Why is Government conducting this consultation?

This consultation seeks views on the conclusions of the first phase of the Government’s feasibility study into whether a power project using the vast natural tidal range resource of the Severn Estuary could be supported and, if so, on what terms. The consultation focuses on;

- which of the ten possible Severn tidal power options under consideration should be short-listed for detailed assessment during 2009
- the scope of the Strategic Environmental Assessment that is being carried out within the Severn tidal power feasibility study
- the issues the feasibility study is considering and how these are being approached

Issued: 26 January 2009
Respond by: 23 April 2009
Enquiries to: Department of Energy and Climate Change
Severn Tidal Power Team
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http://severntidalpowerconsultation.decc.gov.uk
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Annex 7: Regional Social and Economic Impacts Study
Foreword

Combating climate change is the biggest long-term challenge we face. To rise to it, to meet our part of a European commitment, and to show the world that a low-carbon economy is possible, renewable power must provide almost a third of our electricity by 2020, and we have to progressively decarbonise our electricity.

That is the scale of the task. I believe Britain has the resources to meet it, and to create jobs and wealth as we do so. The world-leading expertise that we built up for oil and gas in the North sea can now harness the wind, waves and tides in all our coastal waters – in 2008, we overtook Denmark to produce more offshore wind power than any country in the world.

We have the innovative start-ups and laboratories to create the next generation of clean power technologies. And we have been endowed with sources of clean power like the Severn Estuary.

With the second-largest tidal range in the world, it is a huge reserve of energy. At a spring tide, 450 million litres a second pass through the Estuary. The largest proposal to make use of this power would save more CO2 than turning off two medium-sized coal-fired power stations.

Publishing this consultation on the feasibility study so far, I want to make sure we have an open debate about how to make our actions on climate change not just ambitious, but fair to people.

That means fair for households and businesses, keeping down energy bills. Harnessing the power of the Severn could cut the costs of building up our renewable power to the level we need, but we need to look at which options offer the best deal. Fairness means local communities having a stake in the projects in their area. Different projects in the Severn have different effects on local businesses, and create different numbers of jobs.

There is an important debate, too, about the effects on the natural environment. Failing to stop climate change would have catastrophic effects for the environment globally including for many of our national species. But the Severn, and its tributaries, is also an area of international conservation significance – with many of the birds and fish that make their home in the Estuary protected. We need to think about how to balance the value of this unique natural environment against the long-term threat of global climate change.
To be fair and sustainable, the debate on how to harness the Severn needs to be as open as possible. This feasibility study looks at the most promising options. Before decisions are made there will be a second public consultation, and I am keen to start the debate early.

I want to thank the many stakeholders – organisations and individuals – who are contributing their time and expertise to the feasibility study. Your input is helping to ensure we reach the right decision, make the most of our natural resources, and protect wildlife here in Britain and for a sustainable planet.

The Rt. Hon Ed Miliband
Secretary of State for Energy and Climate Change
Executive Summary

1. We must reduce our carbon dioxide emissions from energy and simultaneously secure our energy supply. Under the Climate Change Act the Government is required to reduce greenhouse gas emissions by 80% by 2050. The draft UK Renewable Energy Strategy considers ways in which the UK can meet, in the most cost-effective manner, our proposed target of supplying 15% of energy (electricity, heat and transport) from renewable sources by 2020. The measures proposed for the Renewable Energy Strategy aim to stimulate the market to deliver the necessary investment by providing a clear long term policy framework and removing the practical barriers to renewable generation.

2. The Committee on Climate Change proposed in December 2008 that the electricity sector should be largely de-carbonised by 2030. There are a number of ways this could be achieved – reducing our energy demand, investing in nuclear and renewable power, capturing the carbon emissions of new and existing fossil fuel power stations. It is likely that all of these will need to be pursued.

3. The Severn Estuary’s 14m (45 foot) tidal range represents a phenomenal source of indigenous, predictable (though intermittent), low-carbon energy. In the 2006 Energy Review the Government asked the Sustainable Development Commission to investigate tidal power opportunities across the UK. The Commission also considered other UK estuaries as well as the Severn. Their report in October 2007 concluded, with conditions, that there is a strong case for a sustainable Severn Barrage, and also potential for barrages in other locations (such as the Mersey, Wyre and Thames).

4. In response, the Government launched a two-year feasibility study to investigate whether we could support a Severn tidal power scheme and, if so, on what terms. The study is considering the costs, benefits and impact of the generation of tidal power in the Severn Estuary. It began in January 2008 and is now at its mid-way point and this interim Consultation Document seeks views on:
   - the process used to move from the long-list to the short-list of schemes
   - the proposed shortlist, and
   - the issues proposed for further investigation, including the scope of the Strategic Environmental Assessment

5. The decision as to whether or not to support a Severn tidal power scheme will be taken following further consideration of the issues and a second public consultation, probably in 2010.

A Severn tidal power project has benefits, costs and risks and a provisional assessment of these is set out in this consultation paper. Also published are the reports that have been prepared for the study by external consultants. Whether to go ahead with a Severn power generation scheme needs to be considered in the context of the alternative means of meeting our energy and climate change goals.

The draft Renewable Energy Strategy suggests that a Severn tidal power generation may not be essential for meeting 2020 targets on renewable energy. Other sources of supply exist, and Severn tidal power must be considered on its merits alongside these. Our analysis of comparative costs shows that while Severn tidal power is relatively expensive compared to current cost estimates for other renewable sources (particularly in the 35 year financing period when the capital costs are being paid off), it could potentially reduce the cost of meeting our renewable energy target of supplying 15% of energy from renewable sources by 2020.

Ten proposals to generate electricity from the Severn Estuary came forward from a public Call for Proposals in May 2008 and a strategic review of existing options used in the Sustainable Development Commission’s and previous reports. Proposals include barrages, land-connected and offshore lagoons, a tidal fence and a tidal reef. These proposed schemes are in varying stages of development, with some using tried and tested technology, and others using tested structures, but completely new materials. Some proposals are based on embryonic technologies which have not been prototyped or deployed, let alone at the huge scale proposed. Locations vary too, with the largest schemes spanning the Estuary from Minehead to Aberthaw (15 miles) and the smallest lying upstream of the Severn road crossings. Energy outputs also vary with the largest option (the Outer Barrage) estimated to generate up to 7% of UK electricity and the smallest generating roughly the same output as a large fossil fuel power plant.

However, careful consideration of the benefits, consequences, risks and costs of any Severn tidal power project is needed. The Severn Estuary is an internationally important nature conservation site for the species that occur there, including migratory fish and over-wintering birds and for its estuarine habitats including mudflat and salt marsh. The impact of both barrages and lagoons would be to retain water: low tide levels would rise slightly upstream and within impounded areas and overall high tide levels would be reduced by about a metre. Some areas of habitat currently uncovered at low tide would be permanently underwater, displacing bird populations. The passage of migratory fish, like eel and Atlantic salmon, would be impeded and high mortality rates for some species would be expected. Impacts on protected sites would need to be compensated for under environmental protection legislation, which safeguards our biodiversity and water quality. The environmental effects of the innovative
technology schemes – the tidal reef and tidal fence – are currently unclear as these proposals are less detailed, but they may be less damaging than barrages or lagoons.

Flood risk impacts have been considered. We do not expect Severn power development to affect upstream flooding of the Severn, such as the floods that occurred around Tewkesbury in 2007. It could, depending on the scheme, provide positive benefits by protecting against storm surge flooding from the sea. Further studies are being done to understand how the suspended sediments and wave action in the Estuary would be affected, and whether this might put pressure on coastal flood defence (and therefore add to the costs of a scheme). Some land drainage systems that discharge through structures that are controlled by the tides would be affected and might require pumped drainage as a remedy.

Severn tidal power development is expected to benefit the economies of Wales and the South West of England. A larger scheme is centrally estimated to bring an annual average of 1,500 additional jobs during a construction period of up to to 10 years; a smaller scheme would be closer to 500 jobs annually over 5 years. Operation of a scheme would create additional jobs both directly and indirectly, centrally estimated to be up to an annual average of 200 for a large scheme and up to 50 annually for a small one. These figures are net of estimated negative impacts on, for example, employment in ports and fisheries in the Estuary and surrounding area. Taken together, construction and the initial 30 years of the operational phase can be expected to deliver £3.55 billion for a larger scheme, or £620 million for a smaller scheme, net additional Gross Value Added to the local economies.

A barrage across the Severn Estuary could carry a new road or rail link. A link would be expensive as it would need to be elevated to provide adequate clearance for vessels to pass through locks and would not necessarily be less expensive than a separate construction structure. The feasibility study has commissioned work by Network Rail and the Highways Agency\(^3\) and has found no evidence that the existing road and rail infrastructure is inadequate or unable to meet anticipated traffic for at least the next 15-20 years.

However, it is possible that new transport links will be needed beyond 2025-30. With this in mind it would be feasible to accommodate suitable foundations either as part of the design of a barrage or subsequently by developing a design that adapted the existing structure for a future transport link. Any such development would be subject to environmental and other assessments at the time.

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It is estimated that all proposals would require some Government support through planning and possibly construction phases due to their high capital costs and the scale of regulatory risks, particularly on the environmental side. The costs of this support would fall on electricity consumers and taxpayers. For the smaller schemes (with an estimated construction cost of £2-4 billion and output of 2-3 TWh annually) the private sector could reasonably be expected to own, finance and take on most of the construction risk, provided there is sufficient revenue certainty. However, a larger scheme (such as the Cardiff-Weston barrage, with an estimated construction cost of £20.9 billion and annual output of 17TWh) would need Government assistance to finance its construction. The private sector could operate any scheme constructed. Like almost all renewable energy generation, all proposed schemes would require revenue support in addition to revenues from power prices during the financing lifetime of their operation (the first 35 years) in order for them to be price competitive with non-renewable electricity sources. Beyond this period, the schemes could generate power for a low upkeep cost for the remainder of their estimated 120 year minimum lifespan.

Some schemes could work in combination with each other; for example a lagoon with a barrage further upstream or a combination of lagoons. The option of a suitable combination of short-listed schemes and the benefits and risks these might bring will be considered by the feasibility study.

A Severn tidal power project would also require investment in new transmission assets, such as grid connections, cables and relays, depending on the size and location of the scheme. The balancing of intermittent but predictable power generation and demand will require consideration, particularly for the larger schemes. These aspects will be considered in greater detail in the next phase of the feasibility study.

The electricity generated would be as predictably intermittent as the tides. The proposed schemes could generate electricity for 4-6 hours roughly twice a day if using the ebb tide. The study is considering methods to even out generation, or to manage demand, and the effects on the structure and functioning of energy markets.

The ten long-listed proposals to generate electricity from the Severn have been assessed for their feasibility. In the context of the study, feasibility means whether the project has a realistic prospect of being built and whether it could meet the objectives of the study. Five key areas were identified as determining feasibility:

- technical risk;
- the cost and amount of energy produced;
- affordability and value for money for the public sector;

4 This figure includes the estimated cost of compensatory habitats at a 2:1 ratio, excluding optimism bias.
• the environmental impacts; and

• regional level economic and social impacts

19 It is important that we work towards the widest possible range of feasible options for generating energy from the Severn Estuary – including options where there is already evidence to indicate they are potentially feasible and also keep an eye on the less developed and innovative proposals that have come forward where we want to allow for further development to take place.

20 We propose to short-list the following proposals based on traditional hydroelectric technologies, incorporating a mix of existing and new construction techniques:

<table>
<thead>
<tr>
<th>Proposal</th>
<th>Location</th>
<th>Installed Capacity</th>
<th>Construction Cost£</th>
<th>CO₂ Savings/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoots Barrage</td>
<td>By Severn road crossings</td>
<td>1.05 GW</td>
<td>£3.2bn</td>
<td>1.2 Mt</td>
</tr>
<tr>
<td>Beachley Barrage</td>
<td>Just upstream of the Wye confluence</td>
<td>0.625 GW</td>
<td>£2.3bn</td>
<td>0.7 Mt</td>
</tr>
<tr>
<td>Fleming Lagoon</td>
<td>Between Newport &amp; Severn road crossings</td>
<td>1.36 GW</td>
<td>£4.0bn</td>
<td>1.0 Mt</td>
</tr>
<tr>
<td>Bridgwater Bay Lagoon</td>
<td>English shore between Hinkley Pt &amp; Weston-Super-Mare</td>
<td>1.36 GW</td>
<td>£3.8bn</td>
<td>1.1 Mt</td>
</tr>
<tr>
<td>Cardiff-Weston Barrage</td>
<td>(Lavernock Pt – Brean Down, known as Severn Barrage)</td>
<td>8.64 GW</td>
<td>£20.9bn</td>
<td>7.2 Mt</td>
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</table>

21 Cardiff-Weston barrage, with an estimated construction cost of around £21 billion, would be more than five times the cost of other schemes on the proposed shortlist. Unlike the other options, its construction could not be funded by the private sector alone and taxpayers/consumers would likely bear a large part of the cost burden and risk. However, this barrage could also make a significant contribution to our energy goals and we therefore propose to study it further. This will allow the scale of environmental impact and options for mitigation and compensation to be studied.

22 The proposed short-listed schemes are based on relatively well understood hydroelectric technologies, with a mix of existing and new engineering structures. Not all barrage and lagoon schemes have been short-listed. Some do not perform well in terms of the assessment criteria as they have extremely high costs of energy, for example.

23 The Government is keen to continue to consider innovative schemes that may be less environmentally damaging; but some of those that have

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5 These figures include estimates for the cost of compensatory habitats at a ratio of 2:1, excluding optimism bias.
been submitted to the feasibility study – the tidal fence and tidal reef – are not sufficiently developed technically at this point for more detailed evaluation. Substantial Government financial support is available for low-carbon energy innovation to speed the development of such innovative proposals for example through the Energy Technologies Institute, the Carbon Trust and the £50 million Marine Renewables Deployment Fund. The Government would like to see these proposals develop further with the benefit of funding support and commits to considering their progress alongside the other schemes – in particular the Cardiff-Weston barrage which could be on a similar scale – before taking decisions on Severn tidal power generation.

The short-list will make up the reasonable alternatives for Strategic Environmental Assessment (SEA). The SEA is a major part of the feasibility study. It predicts and analyses the environmental and social effects of the short-listed tidal power options to inform decision making. The SEA Scoping Report⁶ (Annex 2) sets out how we propose to assess the environmental and social effects of the short-listed tidal power options over their lifetimes. The Scoping Report establishes baselines and proposes objectives for the scope of the overall SEA. In turn, each objective comprises detailed assessment criteria which facilitate the comparison of the different project proposals on equal terms.

In addition to Strategic Environmental Assessment, the next phase of the feasibility study will consider the impacts of the various short-listed schemes, including on the construction supply chain, and on the energy market and grid. Ecosystem valuation will be used to assign a value to environmental and social impacts. We will also examine potential compliance with environmental protection legislation and the means of ensuring that environmental effects could be mitigated where possible and compensated for if they cannot be mitigated. These studies, and others, will form the evidence base for a decision whether the Government could support a Severn tidal power project and, if so, what the project might be and on what terms it might be supported. A further public consultation, probably in 2010, will seek views on the evidence gathered and the analysis, and will feed into the decision by Government on whether a scheme could be taken forward with Government support. The option remains open not to proceed with any scheme.

If a Severn tidal power project does proceed, it will be subject to the planning and consenting process before construction could begin. This may take 3-5 years and construction at least a further 5-7 years, depending on the scheme or combination of schemes that is selected and whether the development is approved.

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<td>1</td>
<td>Is the feasibility study taking the right issues into account?</td>
</tr>
<tr>
<td>2</td>
<td>Are there other aspects or other evidence that should be taken into consideration?</td>
</tr>
<tr>
<td>3</td>
<td>Have we given due weighting to the different benefits and impacts under consideration in our analysis?</td>
</tr>
<tr>
<td>4</td>
<td>Do you think that it is better to wait for new and perhaps less environmentally damaging technologies to be developed, or to move ahead more quickly with available proposals?</td>
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Consultation Process

Issued: 26 January 2009
Please respond by: 23 April 2009

Enquiries and responses to:
Douglas Cook
Department of Energy and Climate Change
020 7215 0143

stp-consultation@berr.gsi.gov.uk
http://severntidalpowerconsultation.decc.gov.uk

How to Respond

This consultation seeks views in particular on:

- the scope of the Strategic Environmental Assessment that is being carried out within the Severn tidal power feasibility study
- which of the ten possible Severn tidal power options under consideration should be short-listed for detailed assessment during 2009
- the issues the feasibility study is considering and how these are being approached

We want to hear from members of the public, industry, non-Governmental organisations (NGOs), Local Authorities, or any other organisation or public body.

The consultation began on 26 January and will close on 23 April 2009. There are a number of ways to let us know your views.

Online

Visit our website at http://severntidalpowerconsultation.decc.gov.uk. The online consultation has been designed to make it easy to submit responses to the questions. If you decide to submit your response through the website you will be provided with a user name and a password which will allow you to edit or update your submission as many times as you wish whilst the consultation is open.
Consultation Questions

The consultation questions are as follows. These questions are repeated in their respective sections below.

**Overarching Questions (to be taken into consideration throughout the Consultation Document):**

1. Is the feasibility study taking the right issues into account?
2. Are there other aspects or other evidence that should be taken into consideration?
3. Have we given due weighting to the different benefits and impacts under consideration in our analysis?
4. Do you think that it is better to wait for new and perhaps less environmentally damaging technologies to be developed, or to move ahead more quickly with available proposals?

**Regional Economic Impacts Study:**

5. Do you agree with the conclusions of the DTZ study and are there any other factors that the feasibility study should be aware of?

**Financing and Subsidy Mechanism:**

6. Do you agree with PricewaterhouseCoopers’ (PwC) analysis on ownership and delivery of a Severn scheme?
7. Are there any other options for delivery or subsidy that should be considered? Would they be appropriate for all of the tidal power options under consideration?
8. Government believes that the private sector is best placed to design, build and operate a Severn tidal scheme. Government’s role would be to set the conditions in which a scheme could come forward. Do you agree?

Impacts on Energy Markets:

9. What are the impacts and potential risks of tidal intermittency on the balancing and energy market?

10. Is it worth considering exploring the option of demand management?

11. Do you consider that a Severn tidal scheme could impact on investment in other energy supply capacity, and if so in what ways?

Short-listing Process:

12. Do you agree with the factors that have been used to determine the short-list for further study?

13. Do you agree that the test of economic feasibility should be relative to the cost of other renewables?

14. Do you have any further comments on Parsons Brinckerhoff’s Interim Options Appraisal Report? Please support your response with evidence where possible.

Severn Tidal Power Proposals:

15. Do you agree that the two lagoon options selected for further study represent a good basis for studying the lagoons?

16. Given the short-listing criteria, are there any proposals on the short-list which are not suitable? Please support your response with evidence where appropriate.

17. Does the short-list represent an appropriate level of ambition given the energy potential of the Estuary?

18. Are there any other schemes that, in your view, should be short-listed? Please provide appropriate evidence wherever possible and refer to the short-listing criteria.

Strategic Environmental Assessment:

19. Which plans, programmes or environmental protection objectives are most significant for this strategic-level environmental assessment?
20. Is there any additional information that could help supplement the baseline data? Any further information relating to the baseline indicators, existing problems and trends over time would be very useful.

21. Is there any important information that has not been addressed in view of the SEA scope?

[For a range of further detailed questions on the SEA, please see p. 103 of the annexed SEA Scoping Report.]

Next Steps:

22. Do you agree with the work plan, as outlined in Chapter 6? If not please specify any other areas to be studied.

Additional points about this consultation

32. When responding please state whether you are responding as an individual, or representing the views of an organisation. If responding on behalf of an organisation, please make it clear who the organisation represents and, where applicable, how the views of members were assembled. The website registration form provides space to do so.

33. After the consultation has closed, all responses (including respondents’ names) will be published unless respondents specifically request that their responses be kept confidential. This will apply to all responses whether submitted online, posted, faxed or emailed. Please indicate on your response if you want us to treat it as confidential. You should also read the section on confidentiality and data protection below.

Confidentiality & Data Protection

34. Information provided in response to this consultation, including personal information, may be subject to publication or disclosure in accordance with the access to information regimes (these are primarily the Freedom of Information Act 2000 (FOIA), the Data Protection Act 1998 (DPA) and the Environmental Information Regulations 2004).

35. If you want other information that you provide to be treated as confidential, please be aware that, under the Freedom of Information Act, there is a statutory Code of Practice with which public authorities must comply and which deals, amongst other things, with obligations of confidence.

36. In view of this it would be helpful if you could explain to us why you regard the information you have provided as confidential. If we receive a request for disclosure of the information we will take full account of your
explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded as binding on the Department.

37 The Department will process your personal data in accordance with the Data Protection Act and in the majority of circumstances this will mean that your personal data will not be disclosed to third parties.

Additional Copies

38 You may make copies of this consultation document without seeking permission. Further printed copies of the consultation document or copies of the response form can be obtained from:

39 BERR/DECC Publication Orderline ADMAIL 528 London SW1W 8YT
   Tel: 0845 015 0010 Fax: 0845 015 0020 Minicom: 0845 015 0030 http://www.berr.gov.uk/publications

40 Copies of the document in Welsh, Braille, large print and audio are also available on request from the Orderline. An electronic version can be found at http://severn tidalpowerconsultation.decc.gov.uk

Help with Queries

41 Questions about policy issues raised in this document can be addressed to:

   Douglas Cook
   Department of Energy and Climate Change
   Severn Tidal Power Team
   1 Victoria Street
   London SW1H 0ET
   Tel: 020 7215 0143
   Fax: 020 7215 2609
   Email: stp-consultation@berr.gsi.gov.uk

42 If you have comments or complaints about the way this consultation has been conducted, these should be sent to:

   Tunde Idowu
   Consultation Coordinator
   Department for Business, Enterprise and Regulatory Reform
   Better Regulation Team
   1 Victoria Street
   London SW1H 0ET
   E-mail: babatunde.idowu@berr.gsi.gov.uk
The Department of Energy and Climate Change will appoint a consultation coordinator in due course. Tunde Idowu of the Department of Business, Enterprise and Regulatory Reform is acting DECC coordinator in the interim. The Consultation Code of Practice criteria are at Annex 1.

Related documents can be found at: http://severntidalpowerconsultation.decc.gov.uk/supporting_documents. This includes:

- Interim Options Analysis Report
- Strategic Environmental Assessment (SEA) Scoping Report
- 16 Topic Papers that form the basis of the SEA
- Financing and Ownership Report
- Preliminary Review of Possible Mitigation and Compensation Requirements under the Habitats Directive
- Partial Impact Assessment
1: The Overview

Summary

- The UK must reduce its carbon dioxide emissions from energy and at the same time have a secure supply of energy. We have committed to reducing our greenhouse gas emissions by 80% by 2050 and for 15% of UK energy to come from renewable sources in 2020.

- To achieve these goals, the UK must increase the amount of electricity sourced from renewables almost ten-fold over the next 12 years and consider decarbonising our electricity sector almost completely by 2030.

- Tidal electricity generation in the Severn Estuary can contribute to meeting these goals and is being considered alongside alternatives, such as energy saving measures, or other renewables like wind, and nuclear energy.

- The Severn Estuary is an important nature conservation site and careful consideration of the benefits, consequences, risks and costs is required in reaching a decision on whether to take forward any development.

- Following a positive recommendation from the Sustainable Development Commission, a two-year cross-Government feasibility study was launched to update the evidence and provide robust analysis to inform the decision on whether or not to promote a tidal power scheme in the Estuary.

- The study is now at its mid-way point. This consultation sets out what has been learned so far, and asks your views on:
  - the process used to move from the long-list to the short-list of schemes
  - the proposed short-list and
  - the proposed issues for further investigation, including the scope of the Strategic Environmental Assessment.

- There will be a second public consultation in 2010, which will set out fuller evidence and seek your views on whether a scheme should proceed and, if so, on what terms.

Taking action to reduce the risks of serious climate change is crucial. Reducing our carbon dioxide emissions and producing energy from low-carbon and renewable sources are a key means of doing this. The UK is playing a leading role in tackling climate change and has set ambitious renewable energy targets; and is the first country in the world to have mandatory domestic carbon budgets enshrined in law.

Meeting these challenging targets will require fundamental changes to how we generate a secure supply of energy and how we use that energy. There is no “do nothing” option. Using energy more efficiently will reduce demand and emissions, but we cannot achieve our objectives through
energy saving alone – we need to decarbonise our energy supply and in particular the supply of electricity. The Committee on Climate Change advised in December 2008 that the electricity sector should be largely de-carbonised by 2030 in order to meet the 80% reduction in greenhouse gases by 2050 enshrined in the Climate Change Act.

Electricity demand could well grow over the next few decades as low-carbon electricity can be used to fuel other sectors, for example alternative transport technologies such as electric cars. Low carbon technologies, whether its nuclear, carbon capture and storage or renewables – all have a part to play in meeting the demand for less environmentally-damaging electricity generation.

The Stern Review\(^7\) concluded that the cost of not taking action to tackle climate change far outweighs the cost of taking action now. Acting to reduce emissions could cost around 1% of world Gross Domestic Product (GDP). But not acting could cost at least 5% and, under certain conditions, up to 20% of world GDP.

The UK’s energy security can also benefit. By producing more energy domestically, we will reduce our dependency on imports of fossil fuels and electricity and help protect against the risk of rising prices. And there are other benefits too – the estimated £100bn of investment that is needed to meet renewable energy targets can boost the economy, support employment, and speed the development of innovative new technologies.

### 1.1 The Renewable Energy Strategy

Political agreement has been reached on a UK target to deliver 15% of our energy from renewable sources by 2020. This is a very challenging goal. In 2007, only around 1.78% of our final energy consumption came from renewable sources\(^8\). To meet the proposed 2020 targets, we will have to increase the proportion of our energy coming from renewables ten-fold from 2007 levels. The Government intends to publish a Renewable Energy Strategy (RES) this year. Public consultation during summer 2008 on a draft strategy set out a range of possible additional measures designed to encourage the deployment of renewable energy (heat, transport and electricity) sources in the UK, in order to meet the proposed 15% renewable energy target. The responses are now being considered and further work is underway to decarbonise the heat sector, to increase energy savings and reduce emissions from transport (which takes account of the Gallagher Review)\(^9\).

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Ways in which the Welsh Assembly Government intends to contribute to the UK targets are outlined in the Consultation on a Renewable Energy Route Map for Wales\textsuperscript{10}. This shows how it could be feasible for Wales to generate, by 2025, more electricity from renewable sources than the total it currently consumes.

The UK Renewable Energy Strategy consultation presented a number of different scenarios to help the UK meet its share of the EU renewable target by 2020\textsuperscript{11}. These showed that around 28-37\% of the UK’s electricity may need to come from renewable sources, with a central scenario of 32\% renewable electricity. The draft Strategy also showed that Severn tidal power is an option, not a necessity, to achieve 32\% renewable electricity, but to achieve a larger share from renewable electricity, a Severn tidal project would be required.

The table below gives an indication of the relative costs (in £/MWh) for other renewable and alternative energy generation. However, it is important to note that these costs will vary due to different sites being used, knowledge acquired during the installation of early schemes and the availability of components; costs are therefore shown here as a snapshot for comparative purposes.

<table>
<thead>
<tr>
<th>Technology</th>
<th>£/MWh in 2020 (2008 prices)\textsuperscript{12}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onshore wind (high wind speed)</td>
<td>65-72</td>
</tr>
<tr>
<td>Onshore wind (medium wind speed)</td>
<td>68-77</td>
</tr>
<tr>
<td>Onshore wind (low wind speed)</td>
<td>82-91</td>
</tr>
<tr>
<td>Offshore wind (high wind speed)</td>
<td>71-81</td>
</tr>
<tr>
<td>Offshore wind (low wind speed)</td>
<td>75-85</td>
</tr>
<tr>
<td>Biomass regular</td>
<td>109-116</td>
</tr>
<tr>
<td>Biomass energy crop</td>
<td>109-116</td>
</tr>
<tr>
<td>Biomass CHP</td>
<td>128-140</td>
</tr>
<tr>
<td>Wave</td>
<td>145-163</td>
</tr>
<tr>
<td>Biowaste</td>
<td>82-95</td>
</tr>
<tr>
<td>Biogas</td>
<td>163-191</td>
</tr>
<tr>
<td>Tidal Stream</td>
<td>129-148</td>
</tr>
<tr>
<td>Nuclear</td>
<td>38</td>
</tr>
<tr>
<td>Combined Cycle Gas Turbines</td>
<td>53\textsuperscript{13}</td>
</tr>
<tr>
<td>Severn tidal power</td>
<td>104-317</td>
</tr>
</tbody>
</table>


\textsuperscript{12} Figures show difference between estimated costs for development by vertically integrated companies (i.e. suppliers who also generate electricity) rather than independent developers. The figures for wind are broken down by wind speed using load factors for onshore wind of 29\% for high, 27\% for medium and 21\% for low. For offshore wind, the load factors are 39\% for high and 35\% for low. Nuclear figures include the costs of de-commissioning and waste disposal.

\textsuperscript{13} Includes estimated cost of EU Emission Trading Scheme allowances.
A massive increase of on- and offshore wind generation has been provisionally identified as the main means of delivering this expansion, together with biomass, small-scale generation, hydro power and others.

**Figure 1: Renewable electricity generation capacity – comparison between 2006 and projected 2020 (Source: DUKES 2007)**

A Severn tidal power project, using the UK’s largest tidal range (up to 14 metres or 45.9 feet), is another option. Some schemes under consideration could last for over 120 years – much longer than most other forms of generation. Severn tidal power could deliver large-scale energy: the largest scheme under consideration in the feasibility study has a capacity of 15GW, and smaller schemes range from 0.6GW to 1.4GW.

The cost of the energy that could be produced from the Severn Estuary ranges from £104 to £317 per MWh, depending on the scheme. The lowest cost energy would be delivered by the 1.05GW Shoots Barrage and the highest by the most expensive form of offshore lagoons. Even the low end of this range is relatively high compared with current and estimated future cost estimates of other renewables – particularly in the financing period of up to 40 years when the high capital costs are recouped. The levelised costs for the Severn tidal power, discussed in detail in Chapter 2.3, include provision for compensatory habitat at a ratio of 2:1, a 15% contingency and a discount rate of 8%.

While a project in the Severn cannot compete with the cheapest renewable developments on cost terms, delivering 15% of UK energy from renewable sources and our climate change targets, will require more expensive technologies and projects to be considered. Our analysis shows that the costs of the cheapest Severn tidal power projects are similar to the
estimated costs of supplying the final couple of percentage points to deliver 15% renewable energy by 2020. This means that a Severn project could potentially reduce the cost of meeting our renewables target.

There are still a number of uncertainties regarding the cost and potential supply of alternative renewables as well as the cost of the Severn tidal power schemes. For example, concerns about the indirect effects of biofuels might mean that the 10% renewable transport target could not be met sustainably across the EU. The European Commission will review the 10% target in 2014 and, if necessary, will put forward alternative proposals.

However, such comparative cost estimates do suggest that the potential of Severn tidal energy is worth investigating further.

Figure 2: Photo of the Welsh shore of the Severn Estuary, Newport Wetlands looking South (Gary Shanahan)
2: The Feasibility Study

Summary:

- The Sustainable Development Commission’s (SDC) 2007 report ‘Turning the Tide, Tidal Power in the UK’, was broadly favourable to a Severn barrage, but flagged the damaging environmental impact of any Estuary construction.

- Government launched a feasibility study in January 2008 to assess the costs, benefits and impacts of a project to generate power from the tidal range of the Severn Estuary.

- As part of the study, a Strategic Environmental Assessment is being undertaken to obtain a detailed understanding of the potential effects of a tidal power project on the human and natural environment.

- A wide range of organisations and individuals are contributing their expertise to the study by means of consultancies, statutory agencies, steering and working groups and independent peer review.

- The next phase of the study will include detailed technical, commercial and environmental work.

- Ten proposals for tidal power projects in the Severn came forward from a public call for proposals and a strategic review of schemes in the SDC study.

- We estimate that a 3-5 year phase of planning and detailed feasibility would be needed if a scheme does go ahead, and 5-7 years of construction depending on the scheme. This means that the smaller schemes could be operating in 2018, if approved.

2.1 The Potential of the Severn Estuary

The “Turning the Tide” report\(^\text{14}\) by the Sustainable Development Commission (SDC), published in October 2007, considered the potential for tidal power in the UK. It looked across the UK at both the tidal stream and tidal range resources and means to capture it. Table 2 shows viable tidal range and tidal stream sites in the UK and Channel Islands and gives an indication of the resource available as estimated by the SDC.

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\(^{14}\) As reference 1, http://www.sd-commission.org.uk/publications.php?id=607
### Table 2: Tidal Potential in the UK (adapted from SDC’s report: “Turning the Tide”, p.22)

<table>
<thead>
<tr>
<th>Tidal Range Sites</th>
<th>Tidal Stream Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Name</td>
<td>Resource (TWh/year)</td>
</tr>
<tr>
<td>Severn</td>
<td>17</td>
</tr>
<tr>
<td>Mersey</td>
<td>1.4</td>
</tr>
<tr>
<td>Duddon</td>
<td>0.212</td>
</tr>
<tr>
<td>Wyre</td>
<td>0.131</td>
</tr>
<tr>
<td>Conwy</td>
<td>0.06</td>
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<td></td>
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</tbody>
</table>

61 The box below explains these technologies.

**Tidal Stream:**

Tidal stream energy uses the kinetic energy from the motion of the water of naturally occurring tidal currents. This is usually through a group or farm of independent units that capture the local energy passing by in the current. The majority of the UK’s tidal stream resource is generally found in constrained channels such as those in the north of Scotland (in and around the Pentland Firth).

Tidal stream technology is in the early stages of development with a number of prototypes coming forward with the potential to be funded under the **Marine Renewables Deployment Fund** (MRDF). The MRDF was set up by the Department for Trade and Industry in 2004, providing £50m of funding to support the continued development of the marine renewable sector. It has four components, the Wave and Tidal-stream Energy Demonstration Scheme, environmental research, related research and infrastructure support. The former provides capital grants and revenue support to multi-device early stage commercial generation facilities using technologies that have completed their research and development and are ready to move into a commercial environment.
Tidal Range:

Tidal range is the vertical difference between the high tide and the low tide. Tidal range technologies make use of this height difference to generate electricity by creating a differential in the water levels either side of a structure and then passing this water through turbines. There are two main tidal range technologies – barrages and lagoons. Barrages work by building a wall or ‘barrage’ across an estuary, effectively converting it into a hydroelectric dam. This is achieved by placing a number of large concrete caissons (blocks) across the estuary, some of which would house conventional hydro-electric turbines and others sluice gates.

Electricity is generated by allowing the incoming tide to pass through sluices in the barrage. This body of water is then held as the tide ebbs. When the water level on the seaward side of the barrage is low enough the water behind the barrage is released back to the seaward side through the turbines, generating electricity. Lagoons work on similar principles but impound areas of water rather than having a barrier across an estuary.

The majority of the UK’s tidal range resource is located in the Severn Estuary, although there are also smaller sources in the Mersey, Solway, Dutton, Wyre and Conwy Estuaries in the West, and the Thames, Humber and Wash in the East.

The SDC report suggests that the vast majority of the UK’s practical tidal range resource (around 90%) is in the Severn Estuary, which could produce more than 5% of the UK’s electricity needs.

The report was broadly favourable to a Severn Barrage from Cardiff (Lavernock Point) to Weston-super-Mare (Brean Down), which it felt could be built within the principles of sustainable development. The SDC set a number of conditions on its support. These were that:

- a Severn barrage should be part of much wider action on climate change
- a scheme must comply with environmental protection legislation and the provision of compensatory habitat is an integral part of any proposal; early work on scientific and legal feasibility of compliance and cost should be a priority
- Government should be willing to own and lead a Severn energy scheme and consider a range of innovative financing mechanisms
- a Cross-Government approach is taken, with open and transparent engagement with key stakeholders
The report did not recommend tidal stream generation for the Estuary due to its early stage of development and the greater potential elsewhere in the UK.

The SDC noted the other potential tidal range sites in the UK, one being the Mersey which could supply 1.4TWh of electricity annually. They considered that other potential tidal schemes could go ahead with more limited Government involvement than in the Severn Estuary.

Given this positive recommendation by the SDC, the Government announced the terms of reference for a two year feasibility study on harnessing the renewable energy from the tidal range in the Severn Estuary in January 2008.

The aim of the feasibility study is to:

- assess, in broad terms, the costs, benefits and impact of a project to generate power from the tidal range of the Severn Estuary including environmental, social, regional, economic and energy market impacts;
- if applicable, identify a single preferred tidal range project (which may be a single technology/location or a combination of these) from the number of options that have been proposed;
- consider what measures the Government could put in place to bring forward a project that fulfils regulatory requirements, and the steps that are necessary to achieve this;
- decide, in the context of the Government’s energy and climate change goals and the alternative options for achieving these, and after public consultation, whether the Government could support a tidal power project in the Severn Estuary and on what terms.

Many different aspects are being considered within the feasibility study. These include:

- strategic environmental assessment and appropriate assessment
- assessment and appraisal of different scheme options
- financing, ownership structure and revenue subsidy mechanism
- impact on energy markets and the national grid
- economic, social and community impacts
- environmental compensation measures.

A wide range of organisations and individuals are contributing their expertise to the study in order to ensure that its evidence and the assessment based upon it are the best possible. For example, the Strategic Environmental Assessment is supported by a steering group.
made up of statutory environmental agencies, environmental non-Governmental organisations, regional bodies, industry representatives, academics and Government departments. Technical work is peer-reviewed by an independent panel of engineering experts. More information on the organisation of the feasibility study is available on the feasibility study’s website15.

70 So far, the feasibility study has focused on the following areas:
- A high-level consideration of policy issues (including energy, economic, social and environmental issues including regulatory requirements)
- Identification of potential options and a technical assessment long-listed proposals
- Definition of scope of the Strategic Environmental Assessment

71 The next phase of work within the feasibility study is considering
- Environmental and social analysis including producing of an Environmental Report
- Further consideration of the feasibility of compensatory measures under the Habitats Directive
- Completion of further studies to gather an evidence base to inform the potential impact of a tidal power scheme on the energy market, electricity network/grid and local environment.
- Full cost-benefit analysis including fit with other Government policies
- The terms on which a preferred option could be supported
- Public consultation during 2010 on whether the Government could support a tidal power project and, if so, the terms on which Government could support it

72 After the feasibility study concludes, detailed technical, commercial and environmental work would be needed to take forward a scheme, and planning and consenting procedures would need to be completed. This is likely to take 3-5 years and, if successful, would be followed by 5-7 years of construction.

73 The feasibility study is being carried out by a cross-Government team led by the Department of Energy and Climate Change, including representatives of the Welsh Assembly Government and the South West Regional Development Agency, taking external advice as necessary and engaging stakeholders and the wider public.

15 http://www.decc.gov.uk/severntidalpower/
The feasibility study team reports to the Secretary of State for Energy and Climate Change supported by ministers from the Department for Communities and Local Government, the Department for Environment, Food and Rural Affairs, the Department for Transport, Her Majesty’s Treasury, the Department for Business, Enterprise and Regulatory Reform, the Wales Office, the Welsh Assembly Government and the Minister for the South West.

The Government has chosen to look at the feasibility of a tidal power generation scheme in the Severn Estuary so that benefits, costs, impacts and risk can be assessed based on up-to-date, high-level evidence. This consultation paper discusses these issues and proposes a short list of Severn tidal power options for further study. It does not cover whether or not the Government should support a project in the Severn. That decision will be made at the end of the feasibility study, after a second public consultation, probably in 2010.

### 2.2 Proposed Schemes

A consortium led by Parsons Brinckerhoff (PB) was appointed in April 2008 to undertake a Strategic Environmental Assessment and related engineering studies, including a technical assessment of the potential options for capturing the energy of the Severn Estuary.

In order to gather information on both proposals and impacts, the existing evidence base was reviewed and a Call for Evidence and Proposals was issued on 12 May 2008 which invited interested parties to submit evidence-based proposals which generate electricity from the tidal range of the Severn Estuary and other information that may be relevant in considering tidal range proposals and their potential benefits and impacts.

From these submissions a long-list of ten proposals was announced. The projects vary greatly in scale, cost, complexity and ease of delivery.

Details of each of the schemes and their locations are shown below.

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Figure 3: Map of the Bristol Channel and Severn Estuary showing the long-listed proposals’ locations
### Table 3: Table giving key details of all the long-listed options

<table>
<thead>
<tr>
<th>Map Ref.</th>
<th>Scheme</th>
<th>Generation (MW)</th>
<th>Levelised Energy Cost (£/MWh)</th>
<th>Annual Output (est. by power/area) (TWh/year)</th>
<th>Construction Cost (ex. optimism bias but including a range of compensatory habitat (1:1 – 3:1) (£bn))</th>
<th>Annual Carbon Dioxide Savings (Mt CO₂)</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Outer Barrage: Minehead to Aberthaw</td>
<td>14,800</td>
<td>131</td>
<td>25.3</td>
<td>31.0-34.7</td>
<td>10.9</td>
<td>Largest barrage due to its downstream location and would make maximum use of the Severn Estuary tidal resource. Stretches over 25km.</td>
</tr>
<tr>
<td>B2</td>
<td>Hinkley Point to Lavernock Point Barrage</td>
<td>9,000</td>
<td>140</td>
<td>19.32</td>
<td>23.5-26.9</td>
<td>8.3</td>
<td>As Cardiff-Weston but lands at Hinkley Point, generating slightly more power, but at substantially higher cost.</td>
</tr>
<tr>
<td>B3</td>
<td>Cardiff-Weston Barrage</td>
<td>8,640</td>
<td>127</td>
<td>16.8</td>
<td>19.6-22.2</td>
<td>7.2</td>
<td>Barrage from point west of Cardiff to southwest of Weston-super-mare – hence ‘Cardiff-Weston’, most well-studied option. Approximately 16km long.</td>
</tr>
<tr>
<td>B4</td>
<td>Shoots Barrage</td>
<td>1,050</td>
<td>104</td>
<td>2.77</td>
<td>2.9-3.5</td>
<td>1.2</td>
<td>Also known as English Stones scheme and studied in detail by the Sustainable Development Commission. This barrage would run just south of the Severn road crossings.</td>
</tr>
<tr>
<td>B5</td>
<td>Beachley Barrage</td>
<td>625</td>
<td>137</td>
<td>1.67</td>
<td>2.1-2.5</td>
<td>0.7</td>
<td>Barrage further upstream, north of the road crossings, with a smaller generating capacity than Shoots – suggested as a strategic option by the PB consortium.</td>
</tr>
<tr>
<td>L2</td>
<td>Welsh Grounds Lagoon (Fleming)</td>
<td>1,360</td>
<td>183</td>
<td>2.31</td>
<td>4.1-4.9</td>
<td>1.0</td>
<td>One of the previously studied Russell lagoons in the 1980s using a novel form of wall construction – proposal by Fleming Energy.</td>
</tr>
<tr>
<td>L3</td>
<td>Bridgwater Bay</td>
<td>1,360</td>
<td>142</td>
<td>2.64</td>
<td>3.4-4.1</td>
<td>1.1</td>
<td>A lagoon in Bridgwater Bay, which could potentially be used in combination with Cardiff-Weston.</td>
</tr>
<tr>
<td>L3</td>
<td>Other Land Connected Lagoons</td>
<td>760-1360</td>
<td>165-216</td>
<td>1.41-2.6</td>
<td>2.7-3.8</td>
<td>0.6-1.1</td>
<td>A variety of land connected lagoons at different locations. All either smaller scale, or with a higher cost of energy, than Bridgwater Bay and Fleming Lagoons.</td>
</tr>
<tr>
<td>L3e</td>
<td>Offshore Lagoons</td>
<td>760-1,360</td>
<td>269-317</td>
<td>0.27-2.45</td>
<td>3.5-5.8</td>
<td>0.6-1.1</td>
<td>Lagoons located completely offshore, potentially less environmentally damaging, but high cost of energy.</td>
</tr>
<tr>
<td>Map Ref.</td>
<td>Scheme</td>
<td>Generation (MW)</td>
<td>Levelised Energy Cost (£/MWh)</td>
<td>Annual Output (est. by power/area) (TWh/year)</td>
<td>Construction Cost (ex. optimism bias but including a range of compensatory habitat (1:1 – 3:1) (£bn))</td>
<td>Annual Carbon Dioxide Savings (Mt CO₂)</td>
<td>Summary</td>
</tr>
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<td>---------</td>
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<td>----------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>F1b</td>
<td>Tidal Fence – Minehead to Aberthaw</td>
<td>1,280</td>
<td>279</td>
<td>3.3</td>
<td>6.5-6.9</td>
<td>1.4</td>
<td>A barrier constructed either over part of the Cardiff-Weston line or Outer barrage, with open sections, incorporating tidal stream turbines at an unprecedented scale to capture energy from the ebb and flood tides.</td>
</tr>
<tr>
<td>R1</td>
<td>Tidal Reef – Minehead to Aberthaw</td>
<td>5,000</td>
<td>248</td>
<td>13</td>
<td>18.7-19.8</td>
<td>5.6</td>
<td>Innovative concept that could include floating or fixed turbines and caissons, operating on a very low constant depth. Given concept stage it is difficult to accurately forecast costs, energy yields and when the concept will be sufficiently developed for piloting and deployment at the scale proposed.</td>
</tr>
<tr>
<td>U1</td>
<td>Severn Lakes</td>
<td>--</td>
<td>--</td>
<td>15</td>
<td>--</td>
<td>--</td>
<td>A 1 km wide causeway as an addition to the Cardiff-Weston scheme, designed to allow the construction of a number of additional features, including a wave farm on the seaward side and four marinas. (Variant of Cardiff-Weston – not explicitly considered within the Assessment Framework as the Interim Options Analysis Report indicates it is not feasible solely as an energy project).</td>
</tr>
</tbody>
</table>
2.3 Levelised Costs

We have estimated construction costs assuming a 2:1 compensatory habitat ratio and included a sensitivity threshold using 1:1-3:1 given uncertainties on the actual ratio that would be used. A 15% contingency has been incorporated into the construction costs of the schemes produced by Parsons Brinkerhoff. These have not been adjusted for risk or optimism bias at this early stage given the construction costs have been produced using a fair basis assessment. HM Treasury guidance suggests that as a result of Optimism Bias the most likely actual outturn costs may be over 50% higher than estimates. Prior to the study’s conclusion, further work on the costs and risks will be undertaken in order to reduce the estimated magnitude of this optimism bias through effective risk identification and mitigation so it can be applied to costs with confidence.

In calculating the levelised cost of the schemes, we have used an 8% discount rate which reflects a possible Weighted Average Cost of Capital (WACC) that could finance the project, as estimated as part of the financing work undertaken by PricewaterhouseCoopers (PwC). This cost of capital has been estimated assuming no risk exposure – particularly for electricity price risk as the output is assumed to receive a fixed guaranteed price for each unit produced). The Partial Impact Assessment (Annex 6) presents sensitivities using different WACCs, which may be more appropriate for

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Severn Tidal Power Consultation

a project that receives a variable price revenue stream. These costs have been estimated over the expected period of financing for the Severn Tidal Power projects, which PwC have assumed to be 35 years.

82 Unlike other forms of generation, the schemes will last significantly longer than the financing period. Therefore the levelised costs have been adjusted to account for the value of the scheme at the end of the financing period. This value has been estimated (in line with HM Treasury’s Green Book) as the discounted\(^{20}\) future annual profits (estimated as revenues minus operational and maintenance costs).

83 An alternative would be applying a Green Book discount rate of 3.5% to all costs and revenue streams throughout the life of the scheme – reflecting the fact that the public sector has access to a lower cost of capital. However, the cost of capital should reflect the risks associated with any project. The PwC report concludes that risk is generally managed better within the private sector and the existence of private finance generally strengthens this risk transfer so we have not used social discount rates in the study.

84 No adjustment has been made for potential decommissioning costs. Due to discounting (even at Green book rates), any adjustment will have a minimal impact on the estimated levelised costs.

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\(^{20}\) Discounting is the adjustment of costs and benefits to reflect that businesses and society value present over future consumption. For a further discussion on discount rates, http://www.hm-treasury.gov.uk/data_greenbook_index.htm
3: Issues

Summary

- The Sustainable Development Commission’s report, although supporting a sustainable Severn Barrage (Cardiff-Weston), acknowledged a number of issues that would have to be addressed before a Severn project could be built, including an open and transparent assessment of pros and cons, compliance with environmental protection legislation and Government ownership of a scheme given its high costs and long operational lifetime.

- A Severn tidal power scheme would produce relatively expensive electricity compared with the current costs of other renewable and non-renewable options – particularly during the financing period where capital costs are recouped. The lifetime of the barrage proposals has been estimated at 120 years and this varies for other proposals.

- Due to the potential large scale impact of a tidal scheme on the Estuary’s natural environment, its protected habitats and its species, further work is underway to investigate compliance with legislative requirements under the Water Framework, Birds and Habitats Directives.

- A scheme would have positive regional economic and employment benefits, whilst additional impacts may also accrue within the UK and internationally. A larger scheme is centrally estimated to bring a net annual average of 1,500 additional jobs during a construction period of up to 10 years; a smaller scheme would be closer to 500 jobs annually over 5 years. Operation of a scheme would create additional jobs both directly and indirectly, estimated to be up to an annual average of 200 for a large scheme and up to 50 for a small one. These figures are net of estimated negative impacts on, for example, employment in ports and fisheries in the Estuary and surrounding area.

- Government intervention would be necessary to promote a scheme, placing costs on consumers and/or taxpayers. All schemes would require Government support through planning and possibly construction due to the sheer scale of capital costs and impacts. As for most renewable energy generation, consumer-funded revenue support would be needed to make a Severn tidal power scheme commercially viable.

3.1 Benefits

A Severn tidal power (STP) scheme would provide long term access to a renewable, indigenous energy resource. There are several scheme proposals for a barrage on different alignments, each generating different amounts of electricity. Other technology options include tidal lagoons which selectively retain a pool of water and work similarly to a hydroelectric plant or barrage, but without traversing the Estuary and more embryonic technologies like tidal stream and tidal reefs. For a further understanding
of tidal stream, please see the box in Chapter 2 above. The tidal reef is an innovative, embryonic concept of floating or variable pitch turbines that maintain a constant depth underwater. Barrage technologies are estimated to have lifespans of over 100 years, far in excess of most other power generation technologies. Capital costs are high but so is the energy output. The lifetime of other technologies is less certain, but is likely to be in excess of 40 years.

The largest option being studied could contribute up to one-fifth of the electricity share of the UK’s renewable energy targets and save up to 11 MtCO₂ annually.

All of the schemes could help to reduce UK dependency on imports of gas and protect against the risk of rising gas/fossil fuel prices.

We estimate that construction of a Severn tidal power scheme would bring 3,100 (Beachley Barrage) to 20,000 (Minehead-Aberthaw Barrage) gross annual average construction sector jobs over 5 to 10 years of construction. Additional jobs would be created in hospitality and catering to support the needs of construction workers. Permanent operation, maintenance and services jobs would be created in addition to those associated with tourism and ancillary development opportunities. Some of these employment benefits would be realised outside of the UK. Employment impacts in the South West of England and Wales are discussed in Chapter 3.4.

3.2 Environmental and Social Impact

**PROTECTED HABITATS AND SPECIES**

The Severn Estuary is of international, European and national nature conservation significance – acknowledged by the range of statutory nature conservation designations which it has achieved. It is designated as a *Special Protection Area* (SPA) under the Birds Directive and has recently been formally adopted as a Site of Community Importance (SCI) by the European Commission, one stage away from being declared a Special Area of Conservation (SAC) under the Habitats Directive although in practical terms these have equal protection. The Severn is classified as a Ramsar Wetland of International Importance (named after the 1972 Ramsar Convention) and also comprises a series of *Sites of Special Scientific Interest* (SSSIs), designated at a national level. The Rivers Wye, Tywi and Usk, which flow into the Severn Estuary, are also designated as SACs. These rivers provide important spawning habitats for species of migratory fish, including Atlantic salmon, which pass through the Severn Estuary on the way to these spawning grounds.

The map below highlights the different areas of the Estuary which are protected under environmental legislation.
A Severn tidal power scheme would impact significantly on designated nature conservation sites both upstream and downstream of any proposed Severn tidal power scheme. Impacts may be felt as far away as the north coast of Devon and Pembrokeshire.

**FISH**

The passage and survival of migratory fish would be severely affected, particularly by barrage options which block the Estuary and thereby reduce fish access to rivers. The Estuary and its tributary rivers could suffer severe declines of some species such as Atlantic salmon or even a complete loss in the case of Twaite Shad, a species with a particularly restricted distribution within the UK. It is unlikely that the effects on fish will be able to be fully mitigated; although such measures will be further examined in Phase 2. The European eel regulation, namely Council Regulation (EC) No 1100/2007, establishes measures for the recovery of stocks of the European eel. Government needs to ensure current eel stocks in the Severn Estuary return to a safe biological limit. Introduction of a tidal power project could hinder eel stocks in the Severn Estuary returning to a safe biological limit.

**BIRDS**

Substantial wintering water bird populations could be displaced by the loss of intertidal habitat on which they depend for food. Some intertidal
habitats that may be affected are of greater importance for bird feeding than others. Birds’ responses are likely to vary between species and depend on the extent and character of alternative habitat available within the Severn Estuary and beyond. There could be reductions in the local wintering populations within the Severn which could lead to a decline in the overall bird populations. Further investigation and prediction of the changes in the short and long term carrying capacity of the Estuary will be essential to understand the effects on birdlife.

**GEOMORPHOLOGY**

94 Geomorphology refers to the study of the characteristics and configuration and evolution of estuarine land forms and siltation. Removing energy from the water flows would cause fundamental changes to the structure of the Estuary and the deposit of sediment in this highly dynamic environment. Experts currently disagree on the effects of this process – there are two schools of thought and further studies are being done to investigate these issues. On one hand, sediment could be deposited and accrete in the intertidal zone and build up beneficial intertidal habitat or grassland. On the other, erosion might increase, with further loss of intertidal habitat, and at the shore, flood defences being squeezed. The sediment contained within the waters, and where it might be deposited, are also key areas for investigation including whether it could build up in lagoons and behind the smaller, upstream barrages (such as Shoots and Beachley).

**WATER QUALITY**

95 Potential impacts on water quality of the Estuary are uncertain at this stage. Many water quality effects arise as a result of changes in the tidal regime with associated changes in water flows, sediment transport and estuary flushing characteristics. A tidal barrage or lagoon is likely to lead to a reduction in suspended solids in the Estuary, which will increase water clarity. Further work undertaken in the feasibility study will consider the likely impact on water quality of the short-listed options. This work will be informed by the more detailed work to assess the hydrodynamic changes to the Estuary.

**FLOOD RISKS AND BENEFITS**

96 It is expected that some proposed schemes would offer some protection to the area behind them against storm surge flooding from the sea. It is unlikely that any scheme would significantly affect fluvial upstream flooding caused by rain, such as the major floods that hit Tewkesbury in 2007. However, further investigation is needed to understand flood impacts more fully as overall impacts are still uncertain, for example on groundwater levels and water quality.
CLIMATE CHANGE CONSIDERATIONS

97 Large schemes in particular could considerably reduce carbon dioxide emissions from energy supply, helping avoid dangerous climate change. Climate change is already affecting the environment of the Severn Estuary. Rising sea levels and increased storminess will result in coastal squeeze and some loss of intertidal habitats, with significant implications for flood risk management. These impacts have been quantified in Coastal Habitat Management Plans\(^{21}\) and Government policy is that they should be compensated for as part of future coastal flood management.

98 Climate change will affect the number and species of birds wintering in the Severn Estuary. Numbers of some wading birds, such as dunlin, using the Estuary have reduced in recent years due to warmer winters, although there have been increases in some other species.\(^{22}\)

99 The relatively new concept of carbon footprinting will be used to assess changes in greenhouse gas emissions as a result of the construction and operation of a Severn tidal power scheme, balanced against the emissions savings it would deliver. On a narrow assessment, the SDC estimated that construction impacts would be compensated for within roughly 8 months of operation of a Cardiff-Weston barrage.\(^{23}\)

OTHER SEA USERS

100 The Severn Estuary and Bristol Channel and immediate surroundings are used for a wide range of activities, both commercial and leisure based. These include marine aggregate extraction, marine waste disposal, commercial fisheries, military activity, existing energy production (including nuclear, coal and gas fired power stations) tourism and recreation. Impacts may arise on all of these existing uses from any tidal power option being taken forward within the Severn Estuary – these will be examined further during Stage 2.

FRESHWATER ENVIRONMENT AND ASSOCIATED INTERFACES

101 This topic deals with potential impacts on ground water resources, some of which are used as public drinking water supplies for communities around the Estuary linked to underlying geology. It is recognised that it will be necessary to take into account existing structures, including the Severn tunnel railway connection, in further consideration of this subject area.

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\(^{21}\) http://www.severnestuary.net/sep/pdfs/ecsaa/14nfrost.pdf
\(^{23}\) Sustainable Development Commission (2007), p.83
NOISE AND VIBRATION

102 Potential negative effects arising from noise and vibration on local populations are considered to be of most significance during any construction phase, which could last between 5 and 10 years, with an operational phase then anticipated to extend upwards of 120 years. Noise and vibration impacts are also recognised as being of potential significance to wildlife, including on the marine environment and migratory fish. There is the potential for noise impacts to be partially mitigated to the extent that noise and vibration are not expected to be a significant constraint on taking forward any of the proposed options.

WASTE AND RESOURCES

103 Construction of any tidal power scheme will use significant resources and require waste disposal facilities. Availability (capacity) and suitability of existing local waste disposal facilities will be further assessed during the course of the feasibility study. Aggregates and concrete will be required in significant quantities for any tidal power option – assessment as to whether these, and other resources, could be acquired locally will be undertaken alongside consideration of the use of secondary (recycled) aggregate.

WIDER IMPACTS ON HABITATS AND SPECIES

104 A tidal scheme would affect habitats and species outside the Estuary, including other protected sites at some distance from the area. The Severn Estuary is important for a number of mobile and migratory species, including fish and birds. In addition, alterations in tidal flows, tidal range and sedimentation patterns could have indirect impacts on habitats and species adjacent to the Severn Estuary or within/adjacent to the Bristol Channel. The impact on all these protected sites is being assessed. A number of UK Biodiversity Action Plan (BAP) habitats and species are also present within the study area and could be adversely affected by any tidal power scheme – impacts on these habitats and species will also be assessed.
The UK Biodiversity Action Plan is the UK government’s response to the Convention on Biological Diversity, signed in 1992. Action plans have been written for a range of important wildlife habitats, wild plants and animal species which are of conservation concern within the UK – actions are the responsibility of a wide variety of organisations, including government agencies and non-governmental organisations.

Many Local Authorities have written and are implementing their own local Biodiversity Action Plan to form their contribution to UK wide action but also to support action on habitats and species of more local concern which are not identified within the UK wide action plans. Biodiversity Action Groups have been set up locally to review progress and to ensure that actions are undertaken.

3.3 Environmental Protection Legislation

The implementation of the Habitats and Birds Directives applies to the designated habitats and species in and around the Estuary, including the Rivers Usk and Wye, which are tributaries of the Severn. Other relevant legislation, which provides protection to wildlife habitats and species, includes the Water Framework Directive, Water Resources Act, the Wildlife and Countryside Act 1981 (as amended), the Countryside and Rights of Way Act 2000 and the Natural Environment and Rural Communities Act 2006. Other environmental legislation is also of relevance to the feasibility study, including the Bathing Waters Directive (2006/7/EC), the Shellfish Waters Directive (2006/113/EC), Regulation on the European Eel (1100/2007/EC), the Urban Waste Water Treatment Directive (91/271/EEC), the Environmental Liability Directive (2004/35/EC) and the Dangerous Substances Directive (76/464/EEC). The feasibility study will consider the effects of this legislation on potential Severn tidal power projects over the next year.

THE HABITATS DIRECTIVE

The Habitats Directive and supporting Commission guidance require a sequential approach to be applied to developments affecting European Sites in the following order:

- screen for likely significant effects on a European Site.
- fully assess implications of a scheme if likely significant effects cannot be ruled out.
- take measures to avoid or mitigate any adverse effects.
- If adverse effects cannot be eliminated, determine whether there are alternative solutions that avoid adverse effects.
● if there are no alternative solutions, determine whether a scheme is necessary for imperative reasons of over-riding public interest.

● if there are shown to be such reasons, take any necessary compensatory measures to protect the coherence of the Natura 2000 network of European protected sites.

A development in the Severn Estuary would be required to demonstrate that it had passed the various tests required to ensure compliance with the relevant legislation and to ensure that the objectives of the legislation are met.

In accordance with the Habitats Directive and Regulations, a strategic level Habitats Regulations Assessment will be undertaken to assess the potential impact of carrying out any of the tidal power options within the Severn Estuary on any site designated as a Special Protection Area or Special Area of Conservation (Annex 5). In accordance with government policy this process will also be extended to cover Wetlands of International Importance (Ramsar Sites).

A preliminary screening report has been prepared as the first step in the Habitats Regulations Process and is published alongside this consultation. This stage requires the identification of all designated sites which could be potentially adversely affected. Consideration is then given as to whether there is likely to be a significant effect on any of the designated features of these sites from carrying out a tidal power scheme. If there is unlikely to be any significant effect, either alone or in combination with other projects, then the sites are screened out of the analysis. Over 20 sites have come through this initial test and will receive further consideration in the next stage of the feasibility study.

A high-level study was undertaken on the feasibility of a range of compensation and mitigation measures that might be used to address adverse effects. This is published as ‘A Preliminary Review of Possible Mitigation and Compensation Requirements under the Habitats Directive.’

Under Habitats Directive legislation, a development scheme can proceed in certain circumstances even if it is expected to damage protected sites. These circumstances are that the scheme is necessary for imperative reasons of overriding public interest (IROPI) and that there are no alternative solutions to achieve the plan objectives. In this case, compensatory measures must be provided. The Habitats Directive requires that these measures are designed to secure the coherence of the Natura 2000 network (see box). The preliminary study was unable to conclude whether it would be possible to deliver compensation on the scale required and to maintain coherence. The sheer scale and deliverability of compensatory habitat would be a significant challenge. Furthermore, it might not be possible to
directly compensate for all impacts in a like-for-like manner; for example migratory fish species including Atlantic salmon and Twaite Shad. These are likely to be adversely affected by many of the tidal power options – the creation of alternative, potentially suitable habitat for them in other river systems in the UK does not guarantee that these species will use them. These issues will be considered in more depth over the next year.

Natura 2000 is a coherent, European wide ecological network of protected sites recognised as supporting the most important wildlife habitats and species of animals and plants in Europe.

Each country within the European Union has the responsibility to designate sites as Special Areas of Conservation under the Habitats Directive, for sites supporting specific habitats and/or species, and Special Protection Areas under the Birds Directive, for sites with priority bird species. So far the network consists of over 26,000 protected areas across Europe. The European-wide nature of the network aims to ensure sufficient areas of each important natural habitat are protected to enable the conservation of the full range of species associated with that habitat. Furthermore, different environmental sites in the network work together to support migratory and mobile species.

Together these sites are charged with the long-term conservation of the specific features for which they have been designated, and form Europe's biggest contribution towards the aim of halting and reversing global biodiversity loss. The conservation status of each site within the network has to be maintained and improved and environmental quality has to be monitored.

WATER FRAMEWORK DIRECTIVE

The Water Framework Directive (WFD) (2000/60/EC) establishes a framework for the protection of surface waters (e.g. rivers, lakes, estuaries and coastal waters) and groundwaters. Its purpose is to prevent further deterioration and improve the status of aquatic ecosystems (with the aim of achieving good status by 2015), promote sustainable water use, reduce pollution of groundwater and contribute to mitigating the effects of floods and droughts. The Severn and its tributaries are likely to be regarded as heavily modified water bodies because their use has resulted in substantial change to their physical characteristics. As such, it is acknowledged that ‘good’ status is not an achievable aim for these water bodies and the WFD therefore sets an objective of good ecological potential.

The status of surface waters is defined, in WFD terms, according to the condition of a number of biological, chemical and physico-chemical components. The physical and hydrological characteristics of the Severn
Estuary must be able to support the biology that is present. This includes consideration of depth variations, the structure and condition of the intertidal zones, flow, currents and wave exposure.

It is possible that a Severn tidal power scheme would change the condition of many of the components that define the status of the transitional and coastal water bodies in the river basin, and may alter some of the freshwaters too. The scale of the impact may mean that the WFD’s objectives cannot be met in some of the water bodies. However, this does not necessarily mean that it is impossible to comply with the Directive.

If the objectives of the WFD cannot be met article 4(7) of the Directive may apply. Article 4(7) provides that a Member State shall not be in breach of the Directive where failure to achieve good groundwater status, good ecological status or potential or to prevent deterioration in the status of a body of surface water is the result of new modifications to the physical characteristics of a surface water body and the following conditions are met:

(a) all practical steps are taken to mitigate the adverse effect on the status of the body of water;

(b) the reasons are explained in the River Basin Management Plans

(c) the reasons are of overriding public interest and/or the benefits to the environment and to society of achieving the objectives are outweighed by the new modifications to sustainable development; and

(d) the beneficial objectives cannot, for reasons of technical feasibility or disproportionate cost be achieved by other means which are a significantly better environmental option

If the conditions in article 4(7) are complied with, then a scheme could proceed without breaching the WFD. Unlike the Habitats Directive, the option of compensatory measures is not available under the Water Framework Directive and the measures available to mitigate the impact will be critical to determining whether an exemption can be applied under article 4(7).

More work is needed to assess whether a scheme could comply with environmental protection legislation and be consistent with UK sustainability policies more widely. Further studies are underway.

3.4 Regional Economic Impacts Study

A study of regional economic impacts was commissioned from DTZ and is published at Annex 7. The study showed both positive and negative
economic and employment impacts of a Severn tidal power project on the regional economies of Wales and the South West of England.

Overall, schemes are expected to deliver a net quantitative benefit to Wales and the South West of England. The small barrages are estimated to have a net benefit of £620 million additional Gross Value Added\textsuperscript{24} (with a range of £100 million-£1.6 billion). A barrage on the scale of Cardiff-Weston would have a net benefit of £3.55 billion additional Gross Value Added (with a range of £0.4 billion-£9.9 billion). These estimates reflect the overall benefits brought by a scheme and have been adjusted to take into account expected losses as well as gains.

There are a large number of construction and support jobs associated with all the schemes over their construction periods. For Cardiff-Weston barrage there is an estimated gross annual average of 18,000 jobs over a 7-year period. However, the gross figure needs adjustment to reflect the fact that economic activity would be displaced in other areas and some employment opportunities would be realised outside of the region. After accounting for these factors it is estimated that an annual average of 3,400 additional construction and associated services jobs would be created in Wales and the South West of England (with a range of 1,600 to 15,700). For a smaller scheme like the Fleming lagoon on Welsh Grounds, it is estimated that 4,500 gross annual average jobs over a 5-year period would be created, of which the net additional figure for Wales and the South West is 1,000 (with a range of 400 to 4,400).

Operation of a scheme would create permanent jobs directly linked with it; in the area of Wales and the South West of England, these are estimated at up to 1,000 direct and indirect additional permanent jobs (with a range of 500 to 1,500) for a large barrage and up to 270 (with a range of 130 to 400) for lagoon options. Further additional employment opportunities may arise as a result of tourism and ancillary investment. It is likely that a scheme would draw additional visitors into the region and more benign water conditions associated with it could increase the prospect for water recreation.

There would however be some losses in some industries – in particular ports and commercial fisheries. In aggregate, the seven main ports in the Severn Estuary at Bristol, Cardiff, Newport, Sharpness, Swansea, Barry and Port Talbot handle around 5% of all ports cargo in Great Britain. Bristol is the busiest port and supports around 3,000 and 1,600 direct and indirect jobs respectively. A barrage could contain locks (other schemes do not block the Estuary entirely), but for upstream ports a scheme is likely to add extra time and costs to operation. The scale of negative impacts depends on the location and scale of the project. For example, a large barrage, such as Cardiff-Weston, would require vessels to pass through additional locks compared to a barrage located further upstream; the loss of port-

\textsuperscript{24} All Gross Value Added impacts expressed as present values, using 3.5\% social discount rate (2008 prices)
associated jobs could rise to a total of 3,300 (2,200 to 4,400) over the construction period; meaning that in a typical construction year, for a large barrage, port-associated employment could be 1,800 (1,200 to 2,400) lower than it would otherwise have been. For lagoons and smaller barrages located further upstream, it is estimated that the losses would be much smaller ranging from an annual average of zero to 550. During operation, these port-associated job losses are forecast to be mitigated over time through the redeployment of port assets; over a 30-year operational period employment in the average year is forecast to be 600 (400 to 1500) lower than it would otherwise have been for a large barrage and 40 (0 to 170) lower for a smaller scheme. These losses have been incorporated into the calculation of a scheme’s overall impact on Gross Value Added.

Likewise for fishing, there could be up to 80 job losses resulting from all schemes irrespective of size.

Putting all of this together, the overall economic impact of a Severn tidal power scheme on the local economy and employment is expected to be positive. A larger scheme is centrally estimated to bring an annual average of 1,500 (-900 to +14,500) additional jobs during a construction period of up to 10 years; a smaller scheme would be closer to 500 (-100 to +3,200) jobs annually over 5 years. Operation of a scheme would create additional jobs both directly and indirectly, centrally estimated to be up to an annual average of 200 (-1,200 to +900) for a large scheme and up to 50 (-200 to +200) annually for a small one. These figures are net of estimated negative impacts on, for example, employment in ports and fisheries in the Estuary and surrounding area.

A barrage across the Severn Estuary could carry a new road or rail link. Such a link would be expensive as it would need to be elevated to provide adequate clearance for vessels to pass through locks. Such a development would not necessarily be less expensive than a separate construction structure. The feasibility study has commissioned work by Network Rail and the Highways Agency and has found no evidence that the existing road and rail infrastructure is inadequate or unable to meet anticipated traffic for at least the next 15-20 years.

It is possible that new transport links will be needed beyond 2025-30. With this in mind it would be feasible to accommodate suitable foundations either as part of the design of a barrage or subsequently by developing a design that adapted the existing structure for a future transport link. Issues associated with new transport links are not considered further in this consultation, as further specific assessments would need to be undertaken at that time.

25 Severn Barrage Railway Infrastructure, Feasibility Study by Network Rail, August 2008 (http://www.dft.gov.uk/pgr/rail/pi/)
5. Do you agree with the conclusions of the DTZ study and are there any other factors that the feasibility study should be aware of?

3.5 Financing and Ownership

- The private sector is likely to be able to own, finance and take on most, if not all, construction risk for a smaller scheme (i.e. one with a construction cost of <£4bn). For larger schemes, the private sector would not have the capacity to finance or build the scheme without Government sharing some of the risks (and costs) involved.

- The private sector is likely to be able to operate any scheme constructed.

- None of the potential schemes are commercially viable if relying entirely on wholesale power price revenues. Support from taxpayers and/or consumers would be needed in order for them to be commercially viable.

- Government may need to play a more proactive role in the pre-construction phase than is normal for electricity generation projects, in particular for a larger scheme.

- Given the expected timeframes for delivering these projects, the financial analysis has not fully considered the impact of the current financing climate.

Government will base its financing and ownership decisions on the relative value for money of the delivery options, and assessment of their impact on public finances and Government’s spending priorities. PricewaterhouseCoopers (PwC) were commissioned to suggest and analyse a number of potential delivery and ownership structures for the different types of tidal schemes. Chapter 3.5-3.7 is based on this work. A copy of PwC’s report – *Severn Estuary Tidal Power: Financing and Ownership Options* – is attached as Annex 4. Government does not have a preferred delivery/ownership structure for any of the schemes currently but further work in the next year will help determine the appropriate structure. An initial financial impact assessment of each of the shortlisted schemes has also been prepared, and can be found at Annex 6.

The work completed on finance and ownership issues has not fully considered the impact of the current economic climate. Financing assumptions have been based on a capital market with characteristics similar to 2000 – June 2007. Sensitivities have considered a higher cost of capital but have not considered any changes on the availability of capital or appetite for risk.
3.6 Risk Sharing

The identification of significant project risks and who might be best placed to manage them is crucial in deciding the most appropriate financing and ownership structure for a scheme. Risks, deliverability issues and financing issues vary significantly across the schemes.

Due to the significant pre-construction risks (planning and regulatory), particularly surrounding the requirement for compensatory environmental measures, Government might need to take more responsibility, and therefore risk, for the pre-construction phases than is usual for an electricity generation scheme. Compensatory measures could be paid for and delivered by the private sector as part of the cost of a Severn tidal power project, depending on the degree of regulatory risk regarding compliance with environmental protection requirements. However, compensatory arrangements for the larger schemes might have to be partly paid for or underwritten by Government, as the delivery risk for these projects might not be passed to the private sector as effectively.

All the schemes are substantial civil engineering projects and could carry significant construction risks. In general, larger projects have greater construction risks. For a larger scheme, several contracts would have to be let to package the level of risk to sizes that are manageable for construction companies or consortia. Government would still likely have to take on significant risk, for example, for the interaction between different subcontractors, though it may be possible for a private sector “integrator” to absorb some of this. For the smaller schemes, a single contractual package might be achievable if contractors could be brought together, with little Government exposure to cost overruns. Delivery of the compensatory measures package is also a significant construction risk and it may be worthwhile to separate out this delivery into a separate contract.

It may be possible to transfer all operational risks including energy imbalance risks, to the private sector for all schemes. However, fully transferring all the long-term operational risks may not necessarily represent the best value for money to the Government, as the private sector will place a lower value on future revenues. There may be some benefit (in terms of real value for money) in the asset automatically reverting to Government after a specified period. This would mean the asset (and the future benefits) would accrue to Government but would also mean that the long-term risks regarding maintenance and overall costs would also revert back to Government.

Decommissioning risk would probably remain with government for all schemes, due to the length and uncertainty of the life of the asset. However, the private sector could pay for the (expected) cost of decommissioning through an annual charge. It will be important to consider decommissioning
in the feasibility study over the next year, as a high-level decommissioning plan would need to be drawn up prior to the commissioning of any project. This may need to include provisions for future liability, or for a scenario in which the tidal project would need to be decommissioned earlier than expected.

3.7 Delivery Options

Based on analysis of project risk, a short-list of delivery option packages has been determined.

For smaller schemes (such as smaller barrages and lagoons, with a construction cost up to £4bn), these are:

(i) Fully privatised – privately owned and delivered, supported through a fixed-price or variable revenue support mechanism.

(ii) Public Private Partnership – where the private sector would construct, finance, and operate the barrage under contract to Government for a fixed period from the commissioning of the asset. This would be supported through a fixed price revenue support mechanism.

(iii) Regulated Concession – A private operator develops the asset under the oversight of a regulator which is appointed to oversee the price at which the electricity output could be sold. A regulated fixed price revenue support mechanism would be used to support this option.

For larger schemes (such as larger barrages), delivery options are:

(i) Government-financed construction then privatised – Government recoups investment when the asset is privatised post-construction. A revenue support mechanism provided to allow the private sector owner to recoup costs.

(ii) Government-financed construction then franchised – Government recoups its investment when the asset is sold as a franchise post-construction. A revenue support mechanism is provided to allow the private sector owner to recoup costs.

(iii) Government-financed construction then regulated concession – Government recoups its investment when asset privatised as regulated concession post-construction. A fixed-price revenue support mechanism is provided to allow the private sector owner to recoup costs.

(iv) Multiple Public Private Partnerships (PPP) – Government appoints an integrator to deliver the project through a series of linked Public Private Partnership contracts. The PPP contractors would operate the
asset through a contract with Government for a period of 35 years. This would be supported through a fixed price revenue support mechanism.

(i) Regulated asset – A stand-alone regulated Company is created to construct and own the scheme, capitalised by Government and benefiting from a certain amount of Government support (primarily guarantees of debt finance).

Details of the strengths and weaknesses of these ownership structures are set out in the annexed PwC report (Annex 4).

3.8 Subsidy Mechanism

Like most other renewable energy generation, none of the proposals or delivery options is financially feasible when relying purely on revenues from the wholesale electricity market. The Government may wish to pass the subsidy costs from the taxpayer to consumers through a revenue support mechanism in order to align demand for electricity with the actual cost of the generation. Potential mechanisms include:

(i) Market-priced revenue support mechanisms, such as the Renewable Obligation (RO) or a separate ‘Severn Obligation’.

(ii) Fixed-priced support mechanisms, such as a Feed-in-Tariff (FIT), managed Contract for Differences (CfD).

In the UK, the prime means of providing additional support for renewable electricity generation is the Renewables Obligation (RO), which the Government recently announced would be extended until at least 2037.

The RO requires licensed electricity suppliers to source a specific and annually increasing percentage of the electricity they supply from renewable sources. (The current level is 9.1% for 2008/09 rising to 15.4% by 2015/16.) To meet their obligations, suppliers buy Renewable Obligation Certificates (ROCs) from renewable electricity generators – which can be traded – or pay a buy-out price. This market mechanism is intended to offset the relatively higher cost of renewable electricity generation without undue Government intervention in terms of price-setting.

Initial analysis suggests it is unlikely that a large Severn tidal power scheme could be accommodated within an RO scheme. This is due to the volatility it would create in ROC prices as investment in other forms of renewable energy generation may be deterred while the market assesses the impact of such a large scheme. However, smaller projects could potentially be accommodated if the RO were amended in several ways (such as removing the current 1GW limit on generators eligible to receive...
ROCs), some of which are already being considered in respect of the Renewable Energy Strategy (RES). Support for a Severn scheme would be needed during its entire financing period (around 35 years), i.e. beyond the point at which a national RO mechanism will most likely have ended.

In addition to the RO, there are a number of other potential support mechanisms that might be appropriate for a Severn tidal power project. These mechanisms have different implications in terms of their ease of implementation, impact on project financing, and impact and compatibility with the UK electricity market. Potential mechanisms include, but are not limited to:

- Feed-in Tariffs (FITs) provide a guaranteed rate of compensation per kWh to the generators of renewable electricity. Either generating organisations receive all their revenue in the form of a guaranteed payment, or the guaranteed payments are additional payments on top of what generators receive from the sale of their renewable electricity on the wholesale market. This additional payment could potentially fluctuate inversely to the wholesale price, in order to deliver a stable total revenue stream. A FIT is being brought in to support generation of small-scale renewable electricity and being considered for renewable heat also.

- A “Severn Obligation” mechanism could require electricity suppliers to purchase a percentage of their electricity sales from a Severn tidal power project. There are a number of options for how this electricity might be priced at the required premium, including a fixed premium.

- If a project were to become a privatised regulated entity, then its prices could be set and reviewed as part of the regulated entity’s price control.

The key difference between support mechanisms would be the impact they have on the overall cost of capital for the schemes and their impact on the energy market.

The associated cost of capital for a market-priced support mechanism (or a mechanism with long-term price risk) will be higher than that of a fixed-priced mechanism, due to higher revenue uncertainty for market-priced mechanisms. This means that schemes supported through market-based support mechanisms would require a higher expected subsidy level compared to support derived from a fixed-price support mechanism.

However, a revenue support mechanism with short term price risk exposure (e.g. an RO), could encourage the operator(s) to respond to market price signals and optimise electricity delivery to peak power prices as far as possible. Furthermore, utilising existing, understood market design and wholesale trading mechanisms would avoid further segmentation of wholesale power markets. Conversely, using a fixed-price FIT provides
price certainty but removes the incentive for operators to respond to peak power prices.

A regulated (non-fixed) FIT might offer additional Government control over the returns made by the operator, as well as allowing for the design and modification of incentive schemes to encourage cost savings or optimise delivery prices.

6. Do you agree with PwC’s analysis on ownership and delivery of a Severn scheme?

7. Are there any other options for delivery or subsidy that should be considered? Would they be appropriate for all of the tidal power options under consideration?

8. Government believes that the private sector is best placed to design, build and operate a Severn tidal scheme. Government’s role would be to set the conditions in which a scheme could come forward. Do you agree?

3.9 Impact on Electricity Networks

Summary:

- A network impact study considering the detailed aspects of grid connection, including the likely scale and implications of the transmission works, wider transmission network reinforcements and the local connection points, will be undertaken over the next year.

- National Grid investment in new transmission assets would be required for any transmission-connected tidal power generation scheme, with the scale of the transmission works dependent on the size and location of the project selected.

- The balancing of generation and demand by the market and the residual balancing by the system operator will require consideration for the larger schemes.

- Effective demand flexibility may have increasing value in a market with significant levels of intermittent predictable renewable power generation.

A detailed network impact study will need to establish the likely scale and implications of the transmission works associated with the various tidal generation options being considered. Information on the impact on the transmission system already considered within the feasibility study was based on the grid impact assessment of the Cardiff-Weston barrage.
carried out in the 1980s. The use of these dated studies is reasonable at this stage as the scale and cost of the transmission works will generally be proportional to the output (MW) from the generation, and the long-listed projects are to be compared on a like-to-like basis. However, further detailed work is needed as the transmission system, the electricity industry and the market are now fundamentally different. It is therefore necessary to commission technical and engineering studies to identify the potential impact of tidal generation in the Severn Estuary on the transmission system.

This further study will consider all relevant aspects of the grid connection, including the thermal capacity of the network, voltage performance, fault level in-feeds, system stability, and the possible impact on other network users (e.g. Distribution Network Operators and other generators). For large schemes the value of a Direct Current (DC) connection needs to be explored. The study will also review the onshore to offshore connections and indicate the likely preferred connection point(s) for the output.

Any new tidal generation connecting to the transmission system near the Severn Estuary would require National Grid investment in new transmission assets – like many new other low carbon developments. For the smaller tidal generators, these works are likely to include a new transmission voltage substation and a new overhead transmission line connecting the new substation to the existing transmission system. Similar works would also be required for the larger generators, although on a bigger scale. The larger generators would also trigger significant transmission reinforcements away from the Severn Estuary, with the potential for these larger schemes requiring new transmission lines and substations many miles away from the Severn Estuary. The impact on the transmission system could also play a part in the design and type of generators installed, and therefore the energy yield, as well as the generator’s electrical connections and associated systems.

As well as the impact on the physical transmission system of new tidal generation in the Severn Estuary, there would also be effects on the electricity industry. For the smaller projects (<2GW) these are not expected to be significant, and therefore straightforward to accommodate within normal change management processes. For the larger projects, there are likely to be more fundamental issues to consider, such as the economic and efficient balancing of generation and demand by the system operator. This system balancing would be affected significantly by the intermittent nature of the tidal generation with likely massive changes in output as the generation ramps its output up and down twice a day. This type of issue is not expected to halt any potential project altogether, but will require careful consideration if a larger project is to be developed further.
3.10 Dealing with Tidal Intermittency

With increasing levels of intermittent generation including wind and tidal, the electricity market will have to adapt from the current position where generation generally follows demand, to a new world where flexible generation still follows demand but also increasingly follows inflexible generation such as wind and tidal power, which cannot control its fuel source, but which has a relatively low marginal cost of generation.

The biggest issue posed by intermittent generation is that it is not always available. This means that flexible generation (generally thermal) is required as a back-up for the times when tidal and wind generation are not available. This flexible generation used as a back-up comes at a cost – because the flexible plants are only used to fill in the gaps in intermittent generation, the fixed cost of this generation are spread over a smaller output, meaning a higher cost for this conventional generation than would normally be the case.

Estimates of the cost of back-up and balancing for renewable generation are in the region of £10-£20/MWh. Work is planned in the feasibility study to investigate these costs further.

In some instances, there may be a risk that with ever increasing intermittent generation, and low load utilisation rates for thermal generation, there is insufficient flexible generation on the system leading to security of supply risks. However initial analysis by Redpoint et al (2008) suggests that the energy market should be able to adapt to a significant level of intermittent generation, including a potential Cardiff-Weston barrage, in the electricity mix but that there will be costs (associated with back-up capacity and system balancing) to doing so. They suggest the addition of a Cardiff-Weston barrage would not significantly impact on capacity margins, even if this were in addition to a large supply of intermittent wind. Furthermore, since the output of the barrage would be predictable, the costs of system balancing should be less than with an equivalent amount of wind generation.

A second issue with high levels of intermittency is that at times, generation from intermittent renewable and other inflexible capacity will exceed demand, meaning some of this energy will be need to be spilled which may decrease its value. However, analysis from Redpoint estimates that even with a Cardiff-Weston barrage, alongside 40GW of inflexible wind and nuclear generation, the volume of spill could be as low as 1% of the generation from inflexible plant, assuming a high degree of flexibility from thermal generation capacity and use of the electricity interconnector with Europe.
Flexible generation (primarily gas and coal) has been favoured to date to balance generation and demand through the day and, as noted above, is likely to be sufficient to cope with all of the Severn tidal power options, along with other forms of renewable generation. In addition, the feasibility study will be examining whether energy production could be optimised to better align with peak demands by operating on both the ebb and flood tides or by using multiple basins.

Flexible demand could also be effective to support the increased levels of energy balancing that is likely to arise with higher intermittency; if it is economic and sufficient levels could be made available. In this context, flexible demand is new or existing demand that can be directly controlled (or possibly given effective incentives) to switch on and off at a particular time, for example, as the output from a Severn tidal power generator is starting up or shutting down or as wind generation output changes in response to changes in wind speed. The potential for flexible demand may be greater in conjunction with Severn tidal power generation than other forms of renewable generation (such as wind), given the long-term predictability. Interconnection and energy storage could also be used to balance generation and demand as alternatives to flexible generation.

If significant levels of demand could be made more flexible – which would require changes to metering, settlement and billing systems – it could be moved to coordinate with the operation of the intermittent generation and potentially reduce the operation of a flexible CO₂ emitting plant. An intermittent tidal generation scheme is highly predictable and could therefore be much better placed to link to a demand side initiative.

A feature of a standard tidal generation scheme would be the requirement to change its output very quickly from zero to maximum and back to zero twice a day, which would have an impact on the ability of the system operator to balance generation and demand. For a larger scheme, it could be necessary either to place restrictions on the changes in output from the tidal generation, or to rely on other operational tools such as a demand management mechanism. Alternatively, additional flexible generation could ensure generation and demand is balanced during such significant changes in output.

The demand linked to the scheme could be anything that would have a reliable and predictable energy requirement and that was flexible within day in terms of when it needed to be switched on. Examples of such demand could include industrial processes, storage heaters or domestic water heating.
9. What are the impacts and potential risks of tidal intermittency on the balancing and energy market?

10. Is it worth considering exploring the option of demand management?

11. Do you consider that a Severn tidal scheme could impact on investment in other energy supply capacity, and if so in what ways?
Summary

- Ten proposals to generate electricity from the Severn Estuary came forward from a public Call for Proposals and a strategic review of existing options considered in the Sustainable Development Commission report.
- These have been assessed for technical and commercial feasibility against a number of criteria, and the following schemes have been provisionally short-listed for further study:
  - Shoots Barrage (1.05GW scheme located downstream of the new Severn road crossing with an estimated construction cost of £3.2bn)
  - Beachley Barrage (625MW scheme further upstream of the first Severn road bridge with an estimated cost of construction of £2.3bn)
  - Bridgwater Bay lagoon (1.36GW impoundment on the English side of the Estuary with an estimated construction cost of £3.8bn)
  - Fleming Lagoon (1.36GW impoundment on the Welsh bank of the Estuary with an estimated construction cost of £4.0bn)
  - Cardiff-Weston (Lavernock Point to Brean Down) Barrage (8.46GW scheme, commonly known as the ‘Severn Barrage’, with an estimated cost of construction of £20.9bn) being considered for a 2030 timescale.
- Before considering whether to take forward one or more of these schemes, consideration would be given to the prospects for development of a tidal fence or tidal reef as a potentially less environmentally damaging alternative to the shortlisted schemes. It is hoped that these proposals – which are not currently sufficiently technically developed for further evaluation – can benefit from Government funding to confirm their feasibility. Should they develop to become feasible alternatives they will be assessed against other scheme proposals.

4.1 Short-listing

Each of the ten long-listed proposals set out in Chapter 2 has been assessed against a number of different criteria in order to determine their ability to meet the objectives of the study. In the context of the study, this means whether the scheme has a realistic prospect of being built when considered on its individual merits. Our assessment draws on various
supporting reports including a report by Parsons Brinckerhoff (PB) which is published alongside this consultation (Annex 3).

160 The short-listing process will identify the reasonable alternatives that will be studied in the Strategic Environmental Assessment and the Severn based options for the Habitats Directive Appropriate Assessment, set out in the following chapter.

161 Six criteria were identified to determine whether a proposal is feasible in the context of the study:

- **Impact on energy market and security of supply** (including grid implications and impact on financing of other low carbon options)
- **Technical risk** (risk that the technology may not work as planned, confidence levels around costs and yields, likely operation dates and the risks/impact of sedimentation)
- **Cost and amount of energy** (is a proposal sufficiently competitive with other forms of renewable energy and/or carbon abatement that a developer would build it; what contribution could it make to our energy goals)
- **Affordability and value for money** (the capital cost, the role that Government, taxpayers and consumers would need to play in taking on cost and risk and providing a subsidy)
- **Environmental impact** (including carbon dioxide savings, impact on species /habitats and likely requirements under the Birds and Habitats Directives)
- **Regional level economic and social impacts** (including employment effects and potential impact on ports and recreational and commercial fishing)

162 Initial work on **energy market and grid impacts** has shown that the larger the project, the greater the challenge in accommodating the scheme into the current market structure. However, it has not shown that this would be impossible for a representative range of schemes. For example, analysis performed by Redpoint et al\(^{27}\) shows that even a scheme as large as a Cardiff-Weston barrage would not have a significantly worse effect on long-term capacity margins than other forms of renewable generation. For this reason, **this aspect has not been considered explicitly in the initial feasibility assessment**. Further work is planned within the feasibility study to consider these issues in relation to the short-listed options. Chapter 3.9 explains this in more detail.

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\(^{27}\) Redpoint et al (2008) "Implementation of the EU 2020 renewable target in the UK Electricity Sector: Renewable support schemes"
The 5 remaining criteria can be split into two groups:

a. Group 1 Criteria: those which determine whether a project could be built
   - technical risk
   - cost of energy
   - affordability

b. Group 2 Criteria: Those which identify whether there are reasons why a scheme that is less favourable on economic and technical grounds should be given further consideration:
   - environmental impact
   - regional and social factors

Upper and lower thresholds on cost of energy have been set to identify feasible schemes that may be more marginal in terms of the first set of criteria but that may have smaller or more favourable impacts on the second set. The assessment process ensures that those more marginal projects are not lost so that we can study whether they are environmentally less damaging and how they compare to other schemes.

The analysis of each project against the short-listing criteria has been provided by contractors and the cross-Government feasibility study team. Information provided by contractors has been independently peer reviewed: technical and engineering advice by an expert panel convened in liaison with the Royal Academy of Engineering; financing advice by PartnershipsUK; environmental advice via the Statutory Consultation Bodies; and regional advice by the Economic Research Advisory Council.

4.2 Interim Options Analysis

A report produced by the Parsons Brinckerhoff (PB) consortium examines the technical capacity of each of the ten long listed schemes to harness the Severn’s tidal range. This includes estimated capital costs, likely energy yield, cost of the energy generated, carbon dioxide savings (annual and lifetime adjusted to take account of emissions produced during construction) and when a scheme could start operating. It also provides a view on the technical risks associated with each scheme and a high-level environmental and regional impact assessment. The report is published alongside this consultation as Annex 3.

PB has used a fair basis methodology to evaluate the options. In essence, this involves applying a consistent set of cost rates and assumptions (e.g. construction, operation, energy yield) across all options. These may

differ from those of more detailed studies previously undertaken on specific options. Using specific data on one option when it could not be applied to all options could place that option at an unfair advantage or disadvantage. There are also some options which have unique components (for example a Tidal Fence) and in these circumstances, cost estimates have been developed which are consistent with the above principles. Estimates of losses of intertidal habitats have been taken from Admiralty Charts with the same cost rate applied to all options for the compensation of lost habitats. This may have resulted in over estimating the impact that some options have. For example in the Sustainable Development Commission study the Cardiff-Weston Barrage was estimated to cause 14,500ha loss of intertidal habitat whilst this method calculates the loss to be 20,000ha. The basis for estimating costs of compensatory measures is the same across all options. The cost of land has been set at £65k/ha. All tidal range options have been studied on the basis of generating electricity on the ebb tide only unless ebb and flow generation schemes were proposed or the proposal uses tidal stream power.

As a lot of work has already been done on the Cardiff-Weston barrage, the levels of confidence in estimated construction time and costs are higher than for the smaller or less well-known schemes. This means that estimates for the previously less well-studied schemes could rise significantly as more information becomes available on them.

A scheme lifetime of 120 years has been used for all options – although in practice less well-established concepts and construction methods for non-barrage options mean that the lifetime for other projects may be different.

Long-listed designs which span the Estuary include locks to allow the passage of ships. Any future developer would need to include locks as part of the design if a barrage were to be the preferred option (this would also impact on the operation and maintenance of the tidal power plant). It is also essential for other proposals to plan to meet navigation requirements.

4.3 Financing and Support Mechanism Report

A report by PricewaterhouseCoopers examining vehicles for financing large and small scale options and support mechanisms has informed our initial assessments on affordability. This independent report is published alongside this consultation and is discussed further in Chapter 3.5-3.7.
4.4 Cost Thresholds

The estimated cost of energy is a key consideration prior to making any decisions on whether or not to proceed with a tidal power project. At this early stage of the feasibility study, it is not possible to state definitively whether schemes currently represent value for money, although we can see how the projects perform against each other.

The cost levels at which schemes have been considered to be too expensive have been informed by the costs of alternative sources of low/zero carbon electricity and renewable energy required to meet our long-term climate change and renewable energy targets.

Table 4 illustrates the estimated costs of meeting the last 2 percentage points (35 TWh) of the proposed UK’s share of the 2020 Renewable Energy Target. These levelised costs represent the cost of generating energy from renewable sources (including back-up costs) and are the latest costs available and the most accurate comparator available at this time. This includes the costs of renewable heat and transport as well as electricity.

<table>
<thead>
<tr>
<th>Share of renewable energy in 2020</th>
<th>TWh Equivalent</th>
<th>Marginal Levelised cost £/MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-15%</td>
<td>244-261</td>
<td>147-170</td>
</tr>
<tr>
<td>13-14%</td>
<td>226-244</td>
<td>127-147</td>
</tr>
</tbody>
</table>

Sources: Redpoint et al (2008), NERA (2008)

The figures above show that a high cost threshold for assessing potential Severn tidal projects would be the marginal levelised cost of meeting the final 1 percentage point (i.e. achieving 14%-15% renewable energy) of the renewable target – up to £170/MWh.

To take account of the upside, and to provide a greater level of caution in setting the thresholds, we have included an upper threshold of £200/MWh so that schemes that are currently forecast to be expensive but may be more environmentally favourable are not ruled out at this early stage. It is considered that schemes currently estimated to be above £200/MWh are unlikely to be considered ‘economically feasible’ in the foreseeable future.

There are still a number of uncertainties regarding the cost and available supply of alternative renewables as well as the cost of the Severn tidal power schemes. It is likely that the cost of de-carbonising electricity generation using nuclear and fossil-fuel plant using carbon capture and storage will be lower than the cost of increasing renewables. However we believe the
conservative approach we have taken with regards to formulating these cost thresholds and estimating Severn tidal costs, mean the risk of ruling out Severn tidal schemes that could become economically attractive in the future is low. In the feasibility study over the next year, we will further refine costs and use the latest available cost of other renewable and low carbon technologies to ensure fair comparison for both 2020 and 2050 targets given the long term and different building periods of the schemes under consideration.

PROJECTS BASED ON NON-ENERGY REVENUE STREAMS

178 Severn Lakes is a 1 km wide development on the same alignment as the Cardiff-Weston barrage on which we have received limited information. Our understanding is that it is a leisure and energy project which relies on non-energy income streams to justify the cost of the causeway – this means that the gross levelised cost of energy produced is higher than other schemes. It is not therefore a feasible option on the energy it generates alone and will likely have a higher negative environmental impact than an energy only project. As such, this proposal is not considered further in the study. A developer could put forward a proposal that incorporated non-energy uses at the time of consenting and would have to meet the planning and consenting process.

12. Do you agree with the factors that have been used to determine the short-list for further study?

13. Do you agree that the test of economic feasibility should be relative to the cost of other renewables?

14. Do you have any further comments on PB’s Options Appraisal Report? Please support your response with evidence where possible.

4.5 Application of the Assessment Framework

179 The table below shows how each proposal performs against the assessment criteria and how they perform against one another using the fair basis methodology discussed above. The environmental and regional level impacts are a high level assessment and these areas will be studied in greater depth in the feasibility study. Environmental and affordability impacts are comparative assessments. (Please click here for a hyperlink to the table of options data, or Chapter 2.2).
### Table 5: Application of the Assessment Framework

<table>
<thead>
<tr>
<th>Project</th>
<th>Cost of Energy</th>
<th>Technical Risk</th>
<th>Affordability</th>
<th>Environmental Impact</th>
<th>Regional: Economic &amp; Social Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Intertidal Habitat Loss (ha)</td>
<td>Summary</td>
</tr>
<tr>
<td><strong>Barrages</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minehead to Aberthaw Barrage</td>
<td>Low</td>
<td>Low</td>
<td>Difficult</td>
<td>Pre-construction risk entirely borne by public sector. Potential to share some construction risk.</td>
<td>28,000</td>
</tr>
<tr>
<td>Hinkley Point to Lavernock Point Barrage</td>
<td>Low</td>
<td>Low</td>
<td>Difficult</td>
<td>Pre-construction risk entirely borne by public sector. Potential to share some construction risk.</td>
<td>26,000</td>
</tr>
<tr>
<td>Cardiff-Weston Barrage</td>
<td>Low</td>
<td>Low</td>
<td>Difficult</td>
<td>Pre-construction risk entirely borne by public sector. Potential to share some construction risk.</td>
<td>20,000</td>
</tr>
<tr>
<td>Shoots Barrage</td>
<td>Low</td>
<td>Low-medium</td>
<td>Medium</td>
<td>Shared public/ private pre-construction risk. No construction risk exposure</td>
<td>5,000</td>
</tr>
<tr>
<td>Beachley Barrage</td>
<td>Low</td>
<td>Low-medium</td>
<td>Easier</td>
<td>Shared public/ private pre construction risk. No construction risk exposure</td>
<td>3,500</td>
</tr>
<tr>
<td>Project</td>
<td>Affordability</td>
<td>Technical Risk</td>
<td>Cost of Energy</td>
<td>Environmental Impact</td>
<td>Summary</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------</td>
<td>----------------</td>
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<td>----------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Russell Lagoon – Famling Energy</td>
<td>Medium</td>
<td>Medium Low-Medium</td>
<td>Medium Low-Medium</td>
<td>Medium Low-Medium</td>
<td>Shared public/private pre-construction risk. No construction risk exposure. Significant loss of habitat; impact on fish uncertain but may be less than barrages.</td>
</tr>
<tr>
<td>Bridgwater Bay</td>
<td>Low</td>
<td>Medium</td>
<td>Medium Low-Medium</td>
<td>Medium Low-Medium</td>
<td>Shared public/private pre-construction risk. No construction risk exposure. Significant loss of habitat; impact on fish uncertain but may be less than barrages.</td>
</tr>
<tr>
<td>Other Land Connected Tidal Lagoons</td>
<td>High-Medium</td>
<td>Medium Low-Medium</td>
<td>Medium Low-Medium</td>
<td>Medium Low-Medium</td>
<td>Shared public/private pre-construction risk. No construction risk exposure. Significant loss of habitat; impact on fish uncertain but may be less than barrages.</td>
</tr>
<tr>
<td>Offshore Tidal Lagoon</td>
<td>High</td>
<td>Medium Low-Medium</td>
<td>Medium Low-Medium</td>
<td>Medium Low-Medium</td>
<td>Shared public/private pre-construction risk. No construction risk exposure. Significant loss of habitat; impact on fish uncertain but may be less than barrages.</td>
</tr>
<tr>
<td>Tidal Fence &amp; Reef</td>
<td>High</td>
<td>High Medium-Difficult</td>
<td>Medium Difficult</td>
<td>Medium Difficult</td>
<td>All of pre-construction risk and majority of construction risk borne by the public sector. Significant loss of habitat and less detriment to wildlife than other options. Navigation impacts not studied but may pose safety issues. May be less detriment to fisheries.</td>
</tr>
<tr>
<td>Tidal Reef – Minehead to Alerthaw</td>
<td>High</td>
<td>High Medium-Difficult</td>
<td>Medium Difficult</td>
<td>Medium Difficult</td>
<td>All of pre-construction risk and majority of construction risk borne by the public sector. Significant loss of habitat and less detriment to wildlife than other options. Navigation impacts not studied but may pose safety issues. May be less detriment to fisheries.</td>
</tr>
</tbody>
</table>
4.5.1 TIDAL REEF

The tidal reef is a radical new application of existing tidal range technology. The concept, as proposed to the feasibility study, uses fixed flow turbines which operate on a two metre constant head difference, which is maintained by floating concrete caissons or movable ‘crest gates’. It would operate on both the ebb and flood tides. In hydraulic terms, the head attained at the reef would be controlled by the rate of flow through the reef and the head differential across the turbines.

This proposal is at an early stage of development, with no prototype. Using the development of tidal stream technology as a proxy, it is estimated that this technology will need well over a decade to reach commercial deployment and that efficiency and costs could change – positively or negatively. As such, it is difficult to forecast energy yields or costs with any degree of accuracy now. Analysis of the available evidence suggests that costs of energy may be double those of the lower cost options. It is also difficult to judge what the environmental and regional level/social impacts would be – although environmental impacts are likely to be less than a fixed barrage producing equivalent electricity, the effects may extend over a greater area (although the scale of the impact will be lower throughout the area). A tidal reef would need to use a larger span of the Estuary than a barrage to produce equivalent electricity as it generates less efficiently.

A report by Atkins Engineering commissioned by RSPB also considered the tidal reef proposal. It flagged several fundamental technical issues and uncertainties with the concept submitted to the feasibility study and proposed a rather different design (inserting a range of novel tidal turbines in a barrage-type structure). It concluded that costs could be lower than the analysis developed for the feasibility study. However, following review by the study consultants and the panel of expert advisers of the revised technology costs, and some ambitious assumptions on development time, they confirmed the view that there is still too much uncertainty as to whether this design could be developed and applied as envisaged in the revised proposal.

Given these uncertainties, we conclude that this proposal is not yet ready for further evaluation through the Strategic Environmental Assessment process. The next step in the development of this technology would be to pilot and then deploy it commercially and at scale. A comprehensive framework of support to enable new energy technologies such as this to develop and it is hoped that this proposal can benefit from it to develop further. We will consider its feasibility again within the feasibility study before any Government decisions are taken on Severn Tidal power.
4.5.2 TIDAL FENCE

Figure 8: Artist’s impression of the tidal fence proposal (courtesy of Severn Tidal Fence Group)

The tidal fence is the only proposal on the long-list that is wholly based on tidal stream technology. The Severn Estuary has the UK’s largest tidal range resource but just a limited fraction of the tidal stream resource. The feasibility study’s terms of reference exclusively focussed on tidal range technologies for this reason. However, this option was studied to see whether it was a viable alternative to the other schemes and whether impacts differ. During the course of the technical assessment, the tidal fence proposal has been refined to focus on the Minehead to Aberthaw alignment and to use a smaller scale of turbine to optimise performance.

Tidal stream technology is in the early stages of development with a number of prototypes coming forward with the potential to be funded under the Marine Renewables Development Fund (see explanatory box in Chapter 2). The capacity of the largest single tidal stream devices currently being tested is 1.2MW comprising twin 600kW rotors. The tidal fence scheme proposed would involve using 800 turbines of up to 1.6MW to generate up to 1280 MW. This is a significant increase on the scale of turbines currently being developed coupled with a huge increase in the number of devices operating in combination. As the technology develops and more experience is gained, implementation at the large scale envisaged here may be possible and future project costs may decrease but it is difficult to predict when this might be and the scale of the reduction.

Currently, the uncertainties of deploying a new technology with such a large increase in size and scale are considerable – could the devices produce as much energy as stated? What would the costs be? How long would it take to build reliable devices at the size proposed? Using the
current cost estimates, the electricity produced by this proposal would be much more expensive than most other renewable generation and substantially more than many of the other options on our long-list. The proposal may, however, have a less-damaging impact on the operation of the ports and on migratory fish as it is not a full barrier across the Estuary. As with the tidal reef, impacts are likely to extend over a greater area than a barrage with similar output. For these reasons, though we do not consider that it is sufficiently developed to be further evaluated at this point, the Government would like to see how this proposal develops further and will consider its feasibility again before any decisions are taken to pursue a different Severn scheme.

4.5.3 LAGOONS

Tidal lagoons are free standing structures built offshore or in a semi-circular type arrangement connected to the shoreline at each end. They operate on similar principles to barrages (described in section 4.7.4) in that they exploit the difference in tidal height to generate electricity. Unlike barrages, they would not fully cross the Estuary and as such may have a smaller impact on migratory fish and the navigation activities on the Severn. Some estimates show that the loss of intertidal habitat may be greater for land connected lagoons than barrages of similar generating capacity. Further study may show whether on balance lagoons are less environmentally damaging than barrages and have less impact on shipping and other economic activity in the Estuary.

Figure 9: Visualisation of lagoon at Welsh Grounds (Crown Copyright)
i) Offshore Lagoons

188 Offshore lagoons may result in the smallest loss of intertidal habitat if built below the low-water contour. However their impact on the structure of the Estuary and its wildlife and the industries it supports is difficult to predict as scouring may occur as water passes through narrower channels either side of the impoundment and affect water levels. The estimated costs of these proposals are, in our view, beyond the limits that developers would consider viable in taking forward a scheme in the Severn – the cost of energy and capital costs are both relatively high. They have, therefore, not been selected for the short-list.

ii) Land-connected Lagoons

189 The generic tidal lagoon concept was included on the long-list and four potential land-connected lagoon sites were developed and studied to inform the short-listing. They are at different points along the Estuary, of different sizes, and produce varying amounts of energy. In addition a separate proposal from Fleming Energy for a lagoon on the Welsh Grounds was included in the long-list. Some of these lagoon options, such as the Russell Lagoons, have been studied before, while others such as Bridgwater Bay are more recent.

190 The original cost of energy for generic land-connected lagoons using conventional wall construction techniques was relatively high, and above the economic thresholds. A new and innovative means of constructing the walls resulted in lower costs and has been used as a basis for the assessment. Lagoons are based on proven hydroelectric generating technology, so entail a much smaller technological risk than the tidal reef or fence.

191 Lagoons may have lesser environmental and regional impacts compared to similar scale barrage options, although there is greater uncertainty on impacts on estuarine processes and flood risk. The possibility of sediment building up within the impounded area needs to be studied in Phase 2, including how this would impact on costs and energy yield.

192 Although the exact impacts of a lagoon may vary due to its location, they are likely to be broadly consistent and proportionate to their size in particular with regard to cost. The potential benefits of land-connected lagoons merit further study and while they are at the upper reaches of the cost thresholds, we propose to short-list two lagoon options from the long-list of proposals that included a generic lagoon concept and one specific proposal. Studying these two indicative lagoon options would lead to a much greater understanding of their impacts and whether they could be used in combination with other options including each other.
Given the potential broad similarities in environmental and regional impact, it is appropriate to study the lagoons that perform well in terms of the shortlisting criteria and have the potential to work in combination with other options (thereby producing more energy or energy at peak times) as the representative options. These are the Bridgwater Bay lagoon from the generic lagoons and the Fleming Lagoon at Welsh Grounds.

They are estimated to produce broadly similar energy outputs to each other, although are of slightly larger installed capacity than the Shoots barrage. Comparing each lagoon against Shoots will help inform what difference there is between the impacts of a lagoon versus a barrage. Each performs well on the short-listing criteria. The Bridgwater Bay lagoon has the lowest cost of energy out of all the lagoons and could potentially connect more easily to the existing electricity infrastructure at Hinkley Point. While the Fleming lagoon, located on the Welsh side of the Estuary in relatively shallow water uses a different form of wall construction, costs are within the cost thresholds set.

As with all the other types of schemes (barrages, lagoons, fences, reefs), there may be the potential to build a lagoon at different locations but a detailed understanding of the technology and impact of the lagoon concept gained from studying two schemes further is appropriate for this high-level feasibility study and supporting a decision on whether lagoons could be the preferred option.

Details of the other lagoon options considered under generic land-connected lagoons can be found in the Technical Options Appraisal. One shares the Fleming lagoon’s site, but has higher costs of energy due to a different means of wall construction, and can be expected to have an environmental impact consistent with that of the Fleming Lagoon proposal. The second (at English Grounds) is much smaller and energy costs are over the thresholds set. The third, at Peterstone Flats by Cardiff, is of a similar size to the other lagoons and has a medium cost of energy – slightly above the Bridgwater Bay lagoon. However, the embankments of the Peterstone lagoon make landfall adjacent to Cardiff port and to the River Usk (Special Area of Conservation – SAC), which is important to migratory fish species, although loss of intertidal habitat is less than some options. The location also does not lend itself well to be operated in combination with other barrages or lagoons.

4.5.4 BARRAGES

Barrages work by building a wall across the Estuary, effectively converting it into a hydroelectric dam. They are constructed by placing a number of large concrete caissons across the Estuary, some of which would house conventional hydro-electric turbines. The electricity is generated by allowing the incoming tide to pass through sluices in the barrage. This
body of water is then held as the tide ebbs. When the water level on the seaward side of the barrage is low enough the water behind the barrage is released back to the seaward side through the turbines, generating electricity. There is the possibility of generating electricity when the water travels up the Estuary (the flood tide) but this is unlikely to lead to significantly greater generation overall and/or may increase the costs or operational risks.

The basic concept of hydroelectric dams is well understood and a barrage is the application of mature and commercially available technology. A 240MW tidal barrage has been successfully operated at La Rance, Northern France since the 1960s. All of the potential Severn barrages (and other projects) are larger (in size and output terms) than the La Rance barrage or the 254MW barrage currently under construction for 2010, at Shiwa, South Korea. However, a 520MW barrage is planned for Garolim Bay, also in South Korea.

**Figure 10: Upstream view of La Rance barrage (courtesy of EDF)**

The lifetime for tidal barrages has been estimated to be 120 years although some experts think they could generate for much longer.

Beachley is the smallest barrage alignment considered by the study (625MW) and located furthest upstream. This means it does not impact on the major ports and causes the least, although still potentially significant, intertidal habitat loss as it is located upstream of the confluence with the River Wye (SAC) and might have a reduced effect on that river. Some fish mortality is still likely. This option would have a smaller energy output than the majority of other schemes – at least 90% smaller than the estimated output of the barrage from Minehead-Aberthaw. It is the cheapest in terms of capital cost and the unit cost of energy is a little higher than Cardiff-Weston, and lower than Bridgwater Bay lagoon. It is, therefore, one of the most affordable options. There are concerns over the potential
build up of sediment behind a barrage at Beachley, which may impact on future maintenance costs and feasibility. This needs to be studied further. Given the affordability, unit cost and relatively smaller environmental and shipping impact, this option has been included in the short-list despite the relatively small energy output.

201 **Shoots** is the largest barrage that could be taken forward with limited Government involvement in risk and cost bearing. The unit costs of energy are the cheapest estimated for all the Severn options. These factors combine to make it one of the most affordable. It does not directly impede the major ports in the Estuary. Initial figures show that intertidal habitat loss may be smaller than similar output lagoon options, although this remains significant, as do current estimates of impact on fish. Shoots shares the sediment risk of the Beachley barrage. Given the relatively low unit costs of energy and capital cost, this option is proposed for inclusion in the short-list.

202 **Cardiff-Weston** (Lavernock Point – Brean Down) is the alignment generally referred to as the Severn Barrage. It could provide 4.8% of the UK’s electricity (based on estimated demand in 2020). The sheer scale of the capital cost is very challenging, estimated at between £19.6bn and £22.2bn, depending on compensatory measures. Unit cost of energy figures are well below the cost thresholds set and are the second cheapest of all the schemes.

203 Cardiff-Weston could result in up to an estimated 20,000ha loss of intertidal habitat with significant damage to wildlife, and particularly migratory fish species as the barrier would be downstream of the tributary rivers of the Severn. It may offer tidal flood protection to the Gwent Levels and Avonmouth. During its operation ships docking at the regions major ports would have to pass through locks, which will add time and cost to their operation. However, the overall regional economic impact of a Cardiff-Weston barrage is estimated to be substantially positive.

**Figure 11: Artist impression of a barrage (Crown Copyright)**
A Cardiff-Weston barrage could be generating by 2020, even if not fully commissioned. However, this would be a best case scenario. There would still be a risk that it would not contribute significantly towards the 2020 renewables target.

Providing over £20 billion of finance for Cardiff-Weston, either publicly or privately, would be very challenging and it is unlikely that the private sector could carry this risk alone. Taxpayers/consumers would likely bear a large part of the cost burden and risk. The Government will need to consider the macro-economic and fiscal impact this scale of spending and risk exposure would have on a 2020 timeframe. In this context, it may also be appropriate to consider the feasibility of the Cardiff-Weston barrage on a slightly longer timescale, nearer to 2030. This barrage could make a significant contribution to our energy goals and we therefore propose to study it further. This will allow the scale of environmental impact and options for mitigation and compensation to be studied.

Cardiff – Hinkley Point could provide 5.55% of the UK’s electricity needs but with an additional loss of intertidal habitat of 6,000ha and an additional £4.3bn capital cost compared to Cardiff-Weston, with a resulting higher unit cost of energy. This option could provide a second basin that could reduce the intermittency from the Cardiff-Weston barrage and potentially increase the value of the output. It may offer tidal flood protection to the Somerset Levels in addition to the Gwent Levels and Avonmouth. The problems that apply to Cardiff-Weston are magnified in the larger barrages. With a capital cost of £25.2bn and major environmental consequences, we do not believe that this option is feasible or desirable as a separate option due to the additional cost and greater scale of habitat lost for the extra electricity generated compared to Cardiff-Weston and is therefore not short-listed.

Outer Barrage at Minehead to Aberthaw is the largest option, with the potential to provide 7.3% of the UK’s electricity demand. It may also protect the low lying areas of Somerset from tidal flooding. It provides 2% more of the UK’s total electricity demand than Cardiff-Weston, but with an additional loss of 8,000 hectares of intertidal habitat, and an £11.4bn increase in costs and higher unit costs of energy compared to Cardiff-Weston. In addition, technical risk may be higher than Cardiff-Weston as the caissons which house the generating equipment need to be installed at a greater depth. It would require all ships coming to dock at the major ports in the Estuary to travel through locks. We consider that the challenges of this option outweigh its benefits, and that it is simply not feasible on grounds of affordability. This option has not been short-listed.
The above analysis leads to a proposed short list of a variety of sizes, technologies and environmental impacts:

- Shoots barrage
- Beachley barrage
- Cardiff-Weston barrage
- Fleming Lagoon on Welsh Grounds
- Bridgwater Bay Lagoon

The short-list will be decided after the consultation and the review of responses received, and published in a Government response to consultation. There will be a detailed assessment of each of the short-listed schemes in the feasibility study over the next year, except that any scheme option which proves to be unfeasible on further examination will not be studied further.

15. **Do you agree that the two lagoon options selected for further study represent a good basis for studying the lagoons?**

16. **Given the short-listing criteria, are there any proposals on the short-list which are not suitable? Please support your response with evidence where appropriate.**

17. **Does the shortlist represent an appropriate level of ambition given the energy potential of the Estuary?**

18. **Are there any other options that, in your view, should be short-listed? Please provide appropriate evidence wherever possible and refer to the short-listing criteria.**
5: Strategic Environmental Assessment

Summary:

- We are seeking your views on the proposed scope of the SEA.
- The SEA analyses the environmental and social effects of the tidal power options over their lifetimes.
- The Scoping Report accompanying this consultation establishes baselines and proposes objectives, and is based on 16 detailed topic papers on specific environmental and social impacts available alongside this consultation.
- Each objective comprises detailed assessment criteria which facilitate the comparison of the different project proposals on equal terms.
- The main study phase of the SEA will provide more detailed environmental and technical studies and review based on the proposed short-list.

A Strategic Environmental Assessment is being carried out, in accordance with EU Directive 2001/42/EC, to predict and analyse the environmental and social effects of the short-listed tidal power options over their entire lifetime in order to inform decision making at the end of the feasibility study. It will provide a detailed understanding of the potential effects of a tidal power project on the natural and human environment. An SEA ensures that significant effects arising from plans and programmes are identified; assessed; mitigated; and taken into account by decision-makers, and that opportunities for public involvement are provided. The effects include a wide range of social and economic impacts.

The objectives of the plan that the SEA will study are drawn from the feasibility study Terms of Reference:

- to generate electricity from the renewable tidal range resource of the Severn Estuary in ways that will have an acceptable overall impact on the environment and economy both locally and nationally, will meet our statutory obligations and provide benefit to the UK

- to deliver a strategically significant supply of renewable electricity, which is affordable and represents value for money compared to other sources of supply in the context of the UK’s commitments under the forthcoming Renewable Energy Directive and the Climate Change Act and our goal to deliver a secure supply of low-carbon electricity.
SEA involves assessing “reasonable alternatives” for meeting the objectives of a plan or programme. The focus of the feasibility study is the use of the tidal range resource of the Severn Estuary to generate electricity and the identification of alternatives has focused on proposals based in the study area. The short-listing process has been developed to identify which of the options justify being taken forward, and these will be treated as the reasonable alternatives for the SEA. As more evidence becomes available, some proposed short-listed options may drop out if this proves that they are no longer able to meet the plan objectives and/or would no longer meet the criteria set by the assessment framework.

The initial Scoping Report (Annex 3) describes the SEA process in full and identifies potentially significant environmental effects it considers should be covered in the assessment of the short listed options. Full details of the effects to be covered are set out in 16 topic papers. The scoping proposals include detailed assessment criteria and indicators, which will facilitate the appraisal and comparison of the effects and magnitudes of different short-listed options on equal terms. The predicted effects for each option and their performance against the SEA objectives will be presented in the final Environmental Report.

There will be an extensive programme of work under the SEA to gain a fuller understanding of hydraulic and geomorphological issues, as they are fundamental to the assessment of effects in other topic areas. Further research will also be carried out, for example on the numbers, diversity, movement and location of birds and fish in the Estuary. Geographic information systems will be used to capture and analyse data on flood risks. Sediment transfer models will be created to indicate the effects of a Severn tidal power project on marine water quality.

The final scope of the SEA will be decided in the light of all responses to this consultation exercise. The later stages of the SEA, including the Environmental Report, will be undertaken over the next year. The Government is also conducting an integrated Offshore Energy SEA of a draft plan for further rounds of offshore oil and gas licensing. In addition to wind leasing in UK waters, we are looking to share learning where possible.

A strategic Habitats Regulations Assessment will also be carried out in parallel with the SEA to assess the effect on the integrity of protected sites designated under European legislation. This will include determining whether sites would be significantly affected, whether there are over-riding reasons of public interest to take forward a scheme and the feasibility of providing compensation to maintain the coherence of the Natura 2000
network. This will include making any Appropriate Assessments found to be necessary to meet the Habitats Directive requirements.

In making their comments on the SEA Scoping Report and supporting documents, respondents are encouraged to consider the following areas:

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<tr>
<td>19.</td>
<td>Which plans, programmes or environmental protection objectives are most significant for this strategic-level environmental assessment?</td>
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<td>20.</td>
<td>Is there any additional information that could help supplement the baseline data? Any further information relating to the baseline indicators, existing problems and trends over time would be very useful.</td>
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<tr>
<td>21.</td>
<td>Is there any important information that has not been addressed in view of the SEA scope?</td>
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[For a range of further detailed questions on the SEA, please see p. 103 of the annexed SEA Scoping Report.]

Figure 12: Photo of the Severn Estuary (Crown Copyright)
6: Next Steps

Summary

- The feasibility study will include studies of each of the shortlisted schemes, suggest ways in which adverse environmental effects could be mitigated or compensated for and consider compliance with environmental legislation.

- Work will be undertaken on the impacts of the various shortlisted schemes including work on supply chain, impact on the energy market and grid, use of ecosystem valuation, costs and engineering aspects, impact on regional economies and an SEA on the environmental and social impacts.

- This will enable Government to decide, after public consultation (probably in 2010), whether it could support a Severn tidal power scheme and, if so, under what terms and what the preferred option might be.

- The next consultation, among other things, will seek views on the SEA environmental report and, if required Appropriate Assessment(s).

- If a Severn tidal power project does proceed, it will be subject to a full process of planning and consenting, which could take up to 3-5 years, and then a construction phase of a further 5-7 years, depending on the scheme or combination of schemes selected.

The next phase of the feasibility study will provide a full consideration of the costs, impacts and benefits of the short-listed options. It will strengthen the evidence base for concluding whether the Government could support a Severn tidal power project and, if so, what the project might be and the terms on which it could be supported.

6.1 Environmental, Social and Regional Impacts

The SEA, as set out in Chapter 5, will provide a detailed assessment of the environmental and social impacts of each of the short-listed schemes. Where significant effects cannot be avoided, mitigation measures will be identified to reduce them, and the potential need for compensation measures will be identified. Further work to be completed includes a study of compensatory measures and a strategic level Appropriate Assessment. The box below contains an overview of each area, with the sub-headings referring to specific areas covered in detail by the SEA.
SEA Further Study Areas

Hydraulics and Geomorphology

The very large tidal range (the second largest in the world) combined with mobile sediment, strong tidal currents and wave action all contribute to a constantly changing pattern of sand and mud, some of which is exposed at low tide and some of which is always submerged by the estuarine waters.

Ornithology

The Severn Estuary is internationally important for its populations of over-wintering birds, which migrate south from countries such as Russia and Iceland, to over-winter in the milder winters experienced in south west Britain, to feed on the rich mudflats and salt marshes.

Marine Ecology

The extreme environment created by the tidal conditions provides a habitat for specialist communities of plants and animals to exist, including various types of worm and shrimp. The number of different species is relatively low because of the extreme conditions which the Severn Estuary presents, but it is highly productive and these provide food to sustain large numbers of bigger animals such as fish and birds.

Migratory and Estuarine Fish

The Severn Estuary supports many species of fish several of which migrate from marine to freshwaters. The Estuary is used for both commercial fishing and recreational angling and supports important game fisheries within the Estuary itself and into its tributaries rivers, including the Rivers Wye and Usk. Perhaps the best known species is the Atlantic salmon, which migrates up rivers such as the Usk and Wye to spawn, but there are others including the Twaite Shad, whose UK stronghold is within the Severn Estuary area, and the sea and river lamprey.

Flood Risk Management and Land Drainage

Much of the land adjoining the Seven Estuary on both the English and Welsh banks is low lying and protected by existing flood defences. Flood risk is likely to be reduced upstream of any tidal barrage option but there are currently differences of opinion as to downstream effects, and further studies are being proposed to look into this.

Marine Water Quality

There is the potential for marine water quality to be altered by any tidal power scheme which has an impact on the current pattern of tidal water flow and mixing.
The land surrounding the Severn Estuary is also very important for nature conservation, with many Sites of Special Scientific Interest and other nature conservation designations. The next phase of this feasibility study will continue to investigate likely impacts on these sites and important species.

Landscape and Seascape

The Severn Estuary is a unique and constantly changing seascape, in close proximity to significant centres of population, including Bristol, Cardiff, Newport and Gloucester. Various landscapes around the Estuary are protected on account of their importance, including Exmoor National Park and the Wye Valley Area of Outstanding Natural Beauty. Further studies planned for the next stage of the feasibility study will investigate the potential impacts of any tidal power scheme on the landscape and seascape qualities of the Estuary.

Navigation

Several major ports are located within the Severn Estuary, including at Bristol, Cardiff, Newport and Sharpness, and access to these ports could be affected by some of the tidal power options.

Historic Environment

The Severn Estuary and its immediate surroundings are very rich in terms of historic sites and archaeological remains, including, for example, the Gwent Levels. This is further demonstrated by the numbers of Scheduled Ancient Monuments, listed buildings and other important historic sites which can be found around and within the Estuary.

Society and Economy

The principal settlements along the Severn Estuary are Cardiff, Swansea, Newport, Port Talbot, Bristol, Gloucester, Cheltenham and Weston-Super-Mare. Economic sectors include major trading ports, industry, mining, commercial fishing, manufacturing, wholesale, retail, hotels, restaurants and real estate. Tourism and recreation are of high importance. Construction and operation for a Severn tidal power scheme is likely to have a significant impact on these populations and economies.

Other Sea Uses

The Severn Estuary and Bristol Channel and immediate surroundings are used for a wide range of activities, both commercial and leisure based. These include marine aggregate extraction, marine waste disposal, commercial fisheries, some military activity, existing energy production (including nuclear, coal and gas fired power stations) tourism and recreation. Impacts on all of these existing uses may arise from any tidal power option being taken forward within the Severn Estuary. These will be examined further during Stage 2.
**Freshwater Environment and Associated Interfaces**

This topic examines potential impacts on ground water resources, some of which are used as public drinking water supply for communities around the Estuary. It is recognised that it will be necessary to take into account existing structures, including the Severn tunnel railway connection, in further consideration of this subject area.

**Noise and Vibration**

Potential negative effects arising from noise and vibration, on local populations are considered to be of most significance during any construction phase, which could last between 5 and 7 years, dependent on the scale of any project taken forward to the construction phase, with an operational phase then anticipated to extend upwards of 120 years. Noise and vibration impacts are also recognised as being of potential significance to wildlife, including on the marine environment and migratory fish. There is the potential for noise impacts to be partially mitigated to the extent that noise and vibration are not expected to be a significant constraint on taking forward any of the proposed options.

**Carbon Footprinting**

The concept of carbon footprinting is relatively new. It is the process by which an assessment is made of both levels of carbon dioxide and other so called greenhouse gas emissions as a result of the construction and operation balanced against savings in the emissions of these gases as a result of the operation of any tidal power option within the Severn Estuary. This process will be used within the feasibility study as part of the Government’s commitment to reduce carbon dioxide emissions by 80% (set against 1990 levels) by 2050.

**Waste and Resources**

Construction of any tidal power scheme will use significant resources and require waste disposal facilities. Availability (capacity) and suitability of existing local waste disposal facilities will be further assessed during the course of the feasibility study. Aggregates and concrete will be required in significant quantities for any tidal power option. Assessment as to whether these, and other resources, could be acquired locally will be undertaken alongside consideration of the use of secondary (recycled) aggregate.

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**6.2 Engineering and Technical**

Over the next year of the feasibility study, work will focus on optimising the design, operation, energy yield and costs of the short-listed options, including possible operation in combination, through use of 1D and 2D modelling. Also, an analysis of the supply chain for the short-listed schemes will be done, including the material, equipment, facilities and
skills needed for construction. In addition, we plan to carry out an analysis of the impact of the schemes on the energy market, including back up needs and demand management aspects, together with the National Grid study described in more detail in Chapter 3.9.

Consideration will also be given to the costs and risks involved with decommissioning. As noted above, a decommissioning plan will be needed prior to the commissioning of any project.

6.3 Economic and Commercial Aspects

Further details on the delivery structures, finance and subsidy mechanisms for a Severn scheme will be considered and will cover in greater detail those short-listed options which could be completed by 2020. This will look to build on the current research and examine these options in greater detail in order to make decisions on the preferred structures and mechanisms that may be employed.

Further work will be needed to understand the potential risks (including optimism bias) of any schemes as well as the alternatives we are comparing them with. In particular, further work is needed to understand how and at what cost the various risks can be mitigated.

Ecosystems valuation work will help illustrate the relative value to society of the environment affected by any tidal generator and the associated compensatory measures. It may also help inform us on how to maximise the benefits of any potential compensatory arrangements.

6.4 Commercialisation Strategy

Depending on whether a preferred option is identified and what the envisaged timeframe for building it is, a commercial strategy (including procurement and delivery options) will need to be developed. Should the study conclude that a project is not deliverable in the near term, work on commercialisation will be conducted nearer the delivery time to accurately reflect the financing market.

6.5 Planning and Consents

The next phase of the Severn tidal power feasibility study will consider the full range of planning and consenting issues that might be associated with any project. Ten broad categories of issues relating to planning and consenting have been identified:

- planning control;
- environmental protection;
human rights;
navigation;
energy supply control;
health and safety;
national security;
devolution;
transport;
tourism and recreation.

Due to the number of planning and consenting issues involved, several government departments, as well as local planning authorities and the Welsh Assembly Government have an interest in this area and are working together to ensure that all potential issues have been considered.

The specific matters that will arise under the broad headings will inevitably be diverse, ranging across generation and transmission of electricity and planning issues for attaching a structure to the seabed. There are also a number of important areas beyond the structures and their operation that need to be considered, such as the building of new access roads, protecting the marine and onshore environments and ensuring the health, safety and welfare of those working on the project and living in the surrounding areas.

6.6 Further Consultation

The feasibility study will bring together the outputs of the above work for public consultation, probably in 2010. The second consultation will set out the evidence gathered and analysis done, and consider whether a Severn tidal power scheme (or combination of schemes) could be taken forward with Government support and the timeframe for doing so. The consultation will include the Environmental Report of the Strategic Environmental Assessment.

The SEA steering group, SEA technical workshops, Technical and Engineering Expert Panel and Regional and Parliamentary Forums will continue during the feasibility study. More information on wider stakeholder engagement will be available on the Severn tidal power feasibility study website.

Do you agree with the work plan, as outlined above? If not please specify any other areas to be studied.
7: Glossary

**Appropriate Assessment** – a process required of the Birds Directive 79/409/EEC and Habitats Directive 92/43/EEC to avoid adverse effects of plans, programmes and projects on Natura 2000 sites and thereby maintain the integrity of the Natura 2000 network and its features


⇒ **Special Protection Area** (SPA) – strictly protected sites classified in accordance with Article 4 of the above EC Directive. They are classified for rare and vulnerable birds, listed in Annex I to the Birds Directive, and for regularly occurring migratory species (http://www.jncc.gov.uk/page-162)


**Climate Action and Renewable Energy Package** – European Commission’s legislative proposal to achieve agreed EU objectives in the fight against climate change. Committed to reducing overall EU emissions to at least 20% below 1990 levels by 2020, and is ready to scale up this reduction to as much as 30% under a new global climate change agreement when other developed countries make comparable efforts. It has also set itself the target of increasing the share of renewables in energy use to 20% by 2020. (http://ec.europa.eu/environment/climat/climate_action.htm)

**Committee on Climate Change** (CCC) – independent statutory non-departmental public body, established by the Government in 2007 to independently assess how the UK can optimally achieve its emissions reductions goals for 2020 and 2050 (http://www.theccc.org.uk/)
**Department of Energy and Climate Change** (DECC) – DECC brings together much of the Climate Change Group, previously housed within the Department for Environment, Food and Rural Affairs (Defra), with the Energy Group from the Department for Business, Enterprise and Regulatory Reform (BERR) (www.decc.gov.uk)


**Energy Technologies Institute** (ETI) – a public/private partnership, created in December 2007, to accelerate the development and commercial deployment of a focused portfolio of energy technologies which will increase energy efficiency, reduce greenhouse gas emissions and help to achieve energy and climate change goals (www.energytechnologies.co.uk)

**Feasibility study** – a study that will enable the Government to decide whether it could support a tidal power scheme in the Severn Estuary and if so on what terms in the context of the Government’s energy and climate change goals and the alternative options for achieving these (http://www.berr.gov.uk/whatwedo/energy/sources/renewables/explained/severntidalpower/thefeasibilitystudy/page46182.html)

**Geomorphology** – the science concerned with understanding the form of the Earth’s land surface and the processes by which it is shaped, both present day as well as in the past. Includes the processes of weathering and erosion, sediment transport and deposition, the characterisation of landforms and the materials of which they are composed

**Gross Value Added (GVA)** – used in the estimation of Gross Domestic Product, GVA measures the contribution to the economy of each individual producer, industry or sector in the United Kingdom.
Habitats Directive – built around two pillars: the Natura 2000 network of protected sites and the strict system of species protection. All in all the directive protects over 1,000 animals and plant species and over 200 so called “habitat types” (e.g. special types of forests, meadows, wetlands, etc.), which are of European importance. (Council Directive 92/43/EEC) (http://www.jncc.gov.uk/page-1374). These have been applied in the UK by means of “Conservation (Natural Habitats, & c.) Regulations 1994” (http://www.opsi.gov.uk/si/si1994/Uksi_19942716_en_1.htm)

➔ Special Area of Conservation (SAC) – strictly protected sites designated under the EC Habitats Directive. 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 189 habitat types and 788 species identified in Directive Annexes I and II (http://www.jncc.gov.uk/page-23)

Hydrodynamics – the science of the dynamics, or physical forces, of fluids in motion

Marine Renewables Deployment Fund (MRDF) – set up by the Department for Trade and Industry in 2004, providing £50m of funding to support the continued development of the marine renewables sector. The MRDF has four components, the Wave and Tidal-stream Energy Demonstration Scheme, environmental research, related research and infrastructure support (http://www.berr.gov.uk/whatwedo/energy/environment/etf/marine/page19419.html)

Natura 2000 (Network) – EU-wide network of nature protection areas established under the Habitats Directive. The aim of the network is to assure the long-term survival of Europe’s most valuable and threatened species and habitats (http://ec.europa.eu/environment/nature/index_en.htm)

Optimism bias – the demonstrated systematic tendency for people to be over-optimistic about the outcome of planned actions. HM Treasury estimates that Government projects should have an optimism bias applied at a rate of 66%

Phase 1 – the current stage of the feasibility study – i.e. developing a short-list of Severn tidal power proposals by means of a decision-making assessment framework and SEA Scoping

Phase 2 – the second stage of the feasibility study – i.e. short-listed options appraisal and SEA reporting
Ramsar Convention on Wetlands – the Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources (http://www.ramsar.org/)

Ramsar Site of International Wetland Importance – wetlands of international importance designated under the Ramsar Convention. (http://www.jncc.gov.uk/page-161)

renewable energy – energy from sources which can be replenished in a short period of time. Renewable energy includes solar power, wind, wave and tide, and hydroelectricity. Solid renewable energy sources consist of wood, straw and waste, whilst gaseous renewables consist of landfill gas and sewage gas


Renewable Energy Strategy (RES) – the UK’s overall strategy for tackling climate change and to meet our share of the EU target to source 20% of the EU’s energy from renewable sources by 2020; will be published in spring 2009, once the UK’s share of the targets have been agreed (http://www.berr.gov.uk/whatwedo/energy/sources/renewables/strategy/page43356.html)

residual value (of an asset) – the estimated value of a tangible asset (i.e. Severn tidal power project) at the end of the period being considered. (In this report this period is 35 years.) This can either be the resale value of the asset on the market or the value of the asset to society.

Severn Estuary – this is the physical extent of the Estuary and does not reflect the study area. Its downstream limits are the headlands at Lavernock Point on the Welsh coast and Brean Down on the English coast, passing through the small island features of Flat Holm and Steep Holm. The upstream limit is the Haw Bridge, upstream of Gloucester (based on 1 in 100 year flood risk area and also used by the Shoreline Management Plan (SMP) (Gifford, 1998) and Coastal Habitat Management Plan (CHaMP) (ABPmer 2006)

Sites of Special Scientific Interest (SSSI) – the very best wildlife and geological sites; over 4,000 SSSIs in England, covering around 7% of the country’s land area (http://www.english-nature.org.uk/special/sssi/). There are 1,019 SSSIs in Wales, covering around 12% of the land area (http://www.ccw.gov.uk/landscape-wildlife/protection-our-landscape/special-landscapes-sites/protected-landscapes/sssis/current-sssis-in-wales.aspx)
Social discount rates – discount rates recommended in Green Book guidance for assessing social impacts reflecting the rate at which society values the present compared to the future. (Green Book: guidance provided by HM Treasury on legitimate justifications for government intervention and methods for appraising and evaluating policies.)

South West Regional Development Agency (SWRDA) – leads the development of a sustainable economy in South West England, investing to unlock the region’s business potential (http://www.southwestrda.org.uk/)

Stern Review (into the Economics of Climate Change) – set out to provide a report assessing the nature of the economic challenges of climate change and how they can be met, both in the UK and globally (http://www.hm-treasury.gov.uk/stern_review_climate_change.htm)

Strategic Environmental Assessment (SEA) – European Directive 2001/42/EC ‘on the assessment of the effects of certain plans and programmes on the environment’ requires a formal environmental assessment of certain plans and programmes which are likely to have significant effects on the environment. Authorities which prepare and/or adopt such a plan or programme must prepare a report on its likely significant environmental effects, consult environmental authorities and the public, and take the report and the results of the consultation into account during the preparation process and before the plan or programme is adopted. They must also make information available on the plan or programme as adopted and how the environmental assessment was taken into account (http://www.communities.gov.uk/planningandbuilding/planning/sustainabilityenvironmental/strategicenvironmentalassessment/)

⇒ SEA Steering Group – a group has been established to steer the SEA process – the diverse members’ role is to act as technical peers, guiding the selection of SEA methods and identifying the right information sources.

Sustainability Appraisal – a form of assessment used in the UK, particularly for regional and local planning. It considers social and economic effects as well as environmental ones, and appraises them in relation to the aims of sustainable development. Sustainability Appraisal fully incorporating the requirements of the SEA Directive is required for Local Development Documents and Regional Spatial Strategies in England and Local Development Plans in Wales under the Planning and Compulsory Purchase Act 2004.
Sustainable Development Commission – the Government’s independent advisory body on sustainable development, including scrutinising and reporting on Government’s performance on sustainable development (http://www.sd-commission.org.uk/)

UN Framework Convention on Climate Change (UNFCCC) – an international treaty to begin to consider what can be done to reduce global warming and to cope with whatever temperature increases are inevitable. More recently, a number of nations approved an addition to the treaty: the Kyoto Protocol, which has more powerful (and legally binding) measures (http://unfccc.int)

Weighted Average Cost of Capital (WACC) – the rate that a company is expected to pay to finance its assets. WACC is the minimum return that a company must earn on its existing asset base to satisfy its creditors, owners, and other providers of capital.

Welsh Assembly Government (Llywodraeth Cynulliad Cymru, LCC or WAG) – responsible for most of the issues of day-to-day concern to the people of Wales, including the economy, health, education, and local government (http://wales.gov.uk/)
Annex 1: The Consultation Code of Practice Criteria

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

2. Consultation should normally last for at least 12 weeks with consideration given to longer timescales where feasible and sensible.

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

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

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

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

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

Figure 13: View of the Severn Bridge at Sunset (Gary Shanahan)
Annex 2: Severn Tidal Power: Strategic Environmental Assessment Scoping Report
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Abbreviations

The following abbreviations are used in this Scoping Report:

AONB  Areas of Outstanding Natural Beauty
BAP  Biodiversity Action Plan
BERR  Department for Business, Enterprise and Regulatory Reform
BTO  British Trust for Ornithology
CCW  Countryside Council for Wales
Cd  Cadmium
CHaMP  Coastal Habitat Management Plan
cSAC  Candidate Special Area of Conservation
DECC  Department of Energy and Climate Change
Defra  Department for Environment, Food and Rural Affairs
EIA  Environmental Impact Assessment
EC  European Commission
EU  European Union
G8  Group of 8 Nations
GHG  Greenhouse Gases
GIS  Geographical Information System
GW  Gigawatts
Hg  Mercury
HRA  Habitats Regulations Assessment
LNR  Local Nature Reserve
NERC  Natural Environment and Rural Communities Act
Ni  Nickel
NNR  National Nature Reserve
NP  National Park
NPS  National Policy Statement
ODPM  Office of the Deputy Prime Minister
PAH  Polycyclic aromatic hydrocarbons
PCB  Polychlorinated biphenyls
PPG  Planning Policy Guidance
PPS  Planning Policy Statements
PSA  Public Service Agreement
PWS  Public Water Source
RIGS  Regional Important Geological Sites
SDC  Sustainable Development Commission
SEA  Strategic Environmental Assessment
SLR  Sea Level Rise
SNCI  Sites of Nature Conservation Importance
SPA  Special Protection Area
SSSI  Site of Special Scientific Interest
STP  Severn Tidal Power
TAN  Technical Advice Note
UKCIP  United Kingdom Climate Impacts Programme
UN  United Nations
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WeBS</td>
<td>Wetland Bird Survey</td>
</tr>
<tr>
<td>WFD</td>
<td>Water Framework Directive</td>
</tr>
<tr>
<td>Zn</td>
<td>Zinc</td>
</tr>
</tbody>
</table>
Non Technical Summary

Introduction

The Severn Estuary has one of the highest tidal ranges in the world and the most significant tidal range resource in the UK. A cross-government group led by the Department of Energy and Climate Change (DECC, formerly BERR) has initiated the Severn Tidal Power (STP) Feasibility Study to consider whether the Government could support a project which exploits the major energy generation potential of this tidal range, and if so, on what terms.

The STP Feasibility Study fits within the wider context of the UK’s climate change and energy policies. As well as strongly supporting international action to address climate change at EU, G8 and UN levels, the Government has set the ambitious target of reducing the UK’s carbon emissions by at least 80% by 2050. Further to this, the draft EU Renewables Directive sets a mandatory target for the UK of 15% renewable energy supply by 2020.

The Government is publishing a consultation document on the STP Feasibility Study, to seek views on:

- the scope of the Strategic Environmental Assessment that is being carried out within the Study;
- which of the 10 possible Severn tidal power schemes under consideration should be short-listed for detailed assessment during 2009; and
- the issues the Feasibility Study is considering and how these are being approached.

This SEA Scoping Report supports the first of these aims.

Strategic Environmental Assessment

A strategic environmental assessment, which will be compliant with the requirements of the EU Strategic Environmental Assessment (SEA) Directive, is being undertaken to assess the significant environmental effects of proposals to generate electricity from the renewable tidal range resource of the Severn Estuary; and, if the Government can support a tidal power project in the Severn Estuary, then to inform the development of a preferred alternative or alternatives. SEA is an iterative process of gathering data and evidence, assessing effects, developing mitigation measures and making recommendations to refine the plan in view of the predicted environmental effects.

31 Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment
This Scoping Report is being issued to accompany the STP Feasibility Study consultation document as the first step in the SEA process. Its aim is to invite views on the scope of the SEA proposed in this document. The scope includes social and economic effects, in order that sustainable development considerations are addressed. At this stage, views are sought from the Consultation Bodies designated in the SEA Regulations (SI 2004/1633) (Cadw, Countryside Council for Wales, English Heritage, Environment Agency, and Natural England), but in addition, comments from any other party will be considered when refining the scope of the SEA. Following confirmation of the scope, the main assessment phase of the SEA will be undertaken. This will examine the effects of alternative options.

The SEA is being conducted on behalf of the cross-government group by a consortium of specialist environmental consultants led by Parsons Brinckerhoff.

Spatial and Temporal Range

The study area used for the SEA scoping stage broadly extends from tidal limit on the Severn Estuary, downstream as far as a line drawn between Worm’s Head and Morte Point. It includes the landward fringe and tributaries such as the River Wye and the River Usk up to their tidal limit and 1km inland. This study area has been determined by the footprint of the potential spread of options which could extract tidal range power from the Severn Estuary, and areas which may be affected by doing so. Study areas for specific issues extend beyond this area and these are defined separately within the scoping process and are summarised where appropriate in this report. This includes, for example, migratory fish and birds that spend part of their life cycle outside the Severn Estuary.

The temporal range for effects to be considered is the expected lifetime of a scheme, allowing for identification of key issues that may emerge over construction, operation and decommissioning. The expected operational life is assumed to be 120 years although in practice this may be extended and may be less for certain options. The scoping of potential effects has been undertaken principally in relation to operational effects, although mindful of issues that may emerge during the construction or decommissioning phases.

Consultation

BERR (now DECC) advertised in January 2008 the intention to undertake an SEA of proposals to generate electricity from the renewable tidal range resource of the Severn Estuary. Consultation already undertaken to date is listed below:

- In May 2008, selected organisations were contacted to invite representatives to form the SEA Steering Group to guide the SEA. Four
Steering Group meetings to review progress and discuss issues have been held to date.

- A Call for Evidence was issued on 12 May 2008. The Call formed two parts; ‘a Call for Proposals’ and a ‘Call for Information’.
- In developing the proposed SEA scope, a range of methods was used to develop understanding and the evidence base. In some cases, this included ‘technical workshops’, in addition to individual consultations and other activities such as the Call for Information.

The outcome of the environmental assessment of alternatives, using the scope of works defined in this document, will be an SEA Environmental Report. The SEA Environmental Report will be issued to accompany the subsequent consultation proposals on the preferred alternative or alternatives. It is currently anticipated that the public consultation period will occur in Winter 2009/10.

Identification of Alternatives

The focus of the Feasibility Study is the use of the tidal range resource of the Severn Estuary to generate electricity, and as such the identification of reasonable alternatives has focused on proposals based in the study area.

An array of potential tidal range power options in the Severn Estuary have been analysed to identify those that can be included on a short-list of options that have the potential to form the reasonable alternatives for the SEA. This analysis sought to identify options that were most likely to meet the objectives to:

- generate electricity from the renewable tidal range resource of the Severn Estuary in ways that will have an acceptable overall impact on the environment and economy both locally and nationally, will meet our statutory obligations and provide benefit to the UK and
- to deliver a strategically significant supply of renewable electricity, which is affordable and represents value for money compared to other sources of supply in the context of the UK’s commitments under the forthcoming EU Renewable Energy Directive and Climate Change Act and our goal to deliver a secure supply of low-carbon electricity.

The identification of the short-listed options is being consulted on alongside this Scoping Report, and these will be considered during the main SEA assessment phase in accordance with the SEA Directive.

Policy Review

A review of relevant international, national and regional level policy documents has been undertaken; considering plans and policies
such as National Energy Strategies, National and Regional Land use/spatial strategies, Regional Economic Strategies, Environment Agency Management Plans, and Planning Policy Statements and Guidance. This review helped identify potential SEA objectives for the STP Feasibility Study. These potential SEA objectives were then further developed during the scoping process, taking into account informal consultation inputs, to define the proposed SEA objectives.

Baseline Information and Existing Problems

The Severn Estuary is characterised by its hyper-tidal range, leading to large variations in suspended and bed-load sediment between spring and neap tides. This high-energy environment can also move large quantities of sediments and alter channel morphologies between tidal cycles. These hyper-tidal characteristics also lead to the Severn tidal bore phenomenon. Significant problems and trends in the next 100 years and beyond are likely to be driven by climate change and the Severn Estuary’s response to consequent increases in sea level and storminess. These can be expected to result in coastal squeeze32 and a loss of intertidal habitat, although there are plans and policies in place that aim to off-set such losses.

The Severn Estuary and Bristol Channel receive one of the highest UK inputs of the nutrients to the marine environment, reflecting the estuary’s size, the location of human settlements and the catchment’s agricultural land use. The introduction of the EC Water Framework Directive (2000/60/EC), is likely to result in improved surface water quality as it sets a default objective of achieving ‘good status’ by 2015.

The high tidal range in the Severn Estuary and its unusual physical conditions strongly influence the composition, distribution and abundance of its flora and fauna. The resultant ecological importance of the estuary is recognised through nature conservation designations. The Severn Estuary is listed as a Ramsar site (wetlands of international importance) and designated as a Special Protection Area (SPA) for its bird population. The Severn Estuary is also designated a candidate Special Area of Conservation (cSAC) for its range of important estuarine and marine habitats, and migratory fish species. The Rivers Tywi, Usk and Wye have been designated as Special Areas of Conservation (SACs) for their migratory fish species. There are also other SPAs and SACs further afield which may be affected. Furthermore, there are a large number of national nature conservation designations that occur within and adjacent to the Severn Estuary – for example there are over 70 Sites of Special Scientific Interest (SSSIs) within the study area. The sites have been designated for a range of geological and biological interests. In addition to the statutory

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32 The situation where the coastal margin is squeezed between the fixed landward boundary (artificial or otherwise) and the rising mean sea level.
designations, there are a host of non-statutory local designations that apply around the estuary.

The Severn Estuary borders England and Wales and is home to a number of commercial ports including Bristol, Cardiff, Newport and Sharpness/Gloucester. Other sea uses that occur in the Severn Estuary and Inner Bristol Channel include marine aggregate dredging; marine waste disposal; commercial fisheries; recreation and tourism; military activity; energy (including oil & gas, renewable energy resources and power stations); cables and pipelines. Other land-based economic sectors in south east Wales and south west England include agriculture, industry, mining, manufacturing, wholesale, retail, hotels, restaurants and real estate. Tourism and recreation (especially angling) are of high importance and low intensity farming dominates in rural areas. Major transport links include the two Severn bridges and the Severn railway tunnel.

Within the study area there are large areas of land including over 40,000 properties, amenity and agricultural land. These rely on tidal flood defences and land drainage systems to reduce the risk of tidal and fluvial flooding; which needs to be managed in the context of ongoing processes of sea level rise and associated coastal squeeze.

The historic environment of the Severn Estuary is a finite, non-renewable resource and one of the most significant in the UK and consists of internationally, nationally, regionally and locally important sites. The Severn Estuary coastline includes prehistoric and Roman features; its waters hold features reflecting its maritime heritage dating from the Bronze Age, and its associated levels and hills offer a rich and varied archaeological landscape. Some fisheries have heritage as well as economic value. The study area also contains scenic and valued landscapes, many of which are protected through AONB or other designations.

Available data suggests that there is a ‘reasonable’ landbank of aggregate availability within and around the study area, which could be increased further by the current trend towards increasing use of secondary aggregates.

Landfill voidspace and projected landfill lifespan are in decline as existing landfill sites are filled in conjunction with limited increases in the development of new landfill capacity.

**Identifying Potential Issues**

This scoping review has established that tidal power options present a wide range of potential issues that require significant research and assessment to understand adequately.
The Severn Estuary represents one of the largest single project potential contributors of low carbon energy, with the largest options being capable of contributing up to 7% of the UK’s total electricity demand.

The effect of tidal power options would be to reduce the tidal range within the estuary. The potentially major consequences of this for inter-tidal habitats, and flood management and maritime infrastructure, in both the short and long-term will need to be considered further in the main assessment phase of the SEA.

Most of the habitats within the inter-tidal zone that would be lost are protected under National and European Law in their own right, and also support a range of similarly protected waterbirds. Tidal power options are also very likely to adversely affect passage and survival within the Severn Estuary of a range of fish species, again protected under European Law. There are therefore high levels of risk to protected habitats and species, including estuarine habitats, migratory fish and waterbirds amongst others.

The alteration in tidal range may indirectly lead to changes to the Severn Estuary’s water flushing characteristics and its concentrations of suspended sediments. This in turn may alter distributions and concentrations of contaminants in estuary water and sediments. The changes in suspended sediments may also affect primary productivity and the potential for eutrophication effects.

Depending on the nature of shortlisted options, there could be very substantial effects during construction such as on employment and labour pools, the housing market and access to local services, resource availability to existing industrial activities, population changes and health effects. In the longer term there is the possibility of indirect and wider economic effects, for example arising from effects on navigation and other marine activities, access to recreation and tourism, and the opportunity for economic regeneration and new development.

There are also other potential issues in relation to biodiversity; population; human health; fauna; flora; soil; water; air; climatic factors; material assets; cultural heritage, including architectural and archaeological heritage; landscape; and the inter-relationship between these issues.

The scale and nature of the effects that may be identified during the main assessment phase are therefore very likely to pose unprecedented challenges, notably but not exclusively in relation to effects on protected habitats. There is therefore a need for additional studies to better understand the effects of tidal power options, develop mitigation measures.

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33 Eutrophication is an increase in chemical nutrients (compounds containing nitrogen or phosphorus). This in turn can lead to ‘eutrophication effects’ – an increase in an ecosystem’s primary productivity (excessive plant growth and decay), and further effects including lack of oxygen and severe reductions in water quality, fish, and other animal populations.
and identify compensation needs. At this stage, for some potential effects there are currently few (if any) compensation measures identifiable with a high degree of confidence in their effectiveness.

Recommendations for further studies

During the SEA main assessment phase, consideration needs to be given to the potentially significant issues identified in this Scoping Report, the aim being the identification of significant effects in accordance with the SEA Directive. This will entail assessment of the nature and magnitude of environmental changes arising from tidal power options; and their complex interrelationships occurring over long timescales. It is anticipated that specialist studies will be required to support this assessment, and thereby ensure SEA findings are robust.

In line with SEA practice, studies for the main assessment phase will be largely desk-based, utilising existing information. However, an understanding of the effects of tidal power options upon the hydraulics and geomorphology of the Severn Estuary is fundamental to the assessment of the environmental effects of such schemes. Substantial modelling work is therefore proposed to understand better the effects on underpinning estuarine processes of the Severn Estuary and their influence on the natural and human environment. These studies are important to supporting specialist technical assessments elsewhere, for example in relation to marine water quality, flood risk and land drainage. This work is also needed to support studies on impacts on biodiversity and thereby the identification of mitigation, and recognition of the need for compensation measures. Fieldwork is primarily limited to collection of further bird data and levels data to inform assessment of flood risk issues.

A range of other desk-based studies will be required to address the range of issues identified in this scoping report, for example in relation to society and economy, carbon footprint, and navigation and other marine activities.

The effects of any tidal power option arise from a complex interaction of physical, ecological and human factors. Whilst still not fully understood, an appreciation of the interactions between these is important to the development of an integrated scope of works for the main assessment phase. It is inevitable that, given these complexities and the strategic nature of this study, uncertainties on likely effects will remain at the conclusion of the main assessment phase. These uncertainties will be clearly identified.

SEA Objectives and the Assessment Framework

The environmental effects of each of the options to generate electricity from the renewable tidal range resource of the Severn Estuary, and whether the likely effect may be significant, will be considered. SEA
objectives will be used to compare alternatives and to help identify the overall preferred alternative. SEA Objectives have been derived using the review of environmental plans and programmes; the baseline data collation; and the identification of existing problems outlined above. The assessment of significance of effects arising from each option will inform consideration of how far each of the SEA Objectives is likely to be met; allowing a comparison of alternatives.

The assessment process is iterative, involving collecting information, defining alternatives, identifying environmental effects, developing mitigation measures and revising proposals in the light of predicted environmental effects. The assessment will consider secondary, cumulative, synergistic, short, medium and long term permanent and temporary, positive and negative effects arising during the construction, operation and decommissioning stages.

The environmental assessment of the preferred tidal power option will include a high-level description of the option, its likely environmental effects, proposed mitigation and the need for compensation. This information will be sourced principally from the environmental assessment completed for the comparison of the options.

Habitats Regulations Assessment (HRA)

A preliminary screening of requirements under the Habitats Regulations has indicated that a strategic-level appropriate assessment will be required, in accordance with the Habitats Directive. The HRA screening process will be completed following the SEA Scoping stage and the identification of a preferred plan, in line with the Habitats Regulations. The final HRA Screening Report is likely to conclude that significant effects on a number of sites within the Natura 2000 network could occur, and thus an appropriate assessment will be needed for the preferred plan. The HRA will inform, but be separate from, the SEA.

Assumptions

Key assumptions to be used in the SEA of the STP Feasibility Study are set out below:

- The study area for the main assessment phase of the project extends from the tidal limit on the Severn Estuary, downstream as far as a line drawn between Worm’s Head and Morte Point. It includes the landward

34 Under Article 6 (3) of the EU Habitats Directive (Directive 92/43/EEC) as transposed in the UK by the Nature Conservation (Habitats &c.) Regulations (SI 1994/2716), an ‘appropriate assessment’ needs to be undertaken in respect of any plan or project which; either alone or in combination with other plans or projects would be likely to have a significant effect on a site designated within the Natura 2000 network; and is not directly connected with the management of the site for nature conservation.
fringe and tributaries such as the River Wye and the River Usk up to their tidal limit and 1km inland. However, depending on the nature of options shortlisted, and their likely effects, study areas for specific issues will extend beyond this area, for example in relation to effects on migratory birds and fish.

- The SEA will consider construction and commissioning, operation and decommissioning of the short-listed options.
- The STP Feasibility Study covers a number of local authority areas and parts of two English regions and Wales. The SEA will consider potential effects within this area on a common basis and at a strategic scale.
- If any transboundary effects on other EU member states are identified, the appropriate state will be consulted by the Government.
- Where any ancillary development is proposed as an inextricable part of a short-listed option, then this will also be subject to SEA.
- Climate change predictions will be taken into account when considering the future baseline and the assessment of effects.

Mitigation and compensation

During the main assessment phase of the SEA and development of the short-listed options, the potential for adverse environmental effects will be identified. Where possible these will be avoided through the identification of modifications to the options. Where significant adverse effects cannot be avoided, mitigation measures will be identified to reduce them. This may well not be fully possible, so the need for compensation measures to offset these effects will be identified. At this stage, for some potential effects there are currently few (if any) compensation measures identifiable with a high degree of confidence in their effectiveness.

Monitoring

The main assessment phase of the SEA will include recommendations for a proposed monitoring strategy to inform implementation of a tidal power project in the Severn Estuary; if the Feasibility Study shows that the Government can support it. Monitoring will need to consider effects arising during the construction, operation and decommissioning stages. A project may then be developed which will be subject to project-level Environmental Impact Assessment (EIA) and associated monitoring.

Next Steps

In accordance with the requirements of the SEA Regulations, this scoping consultation seeks views from the statutory consultation bodies. We are also seeking views from other persons and organisations and comments
received prior to the close of the consultation will be considered in the
definalisation of the scope. The consultation period will run for twelve weeks.

Following the closure of the scoping consultation stage, all comments will
be reviewed and, where appropriate, modifications will be made to the
scope of the main assessment phase of the SEA.

On completion of SEA scoping, the main assessment phase of the SEA will
commence by undertaking further environmental studies (as identified in
the Scoping Report), input to the design of short-listed options, and the
assessment of the short-listed options against the SEA objectives.

Key Questions for Respondents

When commenting on this document, respondents are encouraged to
consider the following questions:

- Which plans, programmes or environmental protection objectives are
  most significant for this strategic-level environmental assessment?
- Is there any additional information that could help supplement the
  baseline data? Any further information relating to the baseline indicators,
  existing problems and trends over time would be very useful.
- Is there any important information that has not been addressed in view
  of the SEA scope?
- Is the range of environmental problems, issues and receptors covered
  appropriate? Is the level of receptor sensitivity appropriate?
- Is the methodology proposed appropriate for this strategic-level
  environmental assessment?
- Are there any major plans or projects that should be included in the
  assessment of cumulative effects?
- Are there any changes that should be made to the proposed SEA
  objectives; including any consolidation of the objectives? Are there any
  other SEA objectives, assessment criteria or indicators that should be
  included?
- Are the relevant aspects of sustainable development covered, if the
  SEA addresses the issues identified in this SEA Scoping Report?
- Any further suggestions regarding the scope of the SEA and its
  proposed assessment of the short-listed options?
Section 1: Introduction

1.1 The Severn Tidal Power Feasibility Study

The Severn Estuary has one of the highest tidal ranges in the world and the most significant tidal range resource in the UK. The Secretary of State for Business, Enterprise and Regulatory Reform (now the Department of Energy and Climate Change (DECC)) has initiated the Severn Tidal Power (STP) Feasibility Study to consider whether the Government could support a project which exploits the major energy generation potential of this tidal range, and if so, on what terms. This is part of the Government’s wider activities on energy and climate change policy. The STP Feasibility Study will consider all tidal range technologies\(^\text{35}\), but not tidal stream technologies\(^\text{36}\) unless in combination with tidal range.

The STP Feasibility Study is being managed by a cross-government group led by DECC, which includes BERR (which still exists as a department), the Cabinet Office, Department for Environment, Food and Rural Affairs (Defra), Department for Transport, Department for Communities and Local Government, Her Majesty’s Treasury, Wales Office, the Welsh Assembly Government, and the South West Regional Development Agency.

Any project to generate power from the tidal range of the Severn Estuary will need to meet the following objectives (described as the ‘Plan Objectives’);

- to generate electricity from the renewable tidal range resource of the Severn Estuary in ways that will have an acceptable overall impact on the environment and economy both locally and nationally, will meet our statutory obligations and provide benefit to the UK; and

- to deliver a strategically significant supply of renewable electricity, which is affordable and represents value for money compared to other sources of supply in the context of the UK’s commitments under the forthcoming EU Renewable Energy Directive and Climate Change Act and our goal to deliver a secure supply of low-carbon electricity.

The decision on whether to support a STP project will take into account the feasibility and cost of other non-Severn based options to meet the UK’s renewable energy objectives, and goals on low-carbon electricity and carbon reductions.

\(^{35}\) Tidal range is the vertical difference between high and low tides. Electricity is generated by impounding water on the high tide and then passing it through turbines.

\(^{36}\) Tidal stream technologies exploit tidal currents to generate power. The tidal stream resource in the Severn Estuary is not nationally significant (Sustainable Development Commission, 2007).
1.2 Background to the STP Feasibility Study

On 25th September 2007 the Secretary of State for Business, Enterprise and Regulatory Reform (BERR) announced the Severn Tidal Power (STP) Feasibility Study. The relevant parts of BERR have now become the Department of Energy and Climate Change (DECC). Terms of Reference for the Study were published on 22 January 2008 (BERR, 2008b):

‘Building on the work of the Sustainable Development Commission and earlier studies, the STP Feasibility Study will:

- assess in broad terms the costs, benefits and impact of a project to generate power from the tidal range of the Severn Estuary, including environmental, social, regional, economic, and energy market impacts;
- identify a single preferred tidal range project (which may be a single technology/location or a combination of these) from the number of options that have been proposed;
- consider what measures the Government could put in place to bring forward a project that fulfils regulatory requirements, and the steps that are necessary to achieve this;
- decide, in the context of the Government’s energy and climate change goals and the alternative options for achieving these, and after public consultation, whether the Government could support a tidal power project in the Severn Estuary and on what terms.’

The Study is being undertaken through a series of workstreams. The main workstreams are:

- Environmental –including effects on biodiversity, flood management, geomorphology, water quality, and the need for compensatory measures;
- Engineering and technical – options appraisal, costs, design and construction, grid linkage;
- Economic – financing, ownership, energy market impacts;
- Regional socio–economic issues – impacts on business, Severn ports, regional, social and economic impacts;
- Planning and consents - regulatory compliance; and
- Stakeholder engagement and communication.
1.3 Consultation on the STP Feasibility Study

The Government is publishing a consultation document on the STP Feasibility Study, to seek views on:

- the scope of the Strategic Environmental Assessment that is being carried out within the Study;
- which of the 10 possible Severn tidal power schemes under consideration should be short-listed for detailed assessment during 2009; and
- the issues the Feasibility Study is considering and how these are being approached.

This SEA Scoping Report supports the first of these consultation aims.

1.4 Government Policy Drivers

The STP Feasibility Study should be seen within the wider context of the UK’s climate change and energy policies.

Energy policy in the UK faces two very serious challenges: tackling climate change by reducing emissions both here and abroad, and ensuring that our energy supply remains secure. The 2007 Energy White Paper (Department of Trade and Industry, 2007) sets out the Government’s response to these challenges. As well as strongly supporting international action to address climate change at EU, G8 and UN levels, the Government has set the ambitious target of reducing the UK’s carbon emissions by at least 80% by 2050.


1.5 The SEA Directive and Regulations

1.5.1 LEGISLATIVE BACKGROUND


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

Strategic Environmental Assessment (SEA) is an iterative process of gathering data and evidence, assessment of environmental effects, developing mitigation measures and making recommendations to refine plans or programmes in view of the predicted environmental effects. The effects predicted at this stage will remain at a strategic level and will not provide as much detail or certainty as for project level EIAs.

An SEA, which will be compliant with the requirements of the SEA Directive, is being undertaken to assess the environmental effects of proposals to generate electricity from the renewable tidal range resource of the Severn Estuary; and if the Government can support a tidal power project in the Severn Estuary, then to inform the development of a preferred alternative or alternatives.

SI 2004/1633 (The Environmental Assessment of Plans and Programmes Regulations 2004) applies to any plan or programme which relates either solely to the whole or in any part of England, or to England and any other part of the UK. The SEA described in this Scoping Report will therefore be undertaken according to these Regulations37.

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1.5.2 SEA GOOD PRACTICE GUIDANCE

The Government’s ‘Practical Guide to the SEA Directive’ (ODPM et al 2005) provides advice on how to meet the requirements of the SEA Directive and implementing regulations in practice. The preparation of this Scoping Report has followed this guidance which is referred to as the ‘Practical Guide (ODPM et al 2005)’ throughout.

1.5.3 RELEVANCE TO SUSTAINABLE DEVELOPMENT

In addition to the important environmental effects of options, the STP feasibility study aims to look at the effects of any scheme on society and the economy; these are key aspects of sustainable development. Government guidance in relation to wider sustainability appraisals required on certain documents by the Planning and Compulsory Purchase Act 2004 recommends that a single appraisal process is used to look at both environmental and sustainability effects (OPDM, 2005).

The intention is therefore to include sustainability issues where relevant within the SEA. The Scoping Report covers these effects, drawing on guidance and practice on sustainability appraisal. The proposed objectives of the SEA have also been developed having regard to the environmental and wider sustainability plans and polices. The output from this work will be reported within the SEA Environmental Report.

1.5.4 HABITATS REGULATIONS ASSESSMENT (HRA)

The requirements of Article 6 (3) of the EU Habitats Directive (Directive 92/43/EEC) is transposed in the UK by the Habitats Regulations (SI 1994/2716). Article 6 (3) of the EU Habitats Directive requires that an ‘appropriate assessment’ be undertaken in respect of any plan or project which; either alone or in combination with other plans or projects would be likely to have a significant effect on a site designated within the Natura 2000 network; and is not directly connected with the management of the site for nature conservation.

A preliminary screening of requirements under the Habitats Regulations has indicated that a strategic-level appropriate assessment will be required. The HRA screening process will be completed following the SEA Scoping stage and the identification of a preferred plan, in line with the requirements of Regulation 48 of the Habitats Regulations. The final HRA Screening Report is likely to conclude that significant effects on a number of sites within the Natura 2000 network could occur, and thus an appropriate assessment will be needed for the preferred plan. The Habitats Regulations Assessment will inform, but be separate from, the SEA.
The requirements of the Habitats Regulations are addressed further in Section 8.8.8 of this report.

1.6 Purpose of this Report

This Scoping Report is being issued to accompany the STP Feasibility Study consultation document as the first step in the SEA process. Its aim is to invite views on the scope of the SEA proposed in this document.

At this stage, views are sought from the Consultation Bodies designated in the SEA Regulations (SI 2004/1633) (Cadw, Countryside Council for Wales, English Heritage, Environment Agency, and Natural England), but in addition, comments from any other party will be considered when refining the scope of the SEA. Following confirmation of the scope, the main assessment phase of the SEA will be undertaken. This will examine the effects of alternative options.

Further details regarding the structure of this Scoping Report are provided in Section 2.2.

1.7 Authors of this report

The SEA is being conducted on behalf of the cross-government group, by a consortium of specialist environmental consultants. This consortium is led by Parsons Brinckerhoff and also includes Black & Veatch, ABPmer, ENVIRON, HR Wallingford, Wessex Archaeology, APEM, and BTO.
Section 2: Key features of the scoping stage of the sea

2.1 Tasks in the Scoping Process

The Practical Guide (ODPM et al., 2005) breaks the SEA process down into five key stages (A-E) and for each stage it recommends specific tasks that should be undertaken.

The main stages in the SEA process are shown in Figure 2.1 below.

**Figure 2.1 Stages in the SEA process**

A. Setting the context and objectives, establishing the baseline and deciding on the scope

B. Developing and refining alternatives and assessing effects

C. Preparing the Environmental Report

D. Consulting on the draft plan or programme and the Environmental Report

E. Monitoring implementation of the plan or programme

Stage A covers activities to be undertaken at scoping stage. Stages B and C will comprise the main assessment phase of the SEA, according to the scope defined by this phase. Table 2.1 below lists the tasks in Stage A and sets out where these tasks are presented in this Scoping Report.
### Table 2.1 Scoping stage tasks

<table>
<thead>
<tr>
<th>Task in Stage A (Scoping) of the SEA process</th>
<th>Purpose of the Tasks</th>
<th>Section of this Scoping Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1: Identifying other relevant plans, programmes and environmental protection objectives</td>
<td>This stage establishes how other plans, programmes and other environmental protection objectives might influence the SEA process and the development of the STP project. The process is particularly useful for identifying potential SEA objectives by identifying prominent international and national objectives.</td>
<td>Section 5: Identifying other relevant plans, programmes, and environmental protection and enhancement objectives.</td>
</tr>
<tr>
<td>A2: Collecting baseline information</td>
<td>This process provides the evidence base for the assessment and is also necessary to identify existing environmental problems and potential SEA objectives.</td>
<td>Section 6: Collecting baseline information and identifying existing problems.</td>
</tr>
<tr>
<td>A3: Identifying environmental problems</td>
<td>Through the gathering of baseline data and the review of other relevant plans, programmes and environmental protection objectives it is possible to identify potential future environmental issues that the SEA and STP Feasibility Study must take into consideration when assessing options.</td>
<td>Section 7: Identifying Potential Issues.</td>
</tr>
<tr>
<td>A4: Developing SEA objectives</td>
<td>The SEA objectives are developed to help structure the assessment of the potential environmental and sustainability effects of the alternatives being considered as part of the STP Feasibility Study. The SEA objectives will be used as a benchmark for comparing the relative performance of options, with the assessment indicating the extent to which the objectives can be met.</td>
<td>Section 8: Developing SEA objectives and the assessment framework.</td>
</tr>
<tr>
<td>A5: Consulting on the Scope of the SEA</td>
<td>This process seeks feedback on whether the SEA covers all necessary issues and establishes the framework for the rest of the process.</td>
<td>Section 9: Next steps.</td>
</tr>
</tbody>
</table>

### 2.1.1 STUDY AREA

The location of the Severn Estuary is shown in Figure 2.2.

The study area used for the scoping stage of the SEA broadly extends from the River Severn upstream tidal limit at Maisemore to downstream on the Severn Estuary as far as a line drawn between Worm’s Head and Morte Point. It includes the landward fringe and tributaries such as the River Wye and the River Usk up to the tidal limit and 1km inland.

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38 A recognised method of assessing the effects of a plan or programme, to compare alternatives and to assess the preferred alternative.
This study area has been determined by the footprint of the potential spread of options which could extract tidal range power from the Severn Estuary, and any areas which may be affected by doing so.

However, study areas for specific issues will extend beyond this area and these are defined separately within the scoping process and are summarised where appropriate in this report. This includes, for example, migratory fish and birds that spend part of their life cycle outside the Severn Estuary.

2.1.2 TEMPORAL RANGE FOR EFFECTS

For the purposes of Scoping, the temporal range for effects considered is the expected lifetime of the scheme, allowing for identification of key issues that may emerge over construction, operation and decommissioning. The expected operational life is currently assumed to be 120 years although in practice operation may be extended or may be shorter for certain options.

Owing to the early stage of option development, and the strategic nature of this study, there is currently little detail regarding the nature of construction and decommissioning. The scoping of potential effects has therefore been undertaken principally in relation to operational effects, although mindful of issues that may emerge during the construction or decommissioning phases.

2.2 Structure of the Scoping Report

The structure of this Scoping Report adheres to the requirements of the SEA Directive (2001/42/EC) as well as the applicable Regulations (SI 2004/1633) and the Practical Guide (ODPM et al., 2005). Table 2.2 below sets out the structure of this Scoping Report. The Scoping Report has been prepared to assist consultees comment on the scope and the level of detail proposed for the SEA Environmental Report.

At the start of each section of this Scoping Report, the requirements of the SEA Directive are summarised.
Figure 2.2 The Severn Estuary
## Table 2.2 Report structure

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
<td>Provides an overview of the objectives for the STP Feasibility Study as a whole and sets the SEA and its scoping stage in this context.</td>
</tr>
<tr>
<td>2. Key features of the scoping stage of the SEA</td>
<td>Sets out the activities to be undertaken during scoping. Sets the spatial and temporal scope used. Describes the structure of the Scoping Report.</td>
</tr>
<tr>
<td>3. Consultation</td>
<td>Provides an overview of the consultation that has been conducted. Sets out the consultation process to be employed in later stages of the process.</td>
</tr>
<tr>
<td>4. Identification of alternatives considered</td>
<td>Describes the approach to the development and assessment of alternatives.</td>
</tr>
<tr>
<td>5. Identifying other relevant plans, programmes, and environmental protection and enhancement objectives</td>
<td>Identifies synergies and potential inconsistencies with relevant national and regional plans. Contributes to the development of SEA objectives and the SEA framework.</td>
</tr>
<tr>
<td>6. Collecting baseline information and identifying existing problems</td>
<td>Summarises the baseline information. Identifies trends in key baseline data and receptors and existing environmental problems. Provides a preliminary assessment of the receptors’ sensitivity to changes.</td>
</tr>
<tr>
<td>7. Identifying potential issues</td>
<td>Summarises the key issues for the human and natural environment that could arise from STP options. Defines the scope of studies in the main assessment phase to assess change and issues.</td>
</tr>
<tr>
<td>8. Developing SEA objectives and the assessment framework</td>
<td>Explains the purpose of SEA objectives and how they are derived. Sets out the assessment framework and defines key assumptions to be used in the main SEA assessment.</td>
</tr>
<tr>
<td>9. Next steps</td>
<td>Summarises the next steps in the SEA. Sets out the contents of the proposed environmental report for the main SEA assessment and identifies particular areas where responses to the Scoping Report are sought.</td>
</tr>
</tbody>
</table>
Section 3: Consultation

The SEA Directive requires consultation with authorities designated by Member States ‘which, by reason of their specific environmental responsibilities, are likely to be concerned by the environmental effects of implementing plans and programmes (Article 6.3)’.

Consultation should be undertaken with these authorities ‘when deciding on the scope and level of detail of the information to be included in the environmental report’ (Article 5.4).

Furthermore, authorities with environmental responsibility and the public ‘...shall be given an early and effective opportunity within appropriate time frames to express their opinion on the draft plan or programme and the accompanying environmental report before the adoption of the plan or programme’ (Article 6.2).

3.1 Purpose of this Scoping Consultation

In accordance with the SEA Directive, the aim of this scoping consultation is to invite stakeholder views on the scope of the Strategic Environmental Assessment (SEA) for proposals to generate electricity from the renewable tidal range resource of the Severn Estuary. Public comment is sought in addition to statutory requirements. The consultation period will run for twelve weeks.

In making their comments on this document and supporting documents, respondents are encouraged to consider the following questions:

- Which plans, programmes or environmental protection objectives are most significant for this strategic-level environmental assessment?
- Is there any additional information that could help supplement the baseline data? Any further information relating to the baseline indicators, existing problems and trends over time would be very useful.
- Is there any important information that has not been addressed in view of the SEA scope?
- Is the range of environmental problems, issues and receptors covered appropriate? Is the level of receptor sensitivity appropriate?
- Is the methodology proposed appropriate for this strategic-level environmental assessment?
- Are there any major plans or projects that should be included in the assessment of cumulative effects?
- Are there any changes that should be made to the proposed SEA objectives; including any consolidation of the objectives? Are there any other SEA objectives, assessment criteria or indicators that should be included?
- Are the relevant aspects of sustainable development covered, if the SEA addresses the issues identified in this SEA Scoping Report?
- Any further suggestions regarding the scope of the SEA and its proposed assessment of the short-listed options?

3.2 SEA Consultation to Date

BERR (now DECC) advertised in January 2008 the intention to undertake an SEA for the STP Feasibility Study.

The scoping consultation already undertaken to date is summarised below. Further information can be found in the SEA Pre-scoping Consultation Report (Parsons Brinckerhoff, 2008b).

3.2.1 SEA STEERING GROUP

In May 2008, selected organisations were contacted to invite representatives to form the SEA Steering Group. The objective of the Steering Group is to guide the SEA to ensure it is delivered in an effective, efficient and timely manner, to provide general advice and technical expertise to ensure a robust evidence base and outcomes, to promote stakeholder involvement in the process and consultations, and to achieve timely preparation of quality documents to inform decision milestones within the STP Feasibility Study.

The Steering Group does not have decision making powers but is constituted in an advisory capacity to advise the SEA team at specific key points during the study to ensure that outputs are sufficiently robust to facilitate the Project Board in their decision making. Specifically, the Steering Group is responsible for:

- Reviewing the Call for Evidence and criteria for options assessment, and the selection of alternatives from potential schemes following assessment of the evidence base;
- Monitoring compliance with legal requirements such as those of the SEA Directive, the Birds and Habitats Directives and the implementing regulations;
- Inputting to the scoping, consultation and methodology selection for the SEA;
- Reviewing proposed data collection objectives, scope and methods;
- Reviewing the drafts of the SEA documents;
- Promoting stakeholder awareness and engagement in the SEA process.

Steering Group meetings to review progress and discuss issues have been held on 21st May, 1st July, 5th September and 4th November 2008.

### 3.2.2 CALL FOR EVIDENCE

The consortium managing the SEA process issued a Call for Evidence on 12th May 2008 (BERR 2008a). The Call formed two parts:

- ‘Call for Proposals’ inviting evidence-based proposals for development, which will generate electricity from the tidal range of the Severn Estuary. This closed on 13 June 2008.
- ‘Call for Information’ inviting interested parties to submit information, which could potentially contribute to the evidence base for the initial appraisal of schemes and the SEA. This closed on 11 July 2008.

Over 50 responses were made to the Call for Information. These are summarised in Appendix 1.

### 3.2.3 TECHNICAL WORKSHOPS

During the SEA scoping stage, a range of methods were used to develop both understanding and the evidence base. In some cases, this included ‘technical workshops’ with recognised experts, in addition to individual consultations and other activities such as the Call for Information. Table 3.2 lists the technical workshops held.

These meetings concentrated on establishing the evidence base in each technical area, and identifying the key issues that would apply to the assessment of alternative options. The workshops therefore played a key role in the preparation of the Scoping Report.

### 3.2.4 STAKEHOLDER WORKSHOP

A stakeholder workshop was held in Cardiff on 23rd July 2008. The aim of this workshop was to inform the scope of the SEA with a regional perspective. The workshop was a combination of information sharing from BERR (now DECC) and the team delivering the STP Feasibility Study; and also information gathering, where stakeholders took part in breakout sessions addressing technical topics. The meeting was recorded to capture the key findings that emerged.
Table 3.2 Schedule of technical workshops

<table>
<thead>
<tr>
<th>Date</th>
<th>Workshop Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>25th June 2008</td>
<td>Hydraulics and Geomorphology</td>
</tr>
<tr>
<td>3rd July 2008</td>
<td>Ornithology</td>
</tr>
<tr>
<td>8th July 2008</td>
<td>Migratory Fish, Marine/Estuarine Fish, &amp; Recreational Fisheries(^{39})</td>
</tr>
<tr>
<td>16th July 2008</td>
<td>Flood Risk and Land Drainage</td>
</tr>
<tr>
<td>16th July 2008</td>
<td>Marine Ecology</td>
</tr>
<tr>
<td>30th July 2008</td>
<td>Landscapes and seascapes</td>
</tr>
<tr>
<td>10th September 2008</td>
<td>Hydraulics and Geomorphology (second workshop)</td>
</tr>
</tbody>
</table>

3.3 Future Consultation

Following the closure of the scoping consultation stage, all comments will be reviewed and, where appropriate, modifications will be made to the scope of the main assessment phase of the SEA.

The SEA Environmental Report and draft plan will be issued for formal consultation in line with the requirements of the SEA Regulations. It is currently anticipated that the public consultation period will occur in Winter 2009/10, for a period of 12-weeks.

DECC will be consulting on the draft STP Feasibility Study Plan, accompanied by the SEA Environmental Report. This will take the form of an overarching consultation document.

If any transboundary effects are predicted, then DECC will consult with the relevant EU Member State Governments. The Severn Estuary’s notification as a Ramsar Site means that wider consultation may also need to be undertaken.

During the preparation of the plan implementing the Feasibility Study, the Environmental Report and the opinions expressed will be taken into account. Once the plan is adopted, a post-adoption statement will be made available to consultation bodies and the public.

\(^{39}\) A second workshop on Migratory Fish, Marine/Estuarine Fish, & Recreational Fisheries was held on 12 September 2008 for government departments and government agencies only.
Section 4: Identification of Alternatives

The SEA Directive (Article 5 (1)) requires preparation of an environmental report ‘in which the likely significant effects on the environment of implementing the plan or programme, and reasonable alternatives taking into account the objectives and geographical scope of the plan or programme, are identified, described and evaluated’.

4.1 Introduction

The identification of reasonable alternatives (known hereafter as the short-listed options) has been undertaken through the application of an ‘assessment framework’ (not to be confused with the SEA Assessment Framework described later in this document). The plan objectives look at using the tidal range resource of the Severn Estuary, and as such the identification of reasonable alternatives has focused on proposals based in the study area.

The Interim Option Analysis (Parsons Brinckerhoff, 2008a) contains a technical assessment (including environmental factors, but prior to the main assessment stage of the SEA) of each of the options and identifies proposals that have the technical capability to meet the quantitative elements of the plan objectives. The methodology for the identification of the short-list is further explained in Section 4.3 of this report.

However, the SEA, and the Feasibility Study of which it is part, should be seen as a subset of the UK’s climate change and energy policies as set out in Section 1. As such, further to the technical assessment of the options, a view has been taken by Government as to whether there are any strategic considerations which impact on an option’s ability to be progressed to the shortlist. This includes fit with other policies. Examples might be that the scale of compensatory habitat required is not available or the proposal does not represent value for money and as such would not be built.

DECC has published a consultation document that considers these issues and seeks views on the recommended short-list. Following the consideration of the consultation responses, the short-listing process will have defined the ‘reasonable alternatives’ that the SEA will assess; i.e. the list of options which could feasibly meet the objectives of the plan to utilise the tidal range of the Severn Estuary. In addition, as the principal question the study is addressing is whether the Government can support a tidal power project in the Severn; a ‘do nothing in the Severn’ option is incorporated.
The SEA Environmental Report will include an explanation as to why the alternatives were chosen.

4.2 Proposals Identified

Identification of potential options for the generation of tidal power using the tidal range of the Severn has been undertaken using inputs from three sources:

- Call for Proposals, issued as part of the Call for Evidence issued on 12 May 2008;
- The options studied by the Sustainable Development Commission in ‘Turning The Tide’ (Sustainable Development Commission, 2007);
- Other strategic options which were not covered by proposals in the items listed above.

This process of option identification developed the long-listed options (Table 4.1). These were then screened using the assessment framework to develop the short-listed options.

The alignments of each of the long-listed options are illustrated in Figure 4.1.

<table>
<thead>
<tr>
<th>Table 4.1 Long-listed options</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option No</strong></td>
</tr>
<tr>
<td>B1</td>
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<tr>
<td>B2</td>
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<tr>
<td>B3</td>
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<td>B4</td>
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<td>B5</td>
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<td>F1</td>
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<tr>
<td>L2</td>
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<tr>
<td>L3</td>
</tr>
<tr>
<td>R1</td>
</tr>
<tr>
<td>U1</td>
</tr>
</tbody>
</table>
Figure 4.1 Alignments of long-listed options
4.3 Identification of short-listed options

The long listed options were screened in terms of how they could meet the plan objectives. This included a technical consideration of both quantitative (energy yield, carbon reduction, cost etc.) and qualitative factors (impact on environment, region etc.) with sensitivity testing included contained within the Interim Option Analysis Report (Parsons Brinckerhoff, 2008a).

The proposals that had sufficient merit quantitatively and/or qualitatively were then further assessed to determine their feasibility in meeting the plan objectives and to determine whether it is reasonable to take them forward.

The recommended short list was compiled taking account of the quantitative and qualitative assessment and other issues such as the impact on the energy market, how a project may be financed, what position the Government will want to take including the cost and nature of the support, and associated cost implications to comply with EU environmental protection legislation including compensatory habitats.

The identification of the short-listed options is being consulted on alongside this Scoping Report, through the STP Feasibility Study consultation document, and the chosen options will be considered during the main assessment phase in accordance with the SEA Directive.
Section 5: Identifying other relevant Plans, Programmes, and Environmental Protection and Enhancement Objectives

The SEA Directive (Annex 1) lists the information to be provided in the Environmental Report.

Annex 1a requires ‘an outline of the contents, main objectives of the plan or programme and relationship with other relevant plans and programmes’ and Annex 1e requires ‘the environmental protection objectives, established at international, Community or Member State level, which are relevant to the plan or programme and the way those objectives and any environmental considerations have been taken into account during its preparation’ to be set out.

5.1 Introduction

A review of plans, programmes and environmental protection and enhancement objectives assists with the following:

- The identification of environmental objectives of other relevant plans or programmes that should guide the SEA process.
- The baseline data collection process by identifying key indicators and baseline trends.
- The development of the SEA framework which comprises objectives, indicators and targets.
- Determining whether there are any interactions between the plans, programmes and environmental protection objectives and the emerging plan which is the subject of the SEA process.

At this scoping stage, the review has focused on the international, national and regional level, and has thus considered plans and policies such as National Energy Strategies, National and Regional Land Use/Spatial Plans, and Regional Economic Strategies.
This review identified potential SEA objectives for the STP Feasibility Study. These were then further developed during the scoping process to define the SEA objectives as set out in Section 8.

Local Development Frameworks and other local level plans have not been considered at this stage but relevant objectives or targets within local planning policy frameworks will be identified during the main assessment phase of the SEA.

5.2 Relevant Plans and Programmes

A review of relevant international, national and regional level policy documents has been undertaken. The most relevant plans and programmes are set out below, and this includes those that have been recommended during informal consultation during the scoping process. Further consideration of these plans and programmes has been taken in the environmental baseline (see Section 6), potential issues (see Section 7) and in the development of SEA objectives (see Section 8).

5.2.1 INTERNATIONAL PLANS AND PROGRAMMES


In 2007, the UK agreed with its EU partners to a binding target that 20% of the EU’s energy consumption must come from renewable sources by 2020. The European Commission has proposed in the draft EU Renewables
Directive that the UK’s contribution to this should be to increase the share of renewables in the UK’s energy mix from around 1.5% in 2006 to 15% by 2020.

5.2.2 UK PLANS AND PROGRAMMES

Relevant UK plans and programmes include sustainable development strategies such as the UK Government Sustainable Development Strategy: Securing the Future (UK Government, 2005) and the UK’s Shared Framework for Sustainable Development, One Future – Different Paths (UK Government and Devolved Administrations, 2005) which focus on a synergistic approach to energy supply and demand solutions as well as other plans to ensure environmental and social protection such as Earth Science Conservation in Great Britain – A Strategy (Nature Conservancy Council, 1990), Biodiversity – the UK Action Plan (Various, 1994) and the subsequently published individual habitat and species action plans and associated targets for maintaining, restoring and creating habitats.

There is already a wide range of policies in place to deliver increased renewables deployment in the UK. Of particular note is the draft Renewable Energy Strategy (BERR, 2008c), which contains a range of possible additional measures, including promoting the development of new renewable technologies. Consultation on this document closed on 26th September 2008.

The full Renewable Energy Strategy will be published in Spring 2009, once the EU Directive has been agreed, along with the UK’s share of the target. The Strategy will set out a clear framework to provide certainty and detail on the policies the UK will introduce; and actions the UK will undertake to reach the 2020 target and to promote renewable energy in the UK for the long term.

The draft Renewable Energy Strategy states that achieving the UK’s share of the EU target could require a third or more of electricity to be generated from renewable sources by 2020. Tidal range technologies (potentially including a major tidal range project in the Severn Estuary) have the potential to provide low carbon energy with the largest options being capable of contributing up to 7% of the UK’s total electricity demand.

5.2.3 WELSH PLANS AND PROGRAMMES

sites are to be in favourable condition, by 2015 95% of Welsh SSSIs are to be in favourable condition, with all sites in favourable condition by 2026. The *Marine Renewable Energy Strategic Framework for Wales Phase 1* (Welsh Assembly Government, 2008b) provides environmental data and information on constraints to tidal power generation in Wales and the *Renewable Energy Route Map* (Welsh Assembly Government 2008c) (and the subsequent Welsh Assembly Government Energy Strategy, due early 2009) sets out the Welsh Assembly Government’s plans for diversified renewable energy generation.

There are a wide range of relevant Welsh policies including Technical Advice Notes (TANs) for a variety of topics such as *Renewable Energy* (TAN 8 (Welsh Assembly Government, 2005)); *Nature Conservation and Planning* (TAN 5 (Welsh Assembly Government, 1996)) (and its revision, currently in draft) and *Tourism* (TAN 13 (Welsh Assembly Government, 1997)).

### 5.2.4 English Plans and Programmes

Defra has set a series of targets described as *Public Service Agreements* (PSA), including the promotion of sustainable development, reduction in greenhouse gas emissions and the bringing into favourable condition by 2010 95% of all nationally important wildlife sites. There are wide range of policies including Planning Policy Statements (PPSs) and Planning Policy Guidance (PPGs) for a variety of topics such as *Delivering Sustainable Development* (PPS1 (Department for Communities and Local Government, 2005)); *Biodiversity and Geological Conservation* (PPS9 (Department for Communities and Local Government, 2005)); *Planning and the Historic Environment* (PPG15 (Department for Communities and Local Government, 1994)); *Coastal Planning* (PPG20 (Department of the Environment, 1992)); and *Development and Flood Risk* (PPS25 (Department for Communities and Local Government, 2006)).

Furthermore there are programmes such as the cross Government initiative ‘Making Space for Water’ which is taking forward the developing strategy for flood and coastal erosion risk management in England.

### 5.2.5 Regional Plans

A *River Basin Management Plan* is currently in preparation for the River Severn, under the Water Framework Directive. A consultation document on the draft plan was published in December 2008 (Environment Agency, 2008) and contains important information to inform the next stage of the assessment.

Other plans included in the policy review include regional plans such as spatial and economic strategies for South West England (South West
5.2.6 OTHER PLANS

Other plans which have not yet been included in the policy review but which may need to be considered during the main assessment stage include Shoreline Management Plans, Flood Risk Management Strategies, Catchment Abstraction Management Strategies, Water Resource Management Plans, Water Level Management Plans; relevant Site Management Statements and management plans for SACs, SPAs and SSSIs and Environment Agency Review of Consents Habitat Regulations Assessments.

5.3 Summary

A wide range of plans and programmes were reviewed for relevant environmental protection objectives, and these have been considered in the development of the SEA objectives (see Section 8). Further plans have been recommended for consideration during informal consultation during the preparation of the scoping report; and may also emerge during consultation on this document. The policy review will therefore be updated, following consultation, and the SEA Objectives reviewed and revised where necessary.
Section 6: Collecting Baseline Information and Identifying Existing Problems

The SEA Directive (Annex 1 (b) and (c)) respectively requires baseline data to include ‘the relevant aspects of the current state of the environment and the likely evolution thereof without implementation of the plan or programme’ and ‘the environmental characteristics of areas likely to be significantly affected’.

The SEA Directive (Annex 1 (d)) requires the identification of ‘any existing environmental problems which are relevant to the plan or programme including, in particular, those relating to any areas of environmental importance...’.

6.1 Introduction

For the purposes of scoping, the environmental issues are considered in detail within ‘topic papers’ prepared by specialists in each area (Parsons Brinckerhoff, 2008c – 2008r). The areas covered by the topic papers are:

- existing baseline including problems and future trends (summarised in this Section) including assumptions and limitations;
- key environmental and social issues and the scope of assessment proposed for the main assessment phase (summarised in Section 7);
- proposed SEA objectives and assessment criteria (discussed in Section 8);
- preliminary consideration of mitigation, compensation; cumulative and synergistic effects and trans-boundary effects and a monitoring strategy (discussed in Section 8).

In this Section, for each topic, the key receptors in the study area, their existing problems and future trends in the absence of a STP project are summarised. A preliminary scoping-stage assessment of the sensitivity of each of the receptors to change is presented in Appendix 3.

40 For the purposes of scoping, sensitivity to change is based on judgment of the importance of the receptor and its vulnerability to environmental change. This approach is not suitable for all receptors for the more detailed main assessment phase and will need to be reviewed in the main stage of the SEA.
For some topic areas, relevant receptors and their sensitivity can be identified at this scoping stage. For other receptors, at this stage there is far greater uncertainty as to receptor sensitivity, and their exposure to effects from tidal power options. In these cases it has not been possible to reach a consensus on receptor sensitivity during the scoping phase. It will therefore be necessary to review receptor sensitivity once short-listed options are identified, and in the light of feedback on this Scoping Report.

The future trends are the changes to the baseline that may occur over the lifetime of the Feasibility Study (assumed to be 120 years once operational). Scheme construction is currently expected to start in 2014 or later, and be operational in 2017 or later. The long time period means that there is uncertainty regarding the changes that may occur to the baseline over this timeframe.

Table 6.1 below lists the topics presented and shows how they relate to the requirements of the SEA Directive.

### Table 6.1 Scoping topics

<table>
<thead>
<tr>
<th>STP SEA Scoping Topic</th>
<th>SEA Directive Topic</th>
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<tbody>
<tr>
<td>Hydraulics &amp; Geomorphology</td>
<td>Water</td>
</tr>
<tr>
<td>Society &amp; Economy</td>
<td>Population, Human Health, Air, Cultural Heritage, Material Assets</td>
</tr>
<tr>
<td>Marine Ecology</td>
<td>Biodiversity, Fauna, Flora</td>
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<tr>
<td>Ornithology</td>
<td>Biodiversity, Fauna</td>
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<tr>
<td>Migratory and Estuarine Fish</td>
<td>Biodiversity, Fauna</td>
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<tr>
<td>Terrestrial and Freshwater Ecology</td>
<td>Biodiversity, Fauna, Flora</td>
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<td>Marine Water Quality</td>
<td>Water</td>
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<td>Freshwater Environment &amp; Associated Interfaces</td>
<td>Water, Soil</td>
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<tr>
<td>Flood Risk and Land Drainage</td>
<td>Water, Material Assets</td>
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<td>Noise &amp; Vibration</td>
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<tr>
<td>Carbon Footprinting</td>
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<tr>
<td>Other Sea Uses</td>
<td>Material Assets, Population</td>
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<td>Navigation</td>
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<td>Historic Environment</td>
<td>Cultural Heritage</td>
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<tr>
<td>Landscape &amp; Seascape</td>
<td>Landscape</td>
</tr>
<tr>
<td>Resources and Waste</td>
<td>Material Assets</td>
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</table>

*Note: Environmental issues are considered within 'topic papers’ (Parsons Brinckerhoff, 2008c – 2008r)*
The STP SEA topics are listed in an order that corresponds to the topics listed in the SEA Directive and are not in order of priority or importance. Each of the STP SEA Scoping topics may cover more than one SEA Directive Topic. This is because the estuary is a functional whole and thus the divisions into SEA topics are therefore artificial. The interrelationships between these topics are identified in Section 7.2.4.

Building on the SEA Directive topics, the STP SEA topics were developed at the beginning of the scoping phase based on the issues that were considered to be most important for this strategic level study. As further information on the baseline and potential issues is gathered, the scope of each of these topics may alter accordingly.

Air quality and traffic and transport may typically feature as separate topics in an SEA. However, as this study does not involve any new transportation link; then any transport related effects on air quality will be principally associated with construction. Thus traffic and transport and air quality issues are not significant enough to warrant stand-alone topics and are instead considered within the Society & Economy topic.

In this SEA, an understanding of effects on estuary hydraulics and geomorphology is fundamental to the assessment of many other topics, e.g. marine ecology, birds, fish and water quality. Thus Hydraulics and Geomorphology is discussed prior to the remaining scoping topics.

6.2 Relevance to sustainable development

The intention of this SEA is to consider social and economic effects of the options and thereby address key aspects of sustainable development. The Scoping Report covers effects relevant to social and economic aspects of sustainable development principally within the ‘Society and Economy’, and ‘Resources and Waste’ topic areas. However, topic areas such as ‘Flood Risk and Land Drainage’, ‘Noise and Vibration’, ‘Other Sea Uses’, ‘Navigation’, ‘Landscape and Seascape’ and ‘Migratory and Estuarine Fish’ will also be relevant.

6.3 Hydraulics and Geomorphology

The Severn Estuary is characterised by its hypertidal range (over 14m), leading to large variations in suspended and bed-load sediment between spring and neap tides. This high-energy environment can also move large quantities of sediments and alter channel morphologies between tidal cycles.

These characteristics of the Severn Estuary are due to its shape and location. The funnel shape to the Severn Estuary derives from its geological evolution, human intervention and interaction with present-day physical
processes. The Severn Estuary’s location allows the direct approach by ocean tides and Atlantic swell waves. The net effect is an estuary with an extreme tidal range and exposure to prevailing storms. This also leads to the Severn Bore phenomenon.

Significant problems and trends in the next 100 years and further into the future are likely to be driven by climate change and the Severn Estuary’s response to hotter drier summers, warmer wetter winters and increased flooding, as well as sea level rise and an increased risk of extreme weather events (UKCIP, 2008). These can be expected to result in coastal squeeze and a loss of intertidal habitat, although there are plans and policies in place that aim to off-set such losses (ABPmer, 2008).

6.4 Society and Economy

The principal settlements along the Severn Estuary are Cardiff, Swansea, Newport, Port Talbot, Bristol, Gloucester, Cheltenham and Weston-Super-Mare. Economic sectors include major trading ports, industry, mining, commercial fishing, manufacturing, wholesale, retail, hotels, restaurants and real estate. Tourism and recreation are of high importance. Low intensity farming dominates in rural areas. Major transport links cross the estuary including the two Severn Bridges and the Severn railway tunnel.

Wales has been experiencing net in-migration, and demographic and health trends reflect the declining birth rates and increases in life expectancy. Crime in Wales has been decreasing, being lower than many other areas in the UK but inequality and discrimination still exist.

In the South West of England inequalities in health correlated with socio-economic deprivation are widening, however, life expectancy is increasing. A relatively low overall level of deprivation is likely to continue and there will be continued disparities in levels of crime between areas within the South West.

Employment in Wales has been relatively stable, with a slight increasing trend. Skills will be increasingly important for labour market success. Employment and earnings are lower compared with the UK average; however these have shown a positive trend. The economy appears to be diversifying, and property prices have increased rapidly in the recent past.

The South-West of England’s economy has been forecast to grow significantly over the next 20 years. Economic growth will not be uniform across sectors. Those with the greatest potential for growth in the period to 2010 include business services, other services and education.

41 The situation where the coastal margin is squeezed between the fixed landward boundary (artificial or otherwise) and the rising mean sea level (Doody, 2001).
In both Wales and the South West of England, population growth has been predicted due to increases in employment and economic growth. The populations of South Wales and the South West have been predicted to see significant growth, including an increase in residential development in the coming years, due to the major transport links and relative proximity to London (DTZ, 2008). Recreational and tourism pressures may also increase.

Recent changes in the global, national and regional economic climate (Bank of England, 2008) could result in alterations to trends that were predicted even in the last few months.

It will be important to refine the ‘Society and Economy’ baseline in the next phase of the SEA to ensure that regional issues associated with specific options are addressed.

6.5 Marine Ecology

The high tidal range in the Severn Estuary creates unusual physical conditions which strongly influence the composition, distribution and abundance of its flora and fauna. The resultant ecological importance of the estuary is recognised through international, national and local nature conservation designations.

Paramount is the Severn Estuary cSAC (see Figure 6.1), part of the Severn Estuary European Site, which contains the following habitat types and species (amongst others): estuaries, mudflats and sandflats not covered by seawater at low tide, Atlantic salt meadows, sandbanks which are slightly covered by sea water all the time, sublittoral *Sabellaria alveolata* reefs, sea lamprey, river lamprey, and twaite shad.

The Severn Estuary is also designated as a Rasmar site\(^\text{42}\) for; *inter alia*, its immense tidal range and unusual estuarine communities with reduced diversity and high productivity.

There are further internationally designated sites, principally for their ornithological or fish interests, and these are discussed in subsequent sections below.

Flora and fauna type and distribution are influenced by the high tidal range. Plant life in the water column is limited by the consequent high turbidity and small animals in the water are dominated by detrital grazers. There is little seaweed present because of the high turbidity of the overlying water. Animals living on the estuary bed include seasonally large populations of the brown and other shrimps. Most common species of cuttlefish are

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42 Ramsar sites are wetlands of international importance designated under the Ramsar Convention.
known to occur. Harbour porpoise are seasonally present but overall there are few records for marine mammals.

The Severn Estuary Coastal Habitat Management Plan (CHaMP) has provided an indication of the predicted morphological evolution of the estuary, assuming that the current flood defences are maintained (ABPmer, 2008). Overall there is predicted to be a net loss of approximately 9% of Severn Estuary cSAC intertidal mudflat and sandflat over the next 100 years (2005-2105). Trends in saltmarsh distribution are also expected to show an overall decline in the next fifty years. Plans and policies are already in place with the aim of off-setting such losses. For example, the Severn Estuary CHaMP seeks to provide information for Shoreline Management Plans and coastal defence strategies by quantifying habitat change and identifying options to make up for any negative effects on the sites involved.

6.6 Ornithology

The Severn Estuary is designated as a Special Protection Area (SPA) under the EU ‘Birds Directive’, for supporting qualifying populations of six species of waterbird and an overall assemblage of 68,000 waterbirds which significantly exceeds the required threshold of 20,000 waterbirds. The qualifying species were Bewick swan, dunlin, white fronted goose, shelduck, redshank, and gadwall. The Severn Estuary is also listed as a Ramsar site, a wetland of international importance designated under the Ramsar Convention for its internationally important bird assemblage and for the population size of ten species of waterbird and seabird. Other waterbirds or seabirds are features of the national designation of the Severn Estuary Site of Special Scientific Interest and a further six Sites of Special Scientific Interest (SSSIs) within the study area. These sites are shown on Figure 6.1.

The UK Biodiversity Action Plan (UKBAP) sets national targets for a number of the species included in these designations and for many species in the study area that are not specially designated. In turn Section 41/42 of the Natural Environment and Rural Communities (NERC) Act 2006 lists BAP Species of Principal Importance in England and Wales and Birds of Conservation Concern. The study area also supports bird species that are not subject to specific conservation targets.

Existing issues include recent declines in five of the 16 species that contribute to the overall assemblage for which the SPA is designated. These include white fronted goose and dunlin, which are two of the six specific bird populations for which the SPA was designated. For many of these species, the magnitudes of changes in numbers are broadly similar
to those occurring regionally and nationally. This would suggest that large-scale factors such as climate change are at least partially responsible. Overall, the constituent SSSI units of the SPA are mostly in favourable condition; however a minority are in unfavourable condition, for example due to coastal squeeze and disturbance from public access.

Similarly, decreasing trends in the proportions of waders that winter in south-west Britain have been correlated to increasing temperature and hence to climate change. This trend has been predicted to continue; however, populations that currently winter further south could move north to winter in the Severn Estuary.

Climate change is likely to bring further changes in the distribution of species. However it cannot be assumed that population trends of recent decades would continue. In some circumstances sea-level rise and extreme weather events could reduce the attractiveness of east coast estuaries and increase the importance of the Severn Estuary as an area for wild birds.

6.7 Migratory and Estuarine Fish

The Severn Estuary and Rivers Tywi, Usk and Wye have been designated as Special Areas of Conservation (SACs) (see Figure 6.1) and support seven migratory fish species, including five Annex II species protected under the EU Habitats Directive, notably allis and twaite shad, sea and river lamprey, and Atlantic salmon (the last of these not applying to the River Tywi) (see Figure 6.2 for recorded locations of salmon, sea and river lamprey, and allis and twaite shad). All seven of the migratory fish species that pass through or use the Severn Estuary (sea trout and eel in addition to those listed above) are part of the qualifying criteria for the Severn Estuary’s Ramsar designation, and are UK Biodiversity Action Plan (BAP) priority species. Ten other species (marine migrants: cod, herring, plaice, sole, whiting; and marine stragglers: blue whiting, hake, horse mackerel, ling, saithe) recorded in the Bristol Channel and the Severn Estuary are subject to a Species Action Plan as part of the UK BAP. The estuarine fish community as a whole is also a qualifying feature for the Severn Estuary’s Ramsar designation.

Other rivers of note for their fisheries include the Rivers Ely, Taff, Rhymney, and Ebbw in Wales, Rivers Avon, Yeo, Parrett and Axe in England and the River Severn (Wales and England). In the inner Bristol Channel marine fish are dominant and the majority of individuals within the estuary are juveniles. The River Severn catchment supports coarse, salmonid and eel freshwater fisheries, and these make important contributions to the regional economy. The Severn Estuary and rivers within the study area, particularly the River Usk and Wye and coalfield rivers are important for recreational fisheries. Some fisheries have heritage as well as economic value.
The constituent SSSI units of the Rivers Tywi, Wye and Usk SACs, and the Severn Estuary cSAC are subject to periodic condition assessment. The salmon populations within both the Rivers Usk and Wye are considered to be in unfavourable condition. Environment Agency National Salmon Team review under the Salmon Action Plan indicate that over the next five years there is expected to be a continued minor reduction in salmon stocks in the River Wye and a slight upward trend for the Rivers Usk and Severn.

During the most recent review of the condition of constituent SSSI units, the only UK river deemed to have favourable river lamprey status was the River Usk SAC, and for sea lamprey it was the River Wye SAC. All SAC's in the recent condition assessment round were classed as unfavourable for both allis and twaite shad populations.

6.8 Terrestrial and Freshwater Ecology

There are a large number of Sites of Special Scientific Interest (SSSIs) and a small number of National Nature Reserves (NNRs) within the study area (see Figure 6.1). These are designated for their national importance for species and habitats often on account of rarity, size or extent, or their value as representative populations and habitats. There are also Local Nature Reserves (LNRs), local designated wildlife sites and UK BAP priority species and habitats.

The current status and future trends of terrestrial and freshwater ecology receptors are highly variable, from feature to feature and subject to numerous influences. The main source of information on existing baseline condition used in this report has been taken from SSSI condition reporting.

A review has been conducted of the condition of SSSI units contained within internationally designated sites (SACs, SPAs and Ramsar sites) and units contained within other SSSIs that fall inside the study area. Due to differences in data collection methods, this review has been split into sites that have been assessed using data from Natural England and those that have been assessed using data from CCW.

Of the Special Areas of Conservation and Special Protection Areas (that are also Ramsar sites) assessed by Natural England within the study area:

- The Walmore Common SPA has units in both favourable and unfavourable (no change) condition due to drainage issues;
- The Somerset Levels & Moors SPA & Ramsar site contains units in a predominantly unfavourable condition with the majority of these in an unchanging state. Factors such as water pollution, scrub encroachment, drainage issues and agricultural run-off are all contributing to its condition;
The Severn Estuary cSAC, SPA & Ramsar site (also in Wales) and River Wye SAC have been discussed above.

Data has been obtained from Natural England for the condition of units within the remaining SSSIs identified within the study area. Of these SSSIs, many contain units in a predominantly unfavourable condition.

Data has also been obtained from CCW for SACs and SPAs within the study area:

- Dunraven Bay and Wye Valley Woodlands SACs, predominantly contain features in a favourable condition;
- Limestone Coast of South West and Wales SAC contains favourable and unfavourable condition units;
- Carmarthen Bay Dunes, Pembrokeshire Marine/Sir Benfro Forol, Kenfig and Carmarthen Bay and Estuary SACs, mostly contain features in an unchanging or declining unfavourable condition;
- Bury Inlet SPA contains features that are all of a favourable condition;
- River Usk and River Tywi SACs have been discussed above.

In 2006, data from a Rapid Review was used to make an interpretation of the condition of SSSIs in Wales as a whole. This data has been obtained from CCW for the SSSIs identified within the study area\textsuperscript{44}. Of these SSSIs, most contain units in a predominantly unfavourable condition.

Within designated areas there are a number of factors causing unfavourable condition. In England, Government has set a target to bring 95% of SSSIs into favourable or recovering condition by 2010. The Welsh Assembly Government’s Wales Environment Strategy targets are: by 2010 95% of international sites to be in favourable condition, by 2015 95% of Welsh SSSIs to be in favourable condition, with all sites in favourable condition by 2026. Climate change is expected to become an increasingly significant factor affecting the existing baseline conditions and consideration of conservation objectives over the next 100 years.

\textsuperscript{44} This information provided by CCW on SSSI condition is a combination of Rapid Review data and results from the first programme of Common Standards Monitoring for SAC and SPA features in Wales (completed in 2007). Because many of these sites are also SSSIs, this data has been used to assess condition for a significant number of SSSI features. CCW relies on ‘Rapid Review’ data to assess the condition of SSSIs. Rapid Review monitoring offers only an indicative picture of the condition of a sample of SSSI features. It is based on an assessment of best available information (e.g. survey data, field visits) for the features, combined with CCW officers’ professional judgement. In general, if all the assessed features on the site were deemed to be in favourable condition, then the site was regarded as being in favourable condition. However, if one or more features were judged to be in unfavourable condition then the whole site was deemed to be in unfavourable condition.
6.9 Marine Water Quality

Discharges to the Severn Estuary include direct, diffuse and aerial inputs. A well-mixed estuary, it has a north-south salinity gradient and elevated temperatures in the vicinity of large thermal discharges. Sediment contamination by trace metals, PAHs and PCBs is present and elevated concentrations of Ni, Cd, Hg and Zn (heavy metals) are found at the mouth of the Severn Estuary.

The Severn Estuary and Bristol Channel receive one of the highest UK inputs of the nutrients nitrogen and phosphorus to the marine environment, reflecting the estuary’s size, the location of human settlements and the catchment’s agricultural land use. Waterbodies that are currently considered to be ‘sensitive’ under the EC Urban Waste Water Treatment Directive (91/271/EEC), on the basis that they are eutrophic (nutrient enriched) or may become eutrophic in the near future if protective action is not taken, are shown on Figure 6.3. Sensitive bathing waters are also shown.

The introduction of the EC Water Framework Directive (2000/60/EC) (WFD), is likely to result in improved surface water quality as it sets a default objective of achieving ‘good status’ by 2015. Draft WFD objectives for the Severn could be affected by the proposed tidal power options. It will also be necessary to consider the uncertainties associated with climate change issues. These are as yet poorly understood.

To inform the assessment of existing problems, water quality classes are being introduced under WFD. Depending on ambient salinity, nutrient concentrations could be consistent with the achievement of ‘good’ or ‘moderate’ ecological status. In the absence of ecological evidence of eutrophication effects associated with these elevated nutrient concentrations, the affected waters might be considered to be consistent with the achievement of good ecological status. The draft River Basin Management Plan for the Severn Estuary published in December 2008 will further inform the evaluation of current status.

6.10 Freshwater Environment and Associated Interfaces

The Severn Estuary is bordered by a complex sequence of geologically recent deposits, most of which are water-bearing and in hydraulic continuity with the surface water system, particularly on the low-lying land of the Somerset and Gwent Levels. These deposits contain a large number of services, including drains, culverts and sewers. They form the foundation for an extensive system of tidal defence embankments, and contain building foundations and basements. They also contain areas of landfill and historic waste disposal.
The recent deposits are underlain by folded and fractured bedrock which emerges at ground surface on both sides of the coast, forms two islands in the estuary (Flat Holm and Steep Holm) and is exposed extensively sub-tidally. The Severn railway tunnel runs within these bedrock deposits. Several groundwater sources used for the Public Water Supply emerge from the Carboniferous Limestone and have Source Protection Zones that abut the coastline.

The Severn Estuary contains many sites of geological and geomorphological interest, several of which are designated as SSSIs. Several regionally important geological sites (RIGS) are also present.

Land drainage is dominated by the Severn Estuary itself, several major tributaries and a network of multiple drains on the lower levels, many of which are tide-locked for part of the tidal cycle. Surface water abstraction is also undertaken to provide for the Public Water Supply.

The distribution of soil types is relatively well known and the soil resource is likely to come under increasing protection in the next 5-10 years as EC legislation ‘Soil Framework Directive’ is likely to be implemented. What is less understood are the factors that will influence changes in soil quality: climate change, particularly changing rainfall patterns, affecting soil wetness; land drainage and agricultural practices; erosion rates and patterns. These make it extremely difficult to predict problems that may take place over the next century.

It is assumed that coastal geological and geomorphological SSSIs and RIGs would be affected by climate change. Effects could include reduced accessibility and increased erosion of softer sedimentary sites as a result of sea level rise.

Water resources (both groundwater and surface freshwater) are however likely to come under increasing pressures from anthropogenic activity and factors driven by climate change, such as sea level rise. Implementation of the WFD is however likely to improve freshwater water quality on a catchment-wide basis over the intermediate term.

6.11 Flood Risk and Land Drainage

Within the study area there are large areas of land including over 40,000 properties, amenity and agricultural land. These rely on tidal flood defences and land drainage systems to reduce the risk of tidal and fluvial flooding. The tidal floodplain and known outfalls are shown in Figure 6.4.

The ongoing processes of sea level rise and associated coastal squeeze are the main existing problems facing flood risk management. The forecast of approximately 1m sea level rise (SLR) in the next 100 years (Defra, 2006)
will have significant implications for flood risk management of the coastal flood plain. The Government is addressing this issue through the Shoreline Management Planning process which is led by the Environment Agency.

Defra has overall responsibility for sustainable flood and coastal erosion risk policy in England and the Welsh Assembly Government (WAG) takes a similar role in Wales. ‘Making Space for Water’ (Defra, 2005) is the cross-Government programme taking forward the developing strategy for flood and coastal erosion risk management in England. Delivery of this policy is through ‘operating authorities’.

The Environment Agency commenced work in early 2008 with the objective of delivering a Severn Estuary Flood Risk Management Strategy. The ongoing work is addressing many of the flood risk issues including the assets at risk, the condition of defences, the risk of failure and overtopping of defences, the effects of climate change and sea level rise in particular. The output of the work will be a strategic approach to flood risk issues in the Severn Estuary over a 100 year period.

6.12 Noise and Vibration

Both humans and wildlife are receptors for noise. Sources of noise include industry, transportation noise, urban and commercial areas. In rural locations noise sources include farming activities and wildlife. As a result of the Environmental Noise Directive (Directive 2002/49/EC), strategic noise maps now exist for parts of the Severn Estuary area. These indicate the level of noise problems associated with major industry and transport infrastructure.

Most noise sources in the area are anticipated to gradually increase in level due to intensification of use.

6.13 Carbon Footprinting

The global level of Greenhouse Gases (GHGs) in the atmosphere due to anthropogenic activity causes global warming and changes to the climate. Changes to the climate will cause a wide range of problems, inter alia, including increased risk of inland flash floods, more frequent coastal flooding and increased erosion (due to storminess and sea level rise) (IPCC, 2007).

Information about the current status of UK emissions has been published by UK Climate Impacts Programme (UKCIP, 2008). It summarises the current state of the climate in the UK and shows maps of, for example, recent mean and maximum temperatures, and recent precipitation across the UK which have all increased.
The Severn Estuary supports a range of habitats, mainly intertidal areas, which both store carbon and interact with atmospheric levels of GHGs through the capture of carbon from the atmosphere. Decomposition of organic matter in these habitats may also act as a source of methane, another GHG.

The UK’s contribution to future trends is reliant upon the commitment of the UK to meeting the targets set in UK legislation following the Kyoto Protocol and the UN Framework Convention on Climate Change, both of which emphasise the need to significantly reduce GHG emissions.

Under the Kyoto Protocol, which is legally binding, the UK has committed to reduce its GHG emissions to 12.5% below 1990 baseline for CO₂, methane and nitrous oxide, and below 1995 baseline for fluorinated compounds over the period 2008-2012. The UK has currently committed to a national goal of reducing CO₂ emissions by 20% by 2010 and to reduce greenhouse gas emissions by 80% by 2050.

6.14 Other Sea Uses

Sea uses that occur in the Severn Estuary and Inner Bristol Channel include marine aggregate dredging; marine waste disposal; commercial fisheries; recreation and tourism; military activity; energy (including oil & gas, renewable energy resources and power stations); cables and pipelines (see Figures 6.5 and 6.6).

Changes in policy and practices may result in changes in fisheries and aggregates dredging being focused offshore. Industrial waste discharges may be expected to continue to decline, but estuarine pollution via surface runoff may increase due to increased rainfall.

6.15 Navigation

The Severn Estuary is home to a number of commercial ports including significant facilities at Bristol, Cardiff, Newport and Sharpness/Gloucester. The largest port, the Port of Bristol comprises both Avonmouth and Royal Portbury docks. The ports and the services they support are an important part of the local and regional economy, and are responsible for handling a significant proportion of UK trade.

All of the major ports within the Severn Estuary currently rely on locking into their respective docks and each plan ship movements according to available draughts as a consequence of the high tidal range. The operation of the ports requires regular survey and dredging of navigation channels.
Future trends in water levels are most likely to be in response to climate change and the effect of an increased mean sea level. The Bristol Port Company has submitted proposals for the construction of a non-locked deep sea container terminal with an annual capacity of 1.5 million containers.

6.16 Historic Environment

The historic environment is a finite non-renewable resource. In the Severn Estuary it consists of both natural and built components and is one of the most significant in the UK. It consists of internationally, nationally, regionally and locally important sites (see Figure 6.7). The Severn Estuary’s features are located along its coast-line (including prehistoric and Roman features); its waters hold features reflecting its maritime heritage dating from the Bronze Age, and its associated levels and hills offers a rich and varied archaeological and historic landscape such as the Gwent Levels.

The potential of the Severn Estuary is not however limited to, or even fully represented by, the number of nationally designated sites, but also includes a vast number of non-designated sites and finds, and has a high potential for the discovery of new finds. The historic environment also includes cultural issues such heritage fishing, name places with cultural associations or traditional skills dependent on the estuary.

The historic environment may be affected by changes to the coastline through coastal erosion and future developments. However, the future will also see the continued exploration of the historic environment of the Severn Estuary and the collation of existing material.

6.17 Landscape and Seascape

Statutory and non-statutory designated landscapes in and near the Severn Estuary include National Parks (NPs), Areas of Outstanding Natural Beauty (AONB), Heritage Coast sites and the Gwent Levels historic landscape (see Figure 6.7). National Parks seek to conserve and enhance landscapes’ natural beauty, wildlife and cultural heritage and to promote opportunities for the understanding and enjoyment of their special qualities by the public. AONBs seek to conserve and enhance the natural beauty of the area.

Changes to landscape and seascape character and impacts on visual amenity are likely to arise from response to sea level rise and increased flooding, development and changes in farming practices.
6.18 Resources and Waste

There are over 100 landfill sites currently permitted for the disposal of waste in and around the study area. There are limited facilities for the disposal of hazardous waste (e.g. contaminated soils) in the UK; three operational sites have been identified in and around the South West England study area, while there is no capacity for hazardous waste disposal in Wales.

Landfill voidspace and projected landfill lifespan are in decline as existing landfill sites are filled in conjunction with limited increases in the development of new landfill capacity.

The South West and South Wales Regional Aggregates Working Parties (which provide advice on the supply and demand for construction aggregates) estimate that the South West region permitted reserves in 2005 were around 900 million tonnes for crushed rock and 53 million tonnes of sand and gravel and in 2006 in South Wales available active aggregate reserves comprised 370 million tonnes. The availability of reserves could be extended through increased use of secondary aggregate material. Further assessment will be needed of the availability and suitability of secondary aggregates within a predetermined distance of the proposed development.

Severn Estuary marine sources supply 80-90% of the local aggregates requirements for the construction industry in South Wales. The current reserve permitted in licensed areas may not be sufficient to supply exceptional additional quantities in addition to the baseline market demand.
Figure 6.1 International and National Nature Conservation Sites
Figure 6.2 Recorded Locations of Salmon, Allis and Twaite Shad and Sea and River Lamprey
Figure 6.2 Recorded Locations of Salmon, Allis and Twaite Shad and Sea and River Lamprey
Figure 6.3 Locations of Bathing Waters and Sensitive Areas
Figure 6.4 Tidal Floodplain and Outfalls
Figure 6.5 Marine aggregate extraction, dredging disposal areas, other marine assets.
Figure 6.5 Marine aggregate extraction, dredging disposal areas, other marine assets
Figure 6.6 Other marine uses and tourist attractions
Figure 6.6 Other marine uses and tourist attractions
Figure 6.7 Historic Environment and Landscape
Section 7: identifying potential issues

The SEA Directive (Annex 1 (f)) requires the identification of ‘the likely significant effects on the environment, including on issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape and the interrelationship between the above factors’.

The SEA Directive (Annex 1 (f)') also requires SEA environmental reports to include consideration of ‘secondary, cumulative, synergistic, short, medium and long term permanent and temporary, positive and negative effects’.

7.1 Introduction

One of the key purposes of scoping is the identification of the environmental issues that should then be considered in the scope of the assessment of plan alternatives. Issue identification is also an important step towards the development of appropriate SEA Objectives, that are used in part of the process of option assessment.

The identification of key environmental issues has been based upon the collation of baseline data and the review of other relevant plans, programmes and environmental protection and enhancement objectives. The identification process has retained a strategic perspective and has been focused upon those issues that are particularly relevant in view of the nature and scale of the Feasibility Study's likely effects.

To ensure coverage of the potential issues, a range of generic options has been considered in the scoping topic papers (Parsons Brinckerhoff, 2008c – 2008r) to help identify the spread of issues that may arise from the development of tidal power in the Severn Estuary. The range of options comprises a large barrage constructed across the wider region of the Estuary, a small barrage constructed across the narrower region of the Estuary, and a land connected lagoon constructed on one or other side of the Estuary. This does not presuppose that these, or any other options, will form the shortlist of options that will be considered in the main assessment phase of the SEA.

The requirements of the strategic-level Habitats Regulations Assessment are addressed in Section 8.8.8.
7.2 Potentially Significant Issues

7.2.1 INTRODUCTION

This section provides a review of potentially significant issues that could be associated with tidal range power development in the Severn Estuary. It has been prepared adopting the precautionary principle. If a risk has been identified that tidal power options might cause severe or irreversible harm to society or to the environment, and in the absence of a scientific consensus that harm would not ensue, the assumption has been made that such a risk exists. The identification of such risks is not necessarily an indication at this stage of the severity or likelihood of effects.

Any large-scale tidal power development within the Severn Estuary which takes a significant fraction of the energy out of the system will inevitably make significant changes to the tidal regime. It will reduce tidal energy over a wide area (both up and downstream), with consequential effects for human activities and the natural environment.

Changed tidal conditions will have a wide range of secondary effects on the physical environment of the Severn Estuary, including effects on water levels, flows, waves, estuary sediment regime and morphology, and water quality.

An understanding of the effects of tidal power options upon the hydraulics and geomorphology of the Severn Estuary is therefore fundamental to predicting the environmental effects of such schemes.

7.2.3 UNCERTAINTIES AFFECTING THE IDENTIFICATION OF POTENTIALLY SIGNIFICANT ISSUES

Data gaps, assumptions and uncertainties are considered in detail within ‘topic papers’ (Parsons Brinckerhoff, 2008c – 2008r).

Consultations and research during scoping have identified that the effects of tidal power options on the geomorphology of the Severn Estuary are an area of considerable uncertainty. This requires further investigation to inform many of the future studies within the SEA. Such investigations notwithstanding, there is however likely to be residual uncertainty in relation to physical effects in general and long-term geomorphological effects in particular, on completion of the SEA.

The scoping stage has also identified major uncertainties in understanding relating to the life history and behaviour of many migratory and estuarine fish, and the consequent effects of a major tidal power scheme. Given their conservation importance this represents a further key area that will need to be addressed. It will not be possible to gain a full understanding of this
area within the timescale of the Feasibility Study, so therefore studies will need to concentrate on assembling current knowledge and uncertainties will be emphasised.

Waterbirds are also designated to international level and require adequate data to support their assessment, even at a strategic level. There are important gaps in data that need to be addressed in order that robust impact modelling can be undertaken. The approach proposed within the SEA, adopting Habitat Association modelling, may need to be supplemented with Individual Based Modelling for selected species to further reduce the level of uncertainty attached to the assessment.

Until the outcome of assessments of effects on hydraulics and suspended sediments within the SEA are known, it is difficult to define studies that might be required to assess interactions between suspended sediments, primary productivity and eutrophication effects. This could have important implications for marine ecological effects. The scope of water quality studies will therefore need to be kept under review until the preliminary findings of SEA studies in relation to suspended sediments are known.

The process of issue-identification has been informed by a preliminary review of receptors\(^{40}\) in each topic area and their potential sensitivity, and the effects of a representative range of tidal power options. This process is described more fully in each topic paper (Parsons Brinckerhoff, 2008c – 2008r). It has not however been possible to achieve consensus during informal feedback on the preliminary assignment of the sensitivity of some receptors. The preliminary assignment of sensitivity to receptors within the topic papers is therefore uncertain, and in some cases is not possible at this scoping stage. Receptor sensitivity will therefore need to be reviewed at the outset of the main SEA Assessment phase, once the physiochemical effects of short-listed options are better understood.

7.2.3 REVIEW OF POTENTIALLY SIGNIFICANT ISSUES

Notwithstanding the uncertainties outlined above, in accordance with the SEA Directive (Annex 1 (f)), environmental issues have been identified and are considered further within ‘topic papers’ (Parsons Brinckerhoff, 2008c – 2008r).

The review of key issues has established that tidal power options present a wide range of potential issues that require significant research and assessment to understand adequately.

The Government has set ambitious targets to reduce carbon emissions by 80% by 2050 and increase renewable energy. The Severn Estuary

\(^{40}\) A receptor is an entity that may be affected by direct or indirect changes to an environmental variable.
represents one of the largest single project potential contributors of low carbon energy, with the largest options being capable of contributing up to 7% of the UK’s total electricity demand.

The effect of tidal power options would be to reduce the tidal range within the estuary. Previous studies have shown that a large barrage between Cardiff and Weston would result in a raising of mean upstream water levels by some 2.5 to 3m in ebb-generation mode and a greater than 50% reduction in the upstream tidal range to 4.5m on spring tides and 2.5m on neap tides (STPG, 1986). High water height would be reduced by as much as 1m on spring tides but approximately 0.5m on neap tides. The tidal influence downstream of such a barrage showed a slight reduction in high water and raising of low water, resulting in a net reduction in tidal range of around 1m in the sea outside the barrage. This effect diminishes with distance away from the barrage, but was still predicted at distances of around 100km seaward, indeed a reduction of 0.05m in tidal range was predicted at Morte Point.

The changes in tidal range will result in a large change to the exposure of intertidal flats in the estuary, although this may be reduced through mode of operation and/or lagoon configuration. One modelling study has estimated this effect as a direct reduction of about 14,500ha on spring tides for sites upstream of a barrage on the Cardiff-Weston alignment (SDC, 2007). More recent estimates have been made to allow a direct comparison of long-listed options. These have suggested greater reductions in intertidal area, at around 20,000ha for an equivalent barrage. However, the estimations were calculated on a more simplistic and conservative basis (Parsons Brinckerhoff, 2008a). With the reduced tidal range predicted outside the barrage, there will also be a very much smaller reduction in the intertidal area seaward of the barrage.

The consequent effects on the morphology of the Severn Estuary are uncertain and subject to divergent hypotheses, but these changes would be to the detriment of inter-tidal and sub-tidal habitats and infrastructure such as outfalls and flood defence embankments (Parsons Brinckerhoff, 2008c).

These habitats are protected under European law in their own right, and also support a range of similarly protected waterbirds. Tidal power options are also very likely to adversely affect passage and survival within the Severn Estuary by a range of fish species, again protected under European law. There are therefore high levels of risk to protected habitats and species, particularly, but not only, estuarine habitats, migratory fish and waterbirds.
The alteration in tidal range may indirectly lead to changes to the Severn Estuary’s water flushing characteristics and its concentrations of suspended sediments. This in turn may alter distributions and concentrations of contaminants in estuary water and sediments. The changes in suspended sediments may also affect primary productivity and the potential for eutrophication effects. Tidal power options therefore have the potential to affect the water quality status of the Severn Estuary and need consideration having regard to the objectives of the Water Framework Directive.

Depending on the nature of shortlisted options, there could be very substantial effects during construction such as on employment and labour pools, the housing market and access to local services, resource availability to existing industrial activities, population changes and health effects. In the longer term there is the possibility of indirect and wider economic effects, for example arising from effects on navigation and other marine activities, access to recreation and tourism, and the opportunity for economic regeneration and new development.

There is also a need for greater understanding of other potential effects such as for flood risk and land drainage, landscape and seascape, and the historic environment. A wide range of other effects to the natural and human environment are also likely. The spread of environmental and social issues presented by tidal power options as discussed in the topic papers (Parsons Brinckerhoff, 2008c – 2008r), are summarised in Table 7.1. These issues will need to be considered in the main assessment phase of the SEA.

The scale and nature of the effects that may be identified during the main assessment phase are therefore very likely to pose unprecedented challenges, and for some potential effects there are currently few (if any) mitigation or compensation measures available with a high degree of confidence in their effectiveness. This has been supported by a preliminary review specifically in relation to the Habitats Directive (Parsons Brinckerhoff, 2008s).

Specialist SEA studies are therefore needed to understand the effects of options, develop mitigation measures and identify compensation needs.
### Table 7.1 Potentially significant issues

<table>
<thead>
<tr>
<th>Topic</th>
<th>Potentially significant issues</th>
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</table>
| **Hydraulics and Geomorphology** | - Changing tidal conditions upstream and downstream of options  
                                  - Consequent effects on the baseline environment, e.g. water levels, flows (including the  
                                    Severn tidal bore), waves, estuary sediment regime and morphology, water quality,  
                                    existing defences |
| **Society and Economy**       | - Effects of direct and indirect employment opportunities/ constraints on employment and the economy  
                                  - Effects of in-migration and economic changes on population characteristics, distribution  
                                    and trends within the study area  
                                  - Effects of direct and indirect employment opportunities/constraints on the distribution of  
                                    areas of social deprivation, low earnings, and high dependence on benefits  
                                  - Effects such as noise and air quality, flooding, in-migration and other indirect effects on  
                                    health and quality of life  
                                  - Changes to access to community services and facilities  
                                  - Changes to access to recreational facilities and open space  
                                  - Effects on land use, quality and regeneration  
                                  - Effects of in-migration on the quality, value and availability of housing stock  
                                  - More detailed baseline needed with greater relevance to regional issues |
| **Marine Ecology**            | - Reduced intertidal areas and reduced inundation and extent of saltmarsh resulting in loss of functionality  
                                  - Reduction in extent of Sabellaria alveolata reef  
                                  - Implications for distribution and extent of fauna and flora as a result of changes in  
                                    sediment erosion and deposition patterns, salinity, turbidity and water exchange  
                                    (flushing)  
                                  - Changes in the primary productivity (planktonic and epibenthic) due to changes in the  
                                    light climate, water depth and bed shear stresses  
                                  - Effects on spread of non-native marine species |
| **Ornithology**              | - Disturbance to birds during construction  
                                  - Displacement of birds  
                                  - Changes to or loss of intertidal habitat available for birds  
                                  - Changes to saltmarsh affecting breeding waders, waterbirds and Section 41/ 42 (NERC,  
                                    2006) wintering passerines  
                                  - Changes to freshwater wetlands for birds |
| **Migratory and Estuarine Fish** | - Potential loss of genetic diversity and/or local species extinction  
                                  - Alterations to migratory cues for fish  
                                  - Disruption to movements including turbine injury and mortality and complete loss of  
                                    certain or all stock  
                                  - Habitat changes or loss for feeding and nursery areas, or movements  
                                  - Water quality effects on fish movements and survival  
                                  - Consequent effects on commercial (net and fixed engine) fisheries, recreational  
                                    freshwater and sea angling |
| **Terrestrial and Freshwater Ecology** | - Permanent habitat degradation, fragmentation and loss arising from construction in or near sensitive sites, leading to species disturbance and mortality  
                                  - Changes to water levels and quality and associated flora and fauna from operation  
                                  - Effects on spread of invasive species  
                                  - More detailed review of receptors and their sensitivity is needed |

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45 Issues may apply to construction and operational phases unless indicated otherwise. ‘Society and Economy’ and ‘Resources and Waste’ have particular relevance to sustainable development issues.
<table>
<thead>
<tr>
<th>Topic</th>
<th>Potentially significant issues</th>
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<tbody>
<tr>
<td><strong>Marine Water Quality</strong></td>
<td>• Change in concentrations of contaminants in estuary water/sediments</td>
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<td>• Changes to estuary salinity regime and stratification</td>
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<td></td>
<td>• Changes to estuary water flushing characteristics and light attenuation</td>
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<td></td>
<td>• Changes to sediment concentrations, transport and processes</td>
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<td></td>
<td>• Changes in suspended sediments leading to changes in primary productivity and potential for eutrophication effects</td>
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<tr>
<td><strong>Freshwater Environment</strong></td>
<td>• Altered freshwater water quality</td>
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<td>and Associated Interfaces</td>
<td>• Altered freshwater groundwater regimes</td>
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<td>• Altered water quality affecting the Public Water Supply</td>
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<td>• Changes to Geological and Geomorphological SSSIs</td>
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<tr>
<td><strong>Flood Risk and Land Drainage</strong></td>
<td>• Attenuation of surge tides reducing flood risk</td>
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<td>• Changes to propagation of wave action into the upper estuary</td>
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<td></td>
<td>• Changes to tidal regime restricting fluvial discharge through some low outfalls in the upper estuary</td>
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<td>• Morphological changes affecting defence structures</td>
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<td>• Potential for enhanced water level management for nature conservation</td>
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<tr>
<td><strong>Noise &amp; Vibration</strong></td>
<td>• Construction phase noise affecting human health and disturbing wildlife</td>
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<td>• Operation phase noise affecting wildlife</td>
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<td><strong>Carbon Footprinting</strong></td>
<td>• Changes to greenhouse gas emissions arising from:</td>
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<td></td>
<td>• Raw material supply and component manufacture</td>
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<td>• Energy generation from renewable sources</td>
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<td>• Transportation during construction and installation</td>
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<td></td>
<td>• Operational dredging, and pumping</td>
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<td>• Changes to the estuarine ecosystem, including habitat loss/creation leading to changes in methanogenesis and sequestration</td>
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<td>• Decommissioning</td>
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<td><strong>Other Sea Uses</strong></td>
<td>• Changes to sediment characteristics in aggregate dredging areas</td>
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<td></td>
<td>• Change to dilution and dispersion of water discharges and disposals</td>
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<td>• Change to the hydraulic function of marine outfalls</td>
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<td>• Changes to the integrity of marine infrastructure in the estuary</td>
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<td>• Changes to navigation affecting other sea uses</td>
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<td>• Changes to marine fish and thus marine commercial fishing activities</td>
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<td><strong>Navigation</strong></td>
<td>• Changes in tide levels and salinity affecting port access</td>
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<td>• Options acting as physical barriers to navigation</td>
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<td>• Changes to currents presenting a potential navigation hazard</td>
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<td></td>
<td>• Changes in immersion regime affecting marine structure maintenance</td>
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<td><strong>Historic Environment</strong></td>
<td>• Direct damage to features and disturbance of wider surroundings</td>
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<td>• Indirect damage or exposure of features due to physical changes to the estuarine environment</td>
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<td>• Visual impact on the historic environment</td>
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<td>• Changes to access to the historic environment</td>
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<td>• Effects on heritage fishing and other cultural issues such as name places with cultural associations or traditional skills dependent on the estuary</td>
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<tr>
<td><strong>Landscape and Seascape</strong></td>
<td>• Changes to land use/infrastructure affecting character of the shoreline and further afield</td>
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<td>• Effect on views of the estuary in its setting due to structures, change in tidal range, intertidal and salt marshes and water clarity as well as new land use/(ancillary) development</td>
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<td></td>
<td>• Reduction in the dynamic character of the estuary through altered tidal conditions with consequent effects on the Severn tidal bore</td>
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<td>• Loss of tranquillity during the construction and operational phase</td>
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<td>• Effect of views from important viewpoints and designated sites</td>
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7.2.4 **TOPIC INTERRELATIONSHIPS**

The effects of any tidal power option arise from a complex interaction of factors. Whilst still not yet fully understood, an appreciation of the potential for interactions between the topics presented within this scoping report, is important to the development of an integrated scope of works for the main assessment phase and thereby ensuring that the requirements of the SEA Directive (Annex 1 (f)) are met.

Table 7.2 below identifies the range of interrelationships between the SEA scoping topics. It indicates those topics with an interrelationship, generally in the sense that together they form a pathway for an effect to occur.

For example, tidal power options’ effects on water currents (an aspect of hydraulics) provide a strong pathway for effects on water quality. Effects on water quality in turn have a strong influence on effects on marine ecological receptors.

There are a host of other interactions between topics that form a pathway for effect. The importance of these for the strategic assessment of effects is not yet fully understood. This may be because the relationship may be weak, or the scale of effects small. For example, mitigation measures to manage flood risk may impact upon archaeological features, but the risk is not well understood at this stage. These linkages are nonetheless identified for further consideration.

Conversely, in some cases there is no apparent linkage between topics that would lead to an effect, for example there is no pathway of effect between ornithology and historic environment. Absence of linkages are therefore also identified.
### Table 7.2 Interrelationships between SEA scoping topics

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<td>Terrestrial and Freshwater Ecology (TFE)</td>
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<td>Noise and Vibration (NV)</td>
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<td>Carbon Footprinting (CF)</td>
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<td>Other Sea Uses (SU)</td>
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<td>Resources and Waste (RW)</td>
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**Key:**
- **Strong relationship/interaction**
- **A relationship/interaction**
- **Limited or no relationship/interaction**
7.3 Scope of assessment proposed to address issues

7.3.1 INTRODUCTION

During the SEA main assessment phase, consideration needs to be given to the potentially significant issues identified in Section 7.2, the aim being the identification of significant effects in accordance with the SEA Directive. This will entail assessment of the nature and magnitude of environmental changes arising from tidal power options; and their complex interrelationships occurring over long timescales. It is anticipated that specialist studies will be required to support this assessment, and thereby ensure SEA findings are robust. Recommendations are therefore set out in Table 7.3 in relation to the scope of these specialist studies.

The proposed scope of studies is an evolution of the analyses and recommendations undertaken within the scoping of specific topic areas. The outcome is a prioritised programme of studies, taking into account the key environmental risks, the strategic nature of the study, and technical limitations imposed by the timescale for reporting within the STP Feasibility Study as a whole.

At the completion of the SEA, there will inevitably be issues that will not have been explored to the extent that all reasonable uncertainty is removed. Some of these issues have already emerged during the scoping process, but these and others will be described as the SEA progresses. Notably, the complexity of interactions between the component parts of the studies has been identified. This helps ensure that interdependencies are acknowledged within the programme of work for the main assessment. Nonetheless, the effects of tidal power options arise from a highly complex interaction of physical, ecological and human factors; and not all of these can be understood or described in the SEA. The uncertainties that remain will be reported and measures to address them, such as further research or monitoring, identified.

The SEA scope of work has been the subject of informal consultation with Statutory Consultation Bodies and the SEA Steering Group, and will also be informed by the planned public consultation exercise in Winter 2008/9. The main assessment studies will continue to be subject to review and input by technical review groups in each key area, with each group meeting at the detailed planning stage, and to review preliminary findings.
### Table 7.3 Proposed data collection and tools

<table>
<thead>
<tr>
<th>Hydraulics and Geomorphology</th>
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<tbody>
<tr>
<td>An understanding of hydraulic and geomorphological issues is fundamental to the assessment of effects in other topic areas. An extensive programme of work is therefore planned with the main assessment SEA phase:</td>
</tr>
<tr>
<td>Desk based review of available evidence at other ‘analogue’ sites;</td>
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<tr>
<td>Improve baseline understanding of intertidal morphology and sediment budgets through the collation of existing data;</td>
</tr>
<tr>
<td>Improve baseline understanding of suspended sediments and their relationships between tidal range/energy through collation of existing data;</td>
</tr>
<tr>
<td>Confirm far-field extent of impacts on hydraulics by applying existing broad-scale models, use outputs to guide offshore boundary conditions for further modelling;</td>
</tr>
<tr>
<td>Model changes to hydraulics from options (water levels and flows). Will include typical spring-neap cycle, extreme flood risk events and climate change scenarios. Quantify direct changes to flow environment;</td>
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<tr>
<td>Quantify direct changes to intertidal areas and inundation to saltmarshes over study area;</td>
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<tr>
<td>Investigate wave regime by applying local wave model driven by winds. Determine wave energy patterns across intertidal areas;</td>
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<tr>
<td>Investigate mud transport by applying mud transport model to investigate baseline and short-listed options. Assess future siltation rates and supply of sediments to saltmarshes;</td>
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<tr>
<td>Develop sediment budget based on studies above. Assess sensitivity to locally sourced construction material;</td>
</tr>
<tr>
<td>Investigate sand transport using inputs above and applying sand transport model to investigate baseline and short-listed options;</td>
</tr>
<tr>
<td>Assess morphological evolution of intertidal using inputs above and applying intertidal process model to representative profiles. Assess rate of change;</td>
</tr>
<tr>
<td>Assess morphological evolution of estuary using inputs and applying morphological models (short-medium term) and other applicable tools from estuary guide (longer-term).</td>
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<table>
<thead>
<tr>
<th>Society &amp; Economy</th>
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<tbody>
<tr>
<td>Desk-based investigations will be conducted of the potential effects in relation to:</td>
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<tr>
<td>Employment and the economy;</td>
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<tr>
<td>Population characteristics, distribution and trends within the study area;</td>
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<td>Distribution of areas of social deprivation, low earnings, and high dependence on benefits;</td>
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<tr>
<td>Health and quality of life;</td>
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<tr>
<td>Access to community services and facilities;</td>
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<tr>
<td>Access to recreational opportunities and open space;</td>
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<tr>
<td>Land use, quality and regeneration;</td>
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<tr>
<td>Quality, value and availability of housing stock.</td>
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<tr>
<td>Workshops will be held with key stakeholders to confirm assumptions and data and ensure that the assessment has a sufficient regional focus.</td>
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</table>

<table>
<thead>
<tr>
<th>Marine Ecology</th>
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<tbody>
<tr>
<td>Essential new data collection requirements have not been identified for marine ecological aspects of the SEA. However, some existing data will need to be collated (e.g. review of the extent of the saltmarsh area using remote sensing data) to support impact predictions using ecological modelling tools;</td>
</tr>
<tr>
<td>There will be lower certainty attached to impact predictions where data is more sparse or old – e.g. <em>Sabellaria alveolata</em> distributions and the sub-tidal ecology of the Upper Severn;</td>
</tr>
<tr>
<td>The hydraulics and geomorphology activities should provide reliable predictions of changes in the key physical parameters which govern the spatial distribution of habitats and species. This information will be used to predict ecological changes under each option using a range of habitat modelling tools. These will provide a high-level forecast of future intertidal and sub-tidal habitat distribution.</td>
</tr>
</tbody>
</table>

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47 All work during the SEA main assessment phase will be by desk-study using existing, available information, unless indicated otherwise.
**Proposed data collection and tools**

### Ornithology

Additional baseline data is considered a prerequisite of further assessment. Fieldwork is therefore planned in the following areas:
- Complete coverage by Wetland Bird Survey (WeBS) Core Counts, to include all waterbirds, including gulls. Counts to cover the spring and autumn passage periods as well as the winter;
- A repeat of the 2002/03 WeBS Low Tide Survey of waterbirds on the Severn Estuary. All waterbirds and gulls included;
- Through the tide cycle surveys to enhance understanding of feeding distributions of waterbirds on the estuary as the tide ebbs and floods;
- Nocturnal surveys to complement the daytime surveys, using specialised night-viewing equipment.

Utilising this and existing data, Habitat Association modelling is considered adequate to assess the effects of different options at this strategic-level. Consideration is being given to the application of Individual-Based Models (IBMs) to selected species assessments, and if there is sufficient input data to support such an approach with acceptable levels of confidence. However, in general the use of IBMs will be more appropriate at the EIA-stage.

### Migratory and Estuarine Fish

This topic probably represents the greatest area of uncertainty in terms of ecological understanding, and also the ability to then assess the implications of the effects of options. Desk-study will therefore focus in the following areas:
- Turbine passage study
- Assessment of effects upon recreational river and sea angling, commercial fishing, heritage fisheries
- Assessment of current fisheries telemetry techniques
- Efficacy of mitigation and compensation measures such as sluice design and fish swimming speeds, behavioural screening, fish transportation, habitat enhancement/creation, stocking, translocation, pheromone release, fish herding, additional sites for inclusion in the SAC list and life history model development.

Consideration has been given to the inclusion of fieldwork within this topic area but on the basis of advice from Statutory Consultation Bodies, it has been concluded that this will not be feasible within the timeframe for the SEA.

### Terrestrial and Freshwater Ecology

This topic area would be addressed by desk-study only. Data collection for the assessment will involve the identification of:
- Terrestrial and freshwater ecology zone of influence for construction and operation,
- Receptors and their sensitivity, and
- Known terrestrial and freshwater ecology receptors within the zone of influence.

The assessment would involve consideration of:
- Sensitive receptors that could be directly affected will be identified using the footprint of the options, or indirectly using the construction zone of influence;
- The operational effects of water level and quality changes on freshwater ecology receptors, in terms of the area that could be subject to change and the magnitude of any such change;
- Secondary effects arising from effects upon other ecological receptors (birds and fish).
**Proposed data collection and tools**

### Marine Water Quality

Hydrodynamic and sediment transport models are to be developed as part of this study and will provide an indication of:
- Temperature, dissolved oxygen, bacterial and salinity distributions and flushing times for contaminants;
- Effects on dilution and dispersion characteristics of key discharges;
- Potential changes in suspended sediment concentrations, patterns and rates of sediment transport and zones of sediment deposition.

Hydrodynamic and sediment transport modelling will give an indication of the changes in water depths, suspended sediment and hence light climate as these will be relevant to assessing the changes in phytoplankton, microphytobenthos, and macroalgae, and the potential utilisation of nutrients for primary productivity. Nutrient modelling, probably using simple risk based tools will be employed; the approach being determined once preliminary findings from hydrodynamic and sediment transport modelling are available.

In addition, desk based reviews will be required in relation to better understand how changes in the estuary environment and associated biological responses may influence:
- Nutrient and carbon cycling within the estuary;
- Contaminant bioavailability.

This work can inform ecosystem services assessment elsewhere in the Feasibility Study of changes in GHG sequestration and releases.

### Freshwater Environment and Associated Interfaces

Extensive desk based review of wide range of data sources will be required, relating to:
- Geological, geotechnical, hydrogeological and pedalogical data;
- Major and minor aquifers;
- Contaminated land;
- Groundwater flow conditions and land drainage;
- Ground elevations and accessibility of designated geological and geomorphological SNCIs, including SSSIs and RIGS;
- River water quality and flows within main sub-catchments and in freshwater flow requirements to estuary.

Predictive modelling and assessment within the hydraulics and geomorphology assessment will then be used to assess major:
- Changes to the groundwater regime; and
- Changes to land and urban drainage processes and the consequential effects on freshwater quality.

### Flood Risk and Land Drainage

The need for a substantial improvement in baseline information will be addressed through a significant desk-based research programme to collect:
- Details of upstream tidal flood defences and outfalls;
- Forecasts of water level regimes and wave height probabilities at representative locations;
- Information for major outfalls discharging upstream of options;
- Assessments from the Environment Agency of flood damages, expected capital and maintenance expenditure and strategic plans for flood risk management assets over a 100 year timescale;
- Environment Agency’s flood outlines.

Full use will be made of GIS to capture and analyse asset information from all databases, including LiDAR import. Simplified modelling techniques will then be applied to:
- Determine flood risk of overtopping or breaching of defences using estuary water levels, defence heights, wave heights and ground levels;
- Assess the flood risk associated with low outfalls with restricted discharge to the estuary. This would entail strategic level assessment for key outfalls.

This will lead to the assessment of measures needed to maintain the existing (or other desired) overtopping and discharge characteristics for both flood risk management, and water level management for nature conservation. The hydraulics and geomorphology work will provide important input information to this assessment.
Table 1: Proposed data collection and tools

### Noise & Vibration
This will be a desk-based assessment only. It will include:
- Estimation of properties and population exposed to ‘disturbing’ levels of noise & vibration;
- Estimation of buildings potentially exposed to vibration;
- Prediction of marine noise and vibration sensitive receptors.
The effects of noise will be assessed using established policy, guidance and standards.

### Carbon Footprinting
This will be a desk-based assessment only. It will include:
- The use of up-to-date and comprehensive data (including long term changes to shipping transit routes) for embodied carbon footprinting, updated as needed;
- Derivation of appropriate estimates for rates of carbon sequestration and methanogenesis in the Severn Estuary.
The GHG emissions associated with the life cycle of options and associated mitigation measures will then be quantified. This will include the construction stage. There are currently no carbon footprinting models that are designed for the carbon footprinting of tidal power, therefore an in-house model will be generated from the data outlined above.

### Other Sea Uses
This will be a desk-based assessment only, or informed by other aspects of the SEA. It will consider:
- Effects on the quality of marine aggregate reserves through the geomorphological studies of changes in sedimentation patterns;
- Effects on marine waste disposal will be informed by the water quality assessment and geomorphological studies;
- Commercial fishing: a desk-based review will be undertaken to provide as detailed an understanding as possible of current fishing practices and catches (to inform ‘fish’ effects);
- Recreation and tourism: Communication with existing recreational user groups and further desk-study will identify potential issues (to inform ‘Society and Economy’);
- Hydraulic and geomorphological studies will inform the assessment of risks to water extraction facilities and dispersion characteristics of power station cooling water;
- Cables and pipelines: Geomorphological studies will inform the assessment of risk of cable exposure;
- Further consultation as necessary with MoD in relation to military exercise areas.

### Navigation
This will be a desk-based assessment only, informed by hydraulic and geomorphological studies within the SEA especially with regard to potential for changes to navigational dredging;
The assessment will build upon available data to identify of the extent to which existing port operating conditions, water levels, and recreational navigation will change and the mitigation of any adverse effects through engineering solutions.

### Historic Environment
This will be a desk-based assessment only in line with good practice guidance (Cadw, 2007). Activities will comprise:
- Further existing data collection and collation using GIS, including assessment of available LiDAR and 3D Seismic data to map the environmental and archaeological potential of the estuary bed;
- Historic environment characterisation study to synthesize new and previously available data, in order to develop a regional framework and strategy to examine the significance of the resource
- Review of the Hydraulics and Geomorphology studies to assess the potential zone of impact on the historic environment
- Desk-based assessment to evaluate the archaeological potential of the area that could be affected, taking into account the terrestrial, intertidal and submerged historic environment.
A desk based assessment of the historic landscape will also be undertaken. Existing historic landscape characterisation studies will be used to assess the potential effects of options. A full ASIDOH2L assessment is not proposed at this stage but the ASHIDOHL2 table formats will be used for representing information for the SEA Environmental Report.
**Proposed data collection and tools**

### Landscape and Seascape

This will be a desk and field-based assessment. Activities will comprise:

- Seascapes characterisation (including landscape, coastline and sea) to provide a consistent level of baseline information for the study area;
- Collection of meteorological information on variations in visibility in the Severn Estuary;
- Establishing a Zone of Theoretical Visibility and Tranquillity Mapping for each option;
- Assessment of visual effects arising from change to the inter-tidal environment and the Severn Bore.

Consideration is being given to the collation of public perception and values concerning the existing seascape/estuarine character through the Feasibility Study stakeholder engagement workstream.

### Resources and Waste

The approach to addressing resources issues will be to identify the:

- The type of resources required and quantities;
- Potential sources of these resources from within the study area (including virgin, recycled or secondary material);
- For those resources that may not be available locally, consideration of their likely source;
- Interactions with other major construction projects in the study area;
- Gaps in resource availability.

The approach to addressing waste issues will be to identify the:

- Nature of waste arisings and quantities and consideration of options for recycling/other treatment;
- Assessment of capacity and lifespan of existing landfill sites and availability to accept waste;
- Details of other waste management facilities, including proposals for any major new waste developments.
Section 8: Developing Sea Objectives and the Assessment Framework

8.1 The purpose of SEA objectives

The use of SEA Objectives is a recognised method of testing of the Feasibility Study proposals and to compare alternatives. This technique is also proposed in the Practical Guide (ODPM et al., 2005). SEA Objectives usually reflect a desired direction of change. It therefore follows that these objectives will not necessarily be met in full by a given option, but the degree to which they do will provide a way of identifying preferences when comparing options.

8.2 Development of the SEA objectives and assessment criteria

The SEA objectives have been developed in accordance with the Practical Guide (ODPM et al., 2005). The SEA objectives were derived using the review of environmental plans and programmes conducted as part of scoping; the baseline data collation; and the identification of environmental issues. The SEA objectives are thus based on a review of all major issues.

The SEA Objectives will be used to differentiate between options. They therefore include objectives that seek to conserve and enhance the environment, i.e. a desired direction of change, as well as the avoidance of adverse effects.

Each SEA Objective is supported by a series of assessment criteria and indicators. These are intended to provide more explicit explanation of how the performance of each short-listed option will be appraised against the SEA objectives.

Table 8.1 presents the proposed SEA Objectives. The associated assessment criteria and indicators are presented in Appendix 2.

Hydraulics and Geomorphology is not an SEA Directive topic in its own right, nor does it have an explicit policy framework. Objectives have therefore not been assigned to this topic. However, in this SEA, an understanding of effects on hydraulics and geomorphology is fundamental to the assessment of many other topics, e.g. marine ecology, water quality and flood risk. Thus the assessment of options in relation to hydraulics and geomorphology will focus on defining the physical changes that
would arise and thereby informing the appraisal of options in relation to other topics.

### Table 8.1 Summary of SEA Objectives

<table>
<thead>
<tr>
<th>SEA Objective&lt;sup&gt;48&lt;/sup&gt;</th>
<th>Society and Economy</th>
<th>Marine Ecology</th>
<th>Ornithology</th>
<th>Migratory &amp; Estuarine Fish</th>
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</thead>
<tbody>
<tr>
<td>SE.1</td>
<td>To seek to create local employment opportunities accessible to all.</td>
<td>ME.1: To avoid adverse effects on designated marine wildlife sites and protected habitats of international and national importance.</td>
<td>O.1: To avoid adverse effects on designated wildlife sites for birds and protected habitats of international and national importance.</td>
<td>F.1: To avoid adverse effects on designated wildlife sites for fish of international and national importance.</td>
</tr>
<tr>
<td>SE.2</td>
<td>To avoid adverse effects on the local and regional economy.</td>
<td>ME.2: To avoid adverse effects on valuable marine ecosystems.</td>
<td>O.2: To avoid adverse effects on other protected bird habitats and species.</td>
<td>F.2: To avoid adverse effects on the populations of other protected fish species and habitats.</td>
</tr>
<tr>
<td>SE.3</td>
<td>To seek to promote the development of sustainable communities.</td>
<td>ME.3: To avoid adverse effects on other protected marine species and their habitats.</td>
<td>O.3: To avoid adverse effects on national and local biodiversity target features that include bird habitats and species.</td>
<td>F.3: To avoid adverse effects on national and local biodiversity target features that include fish habitats and species.</td>
</tr>
<tr>
<td>SE.4</td>
<td>To avoid adverse effects on physical and mental health.</td>
<td>ME.4: To avoid adverse effects on national and local biodiversity target features that include marine habitats and species.</td>
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<td>F.4: To avoid adverse effects on recreational and heritage fishing.</td>
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<td>SE.5</td>
<td>To avoid adverse effects on access to community services and facilities.</td>
<td>ME.5: To avoid deterioration in status class of WFD water bodies.</td>
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<td>F.5: To avoid adverse effects on commercial fish resources.</td>
</tr>
<tr>
<td>SE.6</td>
<td>To avoid adverse effects on access to recreational facilities and open space.</td>
<td>ME.6: To minimise the risk of introduction of non-native invasive marine species.</td>
<td></td>
<td>F.6: To minimise the risk of introduction of non-native invasive fish species.</td>
</tr>
<tr>
<td>SE.7</td>
<td>To avoid adverse effects on existing, proposed and committed land uses.</td>
<td>ME.7: To conserve and enhance designated marine site features.</td>
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<tr>
<td>SE.8</td>
<td>To seek opportunities to improve degraded environments.</td>
<td>ME.8: To restore and enhance marine BAP species populations and/or BAP habitat.</td>
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<td>SE.9</td>
<td>To avoid adverse effects on the housing market.</td>
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<td>Marine Ecology</td>
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<td>Ornithology</td>
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<td>Terrestrial and Freshwater Ecology</td>
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48 When proposals are considered in the context of the Habitats Regulations (SI 1994/2716), a different test will apply, i.e. to identify whether there will be adverse effects on the integrity of Natura 2000 sites.
## SEA Objective 48

### Marine Water Quality

| WQ.1 | To avoid adverse effects on water quality in relation to water quality standards. |
| WQ.2 | To avoid adverse effects on designated marine wildlife sites of international and national importance due to changes in water quality. |
| WQ.3 | To avoid adverse effects on water quality which would affect human health, flora and fauna, recreation and other users. |
| WQ.4 | To avoid adverse effects on inherent water characteristics (temperature, salinity, pH) that could lead to adverse changes in water quality. |
| WQ.5 | To minimise risks of pollution incidents. |

### Freshwater Environment and Associated Interfaces

| FE.1 | To avoid adverse effects on water quality (whether surface water, groundwater or coastal waters) in relation to water quality standards. |
| FE.2 | To avoid adverse effects on water quality which would affect human health, flora and fauna, recreation and other users. |
| FE.3 | To avoid adverse effects on water abstractions (whether surface water or groundwater), particularly those utilised for the PWS. |
| FE.4 | To avoid adverse effects to designated freshwater sites of nature conservation interest. |
| FE.5 | To avoid adverse effects to buildings and infrastructure. |
| FE.6 | To avoid adverse effects on the soil resource. |
| FE.7 | To avoid adverse effects on agricultural land currently in use. |
| FE.8 | To avoid adverse effects on designated geological and geomorphological sites of international and national importance. |
| FE.9 | To conserve and enhance designated geological and geomorphological site features. |

### Flood Risk and Land Drainage

| FR.1 | To avoid an increase in flood risk to property, land and infrastructure where this might otherwise occur as a consequence of the construction and operation of any tidal power structure. |

### Noise and Vibration

| NV.1 | To avoid adverse effects of negative noise and vibration on (humans) noise sensitive receptors. |
| NV.2 | To avoid adverse effects on the acoustic quality of the marine environment. |
| NV.3 | To avoid adverse effects on noise (vibration) sensitive receptors. |
| NV.4 | To avoid adverse effects through vibration. |

### Topic: Carbon Footprinting

| CF.1 | To seek to maximise the opportunities for use of sustainable sources of energy for the UK. |
| CF.2 | To avoid adverse effects from GHG emissions over the lifecycle of the project. |

### Other Sea Uses

| SU.1 | To avoid adverse effects on the aggregate extraction industry. |
| SU.2 | To avoid adverse effects on marine waste disposal sites and infrastructure. |
| SU.3 | To avoid adverse effects on the commercial fishing industry. |
| SU.4 | To avoid adverse effects on marine recreational users. |
| SU.5 | To avoid adverse effects on tourism in the region. |
| SU.6 | To avoid adverse effects on military activity in the region. |
| SU.7 | To avoid adverse effects on the energy industry. |
| SU.8 | To avoid adverse effects on seabed cables in the region. |

### Navigation

| N.1 | To avoid adverse effects on Severn Estuary Navigation arising from sedimentation, geomorphology, water density, and water levels. |
| N.2 | To avoid adverse effects on the integrity of existing and proposed port operations. |


### Historic Environment

**HE.1** To avoid adverse effects on designated sites in the historic environment.

**HE.2** To avoid adverse effects on the non-registered internationally, nationally, regionally and locally important sites within the historic environment.

**HE.3** To avoid adverse effects on the potential historic environment, the as yet unidentified sites and finds, within the Severn Estuary.

**HE.4** To avoid adverse effects on the character, quality and integrity of the historic and/or cultural landscape.

### Landscape and Seascape

**LS.1** To conserve the character and qualities of the landscape/seascape, recognising its diverse features and distinctiveness at different scales – including designated and non-designated areas.

**LS.2** To conserve the character and qualities of the physical and visual resource associated with land and sea.

**LS.3** To accord with the Aims and Articles of the European Landscape Convention.

### Resources and Waste

**RW.1** To seek to promote sustainable use of resources.

**RW.2** To seek to reduce waste generation and disposal, increase re-use and recycling and achieve the sustainable management of waste.

### 8.3 Internal Compatibility of the SEA objectives

The Practical Guide (ODPM *et al.*, 2005) recommends that an internal test of compatibility is undertaken on the SEA objectives. This process can highlight any potential conflicts or inconsistencies which might need to be resolved and can also demonstrate the close inter-relationships and linkages between many of the objectives. Table 8.2 consolidates the objectives by topic to present a summary of an assessment of the internal compatibility of all objectives, as a matrix.

The compatibility matrix shows that there are no definite areas of conflict between any of the SEA objectives; and that the majority of objectives are either compatible or there is no link between them (so there is no conflict). However, for a number of the SEA objectives there is some uncertainty about how compatible they would be, with the outcome only likely to be apparent during the more detailed assessment in the main assessment phase. Key areas of uncertainty relate to the compatibility of most SEA objectives with those relating to local employment opportunities, marine recreation and tourism in the region.

The identification of the potential uncertainty does not necessarily mean that objectives need to be changed; rather these uncertainties will be taken into consideration at later stages in the SEA process. The compatibility matrix has classified these so that subsequent decisions can be made with this in mind.
### Table 8.2 SEA objective compatibility matrix

<table>
<thead>
<tr>
<th>Society and Economy (SE)</th>
<th>O</th>
<th>F</th>
<th>ME</th>
<th>TFE</th>
<th>WQ</th>
<th>FE</th>
<th>FR</th>
<th>NV</th>
<th>CF</th>
<th>SU</th>
<th>N</th>
<th>HE</th>
<th>LS</th>
<th>RW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Omnithology (O)</strong></td>
<td>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Migratory and Estuarine Fish (F)</strong></td>
<td>?</td>
<td>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Marine Ecology (ME)</strong></td>
<td>?</td>
<td>?</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Terrestrial and Freshwater Ecology (TFE)</strong></td>
<td>?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Marine Water Quality (WQ)</strong></td>
<td>?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Flood Risk and Land Drainage (FR)</strong></td>
<td>?</td>
<td>?</td>
<td>✓</td>
<td>0</td>
<td>✓</td>
<td>0</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Noise and Vibration (NV)</strong></td>
<td>?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>?</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Carbon Footprinting (CF)</strong></td>
<td>?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>?</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Resources and Waste (RW)</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>?</td>
<td>?</td>
<td>0</td>
<td>✓</td>
<td>✓</td>
<td>?</td>
<td>?</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Key**

✓ Objectives are compatible

0 There is no link between the objectives

? It is uncertain whether the objectives are compatible

✗ The objectives are incompatible
8.4 Approach to the SEA

The SEA Directive requires (Article 5.1) ‘an environmental report...in which the likely significant effects on the environment of implementing the plan or programme, and reasonable alternatives taking into account the objectives and the geographical scope of the plan or programme, are identified, described and evaluated’.

8.4.1 INTRODUCTION

The proposed methodology to identify and assess the potentially significant effects of the STP Feasibility Study is set out below.

The effects of each option will be considered in relation to each receptor, and whether the likely effect may be significant. The assessment of significance of effects arising from each option, will then permit testing of the Feasibility Study proposals against the SEA Objectives (table 8.1) to inform whether each of the SEA Objectives is likely to be met.

The assessment process will follow the stages outlined below in Figure 8.1, which are also explained in further detail in subsequent sections. Importantly, the assessment process involves an iterative process of collecting information, defining alternatives, identifying environmental effects, developing mitigation measures and revising proposals in the light of predicted environmental effects.

**Figure 8.1 Approach to the SEA**

1. Identification of receptor sensitivity/vulnerability
   - 2. Assessment of magnitude of environmental change
   - 3. Assessment of significance of effects on receptors
   - 4. SEA objective compliance
   - 5. Assessment of overall preferred option
8.4.2 IDENTIFICATION OF SENSITIVITY & VULNERABILITY OF RECEP'TORS

The first stage is to undertake an assessment of the vulnerability of each receptor, based on its importance and sensitivity to change. Importance is generally based on scale, rarity and level of statutory designation. Vulnerability is generally based on the nature of each receptor (i.e. its intrinsic sensitivity), its current condition, and its dependence (or otherwise) on a narrow range of environmental conditions and its exposure to the effects of each project option. Some receptors may be of a high level of importance, but relatively robust to the effects of project options, whereas others may be of lesser importance but highly vulnerable to the effects of project options.

The preliminary identification of receptors has been initially undertaken within this scoping report’s associated topic papers (Parsons Brinckerhoff, 2008c – 2008r). There is uncertainty attached to the level of sensitivity assigned to some receptors. Receptor sensitivity will be reviewed and updated where necessary. The proposed receptors and a preliminary review of their sensitivity are presented in Appendix 3.

8.4.3 ASSESSMENT OF MAGNITUDE OF ENVIRONMENTAL CHANGE

The second stage is to undertake an assessment of the magnitude of environmental change that the receptor will be exposed to, based on the specialist studies proposed within this scoping report. This will include an assessment of whether the likely change is temporary, permanent, short, medium or long term, direct or indirect. The assessment of the magnitude of environmental change will assume that reasonable mitigation measures are incorporated.

In assessing environmental changes, consideration will need to be given to the fact that most receptors form part of an estuary system; with complex interrelationships occurring over long timescales. Assessment of change will need to consider these carefully when assessing the impacts of the construction, operation and decommissioning of options. It will also take into account secondary, cumulative and synergistic effects.

8.4.4 ASSESSMENT OF SIGNIFICANCE OF EFFECTS ON RECEP'TORS

The third stage is to undertake an assessment of the significance of effects of the option on each receptor, based on the vulnerability of the receptor and the magnitude of environmental change. The assessment will also use the assessment criteria and indicators described in Appendix 2 and thereby link to one or more SEA Objectives.
The example layout presented in Table 8.3 below will summarise the assessment of significance of each option against each receptor. In accordance with the SEA Directive (Annex 1 f1), this will include consideration of secondary, cumulative, synergistic (these are described in more detail in Section 8.5), short, medium and long term, permanent and temporary and beneficial (positive) and adverse (negative) effects.

The effects predicted at this stage will remain at a strategic level and will not provide as much detail or certainty as for project level EIAs. Major areas of uncertainty will be documented in the assessment. The focus will be on identifying significant effects and also mitigation measures to avoid or reduce such effects where they are identified (in accordance with the SEA Directive, (Annex 1 (g)).

Table 8.3 Example assessment of significance

<table>
<thead>
<tr>
<th>OPTION</th>
<th>TITLE, NUMBER AND/OR DESCRIPTION OF THE OPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of Effect</td>
<td>Change to water levels</td>
</tr>
<tr>
<td>Receptor (SEA objective)</td>
<td>Vulnerability</td>
</tr>
<tr>
<td>Society &amp; Economy</td>
<td></td>
</tr>
<tr>
<td>South Wales urban population (SE1: To seek to create local employment ....)</td>
<td>Medium</td>
</tr>
<tr>
<td>Marine Ecology</td>
<td></td>
</tr>
<tr>
<td>Saltmarshes and Reed Beds (ME1: To avoid adverse effects on designated marine wildlife sites ...)</td>
<td>High</td>
</tr>
</tbody>
</table>

Note: Text in table is for illustrative purposes only.

8.4.5 SEA OBJECTIVE COMPLIANCE

The assessment of significance leads to the determination of SEA Objective compliance. The degree to which the SEA objective is met will correlate with the level significance of the effect upon relevant receptors.

The SEA Objectives, assessment criteria and associated indicators were developed with the receptors in mind. By using these assessment criteria and indicators to inform the identification of significance of effects, this directly links the process to the assessment of compliance with SEA Objectives.

Compliance with the SEA objectives will be recorded and summarised. Table 8.4 below provides an illustration of how the adverse and beneficial effects of each option will be summarised, by recording the effects of...
greatest significance. Where there are half circles this indicates where there are both beneficial and adverse effects.

This assessment will be undertaken within individual topic papers, but these will be themed and synthesised within the SEA Environmental Report, as described in Section 8.6. This will allow issues of interrelationships between topics to be addressed.

Table 8.4 Example summary environmental effect and SEA compliance matrix

<table>
<thead>
<tr>
<th>Options</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEA objectives</td>
<td>1.3 To seek to promote the development of sustainable communities.</td>
<td>Major adverse effect on local businesses and jobs and result in out-migration of population</td>
<td>Moderate adverse effect on out-migration of population</td>
<td>Moderate beneficial effect on temporary employment in areas of need</td>
</tr>
<tr>
<td></td>
<td>1.4. To avoid adverse effects on physical and mental health.</td>
<td>Minor adverse effect on existing local businesses and jobs</td>
<td>Minor beneficial effect on temporary employment in areas of need but also have a major adverse effect property and land values</td>
<td>Moderate beneficial effect on temporary employment in areas of need but also have a moderate adverse effect on crime</td>
</tr>
</tbody>
</table>

**Significance of effect**

<table>
<thead>
<tr>
<th>Significance of effect</th>
<th>Objective not met</th>
<th>Significance of effect</th>
<th>Objective met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Adverse</td>
<td>[ ]</td>
<td>Major Beneficial</td>
<td>[ ]</td>
</tr>
<tr>
<td>Moderate Adverse</td>
<td>[ ]</td>
<td>Moderate Beneficial</td>
<td>[ ]</td>
</tr>
<tr>
<td>Minor Adverse</td>
<td>[ ]</td>
<td>Minor Beneficial</td>
<td>[ ]</td>
</tr>
<tr>
<td>No Effects</td>
<td>[ ]</td>
<td></td>
<td>[ ]</td>
</tr>
</tbody>
</table>

Note: Text in table is for illustrative purposes only.

### 8.4.6 OPTION COMPARISON

The effects predicted to occur over the lifetime of the options and the performance against the SEA objectives will be presented in a matrix for each option. This will inform the process of identification of the preferred option.
The options will be assessed against a future ‘do-nothing’ baseline. The do-nothing assessment will be a prediction of the trends in the baseline; beginning with construction in 2014 or later and extending for 120 years once operational (the assumed lifetime of the plan).

The assessment of baseline environmental conditions becomes more uncertain the further ahead the study looks. It should be possible to make reasonably good predictions of conditions in 20 years time, but assessment of the baseline 140 years into the future is subject to very high levels of uncertainty. Conditions then will depend on what level of global atmospheric carbon dioxide is actually reached, how this affects climate change and how that in turn affects baseline environmental conditions.

In accordance with the SEA Directive (Annex 1 (h)), any difficulties encountered in compiling the required baseline information will be described.

8.4.7 ASSESSMENT OF PREFERRED OPTION

The environmental assessment of the preferred option will include a high-level description of the option, its likely environmental effects, proposed mitigation measures and the scope of compensation measures needed. This information will be sourced principally from the environmental assessment completed for the comparison of the options. Any important changes in the nature of any short-listed option brought forward to the preferred option will be assessed at this stage.

The requirements of the strategic-level Habitats Regulations Assessment are addressed in Section 8.8.8.

8.5 Secondary, cumulative and synergistic effects

The Practical Guide (ODPM et al., 2005) defines these as follows:

*Secondary or indirect effects* are effects that are not a direct result of the plan, but occur away from the original effect or as a result of a complex pathway. Examples of secondary effects are a development that changes a water table and thus affects the ecology of a nearby wetland; and construction of one project that facilitates or attracts other developments.

*Cumulative effects* arise, for instance, where several developments each have insignificant effects but together have a significant effect; or where several individual effects of the plan (e.g. noise, dust and visual) have a combined effect.

*Synergistic effects* interact to produce a total effect greater than the sum of the individual effects. Synergistic effects often happen as habitats,
resources or human communities get close to capacity. For instance a wildlife habitat can become progressively fragmented with limited effects on a particular species until the last fragmentation makes the areas too small to support the species at all.

The Practical Guide (ODPM et al. 2005) states that these terms are not mutually exclusive. Often the term cumulative effects is taken to include secondary and synergistic effects. Interrelationships have been identified in Section 7.2.4 and this will be used to help identify where several effects of the STP options may combine to have a significant effect on a receptor.

In addition to the potential for cumulative, synergistic or secondary effects arising from effect interaction, a number of potential projects, plans and policies have been identified to date which may have cumulative or synergistic effects with a STP option. These include:

- Secondary development not currently associated with the STP option, for example roads, new commercial or industrial developments;
- The provision of compensatory measures for the STP option outside the Severn Estuary;
- Further development of tidal power available within the Severn Estuary, for instance use of tidal stream technologies;
- Offshore wind energy within the Severn Estuary, Bristol Channel and nearby coastal areas;
- Other power generation projects such as the potential new Hinkley Nuclear Power Station development;
- Aggregate extraction and disposal of waste for construction of both the STP option and other construction projects;
- Port development, such as Bristol Container Port;
- Defence Training Academy facilities, RAF St Athan;
- Interaction of construction traffic with changes planned to local highway networks;
- Projects under the Water Framework Directive such as water company investments to improve water quality;
- Flood defence and coastal management strategies such as the Severn Estuary Flood Risk Management Strategy;
- Increased recreational usage of the Severn owing to the reduced tidal range and velocities.

Other known and likely development proposals will be identified through consultation on this document and a review of relevant local development plans. A review of the relevant significant planning and consent applications will also be undertaken.
The approach to the assessment of secondary, cumulative and synergistic effects from interaction with other projects, plans and policies will be based on the SEA assessment framework set out above, in so far as information allows. For each option assessed, any additional development likely to occur will be identified and captured within each option ‘scenario’. The risk of cumulative effects occurring will be assigned.

It is anticipated that detailed information for other projects, plans and policies will not uniformly be available during the SEA process, and a high-level, qualitative approach will be needed. However, the SEA will identify where necessary the risk of such effects, based on current knowledge, and uncertainties will be documented.

8.6 Management of interrelationships

The management of the main assessment phase studies will need to be mindful of the interrelationships between topic-based effects, so that these are considered in a holistic rather than compartmentalised manner.

To aid understanding of the major effects and their interactions (as set out in Section 7.2.4), topic-based assessments will be undertaken within the following broad themes:

- Physicochemical environment;
- Biodiversity;
- Landscape and seascape, historic environment;
- Society & Economy; and
- Carbon footprint, resources and waste.

The content of each theme is illustrated on Figure 8.2. Each theme will be synthesised, to ensure that the necessary connections are made within and between themes. Work will also be sequenced where necessary so that outputs inform subsequent parts of the assessment:

- The initial concept design for short listed options will undergo preliminary assessment of hydraulic and geomorphological effects. This will allow feedback on the large-scale effects and adjustments made to option design to reduce such effects;
- Each option will be developed as a ‘scenario’, that defines the key features of the option, its ancillary development, and the other plans or projects that it might interact with. This will include the future baseline as a scenario;
- Following refinement of the conceptual designs into ‘scenarios’, the physicochemical effects of the options on estuary form and function will be assessed;
The will provide the fundamental information to inform assessments of impacts upon biodiversity, society & economy, landscape/seascape and the historic environment, carbon footprint, resources and waste;

- Assessment of effects, and interactions within and between themes will then be captured within the SEA reporting;

- The assessment of compliance with the SEA Objectives will similarly be consolidated by theme;

- Emerging outcomes will be provided into the conceptual design process, in order that mitigation measures can be accommodated, and these in turn will feedback into the assessment process;

- Linkages will also be made with other aspects of the STP Feasibility Study.

This process is illustrated in Figure 8.2 below. The process will be an iterative one, but broadly follow the sequence shown. This will ensure that option design and operation is informed by the effects that are identified during the evolving SEA process.

### 8.7 Other Feasibility Study activities

In addition to the main assessment phase of the SEA, Phase 2 of the Feasibility Study may include a series of studies on other issues associated with short-listed schemes. These could include further consideration of ecosystem valuation, impacts on the regional economy, need for compensation measures under the Habitats Directive, and planning and consents issues.

### 8.8 Key assumptions to be used in assessment

Key assumptions to be used in the SEA are set out below.

#### 8.8.1 STUDY AREA

The study area to be used as the basis for the main assessment phase of the project extends from the tidal limit on the Severn Estuary, downstream as far as a line drawn between Worm’s Head and Morte Point. It includes the landward fringe and tributaries such as the River Wye and the River Usk up to their tidal limit and 1km inland.
Figure 8.2 Sequencing of main SEA assessment phase

Key:
- SEA Task
- Other STP task

- Concept design of options
  - Hydraulics & geomorphology – initial modelling & assessment
  - Refined concept design of options & development of scenarios
  - Physicochemical environment
  - Hydraulics & geomorphology
  - Marine water quality
  - Freshwater/Groundwater, Soils
  - Flood Risk & Land Drainage

- Landscape & Seascape
- Historic Environment
- Society & Economy
  - Society
  - Economy
  - Navigation
  - Other Sea Uses
  - Noise & Vibration
- Biodiversity
  - Habitats, Other Marine Ecology
  - Marine, Estuarine & freshwater fish
  - Ornithology
  - Terrestrial & freshwater ecology
- Carbon Footprint
- Resources & Waste
- SEA Reporting

STP Feasibility Study workstreams: regional, planning & consents; and stakeholder engagement.

Further refinement of concept design of options, e.g. mitigation
Habitats Regs Assessment
However, depending on the nature of options shortlisted, and their likely effects, study areas for specific issues will extend beyond this area. Notable examples comprise:

- Hydraulics and geomorphology – the study area will be defined by continental shelf-modelling, and the resultant westward boundary of water level effects;
- This in turn may extend the study area for other aspects of the assessment westward, depending on the linkages between receptor and water levels;
- Several migratory fish and birds spend part of their life cycle outside the Severn Estuary and effects outside the Severn Estuary may therefore occur; and
- The Zone of Theoretical Visibility for landscape effects will extend some distance from the Severn Estuary and its tributaries.

### 8.8.2 TIMESCALES

The SEA will consider construction and commissioning, operation and decommissioning of the short-listed options.

Construction and Commissioning: This phase begins at the commencement of the construction works and ends when the construction of the proposed scheme is complete. It is anticipated that, depending on the option, this phase would start in 2014 or later and last approximately 4-10 years.

Operation: This phase begins when power is generated at the site and would end when power generation ceases. This phase also includes maintenance of the scheme. Depending on the option, the operational phase would start in 2017 or later, and a scheme life of 120 years is assumed for the assessment.

Decommissioning: This phase begins when the scheme is shut down with no intention of further use for the purpose of generating electricity and work is undertaken to decommission the site.

In addition to understanding the types of effects that will occur during each phase, it is important for the timescale of the effects to be identified i.e. whether they would persist in the short, medium, or long term and if they would be permanent or temporary. For example, the temporal range of effects will need to include the timescale required for the estuary to reach geomorphological equilibrium after construction and after decommissioning.
8.8.3 CONSIDERATION OF MITIGATION AND COMPENSATION

During the early development of the short-listed options, the potential for adverse environmental effects will be identified and where possible these will be avoided through the identification of modifications to the options.

Where significant adverse effects cannot be avoided, mitigation measures will be identified to reduce them. The Environmental Report will include information on any proposed mitigation measures.

Where these mitigation measures are not considered likely to satisfactorily reduce adverse effects, the potential need for compensation measures will be identified. Compensation measures themselves will have effects on the environment, but at this stage of development will be indefinite in scope. Where possible, the risks of effects will nonetheless be identified in outline.

Both mitigation and compensation needs are currently subject to uncertainty, and may remain at least partially so in the main assessment phase. Further to this, consideration of mitigation and compensation measures for a range of effects on receptors will need to be integrated with mitigation and compensation measures required for Habitats Directive compliance. The scale and nature of such effects that may be identified during the main assessment phase are very likely to pose unprecedented challenges, and for some potential effects there are currently few (if any) mitigation or compensation measures available with a high degree of confidence in their effectiveness (Parsons Brinckerhoff, 2008s).

8.8.4 EFFECTS OUTSIDE THE STUDY AREA AND OUTSIDE THE UK

The STP Feasibility Study covers a number of local authority areas and parts of South East Wales and South West England. The SEA will consider potential effects within this area on a common basis and at a strategic scale.

Strategic-scale effects outside the main study area will also be considered. In accordance with the SEA Directive, if any transboundary effects on other EU member states are identified, the appropriate EU member state will be consulted.

8.8.5 ANCILLARY DEVELOPMENT

Where any ancillary development is proposed as an inextricable part of a short-listed option, then this will also be subject to SEA as described
in Section 8.4 above, in so far as information allows. Examples might include:

- Construction areas, access roads, other required development at the landfalls, grid connections;
- New aggregate extraction and disposal of waste sites solely for construction of an STP option;
- Increased requirement for dredging within the Severn Estuary to support construction or operation.
- Increased requirement for additional facilities elsewhere such as new capacity for construction of turbines; caissons; docks; ships etc.

In line with the strategic nature of this study; there may be less information for these ancillary areas than for the option itself. The SEA will identify the risk of effects, based on current knowledge, and uncertainties will be documented.

Where any associated development that is not an inextricable part of a short-listed option is proposed, then this will be considered under cumulative effects.

### 8.8.6 CONSIDERATION OF CLIMATE CHANGE

Climate change is predicted to lead to hotter drier summers, warmer wetter winters and increased flooding, as well as sea level rise and an increased risk of extreme weather events. The following predictions will be taken into account when considering the future baseline and the effect assessment.

The Defra (2006) allowances\(^ {49} \) for sea level rise for south west England are approximately 1m over the next 100 years. This does not incorporate either tidal surges or waves, due to the uncertainty involved in the prediction of these parameters. In relation to the potential for increased storminess the guidance suggests applying an indicative sensitivity range\(^ {50} \) with an increase of 5% for the period 1990 to 2055 to offshore wind speed and extreme wave height, and then an increase of 10% for the period 2055 to 2115. For peak river flows (preferably for larger catchments) respective increases are 10% from 1990 to 2025 and then 20% from 2055 to 2115.

It is anticipated that UKCIP will update climate change predictions (UKCIP, 2008) with the potential that Defra may revise present guidance. Where possible the revised predictions will be incorporated within the assessment.

\(^{49}\) In relation to improved predictions which offer greater certainty

\(^{50}\) Used to infer a lower degree of certainty and application of these values should be made with sensitivity analysis techniques
8.8.7 MONITORING STRATEGY

The SEA Directive (Article 10 (1)) requires Member States to “monitor the significant environmental effects of the implementation of plans or programmes in order, inter alia, to identify at an early stage unforeseen adverse effects, and to be able to undertake remedial action.”

Monitoring is essential to determine whether the SEA’s predictions of environmental effects were accurate; whether the plan is contributing to the achievement of the desired SEA objectives; whether any mitigation measures are performing as well as expected and whether there are any adverse environmental effects and whether these are within acceptable limits, or whether further remedial action is desirable.

More immediately, to underpin the more detailed assessment that could be required for a development application (e.g. through an EIA), recommendations will be provided in the SEA on the nature, type and frequency of monitoring that might be required. It is noted that a significant monitoring programme might be required covering key receptors and for an appropriate period of time. The focus will be placed on those receptors for which there has been a potential impact or uncertainty identified. This is necessary to provide a sufficient understanding of seasonal and annual variation to support effect assessment predictions.

In some cases, suggestions on the nature of such a monitoring programme have started to emerge during the scoping process. These measures are not needed directly for the main assessment phase of the SEA but will be considered in more detail for their effectiveness and appropriateness in the next phase of work. Further to this, there is the potential for such monitoring to have synergies with substantive longer-term research programmes. Arrangements for data sharing will need to be established in the next phase of work.

Given the long-time scales that are associated with such studies, it is recommended that investigation be given to the commissioning of an extended programme of research outside the Feasibility Study. This will enable research findings to inform later stages of project development; should the Government decide to progress beyond the Feasibility Study. There are some parallels with the development of the offshore wind industry in this regard.

The main assessment phase of the SEA must therefore include a proposed monitoring strategy to inform implementation of a tidal power project in the Severn Estuary; if the Feasibility Study shows that the Government can support it. A project may then be developed which will be subject to project level Environmental Impact Assessment (EIA) and associated monitoring.
The monitoring at project level will take account of the monitoring strategy developed at plan level.

**8.8.8 HABITATS REGULATIONS ASSESSMENT**

Under Article 6 (3) of the EU Habitats Directive (Directive 92/43/EEC) as transposed in the UK by the Habitats Regulations (SI 1994/2716), an ‘appropriate assessment’ needs to be undertaken in respect of any plan or project which:

- Either alone or in combination with other plans or projects would be likely to have a significant effect on a site designated within the Natura 2000 network\(^51\)
- Is not directly connected with the management of the site for nature conservation e.g. a site conservation plan.

This includes Special Areas of Conservation (SACs) designated under the Habitats Directive for their habitats and/or species of European importance and Special Protection Areas (SPAs) designated under the Birds Directive for rare, vulnerable and regularly occurring migratory bird species and internationally important wetlands. It is Government policy that Wetlands of International Importance, designated under the 1971 Ramsar Convention (known as Ramsar Sites) are also considered under the terms of the Habitats Regulations.

Accordingly, a preliminary Habitats Regulations Assessment (HRA) Screening exercise is being undertaken to determine whether the STP Feasibility Study could have a significant effect on sites within the Natura 2000 network and Ramsar sites. The process is running alongside, but is separate to, this SEA scoping process.

The preliminary HRA screening has shown that it will not be possible to say with sufficient certainty that there will not be a significant effect on a number of sites within the Natura 2000 network and Ramsar sites. The HRA screening process will be completed following the SEA Scoping stage and the identification of a preferred plan, in line with the requirements of Regulation 48 of the Habitats Regulations. The final HRA Screening Report is likely to conclude that significant effects on a number of sites within the Natura 2000 network could occur, and thus an appropriate assessment will be needed for the preferred plan.

The strategic-level HRA on the preferred plan (Stage 2 Appropriate Assessment), prepared in accordance with the Habitats Directive will form a separate document. The SEA will inform, but be separate from, the HRA.

---

\(^51\) Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) (Natura 2000 network sites are also known as European Sites)
Whilst the HRA is to be documented separately, it is the intention that the SEA studies will provide the technical foundation for the HRA, as well as the SEA. The studies will therefore inform the HRA's assessment of ‘adverse effects on site integrity’, giving consideration to the assessment of effects in relation to the Conservation Objectives for each relevant European Site.

Should any scheme be taken forward it will require HRA at project level to either confirm findings and address any issues of uncertainty that are identified at this strategic stage.
Section 9: Next Steps

9.1 The next stages in the SEA process

Following the closure of the scoping consultation stage, all comments will be reviewed and, where appropriate, modifications will be made to the scope of the main assessment phase of the SEA.

On final agreement of the Scoping Report, the main assessment phase of the SEA will commence by undertaking further environmental studies (as identified in the Scoping Report), input to the design of short-listed options, and the assessment of the short-listed options against the SEA objectives.

In accordance with SEA guidance, Stage B (developing and refining alternatives and assessing effects) is the next main stage in the assessment process. Table 9.1 below lists the tasks in Stage B and also outlines stages C and D (ODPM et al., 2005).

<table>
<thead>
<tr>
<th>Stages and Tasks</th>
<th>Purpose of the Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage B: Developing and refining alternatives and assessing effects</strong></td>
<td></td>
</tr>
<tr>
<td>B1: Testing the plan or programme objectives against the SEA objectives</td>
<td>To identify potential synergies or inconsistencies between the objectives of the plan or programme and the SEA objectives and help in developing alternatives.</td>
</tr>
<tr>
<td>B2: Developing strategic alternatives</td>
<td>To develop and refine strategic alternatives.</td>
</tr>
<tr>
<td>B3: Predicting the effects of the plan or programme, including alternatives</td>
<td>To predict the significant environmental effects of the plan or programme and alternatives.</td>
</tr>
<tr>
<td>B4: Evaluating the effects of the plan or programme, including alternatives</td>
<td>To evaluate the predicted effects of the plan or programme and its alternatives and assist in the refinement of the plan or programme.</td>
</tr>
<tr>
<td>B5: Mitigating adverse effects</td>
<td>To ensure that adverse effects are identified and potential mitigation measures are considered.</td>
</tr>
<tr>
<td>B6: Proposing measures to monitor the environmental effects of plan or programme implementation</td>
<td>To detail the means by which the environmental performance of the plan or programme can be assessed.</td>
</tr>
</tbody>
</table>

| Stage C: Preparing the Environmental Report |

| Stage D: Consulting on the draft plan or programme and the Environmental Report |
9.2 Proposed structure of Environmental Report

Table 9.2 below sets out the proposed structure of the Environmental Report and how each section satisfies the information requirements of Article 5 (as detailed in Annex 1) of the SEA Directive.

<table>
<thead>
<tr>
<th>Contents</th>
<th>Description</th>
<th>SEA Directive Article 5, Annex 1 Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-technical summary</td>
<td>● Summary of the SEA process</td>
<td>(j)</td>
</tr>
<tr>
<td></td>
<td>● Summary of the likely significant effects of the plan or programme</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Detail on how the SEA has influence the development of the options</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● How to comment on the report</td>
<td></td>
</tr>
<tr>
<td>Background</td>
<td>● Purpose of the SEA</td>
<td>(a)</td>
</tr>
<tr>
<td></td>
<td>● Objectives of the plan</td>
<td></td>
</tr>
<tr>
<td>Methodology used</td>
<td>● Approach adopted in the SEA</td>
<td>(e),(h)</td>
</tr>
<tr>
<td></td>
<td>● Who was consulted, and when</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Difficulties encountered in compiling information or carrying out the assessment</td>
<td></td>
</tr>
<tr>
<td>SEA objectives and baseline and context</td>
<td>● Links to other international, national, regional and local plans and programmes, and relevant environmental objectives including how these have been taken into account</td>
<td>(a),(b),(c),(d),(e)</td>
</tr>
<tr>
<td></td>
<td>● Description of baseline characteristics and predicted future baseline</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Environmental issues and problems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Limitations of the data, assumptions made etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● SEA objectives, targets and indicators</td>
<td></td>
</tr>
<tr>
<td>Issues and alternatives</td>
<td>● Main strategic alternatives considered and how they were identified</td>
<td>(e),(f),(g),(h)</td>
</tr>
<tr>
<td></td>
<td>● Comparison of the significant environmental effects of the alternatives</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● How environmental issues were considered in choosing the preferred strategic alternatives</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Other alternatives considered and why they were rejected</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Any proposed mitigation measures</td>
<td></td>
</tr>
<tr>
<td>Preferred Option</td>
<td>● Significant environmental effects of the proposals</td>
<td>(d),(f), (g)</td>
</tr>
<tr>
<td></td>
<td>● How environmental problems were considered in developing the proposals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Proposed mitigation measures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Uncertainties and risks</td>
<td></td>
</tr>
<tr>
<td>Implementation</td>
<td>● Links to other tiers of plans and programmes and the project level (EIA, design guidance etc.)</td>
<td>(i)</td>
</tr>
<tr>
<td></td>
<td>● Proposals for monitoring</td>
<td></td>
</tr>
</tbody>
</table>
9.3 SEA Scoping Report consultation

In accordance with the requirements of the SEA Regulations (set out in Section 3), this scoping consultation seeks views from the statutory consultation bodies. Through this consultation we are also seeking views from other persons and organisations and comments received prior to the close of the consultation will be considered in the finalisation of the scope.

The consultation period will run for twelve weeks.

9.3.1 KEY QUESTIONS FOR RESPONDENTS

In making their comments on this document and supporting documents, respondents are encouraged to consider the following questions:

- Which plans, programmes or environmental protection objectives are most significant for this strategic-level environmental assessment?
- Is there any additional information that could help supplement the baseline data? Any further information relating to the baseline indicators, existing problems and trends over time would be very useful.
- Is there any important information that has not been addressed in view of the SEA scope?
- Is the range of environmental problems, issues and receptors covered appropriate? Is the level of receptor sensitivity appropriate?
- Is the methodology proposed appropriate for this strategic-level environmental assessment?
- Are there any major plans or projects that should be included in the assessment of cumulative effects?
- Are there any changes that should be made to the proposed SEA objectives; including any consolidation of the objectives? Are there any other SEA objectives, assessment criteria or indicators that should be included?
- Are the relevant aspects of sustainable development covered, if the SEA addresses the issues identified in this SEA Scoping Report?
- Any further suggestions regarding the scope of the SEA and its proposed assessment of the short-listed options?

Section 10: References


BERR, 2008a. Severn Estuary Tidal Power – Call for Evidence

BERR, 2008b. Severn Tidal Power Feasibility Study – Terms of Reference


Convention on Wetlands of International Importance especially as Waterfowl Habitat (The Ramsar Convention, 1971).


Dated 02 February 2005


European Landscape Convention (The Florence Convention, 2000).
IPCC, 2007. Intergovernmental Panel on Climate Change’s (IPCC’s) Fourth Assessment Report on Climate Change.
Parsons Brinckerhoff, 2008b. Severn Tidal Power Feasibility Study – SEA Pre-scoping Consultation Report


# Section 11: Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate Assessment</td>
<td>A process required by the Habitats Regulations (SI 1994/ 2716) to avoid adverse effects of plans, programmes and projects on Natura 2000 sites and thereby maintain the coherence of the Natura 2000 network and its features.</td>
</tr>
<tr>
<td>Bristol Channel</td>
<td>The area seaward of the headlands at Lavernock Point on the Welsh coast and Brean Down on the English coast (see Severn Estuary below).</td>
</tr>
<tr>
<td>Coalfield river</td>
<td>A river draining a coalfield valley</td>
</tr>
<tr>
<td>Compensation</td>
<td>Measure which makes good for loss or damage to an environmental receptor, without directly reducing that loss/damage (see mitigation).</td>
</tr>
<tr>
<td>Cumulative effects</td>
<td>Effects arise, for instance, where several developments each have insignificant effects but together have a significant effect, or where several individual effects of the plan have a combined effect.</td>
</tr>
<tr>
<td>Effect</td>
<td>Used to describe changes to the natural or social environment as a result of an option.</td>
</tr>
<tr>
<td>Eutrophication</td>
<td>An increase in chemical nutrients (compounds containing nitrogen or phosphorus). This in turn can lead to ‘eutrophication effects’ – an increase in an ecosystem's primary productivity (excessive plant growth and decay), and further effects including lack of oxygen and severe reductions in water quality, fish, and other animal populations.</td>
</tr>
<tr>
<td>Geomorphology</td>
<td>The study of the changing form of the estuarine environment and its components in relation to physical forcing.</td>
</tr>
<tr>
<td>Hydrodynamics/hydraulics</td>
<td>The science of physical forces acting on the water.</td>
</tr>
<tr>
<td>Hypertidal</td>
<td>A tidal range in excess of 6m.</td>
</tr>
<tr>
<td>Indicator</td>
<td>A measure of variables over time, often used to measure achievement of objectives.</td>
</tr>
<tr>
<td>Lagoon(s)/Land-connected lagoons</td>
<td>A man-made enclosed body of water that retains a head of water on the rising tide and then runs the water through turbines when the tide level drops. A land connected lagoon uses the shoreline to make the enclosure. Applied to a number of locations including the Russell Lagoons, Bridgwater Bay, Fleming Lagoons</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Large barrage</td>
<td>A manmade obstruction across a watercourse to retain a head of water on the rising tide, and then run the water through turbines when the tide level drops. Large barrage alignments are approximately from Lavernock Point, west of Cardiff, to Brean Down, south-west of Weston-Super-Mare.</td>
</tr>
<tr>
<td>Long-listed options</td>
<td>All options identified in the SDC report, Call for Proposals and other strategically selected proposals.</td>
</tr>
<tr>
<td>Mitigation</td>
<td>Measures to prevent, or reduce as fully as possible any significant adverse effects.</td>
</tr>
<tr>
<td>Negative effects</td>
<td>Changes which are unfavourable for an environmental or social receptor. Can sometimes be referred to as ‘adverse’.</td>
</tr>
<tr>
<td>Permanent effect</td>
<td>An effect which will last at least for the lifetime of the structure (i.e. it is seen as permanent in relation to the human lifetime).</td>
</tr>
<tr>
<td>Phase 1</td>
<td>The current stage of the STP Feasibility Study – i.e. the Decision Making Assessment Framework (to develop a short-list of options) and SEA Scoping.</td>
</tr>
<tr>
<td>Phase 2</td>
<td>The second stage of the STP Feasibility Study – i.e. short-listed options appraisal and main assessment stage of the SEA.</td>
</tr>
<tr>
<td>Positive effects</td>
<td>Changes which are favourable for an environmental or social receptor. Can sometimes be referred to as ‘beneficial’.</td>
</tr>
<tr>
<td>Ramsar site</td>
<td>Ramsar sites are designated under the International Convention on Wetlands of International Importance 1971 especially as Waterfowl Habitat (the Ramsar Convention).</td>
</tr>
<tr>
<td>Receptor</td>
<td>An entity that may be affected by direct or indirect changes to an environmental variable.</td>
</tr>
<tr>
<td>Scoping</td>
<td>The process of deciding the scope and level of detail of an SEA, including the environmental effects and alternatives which need to be considered, the assessment methods to be used, and the structure and contents of the Environmental Report.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>SEA objective</td>
<td>A statement of what is intended, specifying the desired direction of change in trends.</td>
</tr>
<tr>
<td>Seabed</td>
<td>The areas permanently covered by the sea, i.e. Lowest Astronomical Tide. Sometimes referred to as sub-tidal.</td>
</tr>
<tr>
<td>Secondary effects</td>
<td>Effects which are not a direct result of the Feasibility Study, but occur away from the original effect or as a result of a complex pathway.</td>
</tr>
<tr>
<td>Severn Estuary</td>
<td>This is the physical extent of the Estuary and does not reflect the Study Area (see below) or nature conservation designations.</td>
</tr>
<tr>
<td></td>
<td>Downstream limit – headlands at Lavernock Point on the Welsh coast and Brean Down on the English coast passing through the small island features of Flat Holm and Steep Holm.</td>
</tr>
<tr>
<td></td>
<td>Upstream limit – Haw Bridge, upstream of Gloucester on the River Severn (based on 1 in 100 year flood risk area and also used by Shoreline Management Plan (SMP) (Gifford, 1998) and Coastal Habitat Management Plan (CHaMP) (ABPmer 2006)).</td>
</tr>
<tr>
<td>N.B.</td>
<td>The tidal limit, which for the Severn is at Maisemore (West Parting) and Llanthony (East Parting) weirs, near Gloucester.</td>
</tr>
<tr>
<td>Severn Tidal Power Study Area</td>
<td>The general study area used for Phase 1 of the project broadly extends downstream on the Estuary as far as Worm’s Head to Morte Point. It includes the landward fringe and tributaries such as the River Wye and the River Usk.</td>
</tr>
<tr>
<td></td>
<td>Study areas for individual topics may extend beyond this area and these are defined separately according to topic.</td>
</tr>
<tr>
<td>Short-listed options</td>
<td>All options screened from long-listed options, to be taken forward for analysis in the SEA</td>
</tr>
<tr>
<td>Significant environmental effects</td>
<td>Effects on the environment which are significant in the context of a plan or programme. Criteria for assessing significance are set out in Annex II of the SEA Directive (2001/42/EC).</td>
</tr>
<tr>
<td>Site of Special Scientific Interest (SSSI)</td>
<td>Designated under the Wildlife and Countryside Act 1981, any land considered by Natural England to be of special interest because of any of its flora, fauna, or geological and physiographical features.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
</tr>
<tr>
<td>Small barrage</td>
<td>A manmade obstruction across a watercourse to retain a head of water on the rising tide, and then run the water through turbines when the tide level drops. Small barrages are close to the two existing Severn Road Crossings.</td>
</tr>
<tr>
<td>Special Area of Conservation (SAC)</td>
<td>Strictly protected site designated under the EC Habitats Directive 92/43/EEC. 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 189 habitat types and 788 species identified in Annexes I and II of the Directive (as amended). The listed habitat types and species are those considered to be most in need of conservation at a European level (excluding birds).</td>
</tr>
<tr>
<td>Special Protection Area (SPA)</td>
<td>Strictly protected site classified in accordance with Article 4 of the EC Directive on the Conservation of Wild Birds (79/409/EEC), also known as the Birds Directive. They are classified for rare and vulnerable birds, listed in Annex I to the Birds Directive, and for regularly occurring migratory species.</td>
</tr>
<tr>
<td>Strategic Environmental Assessment (SEA)</td>
<td>Generic term used to describe environmental assessment as applied to policies, plans and programmes. ‘SEA’ is used to refer to the type of environmental assessment required under the SEA Directive.</td>
</tr>
<tr>
<td>Sub tidal</td>
<td>Areas (particularly with reference to habitats) that lie below the level of the lowest astronomical tide.</td>
</tr>
<tr>
<td>Synergistic effects</td>
<td>Effects which interact to produce a total effect greater than the sum of the individual effects, so that the nature of the final impact is different to the nature of the individual effects.</td>
</tr>
<tr>
<td>Temporary effects</td>
<td>An effects which only lasts part of the project lifetime, e.g. is confined to the construction period.</td>
</tr>
<tr>
<td>Tidal bore</td>
<td>A tidal phenomenon in which the leading edge of the incoming tide forms a wave (or waves) of water that travel up a river or narrow bay against the direction of the current.</td>
</tr>
</tbody>
</table>
## Appendix 1: Summary of Responses to Call for Information

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Date Received</th>
<th>Response Type</th>
<th>Hydraulics &amp; Geomorphology</th>
<th>Society &amp; Economy</th>
<th>Ornithology</th>
<th>Migratory &amp; Estuarine Fish</th>
<th>Marine Ecology</th>
<th>Terrestrial &amp; Freshwater Ecology</th>
<th>Marine Water Quality &amp; Associated Interfaces</th>
<th>Freshwater Environment &amp; Land Drainage</th>
<th>Noise &amp; Vibration</th>
<th>Carbon Footprinting</th>
<th>Other Sea Uses</th>
<th>Navigation</th>
<th>Historic Environment</th>
<th>Landscape &amp; Seascape</th>
<th>Resources &amp; Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated British Ports</td>
<td>12.06.08</td>
<td>Letter</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>British Association for Shooting and Conservation</td>
<td>13.07.08</td>
<td>Letter</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>Brian Cheetham Associates</td>
<td>13.06.08</td>
<td>Letter</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>30.05.08</td>
<td>Letter</td>
<td></td>
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<td></td>
<td></td>
<td>✓</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>British Marine Aggregates Producers Association</td>
<td>10.07.08</td>
<td>Letter</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

53 This table solely relates to Call for Information responses. Other inputs to scoping have been provided by many organisations, for example through technical meetings and the SEA Steering Group.
<table>
<thead>
<tr>
<th>Organisation</th>
<th>Date Received</th>
<th>Response Type</th>
<th>Potentially Relevant SEA Scoping Topic Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMTIsis</td>
<td>11.07.08</td>
<td>Tender for information provision</td>
<td>All</td>
</tr>
<tr>
<td>Bristol Pilots Partnership</td>
<td>17.06.08</td>
<td>Letter</td>
<td></td>
</tr>
<tr>
<td>Bristol Ports</td>
<td>11.07.08</td>
<td>Letter + attached reports</td>
<td>Habitat &amp; Geomorphology, Ornithology, Migratory &amp; Estuarine Fish</td>
</tr>
<tr>
<td>Cadw</td>
<td>13.07.08</td>
<td>Journal article</td>
<td></td>
</tr>
<tr>
<td>Campaign to Protect Rural England</td>
<td>09.07.08</td>
<td>email</td>
<td></td>
</tr>
<tr>
<td>Cardiff Council &amp; Cardiff Harbour Authority</td>
<td>10.07.08</td>
<td>Letter</td>
<td></td>
</tr>
<tr>
<td>Cardiff University</td>
<td>30.06.08</td>
<td>Letter &amp; Information pack</td>
<td></td>
</tr>
<tr>
<td>Cartographical Surveys Ltd</td>
<td>25.06.08</td>
<td>Letter and information tender</td>
<td>Marine Ecology, Terrestrial &amp; Freshwater Ecology, Marine Water Quality, Flood Risk &amp; Land Drainage, Noise &amp; Vibration</td>
</tr>
<tr>
<td>CEFAS</td>
<td>14.07.08</td>
<td>email</td>
<td></td>
</tr>
<tr>
<td>CIWEM</td>
<td>07.07.08</td>
<td>Letter</td>
<td></td>
</tr>
<tr>
<td>Countryside Council for Wales</td>
<td>09.06.08 to 08.10.08</td>
<td>Various emails, letters, Information</td>
<td>Marine Ecology, Terrestrial &amp; Freshwater Ecology, Marine Water Quality, Flood Risk &amp; Land Drainage, Noise &amp; Vibration</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>---------------------</td>
<td>--------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>English Heritage</td>
<td>04.07.08</td>
<td>Letter</td>
<td></td>
</tr>
<tr>
<td>Environment Agency</td>
<td>10.06.08 to 07.10.08</td>
<td>Various emails, letters, information</td>
<td></td>
</tr>
<tr>
<td>Evans Engineering</td>
<td>01.08.08</td>
<td>Letter + Appendices</td>
<td></td>
</tr>
<tr>
<td>Fleming Energy</td>
<td>12.06.08</td>
<td>Letter</td>
<td></td>
</tr>
<tr>
<td>Forest of Dean DC</td>
<td>21.05.08</td>
<td>Letter + hyperlinks to reports</td>
<td></td>
</tr>
<tr>
<td>Gloucester Harbour Trustees</td>
<td>12.06.08</td>
<td>Letter</td>
<td></td>
</tr>
<tr>
<td>Gloucestershire County Council</td>
<td>11.07.08</td>
<td>Letter</td>
<td></td>
</tr>
<tr>
<td>Greater Somerset Local Authorities</td>
<td>11.07.08</td>
<td>Letter &amp; Journal</td>
<td></td>
</tr>
<tr>
<td>Lydney Area in Partnership</td>
<td>13.07.08</td>
<td>Letter</td>
<td></td>
</tr>
<tr>
<td>Maritime &amp; Coastguard Agency</td>
<td>30.07.08</td>
<td>email</td>
<td></td>
</tr>
<tr>
<td>Maritime Energy Research Group</td>
<td>10.07.08</td>
<td>email &amp; attachment</td>
<td></td>
</tr>
<tr>
<td>Organisation</td>
<td>Date Received</td>
<td>Response Type</td>
<td>Potentially Relevant SEA Scoping Topic Area</td>
</tr>
<tr>
<td>------------------------------------</td>
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</tr>
<tr>
<td>Milford Haven Port Authority</td>
<td>12.06.08</td>
<td>email</td>
<td>Hydraulics &amp; Geomorphology  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓</td>
</tr>
<tr>
<td>National Trust</td>
<td>04.06.08</td>
<td>Letter &amp; attachments</td>
<td>society &amp; economy  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓</td>
</tr>
<tr>
<td></td>
<td>11.07.06</td>
<td>Map of area contacts</td>
<td>ornithology  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓</td>
</tr>
<tr>
<td></td>
<td>11.07.08</td>
<td>Letter &amp; Spreadsheet</td>
<td>migratory &amp; estuarine fish  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓</td>
</tr>
<tr>
<td></td>
<td>18.06.08</td>
<td>email &amp; article</td>
<td>marine ecology  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓</td>
</tr>
<tr>
<td>Natural England</td>
<td>12.05.08 to</td>
<td>Various emails, letters,</td>
<td>marine Water Quality  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓</td>
</tr>
<tr>
<td></td>
<td>09.10.08</td>
<td>information</td>
<td>freshwater environment &amp; associated interfaces  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓</td>
</tr>
<tr>
<td>Neath Harbour Commissioners</td>
<td>12.06.08</td>
<td>Letter</td>
<td>Historic Environment  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓</td>
</tr>
<tr>
<td></td>
<td>05.06.08</td>
<td>email</td>
<td>Landscape &amp; seascape  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓</td>
</tr>
<tr>
<td>PML Applications Ltd</td>
<td>11.07.08</td>
<td>email &amp; attachments</td>
<td>Resources &amp; Waste  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓</td>
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<tr>
<td></td>
<td>23.06.08</td>
<td>Email</td>
<td>navigation  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓</td>
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<tr>
<td>Ravensrodd Consultants Ltd.</td>
<td>19 &amp; 27.05.08</td>
<td>emails</td>
<td>Historic Environment  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓</td>
</tr>
<tr>
<td>RSPB</td>
<td>11.07.08</td>
<td>Letter</td>
<td>Landscape &amp; seascape  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓</td>
</tr>
<tr>
<td>Organisation</td>
<td>Date Received</td>
<td>Response Type</td>
<td>Potentially Relevant SEA Scoping Topic Area</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
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<td>---------------------------------------------</td>
</tr>
<tr>
<td>Sedgemor District Council</td>
<td>25.05.08, 11.07.08, 03.07.08, 16.06.08</td>
<td>email &amp; reports</td>
<td>All</td>
</tr>
<tr>
<td>Severn Estuary Partnership</td>
<td>Undated</td>
<td>Spring 2008 Newsletter</td>
<td>All</td>
</tr>
<tr>
<td>Severn Sands</td>
<td>30.06.08</td>
<td>Dredging Map</td>
<td>All</td>
</tr>
<tr>
<td>SE Wales Biodiversity Records Centre</td>
<td>11.07.08</td>
<td>email</td>
<td>Marine Ecology, Terrestrial &amp; Freshwater Ecology, Marine Water Quality</td>
</tr>
<tr>
<td>Sharpness Dock</td>
<td>12.06.08</td>
<td>Letter</td>
<td>All</td>
</tr>
<tr>
<td>Shawater</td>
<td>11.07.08</td>
<td>email with references</td>
<td>All</td>
</tr>
<tr>
<td>Somerset County Council, Historic Environment Service</td>
<td>11.07.08</td>
<td>Letter</td>
<td>All</td>
</tr>
<tr>
<td>Stroud District Council</td>
<td>17.07.08</td>
<td>email</td>
<td>All</td>
</tr>
<tr>
<td>South West Regional Assembly</td>
<td>10.06.08</td>
<td>email with links to documents</td>
<td>All</td>
</tr>
<tr>
<td>Trans-send</td>
<td>24.07.08, 25.07.08</td>
<td>email &amp; supporting document</td>
<td>All</td>
</tr>
<tr>
<td>Vale of Glamorgan Council</td>
<td>29.05.08</td>
<td>email</td>
<td>All</td>
</tr>
<tr>
<td>Organisation</td>
<td>Date Received</td>
<td>Response Type</td>
<td>Potentially Relevant SEA Scoping Topic Area</td>
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<td>-------------------------------------------</td>
</tr>
<tr>
<td>Welsh Assembly Government</td>
<td>01.08.08</td>
<td>Letter</td>
<td>✅</td>
</tr>
<tr>
<td>West Mendip Internal Drainage Board</td>
<td>05.06.08</td>
<td>Letter</td>
<td>✅</td>
</tr>
<tr>
<td>Wye &amp; Usk Foundation</td>
<td>10.07.08</td>
<td>Report</td>
<td>✅</td>
</tr>
</tbody>
</table>

**Key**

- ✅ Correspondence is of potential relevance to SEA Scoping topic
- [blank cell] Response not relevant to topic
Appendix 2: Objectives, Assessment Criteria and Indicators

### SEA Objective

**Topic: Hydraulics and Geomorphology**

Hydraulics and Geomorphology is not an SEA Directive topic in its own right, nor does it have an explicit policy framework. It is therefore problematic to develop SEA Assessment objectives and criteria in this area. However, in this SEA, an understanding of effects on Hydraulics and Geomorphology is fundamental to the assessment of many other topics, e.g. marine ecology, birds, fish, and water quality. Thus the assessment of options in relation to Hydraulics and Geomorphology will focus on informing the appraisal of options in relation to other topics.

### Topic: Society and Economy

- To seek to create local employment opportunities accessible to all.
- To avoid adverse effects on the local and regional economy.
- To seek to promote the development of sustainable communities.
- To avoid adverse effects on physical and mental health.
- To avoid adverse effects on access to community services and facilities.
- To avoid adverse effects on access to recreational facilities and open space.
- To avoid adverse effects on existing, proposed and committed land uses.
- To seek opportunities to improve degraded environments.
- To avoid adverse effects on the housing market.

### SEA Assessment Criteria

<table>
<thead>
<tr>
<th>Objective</th>
<th>Assessment Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Will the option positively affect existing local employment opportunities?</td>
<td>Will the option create temporary &amp;/or permanent employment in areas of deprivation?</td>
</tr>
<tr>
<td>Will the key economic activities around the estuary be affected negatively by the option?</td>
<td>Will the option have a beneficial effect on local and regional businesses?</td>
</tr>
<tr>
<td>Will the option result in in-migration of population or otherwise affect existing population dynamics within the rural and urban areas of South Wales and South West England?</td>
<td>Performance in the following industries: Construction and engineering, Transport and logistics, Fishing, Tourism, Accommodation, Ports, Aggregates</td>
</tr>
<tr>
<td>Will the option result in an increase in crime and integration problems in a community?</td>
<td>Number of employment opportunities created in deprived areas, Estimated number of recruited local workers, Estimated number of additional/indirect business and jobs as a result of the development, Number and type on in-migrants in relation to existing population characteristics in the study area, Percentage of existing crime rate in the area, Percentage of population in 'good health'.</td>
</tr>
</tbody>
</table>

### SEA Indicators

- Number of employment opportunities created in deprived areas.
- Estimated number of recruited local workers.
- Estimated number of additional/indirect business and jobs as a result of the development.
- Number and type on in-migrants in relation to existing population characteristics in the study area.
- Percentage of existing crime rate in the area.
- Percentage of population in 'good health'.

54 Monitoring of these indicators (which may be revised during the assessment phase of the SEA) will need to be undertaken once effects have been identified.
<table>
<thead>
<tr>
<th>SEA Objective</th>
<th>SEA Assessment Criteria</th>
<th>SEA Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Will the construction of the option result in a temporary severance of access to community services and facilities?</td>
<td>Satisfaction with the local area as a place to live.</td>
</tr>
<tr>
<td></td>
<td>Will operation of the option result in a permanent severance of access to community services and facilities?</td>
<td>Relative increases in air emissions anticipated from traffic, construction equipment, etc.</td>
</tr>
<tr>
<td></td>
<td>Will the reduced access disproportionately affect different receptors?</td>
<td>Number of major community services and facilities with access decreased or increased as a result of the option.</td>
</tr>
<tr>
<td></td>
<td>Will the construction of the option result in a temporary severance of access to recreational facilities and open space?</td>
<td>Number of deprived communities with a decrease in access.</td>
</tr>
<tr>
<td></td>
<td>Will operation of the option result in a permanent severance of access to recreational facilities and open space?</td>
<td>Number of recreational facilities and/or open space with access changed as a result of the option.</td>
</tr>
<tr>
<td></td>
<td>Will the option result in the loss of existing, proposed or committed developments?</td>
<td>Area of landtake and land use of the land take.</td>
</tr>
<tr>
<td></td>
<td>Will the option result in the loss of agricultural land?</td>
<td>Committed and proposed developments in the area that will be directly affected by the option.</td>
</tr>
<tr>
<td></td>
<td>Will the option result in the regeneration of brownfield land?</td>
<td>Area of brownfield land directly affected by the option.</td>
</tr>
<tr>
<td></td>
<td>Will the option provide opportunity for regeneration?</td>
<td>Regeneration potential.</td>
</tr>
<tr>
<td></td>
<td>Will the influx of migrants result in an increased demand for housing?</td>
<td>Housing stock and deficit in housing provision.</td>
</tr>
<tr>
<td></td>
<td>Can the housing demand be met locally?</td>
<td></td>
</tr>
<tr>
<td>SEA Objective</td>
<td>SEA Indicators</td>
<td></td>
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<tr>
<td>------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on designated marine wildlife sites and protected habitats of international importance.</td>
<td>Changes in quality/extent of internationally important site features, e.g., within SPA, SACs, Ramsar Sites.</td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on other protected marine species and their habitats.</td>
<td>Changes in quality/extent of nationally important site features, e.g., within SSSI.</td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on valuable marine ecosystems.</td>
<td>Changes in quality/extent of regionally important site features, e.g., within Local Wildlife Sites etc.</td>
<td></td>
</tr>
<tr>
<td>Will the option result in the loss of marine habitats of international importance?</td>
<td>Will the option adversely affect the achievement of favourable conservation status and hence integrity of internationally important marine wildlife sites (as defined for the potentially affected designated marine sites by the relevant Conservation Objectives developed under Regulation 33 of the Habitats Regulations)?</td>
<td></td>
</tr>
<tr>
<td>Will the option adversely affect the favourable condition of nationally important marine wildlife sites?</td>
<td>Will the option adversely affect other statutory or non-statutory condition of nationally important marine wildlife sites?</td>
<td></td>
</tr>
<tr>
<td>Will the option affect other statutory or non-statutory populations of internationally or nationally protected marine species?</td>
<td>Will the option adversely affect populations of internationally or nationally protected marine species?</td>
<td></td>
</tr>
<tr>
<td>Will the option affect other statutory or non-statutory marine BAP species?</td>
<td>Will the option adversely affect populations of internationally or nationally protected marine BAP species?</td>
<td></td>
</tr>
<tr>
<td>Will the option adversely affect achievement of WFD ecological objectives?</td>
<td>Will the option adversely affect achievement of WFD ecological objectives?</td>
<td></td>
</tr>
</tbody>
</table>

Changes in quality/extent of internationally important site features, e.g., within SPA, SACs, Ramsar Sites.
Changes in quality/extent of nationally important site features, e.g., within SSSI.
Changes in quality/extent of regionally important site features, e.g., within Local Wildlife Sites etc.
Changes in abundance and range of SAC designated species.
Changes in abundance and range of BAP species.
Changes in WFD ecological elements.
<table>
<thead>
<tr>
<th>SEA Objective</th>
<th>SEA Assessment Criteria</th>
<th>SEA Indicators$^4$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topic: Ornithology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on designated wildlife sites for birds and protected habitats of international and national importance.</td>
<td>Will the option result in changes in the populations of bird species of international importance, i.e. SPA and Ramsar features, and so affect their favourable conservation status and hence the conservation objectives and integrity of these sites (as defined for the potentially affected designated sites by the relevant Conservation Objectives developed under Regulation 33(2) of the Conservation (Natural Habitats &amp;c.) Regulations)? Will the option affect other sites within the Natura 2000 network? Will the option result in changes in the populations of bird species of national importance, i.e. SSSI features, and so affect their favourable conservation status and hence the conservation objectives and integrity of these sites? Will the option affect other statutory or non-statutory wildlife sites important for birds? Will the option maintain BAP habitats and bird species in line with UKBAP targets or affect the status of Section 41/42 listed BAP species in England and Wales or BoCC listed species?</td>
<td>Changes in bird abundance on the Severn Estuary SPA and Ramsar Site. Changes in bird abundance on other identified SPAs. Changes in bird abundance on the six relevant SSSIs with a bird interest. Changes in bird abundance on National Nature Reserves and other Local Nature Reserves. Changes in abundance and range of BAP and BoCC listed species.</td>
</tr>
<tr>
<td>To avoid adverse effects on other protected bird habitats and species.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on national and local biodiversity target features that include bird habitats and species.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEA Objective</th>
<th>SEA Assessment Criteria</th>
<th>SEA Indicators</th>
</tr>
</thead>
</table>
| Topic: Migratory & Estuarine Fish                                            | To avoid adverse effects on designated wildlife sites for fish of international and national importance.  
To avoid adverse effects on the populations of other protected fish species and habitats.  
To avoid adverse effects on national and local biodiversity target features that include fish habitats and species.  
To avoid adverse effects on recreational and heritage fishing.  
To avoid adverse effects on commercial fish resources.  
To minimise the risk of introduction of non-native invasive fish species.        | Changes in designated features and designation status for fish.  
Abundance of populations of internationally and nationally important fish species.  
Changes in the range of internationally and nationally designated fish species.  
Changes in the physical (biological and chemical) parameters upon which the fish species rely.  
Abundance of populations of fish species caught by recreational anglers.  
Abundance of populations of fish species caught in commercial fisheries.                                                                 |
<table>
<thead>
<tr>
<th>SEA Objective</th>
<th>SEA Assessment Criteria</th>
<th>SEA Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topic: Terrestrial and Freshwater Ecology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on designated terrestrial and freshwater wildlife sites of international and national importance.</td>
<td>Will the option result in the loss of terrestrial and freshwater habitats of international or national importance? Will the option adversely affect ecological networks for terrestrial and freshwater habitats and species? Will the option affect other statutory or non-statutory terrestrial and freshwater wildlife sites? Will the option adversely affect the achievement of favourable conservation status and hence integrity of internationally important wildlife sites (as defined by relevant Conservation Objectives)? Will the option adversely affect the achievement of favourable conservation status for nationally important terrestrial and freshwater wildlife sites? Will the option restore and enhance terrestrial and freshwater BAP habitats and species in line with UKBAP targets?</td>
<td>Changes in quality/extent of internationally important site features, e.g. within SPAs, SACs Ramsar Sites. Changes in quality/extent of nationally important site features, e.g. within SSSIs. Changes in quality/extent of regionally important site features, e.g. within Local Wildlife Sites etc. Changes in abundance and range of SAC designated species. Changes to ecological networks by reference to broad-scale physical effect. Changes in quality/ extent of BAP habitats. Changes in abundance and range of BAP species.</td>
</tr>
<tr>
<td>To avoid adverse effects on valuable terrestrial and freshwater ecological networks.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on other protected terrestrial and freshwater habitats and species.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects to national and local biodiversity target features including terrestrial and freshwater habitats and species.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To minimise the risk of introduction of non-native invasive terrestrial and freshwater species.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To conserve and enhance designated freshwater and terrestrial site features.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To restore and enhance freshwater and terrestrial BAP species populations and/or BAP habitat.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEA Objective</td>
<td>SEA Assessment Criteria</td>
<td>SEA Indicators</td>
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<tr>
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</tr>
<tr>
<td>Topic: Marine Water Quality</td>
<td>Will existing water quality standards (as defined in the WFD, revised Bathing Waters Directive, Shellfish Waters Directive etc) be compromised as a result of the development? Will development give rise to water quality changes which may lead to detrimental effects on internationally or nationally designated marine sites, fauna and flora or human health, water supply and other uses or lead to a deterioration in water status? Will the development result in changes to salinity, temperature or pH and if so, what are the potential consequences for dissolved oxygen, nutrients or contaminants? Will the option lead to pollution risks during the construction, operation and decommissioning of the development.</td>
<td>Changes to water quality parameters, including WFD priority substances. Changes to water, sediment and biota samples from key sites. Water quality standards. Dissolved oxygen, nutrients and suspended solids. Changes to physical parameters – salinity, temperature or pH. Construction and operational discharges.</td>
</tr>
<tr>
<td>Topic: Freshwater Environment and Associated Interfaces</td>
<td>SEA Objective</td>
<td>SEA Assessment Criteria</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>---------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>To avoid adverse effects on water quality (whether surface water, groundwater or coastal waters) in relation to water quality standards.</td>
<td>Will option cause deterioration in water quality such that RQO or requirements of WFD are not attained/maintained?</td>
<td>Estimate changes in physical, chemical and biological water quality (further details to be collated at nominated site stage where applicable) (Changes to water, sediment and biota samples at key sites. Water quality standards, plus WFD priority substances, where applicable)</td>
</tr>
<tr>
<td>To avoid adverse effects on water quality which would affect human health, flora and fauna, recreation and other users.</td>
<td>Will option cause potential negative effects to human health?</td>
<td>Estimate potential changes in availability and water quality at surface and groundwater abstractions. Indicators as above Plus SPZ configurations in the case of groundwater abstractions</td>
</tr>
<tr>
<td>To avoid adverse effects on water abstractions (whether surface water or groundwater), particularly those utilised for the PWS.</td>
<td>Will option reduce available surface water resources in terms of quantity or quality?</td>
<td>Estimate changes in stress on land drainage and associated infrastructure</td>
</tr>
<tr>
<td>To avoid adverse effects to designated freshwater sites of nature conservation interest.</td>
<td>Will option reduce available fresh water resources in terms of quantity or quality?</td>
<td>Assess changes in integrity of nature conservation sites due to changes in groundwater levels, and/or surface water flows and/or quality</td>
</tr>
<tr>
<td>To avoid adverse effects to buildings and infrastructure.</td>
<td>Will option negatively affect PWS or other licensed or unlicensed sources in terms of quality of quality?</td>
<td>Assess changes in hydrology of Severn Estuary on Severn Tunnel and implications for tunnel integrity</td>
</tr>
<tr>
<td>To avoid adverse effects on the soil resource.</td>
<td>Will option affect sites of nature conservation importance or protected areas, including freshwater fisheries, by changes in water levels, flows or quality?</td>
<td>Assess changes in groundwater elevations and chemistry caused by impoundment schemes on buildings, sewers, CSOs etc. Diversity, quality and coverage of soil resource Agriculture land quality, accessibility to machinery</td>
</tr>
<tr>
<td>To avoid adverse effects on agricultural land currently in use.</td>
<td>Will option negatively affect the Severn railway tunnel or other important transportation infrastructure?</td>
<td>Estimate altered accessibility to geological and geomorphological SSSIs</td>
</tr>
<tr>
<td>To avoid adverse effects on designated geological and geomorphological sites of international and national importance.</td>
<td>Will option negatively affect buildings?</td>
<td>Estimate rate of increased deterioration by physical or chemical processes</td>
</tr>
<tr>
<td>To conserve and enhance designated geological and geomorphological site features.</td>
<td>Will option affect land drainage, including pipes, sewers, culverts?</td>
<td></td>
</tr>
<tr>
<td>SEA Objective</td>
<td>SEA Assessment Criteria</td>
<td>SEA Indicators</td>
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<tr>
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</tr>
<tr>
<td><strong>Topic: Flood Risk and Land Drainage</strong></td>
<td>Will the option result in a reduction in flood risk to property, land and infrastructure assets? Will the option allow existing flood risk levels to be maintained whilst deferring improvements to flood defences? If the option results in an unacceptable increase in flood risk by the restriction of fluvial discharge to the estuary as a result of changes to the tidal regime, are adequate mitigation measures available? Will the option result in a potential change to flood risk as a result of any change to wave climate, and are adequate measures available to mitigate any adverse changes?</td>
<td>Changes to water levels at key locations. Risk of flooding of assets (land, property and infrastructure). Costs to manage water levels at baseline (or alternative desired) level</td>
</tr>
<tr>
<td><strong>Topic: Noise and Vibration</strong></td>
<td>Will noise &amp; vibration exceed levels given in PPG24: Planning and Noise; BS4142 Rating Industrial noise affecting mixed residential and industrial areas; BS5228 Noise and vibration control on construction and open sites? Will option give rise to excessive environmental noise &amp; vibration levels? Will vibration exceed levels given in BS5228 Noise and vibration control on construction and open sites. BS 6472 Evaluation of human exposure to vibration in buildings?</td>
<td>Level of specific noise levels in relation to background noise levels. Distance from noise sensitive receptors. Predictions of changes of specific noise levels in relation to background noise levels. Sensitivity of receptors to changes (short and long term) – if information available/may be qualitative. Level of vibration</td>
</tr>
<tr>
<td><strong>Topic: Carbon Footprinting</strong></td>
<td>What is the carbon footprint of each option (life cycle emissions in relation to other options)? What is the carbon payback period?</td>
<td>The carbon (equivalent) emissions payback period will indicate which option is most carbon efficient.</td>
</tr>
</tbody>
</table>

211
<table>
<thead>
<tr>
<th>SEA Objective</th>
<th>SEA Assessment Criteria</th>
<th>SEA Indicators</th>
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<tbody>
<tr>
<td><strong>Topic: Other Sea Uses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on the aggregate extraction industry.</td>
<td>Will the option result in the loss of revenue for the aggregate extraction industry?</td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on marine waste disposal sites and infrastructure.</td>
<td>Will the option affect integrity or hydraulic functioning of marine assets?</td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on the commercial fishing industry.</td>
<td>Will the option result in the loss of revenue for the commercial fishing industry?</td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on marine recreational users.</td>
<td>Will the option alter the recreational usability of the Inner Bristol Channel and Severn Estuary?</td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on tourism in the region.</td>
<td>Will the option result in the loss/increase of revenue for the tourism industry?</td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on military activity in the region.</td>
<td>Will option result in the reduction/increase of military activity in the Inner Bristol Channel and Severn Estuary?</td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on the energy industry.</td>
<td>Will the option affect the functionality of power station water extraction facilities and dispersal of cooling waters?</td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on seabed cables in the region.</td>
<td>Will the option affect the potential future viability of oil and gas blocks in the Inner Bristol Channel and Severn Estuary?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Will the option affect existing cable routes?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of aggregate extraction sites affected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compensation/mitigation costs for marine infrastructure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of outfall structures affected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of outfall consents requiring revision</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of dredge material disposal sites affected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fisheries revenue affected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recreational usage numbers affected and economic value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Visitor numbers affected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tourism income affected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Military usage numbers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of power generation sites affected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of oil and gas blocks affected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of cables affected</td>
</tr>
<tr>
<td><strong>Topic: Navigation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To avoid adverse effects on Severn Estuary Navigation arising from sedimentation, geomorphology, water density, and water levels.</td>
<td>Will the option result in significant changes to navigation within the Severn Estuary for which mitigation is not possible?</td>
<td>Reduction in the amount of dwt using the ports.</td>
</tr>
<tr>
<td>To avoid adverse effects on the integrity of existing and proposed port operations.</td>
<td>Will the option result in a reduction of feasible vessel movements to the ports within the Severn Estuary?</td>
<td>Increased level of low water level.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduced level of spring tide.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase in delay and costs to vessels within the Severn Estuary</td>
</tr>
<tr>
<td>SEA Objective</td>
<td>SEA Assessment Criteria</td>
<td>SEA Indicators</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>Topic: Historic Environment</strong></td>
<td>Will the option negatively affect the designated historic environment?</td>
<td>Loss/damage to designated and scheduled sites, features and landscapes.</td>
</tr>
<tr>
<td>To avoid adverse effects on designated sites in the purpose of historic</td>
<td>Will the option negatively affect the non-registered and non-designated historic</td>
<td>Loss/damage to undesignated sites, features and landscapes.</td>
</tr>
<tr>
<td>environment.</td>
<td>environment in the Severn Estuary</td>
<td>Location of scheduled ancient monuments.</td>
</tr>
<tr>
<td>To avoid adverse effects on the non-registered internationally, nationally,</td>
<td>Will the historic environment receive sufficient research in order to avoid negative</td>
<td>Proximity of option to designated area, design and scale of option</td>
</tr>
<tr>
<td>regionally and locally important sites within the historic environment.</td>
<td>effects on the potential and unknown historic archaeological resource?</td>
<td>(including associated infrastructure works and habitat mitigation</td>
</tr>
<tr>
<td>To avoid adverse effects on the potential historic environment, the as yet</td>
<td>Will the option negatively affect the character and quality of the historic landscape?</td>
<td>Potential for loss/damage to unknown sites.</td>
</tr>
<tr>
<td>unidentified sites and finds, within the Severn Estuary.</td>
<td></td>
<td>Changes to erosion, sedimentation, water levels and water quality.</td>
</tr>
<tr>
<td>To avoid adverse effects on the character, quality and integrity of the</td>
<td></td>
<td>Changes to the historic environment in the intertidal zone.</td>
</tr>
<tr>
<td>historic and/or cultural landscape.</td>
<td></td>
<td>Changes to the submerged historic environment.</td>
</tr>
<tr>
<td><strong>Topic: Landscape and Seascape</strong></td>
<td>Will the option adversely affect landscapes within or immediately adjacent to a National Park, Area of Outstanding Natural Beauty, Heritage Coast or the Gwent Levels historic landscape?</td>
<td>Changes in quality of nationally valued landscapes – number of designations and area of land affected where quantifiable.</td>
</tr>
<tr>
<td>To conserve the character and qualities of the landscape/seascape,</td>
<td>Will the option adversely affect the landscape character of Heritage Coast or the Gwent Levels historic landscape?</td>
<td>Changes in quality of landscape character, tranquility, diversity and distinctiveness – area of land affected where quantifiable.</td>
</tr>
<tr>
<td>recognising its diverse features and distinctiveness at different scales –</td>
<td>Will the option adversely affect local landscape/seascape character?</td>
<td>Changes in quality of views and area of visual resource affected</td>
</tr>
<tr>
<td>including designated and non-designated areas.</td>
<td>Will the option adversely affect visual amenity?</td>
<td>Architectural awards for visual merit of built structures.</td>
</tr>
<tr>
<td>To conserve the character and qualities of the physical and visual resource</td>
<td></td>
<td>Adverse effects on landscape/seascape character, quality and tranquillity and areas affected</td>
</tr>
<tr>
<td>associated with land and sea.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To accord with the Aims and Articles of the European Landscape Convention</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SEA Objective</strong></td>
<td><strong>SEA Assessment Criteria</strong></td>
<td><strong>SEA Indicators</strong></td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td><strong>Topic: Resources and Waste</strong></td>
<td><strong>Will the option result in reduced resource requirements compared to other options?</strong>&lt;br&gt;<strong>Will the option result in sustainable use of resources that are required compared to other options?</strong>&lt;br&gt;<strong>Will the option result in reduced waste arisings compared to other options?</strong>&lt;br&gt;<strong>Will the option result in reduced waste for final disposal compared to other options?</strong></td>
<td><strong>Relative quantity and type (estimate) of waste arising from each option.</strong>&lt;br&gt;<strong>Relative quantity and type (estimate) of waste requiring landfill disposal for each option.</strong>&lt;br&gt;<strong>Relative resource requirements for each option.</strong>&lt;br&gt;<strong>Potential source of resources.</strong>&lt;br&gt;<strong>Carbon impacts of options.</strong></td>
</tr>
</tbody>
</table>
Appendix 3: Receptors and Preliminary Assessment of Sensitivity

### Appendix 3: SEA Receptors and Preliminary Assessment of Sensitivity

<table>
<thead>
<tr>
<th>Topic</th>
<th>Receptor</th>
<th>Preliminary Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydraulics and Geomorphology</strong></td>
<td>Nature conservation features</td>
<td>These receptors have not been assessed for sensitivity, as they form the basic components of the physical environment.</td>
</tr>
<tr>
<td></td>
<td>Water levels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flows</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waves</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sediment regime</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morphology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water quality</td>
<td></td>
</tr>
<tr>
<td><strong>Society &amp; Economy</strong></td>
<td>Welsh urban population</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>South West England urban population</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Welsh rural population</td>
<td>Medium to High</td>
</tr>
<tr>
<td></td>
<td>South West England rural population</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>The local economy</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>The regional economy</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Marine Ecology</strong></td>
<td>Plankton</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Macroalgae</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Intertidal mudflats and sandflats</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Zostera</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>cSAC areas</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Saltmarshes and reed beds</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Shingle and rocky shore</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Subtidal sandbanks</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Sabellaria alveolata reefs</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Other subtidal habitats</td>
<td>Low to Medium</td>
</tr>
<tr>
<td></td>
<td>Epibenthos</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Cephalopods</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Marine mammals and turtles</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>BAP Habitats &amp; Species</td>
<td>Medium to High*</td>
</tr>
<tr>
<td></td>
<td>Non-Native Invasive Species</td>
<td>Unknown*</td>
</tr>
<tr>
<td></td>
<td>Other designated sites/ species – see Terrestrial &amp; Freshwater Ecology</td>
<td>*Following preliminary consultation, it has been suggested that these receptors should be included. A review of receptor and their sensitivity will be undertaken in main SEA Assessment following the full consultation process.</td>
</tr>
</tbody>
</table>

For most topic areas, relevant receptors and their sensitivity can generally be identified at this scoping stage. For some receptors, at this stage there is far greater uncertainty as to receptor sensitivity, and their exposure to effects from tidal power options. In some cases it is therefore not possible to reach consensus on receptor sensitivity at this scoping phase, and it will therefore be necessary to review receptor sensitivity once short-listed options and the nature of their physicochemical effects are better understood.
<table>
<thead>
<tr>
<th>Topic</th>
<th>Receptor</th>
<th>Preliminary Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ornithology</strong></td>
<td>Bewick’s Swan</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>European White-fronted Goose</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Wigeon</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Gadwall</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Mallard</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Pochard</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Ringed Plover</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Grey Plover</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Dunlin</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Whimbrel</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Spotted Redshank</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Redshank</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Water Rail</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Shelduck</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Teal</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Pintail</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Shoveler</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Tufted Duck</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Lapwing</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Curlew</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Little Egret</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Ruff</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Greenshank</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Lesser Black-backed Gull</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Herring Gull</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Black-tailed Godwit</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Bittern</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Migratory and Estuarine Fish</strong></td>
<td>Atlantic salmon</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Sea trout</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Shad</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Lamprey</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Eel</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Sturgeon</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Marine Migrants (sensitivity based on UK BAP species: cod, herring, plaice, sole and whiting)</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Marine stragglers (sensitivity based on UK BAP species: blue whiting, hake, horse mackerel, ling &amp; saithe)</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Freshwater stragglers</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Estuarine species</td>
<td>Will tend to follow sensitivity of target fish species.</td>
</tr>
<tr>
<td></td>
<td>Recreational angling</td>
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</tr>
<tr>
<td><strong>Terrestrial and Freshwater Ecology</strong></td>
<td>European Designated Sites e.g. SPA/SAC</td>
<td>To be assigned in main SEA Assessment Phase.</td>
</tr>
<tr>
<td></td>
<td>European Protected Species e.g. Otters</td>
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</tr>
<tr>
<td></td>
<td>Nationally Designated Sites e.g. SSSI, NNR</td>
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</tr>
<tr>
<td></td>
<td>Nationally Protected Species e.g. Water vole</td>
<td></td>
</tr>
<tr>
<td></td>
<td>UK BAP habitats and species</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Important habitats</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Local BAP habitats and species</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-Native Invasive Species</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Further receptors may be identified in Phase 2</td>
<td></td>
</tr>
<tr>
<td>Topic</td>
<td>Receptor</td>
<td>Preliminary Sensitivity</td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------------------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td><strong>Marine Water Quality</strong></td>
<td>Temperature</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>pH</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Salinity</td>
<td>Medium to High</td>
</tr>
<tr>
<td></td>
<td>Suspended sediment concentrations</td>
<td>Medium to High</td>
</tr>
<tr>
<td></td>
<td>Organic Matter</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Nutrients</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Dissolved oxygen</td>
<td>Medium to High</td>
</tr>
<tr>
<td></td>
<td>Trace metals</td>
<td>Medium to High</td>
</tr>
<tr>
<td></td>
<td>Trace organics</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Radiological contaminants</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Pathogens</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Freshwater Environment and Associated Interfaces</strong></td>
<td>Soils</td>
<td>Low to Medium</td>
</tr>
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<td></td>
<td>Geology</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Geological SSSIs</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Groundwater Resources</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Groundwater PWS Sources</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Severn Tunnel</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Other subterranean infrastructure</td>
<td>Low to Medium</td>
</tr>
<tr>
<td></td>
<td>Surface Water Sources</td>
<td>High</td>
</tr>
<tr>
<td><strong>Flood Risk and Land Drainage</strong></td>
<td>Assets (property, land and infrastructure) at risk of tidal flooding – no defences with 100 years of sea level rise</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Assets (property, land and infrastructure) at risk of fluvial flooding directly affected by restriction of discharge to the estuary</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Noise and Vibration</strong></td>
<td>Urban areas near major transportation infrastructure</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Urban areas (densely populated mix of residential and commercial)</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Semi-urban areas</td>
<td>Low to Medium</td>
</tr>
<tr>
<td></td>
<td>Rural areas near major transportation infrastructure</td>
<td>Low to Medium</td>
</tr>
<tr>
<td></td>
<td>Rural areas</td>
<td>High</td>
</tr>
<tr>
<td><strong>Carbon Footprinting</strong></td>
<td>Global Level of GHG Emissions</td>
<td>High</td>
</tr>
<tr>
<td><strong>Other Sea Uses</strong></td>
<td>Marine Aggregate Extraction</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Marine Waste Disposal</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Commercial Fishing</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Recreation and Tourism</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Military Activity</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Oil &amp; Gas Blocks</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Renewable Energy</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Power Stations (nuclear)</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Cables and Pipelines</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Navigation</strong></td>
<td>Bristol Port</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Cardiff Port</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Newport Port</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Sharpness/Gloucester Port</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Historic Environment</strong></td>
<td>Historic Environment</td>
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</tr>
<tr>
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<td>Terrestrial</td>
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<td>Intertidal</td>
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<td>Submerged</td>
<td>High</td>
</tr>
<tr>
<td>Topic</td>
<td>Receptor</td>
<td>Preliminary Sensitivity</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td><strong>Landscape and Seascape</strong></td>
<td>National Park</td>
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</tr>
<tr>
<td></td>
<td>Area of Outstanding Natural Beauty</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Heritage Coast</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Gwent Levels historic landscape</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Country Park</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Woodland and Forest Park</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Local Authority landscape designation</td>
<td>Varies</td>
</tr>
<tr>
<td><strong>Resources and Waste</strong></td>
<td>Waste management facilities</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Resource availability (regional)</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Resource availability (national)</td>
<td>Medium</td>
</tr>
</tbody>
</table>
Why is Government conducting this consultation?

This consultation seeks views on the conclusions of the first phase of the Government’s feasibility study into whether a power project using the vast natural tidal range resource of the Severn Estuary could be supported and, if so, on what terms. The consultation focuses on:

- which of the ten possible Severn tidal power options under consideration should be short-listed for detailed assessment during 2009
- the scope of the Strategic Environmental Assessment that is being carried out within the Severn tidal power feasibility study
- the issues the feasibility study is considering and how these are being approached

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