Stage G)</b> Hydrologic indices are used to describe changes in long term discharge patterns of rivers. These indices can be linked to other information (e.g. spatial patterns in wetlands) to form cause and effect sequences between wetland hydrology, wetland spatial patterns and wetland functions affecting habitat values.  <i>Comment – finding a simple means to describe, quantify and isolate historic influences enables planners to deduce the processes responsible for current and future wetland changes. This could be investigated as part of a prediction methodology</i>
<p><i>There are several references that could not be obtained because of time restrictions and would be useful to review in any later stages of research:</i></p> <p><i>Tuttle, A.E., and T.G. Dickert. 1986. Cumulative impact assessment in environmental planning: a coastal wetland watershed example. Environmental Impact Assessment Review 5:37-64.</i></p> <p><i>Bedford, B.L. and E.M. Preston. 1988: Developing the scientific basis for assessing cumulative effects of wetland loss and degradation on landscape functions: Status, perspectives, and prospects. Environmental Management 12:755.</i></p> <p><i>Nestler, J. 1992. Cumulative impact assessment in wetlands. Wetlands Research Program Bulletin 1:1-8. U.S. Army Corps of Engineers, Vicksburg, MS.</i></p> <p><i>Preston, E.M., and B.L. Bedford. 1988. Evaluating cumulative effects on wetland functions: A conceptual overview and generic framework. Environmental Management 12:565-583.</i></p> <p><i>Vestal, B., A, Rieser M. Ludwig, J. Kurland, C. Collins, and J. Ortiz. 1995. Methodologies and Mechanisms for Management of Cumulative Coastal Environmental Impacts. Part I— Synthesis, with Annotated Bibliography; Part Development and Application of a Cumulative Impacts Assessment Protocol. NOAA Coastal Ocean Program Decision Analysis Series No. 6. NOM Coastal Ocean Office, Silver Spring, MD.</i></p>	

Title	Comment
<b>Fisheries</b>	
Burns, D.C. 1991. Cumulative effects of small modifications to habitat.  United States	<b>Stage – all stages</b> The paper makes the point that quantitative predictions for small habitat modifications are difficult and that cumulative effects cannot simply be written into a simple relationship. All individual effects on fish habitat result in cumulative effects on global fisheries.  Because of these limitations procedural steps have been set out including: <ul style="list-style-type: none"> <li>• Encourage full disclosure and assessment of potential cumulative impacts during project planning, including ecosystem modelling when necessary;</li> <li>• Encourage development of a common framework for assessment methodologies;</li> <li>• Encourage regulatory agencies to utilise full and complete disclosure using new methodologies;</li> <li>• Discourage actions such as wetland alteration, watershed modification, point and nonpoint source pollution, which cause predicted small losses to fish habitat, unless effective mitigating measures that fully compensate for projected losses are employed;</li> </ul>

Title	Comment
<b>Fisheries</b>	
	<ul style="list-style-type: none"> <li>• Encourage expanded research on habitat improvement and mitigation, focusing on offsetting potential habitat loss and ecosystem restoration;</li> <li>• Encourage development of more integrated approaches to research and professional communication;</li> <li>• Develop and incorporate measures to educate professionals and the public about cumulative effects;</li> <li>• Encourage inclusion of the study of cumulative effects in university fisheries programs; and</li> <li>• Encourage experimental research at the watershed level, the largest practical scope for controlled and replicated study.</li> </ul> <p><i>Comment - some useful conclusions for the Agency from this study include:</i></p> <ul style="list-style-type: none"> <li>• <i>the importance of ecological modelling when professionals deem this to be necessary;</i></li> <li>• <i>the importance of a common framework for assessment methodologies; and</i></li> </ul> <p><i>encouraging research on the impact of cumulative effects of development at a catchment (watershed) level.</i></p>
<p><i>There are several references that could not be obtained because of time restrictions and would be useful to review in any later stages of research:</i></p> <p><i>Schnackenberg, ES and Macdonald, LH (1998). Detecting Cumulative Effects on Headwater Streams in the Routt National Forest, Colorado. Journal of the American Water Resources Association. Volume 35 (5) October 1998. Pp 1163-1177.</i></p> <p><i>Kondolf, G.M. 1995. Planning approaches to mitigating adverse human impacts on land-inland-water ecotones. In Proceedings of the UNESCO/MAB Conference, "Fish and Land/Inland Water Ecotones", Zakopane, Poland, May 1995. (in press)</i></p>	

Title	Comment
<b>Ecological systems</b>	
<p>Bonnell, S. &amp; Storey, K. (2000): Addressing Cumulative Effects through Strategic environmental assessment: a case study of a small hydro development in Newfoundland, Canada.</p> <p>Canada</p>	<p><b>Stage – all stages</b></p> <p>This paper examined the additive and interactive impacts of small scale hydro development in Canada. No specific methods are suggested but useful issues are drawn out. It would be a difficult process to establish animal movement patterns.</p> <p><i>Comment – this paper highlights some issues of how to integrate the process of CEA into plan and programme making and how to subsequently assess impacts. However, as with any journal article it is up to readers to draw the inferences from the paper.</i></p>
<p>Belisle, M and Cassady St Claire, C (2001): Cumulative effects of barriers on forest birds.</p> <p>United States</p>	<p><b>Stage – impact prediction (ODPM stage E)</b></p> <p>This paper examined habitat fragmentation into anisotropic habitats (habitats caused by large or multiple liner barriers running closely parallel to each other).</p> <p><i>Comment - this is not a method – it looks at the effects on different bird species. The results showed that the axes and the direction of potential habitat movement must be acknowledged if predictions are to be accurate. If the patterns of habitat dispersal and animal movement could be ascertained it could be used to predict behaviour modification</i></p>

Title	Comment
<b>Ecological systems</b>	
<p>Landscape Design Associates (2000): Cumulative effects of wind turbines on birds.</p> <p>United Kingdom</p>	<p><i>and enhance mitigation measures.</i></p> <p><b>Stage – impact prediction (ODPM Stage E)</b>            Although this report specifically examines wind turbines it has some transferable issues such as analysis of the use of predictive models such as population viability analysis (a technique used to combine environmental, demographic, genetic and other data about a population to predict the likelihood of particular future changes occurring.</p> <p><i>Comment - some of the background information on the sensitivity of bird species of wind turbines could be transferable to consideration of other developments that provide a barrier to movement such as roads.</i></p>
<p>Gaines, WL, Singleton, PH and Ross, RC (2002). Assessing the cumulative effects of linear recreation routes on wildlife habitats on the Okanogan and Wenatchee national forests.</p> <p>Canada</p>	<p><b>Stage – monitoring (ODPM Stage G)</b>            Examines the effects of fragmentation and disturbance on habitats and species. The assessment consisted of seven steps:</p> <ul style="list-style-type: none"> <li>• Identification of wildlife species and groups;</li> <li>• Identification of focal species within each wildlife group (decide which species are most vulnerable to a particular activity);</li> <li>• Identification of the road and trail associated factors for each focal species;</li> <li>• Development of assessment processes and GIS models to evaluate the influence of road and trail associated factors on focal species habitats;</li> <li>• Application of the models to assess the current conditions of focal species habitats;</li> <li>• Identification of information gap; and</li> <li>• Monitoring and adaptive management.</li> </ul> <p>Completion of this process yields a platform for the consistent evaluation of the cumulative effects of roads and recreation trails on wildlife habitats relative to the existing baseline conditions.</p> <p><i>Comment – this is a complex methodology to understand. The methodology has determined various indicators of impact – i.e. the amount of designated habitat that lies within 60m of a road etc. It states that this could be used to determine changes in the environment over time. What the methodology lacks (and admits it lacks) is data that links this to the actual effects on species and habitats. It is a useful monitoring tool but no more than this. Could not be used for impact prediction without a lot more data on causal effects.</i></p>

Title	Comment
<b>Planning and transport</b>	
<p>Ecoplans (2002): Mid peninsula transportation corridor – report on environmental assessment process commitments.</p> <p>Canada</p>	<p><b>Stage – all stages</b></p> <p>This is an example of a transport specific assessment under the Canadian system.</p> <p><i>Comment - It does not add anything to this study in terms of consideration of methodology. It is quite general. It has been included for the sake of completeness.</i></p>
<p>Maryland Department of Natural Resources</p>	<p><b>Stage – setting the baseline and impact prediction (ODPM Stages B</b></p>

<p>(2002). Draft State Agency Guidelines – Multiple Power Plants</p> <p>United States</p>	<p><b>and E)</b></p> <p>Uses method to determine the carrying capacity of a region where multiple power stations are proposed. The cumulative analysis would identify major air, water, terrestrial, land use and other thresholds in a region where multiple power stations are proposed. Additionally, the cumulative analysis would identify any additional licensing conditions needed to address mitigation.</p> <p>Included in the cumulative analysis would be:</p> <ul style="list-style-type: none"> <li>• Existing facilities;</li> <li>• Existing CPCN applications – filed proposals</li> <li>• Expected applications – Proposals expected to be filed</li> <li>• Speculative proposals – Proposals expected in a 5-10 year window both within and outside the region of interest.</li> </ul> <p><i>Comment – this may be useful when analysing the impacts of multiple IPPC permissions in an area.</i></p>
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## APPENDIX D: AGENCY STAFF AND OTHER CONSULTEES

### Agency Staff

The following members of staff have been consulted about the project.

Name	Area of responsibility
Colin Foan	SIAM Project Manager
Paula Orr	Social Policy Advisor - also working on health issues.
Stuart Stearn	Head of PPC Policy Unit
Ben Glatt	Policy Advisor Incineration – also environmental protection lead for SEA
Catherine Sanders	Regional EIA Co-ordinators
Deborah Dunsford	
Ian Cappit	
Liz Galloway	
Peter Doktor	
Vicky Ellis	
Robin Crawshaw	
Nicola Whittle	
Martin Slater	
Merylyn Hedger	Climate Change Advisor
Tim Reeder	Climate Change Advisor
Ruth Jones	River Basin Characterisation Project, Water Framework Directive
Helen Orme	Habitats Directive
Rob Westcott	Water Management
Hugh Howes	Planning Liaison
Sue Reed	EIA Co-ordination
Julie Richards	Coastal Process Engineering
Phil Irving	Risk Manager
Glenn Watts	Water Resources Planning
Bernard Fisher	Forecasting and Decision Support (air quality)
Rob Curry	Economist
Eileen McKeever	Waterways
John Pygott	Humber Estuary Shoreline Management Plan
Toby Willison	Land Quality
Brian Empsom	Strategic Policy
Mike Brewer	Capital Projects
Jonathon Fisher	River Basin Management Plan Assessment

Name	Area of responsibility
Nicola Lord	
Mervyn Bramley	Research and Development

### Other organisations consulted

These organisations have been contacted about the project. Those with an \* have responded.

#### Organisation

Strategic Rail Authority\*  
RSPB\*  
University of Oklahoma  
Dti (oil and gas licensing)\*  
Enfusion Consultants\*  
DEFRA (various departments)  
Welsh Assembly\*  
IEMA  
University of Manchester\*  
Thames Water  
HR Wallingford\*  
Countryside Agency  
Oxford Brookes University \*  
University of Calgary  
Cascade Consulting  
Defence Estates  
English Nature  
The Kings College University, Edmonton  
CIWEM\*  
Landscape Institute\*  
British Waterways  
Planning Inspectorate\*  
ODPM (Minerals Planning and SEA)\*  
Ministry of Defence  
PV Power Systems\*

## **APPENDIX E: QUESTIONS FOR INTERVIEWS WITH AGENCY OFFICERS**

The questions outlined below were used during the interviews with Agency officers as starting points to identify the current level of knowledge and use of SEA and CEA and also to identify concerns about the future application of CEA to strategic plans and programmes.

- What plans or programmes are you responsible for / work on?
- Is SEA carried out on these plans and programmes at the moment?
- Is CEA carried out on these plans and programmes at the moment?
- If so, at what stage (all SEA stages) and what issues are covered by this?
- What guidance / tools are used for this?
- Is this guidance specific to one type of plan or programme or one type of impact?
- What are the difficulties of applying CEA to the assessment? In terms both of stages (all SEA stages) and issues
- Is more guidance required? Should this be general guidance on CEA or guidance related to specific plans or programmes?
- Can you suggest any useful literature on CEA that should be reviewed as part of the scoping study?





