



DECC

SEVERN TIDAL POWER - SEA TOPIC PAPER

Historic Environment

March 2010

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ABBREVIATIONS

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The following abbreviations are used in this Topic Report:

AONB	Areas of Outstanding Natural Beauty
AAI	Area of Archaeological Importance
BP	Before Present
COWRIE	Collaborative Offshore Wind Research Into The Environment
DCMS	Department of Media and Sport
DECC	Department for Energy and Climate Change
EH	English Heritage
EIA	Environmental Impact Assessment
ES	Environmental Statement
GGAT	Glamorgan Gwent Archaeological Trust
HER	Historic Environment Record
H&G	Hydraulics and Geomorphology topic
HLCA	Historic Landscape Characterisation Area
ICZM	Integrated Coastal Zone Management
IfA	Institute for Archaeologists
JNAPC	Joint Nautical Archaeology Policy Committee
LDP	Local Development Plan
LPA	Local Planning Authority
MoD	Ministry of Defence
MCA	Maritime and Coastguard Agency
MW	Megawatt
NMR	National Monuments Record
ODPM	Office of the Deputy Prime Minister
PMRA	Protection of Military Remains Act
PPG	Planning Policy Guidance
PWA	Protection of Wrecks Act
RoW	Receiver of Wreck
RCAHMW	Royal Commission for Ancient and Historical Monuments Wales
RCZA	Rapid Coastal Zone Assessment
ROV	Remotely Operated Vehicle
SA	Sustainability Appraisal
SEA	Strategic Environmental Assessment
TSA	Targeted Study Area
TWh	Terrawatt hours
UKHO	United Kingdom Hydrographic Office
WA	Wessex Archaeology
WHS	World Heritage Site
WSI	Written Scheme of Investigation
ZTV	Zone of Theoretical Visibility

NON TECHNICAL SUMMARY

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Introduction

A strategic environmental assessment (SEA) is being conducted as part of the Severn Tidal Power (STP) feasibility study, in accordance with the requirements of the EU SEA Directive and UK Regulations. The SEA comprises two phases: Phase 1, the scoping stage, has already been undertaken. This historic environment topic paper forms part of the reporting arising from Phase 2, the main assessment of short-listed options.

This is the historic environment topic paper within the Landscape and Seascape and historic environment theme. The historic environment or historic environment resource is a collective term applied to a diverse resource which encompasses archaeological sites and monuments, evidence for past environments (palaeoenvironmental), historic buildings and structures, historic landscapes and artefacts and structures relating to seafaring.

Overall, the historic environment resource within the Severn Estuary is of national and international significance. Over the last 60 years archaeological investigations, surveys and research programmes have recorded evidence demonstrating the interaction and interplay of humans and the dynamic environment of the estuary from the earliest prehistoric periods through to the present. Within the estuary specific sites, monuments and landscapes of national importance have been designated or registered. Due to the destructive nature of the River Severn sites underwater and on the foreshore of the estuary are not easy to first identify, and then protect using existing legislation and, consequently, the known resource provides a definite under-representation. Potential artefactual and ecofactual remains, which are preserved exceptionally well within the waterlogged deposits of the Severn Levels and intertidal mudflats flanking the estuary, are key to providing further insight into activities such as settlement, industry, defence and seafaring within the estuary. The historic landscapes of the reclaimed levels offer an additional layer of importance and it is possible to identify the potential for buried archaeological remains within these landscapes, by comparison with sites in similar layers exposed on the foreshore or from an increasing number of developer-funded archaeological projects.

By its nature the historic environment resource is finite and non-renewable and whilst the estuarine environment provides excellent conditions for preservation, but it brings with it natural and anthropogenic pressures which combine to compromise the survival of the resource. This ongoing threat of loss only serves to highlight the international significance of the historic environment resource of the Severn Estuary, and consequently the imperative must be to protect, preserve and record as much as is possible to further our understanding of the past human use of the Severn Estuary.

Consultation

The following consultation activities have been undertaken:

- Scoping consultation in January 2009
- Technical Workshops held in June and December 2009
- One to one meetings with curators prior to Technical Workshop 1 in June 2009
- Two Assessment Update Teleconferences with the Regional Work stream in June and November 2009

SEA Objectives

SEA Objectives have been developed to enable alternative options to be compared. Objectives may not necessarily be met in full by a given alternative option, but the degree to which they do will provide a way of identifying preferences when comparing effects of alternative options. The SEA Objectives for this topic are listed below:

- To minimise negative effects on designated sites in the historic environment
- To minimise negative effects on the non-registered internationally, nationally, regionally and locally important sites within the historic environment

- To minimise negative effects on the potential historic environment, the as yet unidentified sites and finds, within the Severn Estuary.
- To minimise negative effects on the character and quality of the historic landscape.

Baseline Environment

Baseline information provides the basis for predicting and monitoring environmental effects, by describing the area that may be affected. Due to the long timescales associated with the construction and operation of alternative options, future baseline information is considered to reflect the predicted changes in the area when considered without the development of a Severn Tidal Power project. The baseline therefore also describes the estuary in a 'do-nothing' scenario.

The approach to this assessment was desk-based and entailed reviewing a wide range of publically available sources of information relating to the historic environment resource to compile a baseline understanding. A full list of the sources consulted is provided in The Historic Environment Baseline (Annex 1 STP, 2010a). Information was gathered from a Study Area which encompasses the intertidal zone down to Mean Low Water, a 1km wide strip of adjacent coastal land, the extent of the drift geology defined by the alluvium of the coastal floodplain (Severn Levels - broadly commensurate with the Flood Risk and Land Drainage topic Study Area) and the marine estuary environment up to Mean Low Water.

Baseline environment up to 2009

The historic environment or historic environment resource is a collective term applied to a diverse resource which encompasses known and potential archaeological sites and monuments, evidence for past environments (palaeoenvironmental), historic buildings and structures, historic landscapes and artefacts and structures relating to seafaring. In combination, the records held by the National Monument Records for both England and Wales within the Estuary Study Area total over 26,000. The scale of the known resource is illustrated on Figures 1.8-1.15 and 1.17.

Figures 1.16 and 1.18 depict in a simplified way the spatial areas across which the potential historic environment resource within the estuary is distributed. Broadly speaking these areas correspond with expanses of intertidal exposures along both coastline and subtidal areas where deeper sediments are present and little aggregate extraction has occurred. These figures demonstrate that almost the whole of the estuary environment is likely to contain some element of the historic environment resource the proof of which can only come with further heritage investigation and survey.

Historic environment receptors are identified as existing within broad physical environments within the Study Area, referred to as Receptor Areas. These areas are defined using spatial, topographical and geological determiners, conceived to facilitate the identification and evaluation of possible effects from tidal power development. The broad Receptor Areas are defined as follows: terrestrial¹; intertidal²; and subtidal³.

¹ The Severn Levels extend across an area of approximately 840km² and comprise a range of low-lying wetland landscapes along the fringes of the Severn Estuary created through gradual sediment deposition on the banks of the Severn during the post-glacial rise in sea-level.

² The huge tidal range of the Severn Estuary means that at low tide a very wide intertidal area is exposed. The complex sedimentary sequence of clays and peat layers of the Wentlooge Formation are exposed by coastal erosion in the intertidal area on both sides of the estuary. The intertidal area functions as a temporary and intermittent window directly onto the extremely well preserved prehistoric land surfaces, which survive buried often at unreachable depths within the reclaimed claylands of the Severn Estuary Levels.

³ The subtidal environment of the Severn Estuary and Bristol Channel is a high energy and dynamic system. The seabed sediments range from areas of deep mud and sand, such as in Bridgwater Bay or the English Grounds, to areas where the seabed has been scoured to bedrock. The strong tidal currents influence highly mobile sediments, and during the spring tides, vast quantities of sediment are held in suspension. The areas of deep

Future baseline during construction: 2014-2020; operation 2020-2140, decommissioning and longer term trends

A description of the future baseline environment for the historic environment resource is not straightforward. The historic environment resource is not easily quantifiable as it exists in many different forms, at different physical scales and is more often discussed in terms of the abstract context of the 'potential' resource. Therefore, predicting and describing the likely nature of the resource over a 120+ year timescale is very difficult.

Essentially the ethos of the current historic environment planning policy and statutory legislation promotes the preservation and conservation of the historic environment record. Where the resource can not be preserved, then it is recorded by way reducing the effect of its loss through the gathering of knowledge about the resource.

The two largest sources of ongoing negative change to the historic environment resource are loss or damage through anthropogenic and natural processes. In terms of future development the expected trend within the Study Area is for piecemeal development to continue within all three receptor areas. Development on a massive scale (i.e. larger than that of any of the Alternative Options) is unlikely and is not predicted in any of the plans, projects or programmes or planning documents included for review in this assessment. Consequently, it is anticipated that any loss of the resource as a result of development would continue to be managed through the planning systems, both terrestrial and maritime.

The historic environment resource within the subtidal and intertidal receptor areas is particularly vulnerable to loss and damage resulting from natural processes such as coastal erosion and consequential flood defence. These processes are set to continue over the course of the future baseline period; predicted sea-level rise is set to be an important trigger for the provision of additional coastal defence and augmentation of existing defences to protect low-lying coastal areas.

Key Environmental Issues and Problems

Ongoing threats from natural and anthropogenic sources

The historic environment resource, which survives as a wide range of sites, monuments, buildings and landscapes, is inherently sensitive to change as it is a finite resource and once lost can not be reinstated or replaced.

The waterlogged conditions of the Severn Estuary Levels and intertidal zone provide excellent conditions for preservation particularly for the archaeological resource, indeed the extraordinary preservation of organic and palaeoenvironmental remains is a key part of the importance of the historic environment resource within the Severn Estuary. However, high energy estuarine environment created by the strong tidal currents and large tidal range are also major contributors to the ongoing loss of the historic environment resource through either the process of coastal erosion, or in some cases the counter-measures put in place to protect the coast from erosion and flooding. In addition to the natural degradation of the historic environment resource, the environment of the Severn Estuary is also the focus of large-scale infrastructure developments, major industry, ports and marine aggregates extraction. All these factors effect the survival of the historic environment resource with piecemeal loss of the resource across a large geographical area.

Data limitations

The data held in the county based historic environment records and national monuments records for Wales and England are major sources of data for the historic environment resource baseline

mud and sand, where the sediments are settled, offer areas of high potential for the preservation of shipwrecks, aircraft wrecks and other maritime archaeological materials

environment. There are number of limitations to these data which mean they cannot be used, in isolation, to coherently represent the historic environment resource at the scale suitable for an SEA. Limitations of these data include:

- Internal bias – bias within each record towards geographical areas where more archaeological investigations have been carried out, such as those associated with developer-funded research;
- Focus on ‘known’ resource – within the datasets there is not necessarily provision for defining/representing areas where there is considered to be an increased ‘potential’ for the historic environment resource to survive. Consequently, using the ‘dots’ as a an indication of distribution of resource is not a valid approach; and
- Definition discrepancies - different approaches in the definition of statutory and non-statutory historic environment designations (in Wales and England), there are also variations in terminology and data storage formats (between all agencies).

Consequently, a purely quantitative review based on a simple representation of the historic environment records cannot accurately reflect the true nature and extent of the resource. For this reason the baseline data is supported by Annex 1 (STP, 2010a) providing a narrative of the resource based on a literature review.

Evaluation of Plan Alternatives

Assessment Methodology

The SEA Directive specifies the criteria that should be taken into account when determining the likely significant effects of the plan and thus these criteria have been adopted throughout the assessment process of this SEA. This topic paper therefore considers the characteristics of the effects and of the area likely to be affected.

This topic has also used the following specific assessment methods.

The assessment methodology follows a qualitative approach informed by professional judgement. The approach is based on the identification of key changes to the existing environment, established using desk-based techniques, resulting from the construction and operation of the alternative options with reference to the results of the Hydraulics and Geomorphology; Flood Risk and Land Drainage; Terrestrial and Freshwater Ecology; Waterbirds; and Navigation SEA Topics.

Commensurate with the strategic scale of the SEA a holistic approach to the definition of value and vulnerability of the historic environment resource has been adopted. Consequently, the historic environment resource as whole is deemed to be of high value and of high vulnerability to the effects of change to the baseline environment.

A qualitative approach has been devised based on the general precept that the larger the physical area of the effect the higher its magnitude.

Alternative Options

There are five shortlisted alternative options that are being assessed within Phase 2 of the SEA for their likely significant effects. These alternative options and key parameters associated with the alternative options are:

Alternative	Location	Length (approx)	Operating mode	Turbine type	No. turbines	Annual energy output	Caissons	Locks
B3: Brean Down to Lavernock Point Barrage	Lavernock Point to Brean Down	16km	Ebb only	Bulb-Kapeller	216 (40MW)	15.1 to 17.0 TWh/year	129	2
B4: Shoots Barrage	West Pill to Severn Beach	7km	Ebb only	Bulb-Kapeller	30 (35MW)	2.7 to 2.9 TWh/year	46	1
B5: Beachley Barrage	Beachley to land directly to the east on the English side	2km	Ebb only	Straflo	50 (12.5MW)	1.4 to 1.6 TWh/year	31	1
L2: Welsh Grounds Lagoon	River Usk to Second Severn Crossing	28km	Ebb only	Bulb	40 (25MW)	2.6 to 2.8 TWh/year	32	1
L3d: Bridgwater Bay Lagoon	Brean Down to Hinckley Point	16km	Ebb & Flood	Bulb-Kaplan	144 (25MW)	5.6 to 6.6 TWh/year	42	1

Assessment of Likely Significant Effects on the Environment

Alternative Option B3: Brean Down to Lavernock Point Barrage

Within the vicinity of B3 there is a proven archaeological and palaeoenvironmental resource of prehistoric and later date, with a strong potential for the presence and survival of further remains including the possibility of shipwrecks and aircraft wrecks. The headland of Brean Down is the location of a significant multi-period archaeological site (Scheduled Monument) and is, consequently, particularly sensitive to any changes in its physical form and/or immediate environs as are two other Scheduled Monuments situated within the environs of B3 on the Welsh coast (Sully Island Fort and St Mary's Bay Well).

The known and potential resource within the construction footprint of the 16km long barrage with its associated temporary (c.10ha) and permanent onshore (c.2.5ha) facilities would be subject to a significant adverse effect resulting from the loss of known and potential archaeological and palaeoenvironmental remains across the subtidal, intertidal and terrestrial areas; effects to the setting of the prominent and adjacent Scheduled Monument of Brean Down and possible effects to the historic landscape in the areas of onshore facilities. Loss of seabed features within the estuary could also result from any new dredging areas within the estuary required to provide aggregates for construction.

Immediately post-implementation, changes to the tidal prism would result in approximately 50% loss of intertidal exposure within the estuary and over the long-term erosion of steeper intertidal profile at new MHW (-1m to -3m). This has serious implications for the survival of the known and potential archaeological and palaeoenvironmental resource along both coastlines between B3 and the Severn

Road Bridge. This change would put much of the prehistoric archaeological resource preserved along the present Welsh intertidal zone at high risk.

Sediment deposition immediately post-implementation in the new and existing subtidal areas would cover and protect any vulnerable seabed features. But it would also restrict access and trigger the requirement for increased navigational dredging (2.0 Mm³/yr) which increases the risk of additional damage to seabed features and deposits which would otherwise be left undisturbed.

The predicted small increase of (up to 0.3m) in Spring High Tide levels along parts of the Welsh coast and up to 0.2m along the Irish coast associated with B3 could result in changes to the existing erosion pattern in areas of intertidal mudflats which could result to changes in erosion and deposition. These changes could have a negative effect on the survival of the historic environment resource where it exists and is sensitive to this type of change.

Alternative Option 2 – B4: Shoots Barrage

There are a low number (c.10) of known/recorded components of the historic environment resource within the vicinity of B4. The known resource within the intertidal zone includes the remains of a submerged Mesolithic forest associated with peat deposits and numerous fish traps and fish weirs. The area is also identified as being of high potential for the presence and survival of additional archaeological and palaeoenvironmental remains, especially buried prehistoric material. The terrestrial hinterland is part of the Gwent Levels Historic Landscape of Outstanding Historic Interest. Whilst there are no known wrecks in the vicinity, the barrage is located in an area of medium to high maritime archaeological potential.

The known and potential resource within the construction footprint of the 7km long barrage structure and its associated temporary (7.5ha) and permanent onshore (2.5ha) facilities would be subject to significant adverse effect resulting from the loss of known and potential archaeological and palaeoenvironmental remains across the subtidal, intertidal and terrestrial zones. Negative effects to the setting and context of the section of the Gwent Levels Historic Landscape of Outstanding Historic Interest in the vicinity of the alternative option are also predicted. Loss of seabed features within the estuary could also result from any new dredging areas within the estuary required to provide aggregates for construction.

Immediately post-implementation, changes to the tidal prism would result in approximately 10% loss of intertidal exposure within the estuary and over the long-term erosion of steeper intertidal profile at new MHW (up to -2m). This has implications for the survival of the known and potential archaeological and palaeoenvironmental resource along both coastlines between B4 and Lydney Harbour. This is of particular concern along stretches of intertidal exposure at Caldicott, and to the north of the outfall of the River Usk where there is a rich resource and the potential for further important discoveries.

Subtidal sediment deposition (up to 7m) during operation would cover and protect any vulnerable features, but it would also restrict access and necessitate the increased navigational dredging (1.75 Mm³/yr) increasing the risk of additional damage to seabed features and deposits which would otherwise be left undisturbed.

Alternative Option – B5: Beachley Barrage

Within the vicinity of B5 there are a low number (c.13) of recorded components of the heritage resource. Within the terrestrial zone remains of prehistoric and Romano-British date are recorded in the vicinity of Beachley, with the earthwork remains Offa's Dyke, an 8th century land division which roughly follows the border between England and Wales ends at Sedbury Cliffs just to the north of the proposed landfall and is a Scheduled Monument. The landscape is dominated by the Severn Road Bridge. Behind the modern sea defences on the right bank of the estuary areas of medieval and post-

medieval ridge and furrow survive as earthworks around Cote Farm. Within the intertidal zone on both sides of the estuary few archaeological and palaeoenvironmental remains are recorded in the intertidal and terrestrial zones. However, the area is considered to be of medium potential for the presence and survival of as yet unrecorded remains. There are no known wrecks within the design footprint and proposed construction dredging areas. However, it is located within an area of medium maritime potential.

The historic environment resource within the footprint of the 2km long structure and that of the temporary (7.5ha) and permanent (2.5ha) onshore facilities would be subject to significant adverse effects resulting from the loss of known and potential archaeological and palaeoenvironmental remains. The visual impact of B5 on the historic landscape would be limited by its close proximity to the existing Severn Road Bridge.

At the start of the operational phase approximately 10% of the existing intertidal area within the estuary would be affected by the predicated changes to the tidal prism. Up to 3m average subtidal accretion within the impoundment is predicted over 120 years, with a small amount of erosion (-0.4m) within the intertidal profile. Immediately outside the impoundment over the 120 operational life 2.1m of subtidal accretion and 1.7m accretion are predicted over the intertidal exposures.

Within the impounded basin the reduction in the intertidal area occurs between the barrage and Lydney. As a result access to intertidal areas important to future research, such as the foreshore at Sedbury and along the coast at Oldbury would be limited at low tide. Whilst the predicted rate of erosion within the impounded intertidal is relatively small, this would still result in the ongoing loss of the important known and potential resource. Adverse effects to areas of medium maritime potential would result from the predicted accretion within and without the impoundment. These changes to access could constrain the process of knowledge gathering which is an important component of the historic environment resource. This accretion would also require increased navigational dredging (1.0 Mm³/yr) increasing the risk of additional damage to seabed features and deposits which would otherwise be left undisturbed.

Alternative Option – L2: Welsh Grounds Lagoon

The recorded historic environment resource within the design footprint is low in number (c.13). However, the impounded area of the option contains some of the most important components of the archaeological resource along the Welsh coast including the prehistoric activity and settlement site of Goldcliff; prehistoric peat exposures in the intertidal zone containing prehistoric artefacts and a number of archaeological sites associated with phases of Romano-British land reclamation in the area which is now defined as the Gwent Levels. The Gwent Levels, itself, is a reclaimed landscape included on the Register of Historic Landscape of Outstanding Historic Interest in Wales. The area of Welsh Grounds is considered to be of one of high potential for the presence and survival of archaeological deposits. There is one known wreck within the lagoon impoundment.

L2 Welsh Grounds Lagoon is the largest of the lagoon short-listed options with an approximate length of 28km starting from land adjacent to the mouth of the River Usk, running in a general easterly direction across an area referred to as Welsh Grounds, continuing to the south of Denny Island and reaching land fall adjacent to the Second Severn Crossing. Construction within the design footprint of the temporary (10ha) and permanent onshore works (5ha) would result in a direct adverse effect to the survival of the known and potential historic environment resource within the terrestrial, intertidal and subtidal receptor areas.

At the start of the operational phase of L2, approximately 25% of the existing intertidal area exposed at low tide within the estuary would be affected by the changes to the tidal prism. Springtide range within the lagoon would be reduced by up to 40%. Within the impoundment subtidal accretion in the region of 3.4m over 120years would occur. No requirement for maintenance dredging to alleviate operational accretion (within and outside the impoundment) is predicted. These changes would

render extensive areas of intertidal area along the foreshore of the Gwent Levels inaccessible at low tide. This would include the area around Goldcliff.

With this lagoon option the spatial area across which indirect effects to the historic environment resource occur are limited, but their magnitude is concentrated.

Alternative Option – L3d: Bridgwater Bay Lagoon

The 59 terrestrial and intertidal receptors within the vicinity of L3d include prehistoric peat deposits within the intertidal and sand cliffs on the beach on the English side. The intertidal zone of the whole of Bridgwater Bay is of high archaeological potential. The headland of Brean Down is a defining landscape feature and also a Scheduled Monument with evidence of human activity dating back over 4000 years. There are a number of known wrecks within the impounded area including a wooden vessel built in 1870. Little detail is available regarding the other wrecks. This is also an area of high maritime archaeological potential.

Construction works within the footprint of the 16km long lagoon embankment and the temporary (7ha) and permanent (2.5ha) onshore facilities would result in the loss of or damage to archaeological and palaeoenvironmental remains. This direct adverse effect would be significant.

At the start of the operational phase approximately 7% of the existing intertidal area exposed at low tide within the estuary would be affected by the changes to the tidal prism. In the short term an initial deposition of fine sediments is predicted with the impounded basin in the vicinity of the turbines in the region of 0.5 to 1m, and just outside the option in the region off Hinkley Point in the order of 2m. Long term accretion in the subtidal part of the lagoon is expected to be c 0.4m after 120 years. Erosion on the intertidal flats within the lagoon is predicted at a rate of 0.5m over 120 years.

Over the long-term these changes are fairly minimal and, consequently, would not result in substantial changes to the accessibility of the subtidal resource, or the survival of the intertidal resource. However, the subtidal accretion would require dredging to maintain navigation channels, and this activity could have an adverse effect on the survival of seabed features and the resource within the impoundment is very sensitive and fragile. Overall, the indirect operational effects of L3d on the historic environment resource within the intertidal and subtidal receptor areas would be significant.

The predicted small increase of (up to <0.1m) in Spring High Tide levels along parts of the southern Irish coast could result in changes to the existing erosion pattern in areas of intertidal mudflats which could result to changes in erosion and deposition. These changes could have a negative effect on the survival of the historic environment resource where it exists and is sensitive to this type of change.

Cumulative and consequential effects

There are a number of identified projects, plans and programmes including marine aggregates dredging, port improvements, managed coastal realignment projects and power station developments and National Grid reinforcements which may take place during the projected construction and operation phase of the alternative options that could have their own negative effects on the historic environment resource. Specific design and construction details of these identified projects, plans and programmes have not been reviewed as part of this assessment.

Significant negative effects resulting in the loss of, or damage to, the survival/setting of the known and potential historic environment resource across a considerable spatial area could be associated with the construction and operation of these individual projects, plans and programmes.

The cumulative loss of a finite resource is a significant factor in the management of the historic environment resource and consequently, it is reasonable to identify cumulative effects to the resource resulting from the combination of the identified plans, projects and programmes in with the

construction and operation of an alternative option. The scale, magnitude and significance of these effects cannot be determined at this stage.

Assumptions, Limitations and Uncertainty

The assessment of direct effects is based on a worse case scenario approach assuming total removal of the known and potential resource within the design footprint of the alternative options. It also assumes that the scale and appearance of the physical structure would have a negative effect on the context/setting of the historic environment resource where such an effect is considered relevant. The scale and magnitude of direct effects within the assessment is fairly certain.

Assumptions on the temporary and permanent onshore infrastructure requirements for the option are based on those described in the Options Definition Report. In line with the Options Definition Report it is assumed that major barrage structures and materials will be delivered by sea direct to the barrage or lagoon location. Similarly it is assumed that in the area of the indicative landfalls land will be required for the following: a permanent access road; permanent export cable reserve; a substation and transfer to overhead cables; permanent offices, workshops and maintenance materials storage; permanent security, visitor centre and public car parking; temporary offices, welfare facilities and car parking for the construction work-force; temporary storage areas for materials delivered by land.

Indirect and far-field effects have been identified using data relating to changes in the tidal prism provided by the Hydraulics and Geomorphology topic. It is considered fairly certain that the majority of these effects would occur within the intertidal and subtidal receptor areas. Careful to avoid over-extrapolation of the Hydraulic and Geomorphology results this assessment concentrates on the probable spatial extent across which there is a potential for the identified indirect effects to occur. This approach avoids specific mention of the response of individual profiles in a bid to keep the assessment high level without biasing, overstating or understating risk to individual sites.

Cumulative and consequential effects have been surmised from a review of project information. Whilst negative effects to the resource resulting from the implementation of the identified projects are likely, there are no specific effects that can be clearly defined at this time. The scale of cumulative and consequential development has been assessed on a basis of proximity of the proposed projects, plans and programmes to the Alternative Options. The assessment is necessarily speculative but should give an idea of scale and magnitude without identifying detail

Measures to prevent, reduce and as fully as possible offset any significant adverse effects on the environment

The measures identified to prevent or reduce likely significant adverse effects identified within this topic are described below:

Preservation *in situ* (prevent)

Applicable where heritage assets of national and international importance would be lost or damaged this measure should be considered early on in the detailed design process which would need to respond to the results of historic environment surveys. An example of this measure would be the change in layout or location of individual buildings or components could be made in order to prevent damage to archaeological remains of national importance.

Preservation by record (reduce)

Where the loss of, or damage to, the historic environment resource is unavoidable this technique aims to ensure better understanding of, and compile and disseminate a record of the threatened resource. Whilst this measure cannot completely ameliorate loss of the resource which is finite and non-

renewable, it is accepted that obtaining knowledge, understanding and permanent record of the resource before it is lost/damaged is preferable to its loss without record. Measure can take many practical forms depending on the scale, location and nature of the resource. The key to the effectiveness of these techniques is timing and the need for and scope of such measures should be identified early on in any development programme to ensure they can be utilised effectively.

The results of all measures to prevent and reduce effect to the historic environment resource will require post-excavation work, archiving finds conservation, reporting and the deposition of material in an appropriate museum. Sites in the estuary often produce large amounts of waterlogged wooden artefacts (for example ships and prehistoric buildings) which present particular challenges of conservation, storage and display.

Offsetting

Offsetting measures within this SEA are measures to as fully as possible offset any significant adverse effects on the environment. These measures therefore make good for loss or damage to an environmental receptor, without directly reducing that loss/damage. In this SEA 'compensation', a subset of offsetting, is only used in relation to those measures needed under the Habitats Directive.

The historic environment resource is by its very nature finite and non-renewable with its geographical and physical context a key element of its intrinsic value. Therefore, once an effect which results in loss of, or damage to the resource has occurred measures to offset these effects, such as replication or relocation of the resource, provide no practicable benefit. Consequently, the practice offsetting is not suitably applied to the historic environment resource and no offsetting measures have been identified.

The provision of compensatory habitats as a measure to offset the negative effects of changes to the tidal prism on existing intertidal habitats within the Severn Estuary would have an effect on the historic environment resource. The geographical locations for the compensatory habitats have not yet been defined. However, by necessity, the compensatory habitats are likely to be located in areas with similar topography, geology and hydrology to that of the Severn Estuary environment. Consequently, the character of the known and potential historic environment resource in such as location would likely be of the same high value, and fragility as the resource identified in this assessment.

It should, therefore, be assumed that such offsetting measures would result in significant adverse effects to the survival of the historic environment resource similar in nature to that outlined above in this assessment. As a basic guide, the larger the area of compensatory habitat required the greater the risk of adverse effects to the historic environment resource.

Assessment against SEA Objectives

This topic paper includes a full assessment of how each alternative option performs against each SEA Objective over the course of its entire life-cycle.

In order to be able to discern performance against the SEA Objectives quantitative approach is required. The quantitative assessment is informed by the qualitative approach used in the assessment of the significance of effects.

In summary:

SEA Objective 1 - *To avoid adverse effects on designated sites in the historic environment*

B3, L2 and L3d have a major negative performance against SEA Objective 1 as construction and operation phases would have adverse effects on the fabric, form and setting of designated sites in the historic environment. B3 and L3d would affect the limestone headland of Brean Down which is an important multi-period archaeological site and a Scheduled Monument. L2 would have a physical

effect on the form and the setting of the Gwent Levels, an Historic Landscape of Outstanding Historic Interest.

B4 has a minor negative performance against SEA Objective 1 as the construction and operation of this option would have an adverse effect on the fabric and setting of part of the Gwent Levels, a Historic Landscape of Outstanding Historic Interest.

B5 performs well against SEA Objective 1 and no effects on the designated sites in the historic environment are predicted.

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

All alternatives options would have a major negative performance against SEA Objective 2. Whilst L2 and L3d have their effects limited in spatial extent to Zones 2 and 3 the effect within these zones and the resulting loss of resource would be as significant as similar effects over a larger spatial area resulting from the barrages.

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

B3, B4 L2 and L3d would all have a major negative performance against SEA Objective 3 as they all direct and indirectly effect identified areas of medium and high potential within the intertidal and subtidal zones which would be directly effects within the design footprint and indirectly effect by changes to the tidal prism over much of the estuary (Zones 2-5).

B5 would have a minor negative performance against SEA Objective 3 as the footprint would have a direct effect on an area of medium potential and its widespread indirect effect resulting from changes to the tidal prism would be less severe over Zones 4 and 5.

SEA Objective 4 - *To avoid adverse effects on the character and quality of the historic landscape*

L2 would have a major negative performance against SEA Objective 4 as the physical structure located along a substantial section of the foreshore of the Gwent Levels Historic Landscape of Outstanding Historic Interest and would consequently have an adverse effect on the setting of the registered landscape.

B3, B4 and L3d will have a minor negative performance against SEA Objective 4 as the physical structures would have an adverse effect on a limited physical area of landscape. The landfall for B4 on the Welsh coast does impinge on the Gwent Levels Historic Landscape Outstanding Historic Interest, but the extent of the effect would be limited to the eastern end of the area. The effect of the remaining options would likely all occur at a relatively localised scale.

B5 performs well against SEA Objective 4 as the physical structure situated next to the existing Severn Road Bridge is unlikely to have a significant effect on the setting of the historic landscape.

Plan Implementation

Legislation and policy compliance

This paper and its associated Annex (STP, 2010a) contains a review of legislation and policy that is specifically relevant to this topic. An assessment has been made as to whether each alternative option would be compliant with existing relevant legislation and policy.

B3 and L3d would have an adverse effect on the form and setting of Brean Down and the setting of a number of smaller Scheduled Monuments. Consequently these alternative options do not comply with the purpose of the *Ancient Monuments and Archaeological Areas Act 1979 Part 1 Section 2* which serves to protect the physical fabric of sites and monuments of national importance from damage.

B4 and L2 would affect the form and setting of the Gwent Levels Historic Landscape of Outstanding Historic Interest (Landscape 17) and would not comply with the principles set out in the non-statutory Register of Landscapes of Outstanding Historic Interest in Wales Part 2.1.

Within the Severn Estuary the predicted loss of a substantial amount of the historic environment resource as a result of the construction and operation of any of the alternative options would conflict with the principles and purpose of national planning policy for the historic environment, as reiterated through local planning documents. Policy defines the resource as finite and non-renewable and consequently strongly advises the retention of the historic environment resource of national importance (whether scheduled or not) be achieved.

Monitoring of significant environmental effects

The SEA Directive requires that monitoring measures are described within the environmental reporting. The monitoring proposals contained within this paper are applicable to all of the alternative options under consideration.

The monitoring techniques applicable to the historic environment resource would differ during the construction, operation and decommissioning phases in accordance with the particular nature of the significant negative effects predicted across the lifetime of an option. The monitoring of significant environmental effects proposed here assumes the completion of any measures to prevent and reduce effects set out above. Monitoring techniques set out below are generally applicable to the historic environment resource in all three receptor areas. The techniques used would be the same as the measure to prevent and reduce effects set out above.

Monitoring of significant environmental effects

Significant Effect	Relevant receptor	Description of monitoring
Direct, permanent negative effect to the survival of resource	Known and potential resource within all three receptor areas.	Programme of archaeological monitoring, where appropriate, during construction phase. Monitoring is the final phase of measures to reduce effects carried out pre-construction. Monitoring of application and effectiveness of protective measures.
Indirect negative effect to survival of resource over the long term and/or access to the resource.	Known and potential resource within all three receptor areas (particularly subtidal and intertidal).	Planned programme of foreshore and subtidal surveys including walkovers, prospection, sampling, excavation etc to offset the long-term loss through the recording of the resource.

