



DECC

## **SEVERN TIDAL POWER FEASIBILITY STUDY**

### **Report to Inform a Stage 2 (Appropriate Assessment) Habitats Regulations Assessment**

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## ABBREVIATIONS



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The following abbreviations are used in this Topic Report:

AA	Appropriate Assessment
AEOSI	Adverse Effect on Site Integrity
B3	Cardiff-Weston Barrage (short-listed option for STP), also known as the Brean Down to Lavernock Point Barrage.
B4	Shoots Barrage (short-listed option for STP)
B5	Beachley Barrage (short-listed option for STP)
CCW	Countryside Council for Wales
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
dSAC	Draft Special Area of Conservation
EIA	Environmental Impact Assessment
EC	European Commission
EU	European Union
HRA	Habitats Regulations Assessment
IOAR	Interim Options Analysis Report
IROPI	Imperative Reasons of Overriding Public Interest
JNCC	Joint Nature Conservation Committee
L2	Welsh Grounds Lagoon (short-listed option for STP)
L3d	Bridgwater Bay Lagoon (short-listed option for STP)
MW	Megawatt
ODR	Options Definition Report
ODPM	Office of the Deputy Prime Minister
NAW	National Assembly of Wales
NE	Natural England
PB	Parsons Brinckerhoff
PPS	Planning Policy Statement
pSAC	Possible Special Area of Conservation
SCI	Site of Community Importance
pSPA	Potential Special Protection Area
SAC	Special Area of Conservation
SDC	Sustainable Development Commission
SEA	Strategic Environmental Assessment
SI	Statutory Instrument
SPA	Special Protection Area
SR	Statutory Rule (of Northern Ireland)
STP	Severn Tidal Power
SSI	Scottish Statutory Instrument
SSSI	Site of Special Scientific Interest
TAN	Technical Advice Note
TWh/year	Terawatt hours per year
WAG	Welsh Assembly Government



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## EXECUTIVE SUMMARY





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### Introduction

The Government announced a two-year feasibility study on harnessing the renewable energy from the tidal range in the Severn Estuary in January 2008. This work has been carried out by a cross-Government team led from the Department of Energy and Climate Change (DECC), 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.

The aim of the Severn Tidal Power (STP) Feasibility Study was to investigate whether the Government could support a tidal power scheme in the Severn and, if so, on what terms.

As part of making any final decision to take forward an option or options at the end of the feasibility study, the option or options to be taken forward would need to be tested against the requirements of the European Community (EC) Habitats Directive (Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora) and Birds Directive (Council Directive 2009/147/EC on the conservation of wild birds).

These directives establish, and provide protection for, a network of sites designated to conserve natural habitats and species that are rare, endangered, vulnerable or endemic within the European Union. These sites are known as the 'Natura 2000' network. The requirements of the EC Habitats and Birds Directives are transcribed into English and Welsh law by the Conservation of Habitats and Species Regulations 2010, normally referred to as the Habitats Regulations.

Article 6(3) of the Habitats Directive states that:

*“Any plan or project not directly connected with or necessary to the management of the site [i.e. Natura 2000 site/s] but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site’s conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to paragraph 4 (see below), the competent national authority shall agree to the plan or project only having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public”.*

The Habitats Regulations implement the requirements of the Habitats and Birds Directives through the application of tests, at several stages. Foremost amongst these is the requirement under Regulation 61 to undertake an 'Appropriate Assessment' of the option/s under consideration, also known as a Stage 2 Habitats Regulations Assessment. It is also Government policy (ODPM, 2005; Defra, 2006; NAW, 2001; WAG, 2009) that sites designated as Wetlands of International Importance under the 1971 Ramsar Convention (known as Ramsar Sites) are considered in the same way as Natura 2000 sites.

This is the Executive Summary of the STP Report to Inform a Stage 2 (Appropriate Assessment) Habitats Regulations Assessment of the alternative options considered within the STP Feasibility Study.

A strategic environmental assessment (SEA) is also being conducted as part of the STP Feasibility Study, in accordance with the requirements of the EU SEA Directive and UK Regulations. The strategic level HRA is being undertaken in parallel with, but separate from, the SEA.

## Contents of the Stage 2 HRA Report

Responsibility for the Appropriate Assessment lies with the competent authority, in this case DECC. This is a report to DECC to inform its assessment of the Adverse Effects on Site Integrity under the Habitats Regulations, as part of the feasibility study of tidal range power generation in the Severn Estuary.

The scope of the studies to inform an Appropriate Assessment was defined by the Report to Inform a Stage 1 (Screening) Habitats Regulations Assessment (Severn Tidal Power, 2010a). That study concluded that for each short-listed alternative option there would be a likelihood of a significant effect upon one or more of the interest features of at least one Natura 2000 and Ramsar site. This means that information to inform an HRA Stage 2 Appropriate Assessment of effects in relation to the potentially affected qualifying features and their conservation objectives for these sites would be required.

The contents of this report are set out in the table below. This report, alongside others being prepared within the Feasibility Study, will inform the Government's decision on whether or not it could support a tidal power project within the Severn Estuary.

<b>Section</b>	<b>Description</b>
Introduction	<ul style="list-style-type: none"> <li>• An overview of the STP Feasibility Study.</li> <li>• An outline of the requirements of the Habitats Directive and Habitat Regulations and the application of Habitats Regulation Assessments.</li> <li>• An overview of the purpose of the Stage 2 HRA Report.</li> </ul>
Methodology	<ul style="list-style-type: none"> <li>• Scope and structure of the HRA.</li> <li>• Approach adopted in the HRA.</li> <li>• Overview of the consultation undertaken throughout the HRA process.</li> <li>• An outline of the limitations to the HRA.</li> </ul>
Natura 2000 Sites and Features Considered in the Assessment	<ul style="list-style-type: none"> <li>• An overview of the outcomes of the Stage 1 HRA report.</li> <li>• Identification of the Natura 2000 Sites considered in the Stage 2 HRA.</li> </ul>
Description of the Options	<ul style="list-style-type: none"> <li>• A description of the STP alternative options.</li> </ul>
Potential Effects of the Options	<ul style="list-style-type: none"> <li>• A description of the adverse effects on Natura 2000 sites and their features predicted as a result of each alternative option considered.</li> </ul>
Mitigation Measures	<ul style="list-style-type: none"> <li>• A description of the potential measures to avoid and reduce adverse effects on Natura 2000 sites and features.</li> </ul>
Consideration of In-combination effects	<ul style="list-style-type: none"> <li>• An overview of how in-combination effects have been considered as part of the assessment.</li> </ul>
Assessment of Effects on Site Integrity	<ul style="list-style-type: none"> <li>• A summary of the approach and results of the test on site integrity carried out for each of the alternative options for each the Natura 2000 sites and relevant features. The test takes into account the predicted effects of mitigation measures where these have been quantified.</li> </ul>
Description of residual effects following the application of mitigation measures	<ul style="list-style-type: none"> <li>• An overview of the approach taken to define the effects remaining after mitigation for each of the alternative options.</li> <li>• A summary of the nature and scale of effects remaining after mitigation for each alternative option by site and feature.</li> </ul>

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## External input to the Stage 2 HRA Report

The following activities to obtain input to the assessment have been carried out since completion of the HRA Stage 1 Screening Report:

- Regular contact between the HRA study team and SEA biodiversity specialists between November 2009 and March 2010 to ensure the correct interpretation of the technical studies that have been used to inform the HRA process.
- Technical Workshops held by the HRA Experts Group in December 2009, and January 2010. This group includes representatives from the Countryside Council for Wales, Natural England, Environment Agency, Joint Nature Conservation Committee, Defra and the Welsh Assembly Government.
- Review of the findings of the assessment of potential Adverse Effects on Site Integrity by SEA topic specialists and statutory nature conservation bodies in March 2010.

## Methodology

The information to inform an Appropriate Assessment of the alternative options within the STP study has been compiled in stages, in line with the requirements of the Habitats Regulations.

The EC guidance (European Commission, 2001) recommends that an Appropriate Assessment should fulfil the following steps:

- Gather the information that is necessary to carry out the Appropriate Assessment.
- Predict the likely impacts of a plan or project on a Natura 2000 site.
- Assess adverse effects against the conservation objectives of the site.
- Identify mitigation measures.

This report broadly follows these stages, as outlined below.

## Natura 2000 and Ramsar Sites and Features Considered in the Assessment

The Report to Inform a Stage 1 Habitats Regulations Assessment (the HRA Screening Report) (Severn Tidal Power, 2010a) identified the sites and features that are considered in this study.

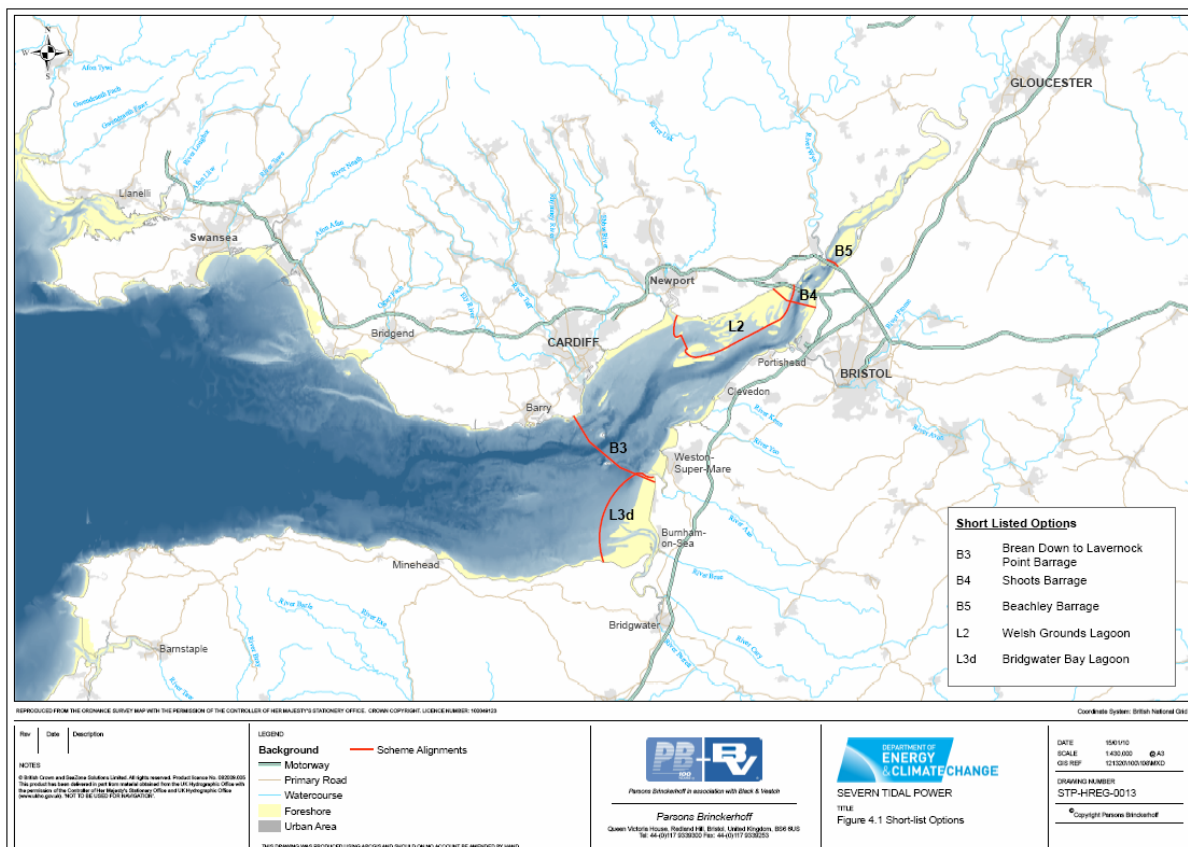
Information on relevant Natura 2000 sites and features has been gathered from a number of sources. Key information, including site citations, site conservation objectives and specific details of site management, has been collated from Natural England and CCW through their Regulation 33 Advice and other site specific documentation.

The collation and analysis of other environmental information relevant to the HRA process has been informed by underpinning specialist studies documented in the SEA Topic and Theme Papers. The specialist studies each define the strategic environmental baseline for their relevant environmental receptors. These supplement the information provided by the statutory nature conservation bodies with additional baseline information and an understanding of how that baseline could change in the future. The following table identifies the SEA Theme Papers and corresponding Topic Papers which are of relevance to the HRA.

STP SEA Theme	STP SEA Topics
Physicochemical (STP, 2010b)	Hydraulics & Geomorphology (STP, 2010d) Marine Water Quality (STP, 2010e)
Biodiversity (STP, 2010c)	Marine Ecology (STP, 2010f) Waterbirds (STP, 2010g) Migratory & Estuarine Fish (STP, 2010h) Terrestrial & Freshwater Ecology (STP, 2010i)

### Alternative Options

Following the review of responses to the public consultation in 2009 on Phase One (Scoping) of the Feasibility Study, the Government confirmed that five alternative options would be studied further within the Feasibility Study, its SEA and this HRA. These alternative options comprise three tidal barrages and two tidal lagoons all of which would be operational for a period of 120 years, shown below.



Alternative options Cardiff-Weston Barrage (B3) also known as Brean Down to Lavernock Point Barrage, Shoots Barrage (B4), Beachley Barrage (B5) and Welsh Grounds Lagoon (L2) are all designed with an ebb-only mode of operation – high water levels are held behind the structure to create a sufficient difference in water level to permit energy generation on the ebb tide. The Bridgwater Bay Lagoon (L3d) alternative option is designed with an ebb-flood mode of operation – there is a sustained duration of high and low water and electricity is generated when the tide is coming in and going out.

A high-level assessment of combinations of short-listed schemes has been undertaken as part of the SEA. However, no specific assessment has been undertaken as part of the HRA. It is recognised that the spatial extent and magnitude of effects of a ‘combination’ or ‘multiple basin’ option could be

the same as or greater than the maximum extent of effects predicted for the five short-listed individual options. Further analysis of the Natura 2000 and Ramsar sites and features that could be affected by a 'combination' or 'multiple-basin' option would be required if one or more of these options were selected for further consideration.

### Potential Effects of the Options on Natura 2000 and Ramsar Sites and Features

The sources of environmental change (hazards), and the direct and indirect pathways by which these changes could affect receptors, have been identified and documented within the Theme and Topic Papers. These inform the HRA. The assessment of effects has been made by consideration of the environmental impacts that result either alone, or in-combination, with other relevant plans or projects.

Each hazard can be associated with a specific phase in the lifecycle of the alternative options. The hazards can therefore be grouped according to whether they result from construction and/or decommissioning works, or as a result of operational effects. The hazards identified are presented in the following table.

<b>Construction and Decommissioning Effects</b>	
A	Permanent habitat loss from the placement of power generation infrastructure
B	Temporary habitat loss/fragmentation/disturbance/introduction or spread of non-native species during construction activities
C	Noise, vibration and light pollution during construction
D	Sediment generation during construction
E	Pollution incident during construction
F	Direct mortality
<b>Operational Effects</b>	
G	Changes to the tidal regime due to the operation of power generation infrastructure
H	Direct mortality of aquatic species (sluices and turbines)
I	Barrier to movement and habitat fragmentation for aquatic species (barrage and turbines)
J	Barrier to movement and habitat fragmentation and for terrestrial species (infrastructure on land)
K	Noise, vibration and light pollution during operation (gates, sluices, turbines and permanent lighting installations)
L	Electromagnetic field from power transmission cables
M	Habitat loss/change as a result of alterations in tidal range upstream of a barrage or lagoon, including potential expansion of non-native species
N	Habitat loss/change as a result of alterations in tidal range downstream of a barrage or lagoon, including potential expansion of non-native species
O	Habitat loss/change as a result of alterations to tidal flows (e.g., flow speeds and flow patterns) and wave action
P	Habitat loss/change as a result of alterations to sediment transport (including erosion and deposition)
Q	Habitat loss/change as a result of alterations to physicochemical parameters such as salinity, dissolved oxygen and the dispersion of regulated discharges
R	Habitat loss/change as a result of alterations in land drainage capacity
S	Reduction in prey/resource availability, e.g., reduced invertebrate populations, reduced fish populations, and displacement effects causing increased competition
T	Increased predation (of the feature)
U	Reduced fitness and/or reproductive success resulting from stress of non-fatal injuries sustained



An analysis of how each of these hazards has the potential to lead to adverse effects has been made for individual sites and features. In doing so specific attention has been given to characterisation of the effects in terms of their likelihood, nature, scale, severity and duration, with a particular focus on how this affects the ability of a site to achieve its conservation objectives.

In summary, the assessment shows that:

- All the alternative options would reduce the tidal range within the impounded part of the Severn Estuary leading to a change to the characteristic physical form and flow of the designated estuary and intertidal habitat features of the Severn Estuary/ Môr Hafren SAC and Ramsar Site.
- For all alternative options, decreased flows and flow speeds would reduce the suspended sediment concentration within the impounded areas and downstream leading to further changes in the extent and composition of the intertidal and subtidal habitat features of the Severn Estuary/ Môr Hafren SAC.
- The effect of changes to or loss of access to the intertidal or saltmarsh habitat would be likely to have an adverse effect on the waterbird species of the Severn Estuary/ Môr Hafren SPA and Ramsar designations. In addition, waterbirds would also be likely to be negatively affected during construction and decommissioning phases by disturbance effects. Specific effects on specific species vary for each alternative option, but all options would have an adverse effect on waterbird features of the Severn Estuary/ Môr Hafren SPA and Ramsar Site.
- Fish populations designated as features under the SACs of the Severn Estuary/ Môr Hafren, River Usk/ Afon Wysg, River Wye/ Afon Gwy, and potentially the River Tywi/ Afon Tywi, could be adversely affected by all the alternative options. The options would lead to alterations to migratory cues and disruption to route of passage, including injury and death from passage through turbines or sluices and the barrier presented by the structure. The same fish populations would also be affected by habitat change and/or loss, habitat fragmentation, changes to water quality and anthropogenic noise disruption.
- The magnitude of the effects on specific fish features varies for each alternative option, but all options would have a significant adverse effect on designated populations and assemblages of SAC fish features (including the migratory species sea lamprey, river lamprey, twaite shad, allis shad and Atlantic salmon) and sub-features, (including the migratory species sea trout, and European eel, and other marine, estuarine and freshwater species included in the Severn Estuary/ Môr Hafren SAC assemblage of fish species). The assessment of effects upon fish has been the subject to limitations in ecological understanding, and is therefore highly uncertain.
- For twaite shad and allis shad there would be a risk of the complete loss of the Severn Estuary/ Môr Hafren, River Usk/ Afon Wysg and River Wye/ Afon Gwy populations under four of the five alternative options. For these four options there would be potential for the loss of the whole UK population if there were also to be significant population reductions in the River Tywi/ Afon Tywi. For Atlantic salmon there would be potential for river specific population collapse and effectively extinction of genetically distinct salmon populations for all options.
- The adverse effects predicted for migratory fish populations would be likely to lead to indirect adverse effects on the designated species of those sites that are dependent on them for some part of the lifecycle. The HRA has therefore identified the potential for adverse effects on otter, a feature of the River Usk/ Afon Wysg and River Wye/ Afon Gwy SACs.
- The designated fish populations of SACs beyond the Severn Estuary/ Môr Hafren SAC on the Cornish, Devon and Welsh coasts also have the potential to be adversely affected, where individuals of those populations stray in to the Severn and are exposed to hazards posed by the

alternative options. The proportion of these populations that would be exposed to these hazards is highly uncertain. However, if there were adverse effects on these populations then there could also be the potential for adverse effects on other features dependent on migratory fish for part of their lifecycle (i.e. otter and freshwater pearl mussel).

- All the options are predicted to lead to changes in water levels beyond the Severn Estuary/ Môr Hafren Natura 2000 and Ramsar Site. Such changes in water levels would lead to uncertain effects on the designated intertidal and coastal habitats of the Carmarthen Bay and Estuaries/ Bae Caerfyrddin ac Aberoedd SAC. Water level changes resulting from all of the options, except the Beachley Barrage (B5) option, could lead to uncertain effects on the designated intertidal and coastal habitats of the Kenfig/ Cynffig SAC.
- For the Cardiff-Weston Barrage (B3) option only, far-field increases in high water levels are predicted to affect designated sites on the West Wales coast within Cardigan Bay and up to the Llyn Peninsula, and on the North Devon and Cornish coasts. The change in water levels is uncertain; however, there could be the potential for adverse effects on SAC sites designated for their coastal habitat features and associated species at these coastal sites. The effect of changes to water-levels at far-field sites are also identified as having potentially adverse effects on features of the Dyfi Estuary/ Aber Dyfi SPA and the Cors Fochno and Dyfi Ramsar Site. If any option for tidal range power generation in the Severn Estuary is considered further after completion of the STP Feasibility Study, then additional modelling work would need to be carried out to confirm the extent and nature of potential changes in water levels.

### Mitigation Measures

Consideration has been given to the identification and evaluation of effective mitigation measures that could reduce or avoid the specific adverse effects identified.

During the feasibility study, the alternative options were refined and measures to prevent or reduce significant adverse effects on the environment were considered. The modifications included changes in operating mode (ebb-only generation compared with ebb-flood generation), changes in turbine numbers and sizes, changes in sluice capacity, and changes in alignment.

Further measures to prevent or reduce likely adverse effects on the environment have been suggested and refined, during later stages of development of the SEA and HRA. Key recommended measures relevant to the HRA include:

- Estuarine habitats and Waterbirds: Seawater level management through pumping at high water (alternative options B3, B4, L2 & L3d); Sluicing after the generation period, combined with early commencement of turbine generation, in ebb-only mode (alternative options B3, B4, B5 and L2 only); topographic modification (the creation of intertidal area); and the introduction of new refuges and/or bird roosts (B3 only).
- Migratory & Estuarine Fish: Altering the current proposed type, size, number and / or position of sluices during detailed design; and increasing the permeability of the structure by diverting a proportion of the available volume of water through safer passage routes; whether they are sluices, free-wheeling turbines or free gaps. Also ensuring that all operating turbines are at optimum efficiency during periods of generation; and using measures to minimise underwater noise disturbance and sediment release.

The nature and scale of alternative options considered are unprecedented, and so are the measures to prevent and reduce their effects. There is a high level of uncertainty associated with the efficacy of potential measures to reduce effects, particularly for potential measures to reduce effects on

migratory fish. Due to this uncertainty only those measures for which quantification of the potential range of efficacy has been possible, for example topographic modification, have been taken into account when predicting the effects arising after the application of mitigation measures. There is a greater level of certainty for measures to avoid effects, for example locating onshore works away from protected habitats.

### Consideration of In-combination Effects

The requirement to undertake an assessment of effects of STP alternative options acting in-combination with other plans and projects has been considered as part of the Appropriate Assessment. Specific consideration is required to identify in-combination effects on sites and features where:

- The initial appraisal of the effects of the alternative options alone are not considered to lead to adverse effects; or,
- Where the appraisal identifies sites and features where potential mitigation measures are objectively considered to avoid adverse effects, or reduce adverse effects to acceptable level.

Consideration of the potential for in-combination effects for each of the alternative options has identified that there are unlikely to be any further sites or features subject to additional adverse effects as a result of combined effects with the relevant plans or projects identified.

### Assessment of Effects on Site Integrity

The information provided on predicted adverse effects and the potential application of effective mitigation has been used to subject each of the alternative options to a 'Test on Site Integrity'. The test considers whether, if a formal Appropriate Assessment was required, the Competent Authority would be able to ascertain whether each of the alternative options, either alone or in combination, would not lead to an adverse effect on site integrity. The test takes into account the predicted effectiveness of mitigation measures where this has been quantified. Therefore the test considers whether:

- it cannot be concluded there would be no adverse effect on site integrity; or,
- it can be concluded there would be no adverse effect on site integrity.

In undertaking the test, it has to be demonstrated with a high level of certainty that the alternative option would not have an adverse effect on the integrity of the site. If there is not a sufficient level of certainty to reach this conclusion then it cannot be concluded there would be no adverse effect on the integrity of the site.

The table below presents the number of SAC, SPA and Ramsar sites for which it could not be concluded that there would be no adverse effect on site integrity, if the Competent Authority were to undertake a formal Appropriate Assessment based on the available information, excluding flyway sites.

Designated Site	Option and number of sites				
	B3	B4	B5	L2	L3d
SAC	19	14	13	14	13
SPA	5	2	1	1	1
Ramsar	5	4	2	2	2



For the Cardiff-Weston Barrage (B3) option there are seven SACs that support priority habitats for which it could not be concluded that there would not be an adverse effect on integrity. These seven SACs support a total of three priority habitats. For the Shoots Barrage (B4) and Welsh Grounds Lagoon (L2) options it could not be concluded that there would not be an adverse effect on integrity for one SAC that supports a single priority habitat.

In addition, 96 SPA and 84 Ramsar 'flyway' sites have been identified. Each of these flyway sites are designated for species of bird that are known to use the Severn Estuary, or which support bird populations that pass through the Severn Estuary whilst on passage. The proportion of such populations which utilise Severn Estuary/ Môr Hafren SPA and Ramsar Site is unknown, therefore in the absence of such information it could not be concluded that there would not be an adverse effect on site integrity for all options.

#### Effects Remaining After the Application of Mitigation Measures

The assessment of effects identified that for each of the alternative options there are Natura 2000 sites and features for which it cannot be concluded that there would not be an adverse effect on site integrity. There is uncertainty associated with the predictions of residual effects and for each feature a range of effects is therefore predicted.

The following list provides a summary of the estimated effects remaining after mitigation that are predicted by the information to inform an Appropriate Assessment. The descriptions of these residual effects focus on the adverse effects identified where the focus of the study has been sufficient to identify with a moderate or high level of confidence that there would be an adverse effect on site integrity after the application of mitigation measures. This does not presuppose the acceptability of any of the alternative options under the later stages of the HRA process. However this information may be used to inform further consideration of the options if the UK government is so minded.

In summary, the assessment has identified that there is potential for the following residual effects within the Severn Estuary/ Môr Hafren Natura 2000 Site and the designated rivers that connect to the Severn Estuary:

<b>Severn Estuary/ Môr Hafren Natura 2000 Site</b>
<ul style="list-style-type: none"><li>• Reduction in extent and reduction in tidal range for the SAC estuaries feature for all options.</li><li>• Reduced extent of SAC intertidal habitat features for all options: mudflats and sandflats not covered by seawater at low tide; Atlantic salt meadows.</li><li>• Potential for the complete loss of the SAC reefs feature for the Cardiff-Weston Barrage (B3). Reduced extent of the SAC reefs feature for the Shoots Barrage (B4), Beachley Barrage (B5) and Welsh Grounds Lagoon (L2) options.</li><li>• Reduced extent of the hard-substrate habitat communities sub-feature of the SAC estuaries feature for all options, including reduced extent of eel grass beds for the Cardiff-Weston Barrage (B3), Shoots Barrage (B4), and Welsh Grounds Lagoon (L2) options.</li><li>• Decline in populations and assemblage of designated migratory and over-wintering bird species associated with reductions in intertidal habitat extent (SPA).</li></ul>

### Severn Estuary/ Môr Hafren Natura 2000 Site (continued)

- Decline in the populations of the SAC features sea lamprey and river lamprey as a result of turbine mortality, disruption to migratory cues, barriers to movement and habitat fragmentation, with potential for population collapse for the Shoots Barrage (B4) and Beachley Barrage (B5) options.
- Potential for population collapse for the SAC feature twaite shad for the Shoots Barrage (B4) option, and potential complete loss of this feature for all other options.
- Population declines of the assemblage of fish species sub-feature of the SAC Estuaries feature:
  - risk of complete loss of the populations of allis shad;
  - potential for population collapse and extinction of genetically distinct populations of Atlantic salmon;
  - risk of both population reductions and river specific population collapse for sea trout; and
  - decline in the populations of European eel and other estuarine, marine and freshwater species.

### River Wye/ Afon Gwy SAC, River Usk/ Afon Wysg SAC and River Tywi/ Afon Tywi SAC

- Decline in, or loss of, the populations of migratory fish species as a result of turbine mortality, disruption to migratory cues, barriers to movement and habitat fragmentation, described in detail below.
- The Cardiff-Weston Barrage (B3), Welsh Grounds Lagoon (L2) and Bridgwater Bay Lagoon (L3d) options have potential to cause a reduction in the River Wye/ Afon Gwy and River Usk/ Afon Wysg populations of river lamprey and sea lamprey. For the L2 option there is potential for collapse of the River Usk/ Afon Wysg sea lamprey population
- The Shoots Barrage (B4) and Beachley Barrage (B5) options have potential to cause a collapse in the River Wye/ Afon Gwy and River Usk/ Afon Wysg populations of river lamprey and sea lamprey.
- All options pose a risk of complete loss of the River Wye/ Afon Gwy population of twaite shad, and all options with the exception of Shoots Barrage (B4) also pose a risk of the complete loss of the River Usk/ Afon Wysg population of twaite shad. The Shoots Barrage (B4) option poses a risk of reduction in the River Usk/ Afon Wysg twaite shad population but the population would likely be retained.
- All options with the exception of Shoots Barrage (B4) have potential to cause a reduction in the River Tywi/ Afon Tywi population of twaite shad which when combined with losses for the River Severn/ Môr Hafren, River Wye/ Afon Gwy and River Usk/ Afon Wysg could threaten the continuation of the UK twaite shad population.
- The Shoots Barrage (B4) option could lead to a decline in the River Tywi/ Afon Tywi twaite shad population but this option would be unlikely to result in population collapse and whole UK population extinction.

**River Wye/ Afon Gwy SAC, River Usk/ Afon Wysg SAC and River Tywi/ Afon Tywi SAC (cont'd)**

- All options pose a risk of reductions in population size and river specific population extinction for the River Wye/ Afon Gwy, River Usk/ Afon Wysg and River Tywi/ Afon Tywi allis shad populations which when combined with predicted losses for the River Severn could threaten the continuation of the UK allis shad population.
- All options pose a risk of population collapse and effectively extinction of genetically distinct populations of Atlantic salmon for the River Wye/ Afon Gwy and River Usk/ Afon Wysg. The risk of population collapse on the River Usk/ Afon Wysg is considered to be less for the Cardiff-Weston Barrage (B3), Shoots Barrage (B4) and Bridgwater Bay Lagoon (L3d) options than for the other two options.

**Burry Inlet SPA & Somerset Levels and Moors SPA (B3 and B4 options only)**

- Decline in populations and assemblage of designated migratory and over-wintering bird species associated with displacement of birds from the Severn Estuary: pintail, knot, redshank, teal, lapwing, shoveler, wigeon, and assemblage of waterfowl (B3).
- Decline in populations of pintail associated with displacement of birds from the Severn Estuary (B4)

Further studies will be required to improve the level of certainty in the current scientific understanding of effects on far field water level changes, the life cycles of migratory fish and the linkages between populations of migratory bird species designated as features of SPAs along relevant flyways. If, in the future, any option for tidal range power generation is considered further, such studies will be required to provide a greater level of certainty with which to undertake a more detailed project level Habitats Regulations Assessment.