DECC

SEVERN TIDAL POWER - SEA TOPIC PAPER

Other Sea Uses

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ABBREVIATIONS

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The following abbreviations are used in this Topic Report:

BERR	Department for Business, Enterprise and Regulatory Reform
BMAPA	British Marine Aggregates Producers Association
CCW	Countryside Council for Wales
cSAC	Candidate Special Area of Conservation
DECC	Department of Energy and Climate Change
EU	European Union
GIS	Geographical Information System
GVA	Gross Value Added
GW	Gigawatt
LIDAR	Light Detection and Ranging
MCA	Maritime and Coastguard Agency
MFA	Marine and Fisheries Agency
MOD	Ministry of Defence
MW	Megawatt
ODPM	Office of the Deputy Prime Minister
PEXA	United Kingdom Hydrographic Office Practice and Exercise Area Charts
RNLI	National Lifeboat Institute
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SARA	Severn Area Rescue Association
SDC	Sustainable Development Commission
SEA	Strategic Environmental Assessment
SMP	Shoreline Management Plan
SSSI	Site of Special Scientific Interest
STP	Severn Tidal Power
SWRDA	South West Regional Development Agency
TAN	Technical Advice Note
TWh	Terrawatt hours
UKCIP	United Kingdom Climate Impacts Programme
UKCPC	United Kingdom Cable Protection Committee
UKHO	United Kingdom Hydrographic Office
WAG	Welsh Assembly Government
WFD	Water Framework Directive

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 Other Sea Uses topic paper forms part of the reporting arising from Phase 2, the main assessment of short-listed options.

Consultation

The following consultation activities have been undertaken:

- Scoping consultation in January 2009
- Technical Workshops held in June and December, 2009
- Meetings, email and telephone correspondence with key stakeholders from the energy and aggregate industry as well as the Royal Yachting Association

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 avoid adverse effects on the aggregate extraction industry
- To avoid adverse effects on marine waste disposal sites and infrastructure
- To avoid adverse effects on marine recreational users
- To avoid adverse effects on sustainable estuary-based tourism in both the South Wales and South West England Regions
- To avoid adverse affects on military activity in the region
- To avoid adverse effects on the energy industry
- To avoid adverse effects on seabed cables in the region
- To minimise adverse effects on the Severn Bore

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, baseline information is considered over three time periods, 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.

Baseline environment up to 2009

Marine aggregate extraction is currently licensed at 12 sites in the Severn Estuary and Bristol Channel and there are a number of additional sites for which licence applications are in progress. In 2008, approximately 1.49 million tonnes of aggregate was extracted, principally sand. Approximately two-thirds of production is landed at Cardiff, Newport and Avonmouth and the industry supports around 1,700 direct and indirect jobs.

The Severn Estuary and Bristol Channel are important for marine waste disposal. A large number of sewage and industrial discharges are made to the Severn Estuary making use of the dilution and dispersion provided by the immense tidal range. In addition a number of power stations (both

conventional and nuclear) abstract and discharge large volumes of cooling water to the Severn Estuary and Bristol Channel. There are eleven open dredge material disposal sites in the Severn Estuary and Bristol Channel that are used for the disposal of capital and maintenance dredgings arising primarily from the navigation sector.

Tourism is an important economic activity in the region with over 7.5m tourist visits generating around £1.7bn per annum. A wide range of recreational activities occur including: sailing, boating, windsurfing, canoeing, surfing, bore surfing, sand surfing, bathing, diving, wildfowling and bird watching.

There is limited military activity in the study area with an underwater explosives site neat Weston-super-Mare, naval activity west of Bridgwater Bay and a military practice area near Redwick.

Several telecommunications cables enter the Bristol Channel from the Atlantic and a number of these cables come ashore at Oxwich Bay and at Brean Down.

Future baseline during construction: 2014-2020

The interim Marine Aggregate Dredging Policy (IMADP) for Wales encourages the migration of aggregate production out of the Severn Estuary and Inner Bristol Channel with the objective of reducing supply from these areas to below 800,000 tonnes by 2015. (It should be noted though that IMADP has no legal application in English waters and therefore target tonnages quoted within IMADP for the whole of the Severn Estuary should be regarded as aspirational).

Proposed large-scale coastal developments may place additional demand on aggregate extraction whilst capital dredge programmes associated with such schemes may also generate large volumes of dredge material which would need to be disposed of. The requirement for dredge disposal grounds may also change as shipping (including ship sizes, schedules etc.) needs alter to meet demand whilst port approaches and channels need to be maintained on safety grounds.

Within the study area, four new (non-nuclear) power stations are scheduled to be operational by the start of the construction phase in 2014. In addition, both Hinkley and Oldbury have been identified as possible sites for new-build nuclear power stations although neither site has been consented. The Outer Bristol Channel has also been identified as a suitable area for wind farm development and RWE npower Renewables has recently (January, 2010) been awarded the Bristol Channel Zone as part of the Crown Estate's Round 3 offshore wind farm development programme

Future baseline during operation 2020-2140, decommissioning and longer term trends

It is likely that forecasted long-term population growth in both South Wales and South West England as well as possible changes in climate will alter the existing baseline conditions for a number of receptors. For example, likely population increases will necessitate further housing development and this will place additional demands on aggregate extraction. A change in regional population may also result in increased waste water entering the Estuary. UKCP09 predictions of 21st century climate change suggest warmer temperatures are likely to be encountered in the south west region. Warmer temperatures may be beneficial to the tourism industry as well as a number of marine recreational user groups. However, for some recreational users (e.g. bird watchers and fishermen) these changes may have an adverse impact should wildlife not be able to adapt to this change in climate.

Key Environmental Issues and Problems

The Interim Marine Aggregate Dredging Policy (IMADP) encourages a precautionary approach to dredge applications in the Severn Estuary and favours a move towards operations taking place further offshore. (This policy is consistent with the conservation objectives of the Severn Estuary/Môr Hafren SAC which (amongst other things) seeks to maintain the gross morphology and benthic community

composition of sub tidal sand banks within the Estuary). However, stakeholders have questioned the feasibility of shifting operations into deeper water and it remains unclear how this policy will be amended in response to these concerns.

The combination of a high tidal range, strong currents, and high levels of turbidity are suggested to limit the level of recreational activity in the Severn Estuary. However, the lower number of recreational users may allow or encourage the existence of other forms of recreation, such as those associated with the wildlife or unique characteristics of the area.

Evaluation of Plan Alternatives

Assessment Methodology

The assessment methodology employed for the Other Sea Uses topic receptors relies heavily on the modelling output from both the Hydraulics and Geomorphology topic and the Marine Water Quality topic. This topic also draws upon the findings presented in:

- The Marine Ecology topic;
- The Waterbirds topic;
- The Resources and Waste topic; and
- The Supply Chain study (DECC, 2010)

The authors have subsequently used expert judgment to decide how these modelled changes to the Estuary may affect the receptors under consideration. These judgments have been made following discussions with key stakeholders, both at the two technical workshops and during additional consultation meetings.

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:	Brean	16km	Ebb &	Bulb-	144	5.6 to 6.6	42	1

Bridgwater Bay Lagoon	Down to Hinckley Point		Flood	Kaplan	(25MW)	TWh/year		

Assessment of Likely Significant Effects on the Environment

Alternative Option B3: Brean Down to Lavernock Point Barrage

A number of the dredgers extracting aggregates from the licence areas in the Bristol Channel land material at ports up-estuary of the barrage and this process follows a 12-hour tidally controlled cycle. The presence of a barrage across the estuary has the potential to interrupt this critical 12-hour extraction-landing cycle since aggregate dredgers may take up to one hour to transit through the barrage lock gates. Potential disruption to this cycle is regarded as significant since the economic viability of the industry in the study area could be threatened. Modelling output from the Hydraulics and Geomorphology topic paper also suggests that should the B3 barrage be constructed, some of the aggregate reserve sites located in the study area could experience a reduction in potential net sediment flux as a result of lower current speeds and a concomitant reduction in bed shear stress. Should these changes occur, it may be the case that existing extraction licence conditions would require revision. However, it should be noted that a degree of uncertainty surrounds this assessment since the extent to which existing sand reserves are essentially relict deposits, left over from glacial times is not well established. The B3 option would also traverse the Holm Sands reserve site, reducing the area available for resource extraction.

Construction of the B3 barrage has the potential to disrupt the waste disposal industry in a number of ways. Firstly, there would be a large reduction in tidal range throughout the Estuary, potentially reducing the performance of gravity driven waste outfalls. A reduction in current speeds inside the barrage may also make existing dredge material disposal sites unsuitable for use. Initial operation of the barrage would also cause an increase in siltation rates and deposited material would need to be dredged to maintain navigation channels and small craft mooring sites. This additional waste material may exceed the receiving capacity of existing waste disposal sites. Finally, widespread erosion of intertidal areas upstream of the B3 barrage is predicted to occur, potentially undermining waste outfalls.

At present, the Estuary is generally regarded to be a very hostile environment for small craft users. However, construction of the barrage would be likely to create more favourable conditions for most marine recreational users up estuary from the option and this could lead to a large growth in recreational usage of the Estuary. However, these changes may not be welcomed by all users, especially those 'extreme' sports users who are attracted to the Estuary's challenging environment. In particular, the B3 option would prevent the formation of the Severn Bore and the long standing tradition of bore surfing would no longer be possible. Increased erosion may also occur up-estuary of the barrage and this may affect the integrity of structures used for marine recreation. In addition, increased siltation inside the barrage option has the potential to affect the viability of marinas and mooring sites.

Within the Estuary, the RNLI, SARA and HM Coastguard operate a number of rescue stations. The presence of the B3 barrage option has the potential to increase incident response times for those rescue organisations operating in the vicinity of the structure as the barrage would bisect existing rescue areas.

Construction of the B3 barrage has the potential to affect sustainable estuary-based coastal tourism in a number of ways. Firstly, the barrage would be likely to alter the aesthetic appeal of the Estuary, potentially making it a less attractive location to visit. The construction phase for the tidal power option could coincide with other large-scale projects which may be consented in the region. This could cause a strain on local resources (including transport infrastructure and accommodation), also potentially threatening coastal tourism. Patterns of sediment transport and deposition would be altered

throughout much of the study area and this could potentially alter the sediment type and/or morphology of existing pleasure beaches. Should these beaches diminish and/or become muddier, sustainable estuary based tourism could be adversely affected. The Estuary is also a popular location for ornithological tourism but a large reduction in the population of estuary waterbirds owing to the loss of intertidal habitat area has the potential to adversely affect this tourism sector. However, a large barrage may become a visitor attraction, possibly attracting around 200,000 visitors per annum (DTZ, 2009).

There are a number of power stations located within the study area. Operation of the barrage would cause erosion of some intertidal areas within the Estuary and this could cause undermining of some power station water abstraction facilities. In addition, development of the B3 option in conjunction with other large-scale energy projects would provide a large influx of power to the national grid, potentially delivering a power surplus to the region and also requiring extensive reinforcements to the national grid. (These issues are covered in detail in the Severn Tidal Power Grid Impact Report).

Alternative Option B4: Shoots Barrage

Modelling output from the Hydraulics and Geomorphology topic paper suggests that should the B4 barrage be constructed some of the aggregate reserve sites located in the study area may experience a reduction in potential net sediment flux. Should these changes occur, it may be the case that existing extraction licence conditions would require revision although as mentioned above, it should be noted that a degree of uncertainty surrounds this assessment.

Construction of the B4 barrage option would cause a large reduction in tidal range upstream of the barrage, potentially reducing the performance of gravity driven waste outfalls. Furthermore, erosion of intertidal areas upstream of the B4 barrage is predicted to occur, potentially undermining these waste outfalls.

Construction of the B4 barrage would greatly reduce current speeds and tidal range up-estuary from the option. Although these changes may be welcomed by some small craft users, it would also mean that the Severn Bore would no longer form. Siltation inside the barrage option could also affect the viability of marinas and mooring sites for small craft.

The presence of the barrage option has the potential to increase incident response times for the SARA rescue craft operating in the vicinity of the structure.

Construction of the B4 barrage has the potential to affect sustainable estuary-based coastal tourism in a number of ways. Firstly, the barrage would be likely to alter the aesthetic appeal of the inner Estuary, potentially making it a less attractive location to visit. The construction phase for the tidal power option could coincide with other large-scale projects which may be consented in the region. This could place a strain on local resources (including transport infrastructure and accommodation), also potentially threatening coastal tourism. Patterns of sediment transport and deposition would be altered throughout much of the study area and this could potentially alter the sediment type and/or morphology of existing pleasure beaches. Should these beaches diminish and/or become muddier, sustainable estuary based tourism could be adversely affected. A large reduction in the population of estuary waterbirds owing to the loss of intertidal habitat area has the potential to adversely affect the sustainable estuary-based tourism sector. However, the barrage could become a visitor attraction, possibly providing a net additional benefit of up to £20 million of GVA (DTZ, 2009).

The proposed location for the B4 option lies in very close proximity to the military practice area near Redwick and plant would require access to this area during the construction period. This has the potential to disrupt military activity at this site.

Alternative Option B5: Beachley Barrage

Modelling output from the Hydraulics and Geomorphology topic paper suggests that should the B5 barrage be constructed some of the aggregate reserve sites located in the study area may experience a reduction in potential net sediment flux. Should these changes occur, it may be the case that existing extraction licence conditions would require revision although as mentioned above, it should be noted that a degree of uncertainty surrounds this assessment.

Operation of the B5 alternative option would cause a large reduction in tidal range upstream of the barrage, potentially reducing the performance of gravity driven waste outfalls.

The B5 barrage would greatly reduce current speeds and tidal range up-estuary from the option. Although these changes may be welcomed by some small craft users, it would also mean that the Severn Bore would no longer form. Siltation inside the barrage option could also affect the viability of marinas and mooring sites for small craft.

The presence of the barrage option has the potential to increase incident response times for the SARA rescue craft operating in the vicinity of the structure.

Construction of the B5 barrage has the potential to affect sustainable estuary-based coastal tourism in a number of ways. Firstly, the construction phase for the tidal power option could coincide with other large-scale projects which may be consented in the region. This could cause a strain on local resources (including transport infrastructure and accommodation), also potentially threatening coastal tourism. Patterns of sediment transport and deposition would be altered throughout much of the study area and this could potentially alter the sediment type and/or morphology of existing pleasure beaches. Should these beaches diminish and/or become muddier, sustainable estuary based tourism could be adversely affected. A large reduction in the population of estuary waterbirds owing to the loss of intertidal habitat area has the potential to adversely affect the sustainable estuary-based tourism sector. However, a barrage could become a visitor attraction, possibly providing a net additional benefit of up to £20 million of GVA (DTZ, 2009).

Alternative Option L2: Welsh Grounds Lagoon

During construction of the L2 lagoon, plant would be present at a number of aggregate extraction sites within the Estuary, potentially disrupting industry operations. The structure itself would also traverse several licence areas, causing a reduction in the area available for aggregate extraction. Modelling output from the Hydraulics and Geomorphology topic paper also suggests that should the L2 lagoon be constructed, some of the aggregate sites located in the study area may experience a reduction in potential net sediment flux. Should these changes occur, it may be the case that existing extraction licence conditions would require revision. However, some uncertainty surrounds this assessment.

The proposed site for the lagoon option occupies the same location as two dredged material disposal sites and the option is also situated close by to another site. All three of these sites would no longer be fit for purpose should the lagoon be constructed.

Construction of the L2 lagoon would be likely to create more favourable conditions for marine recreational activity inside the lagoon and as a result, this area of the Estuary could experience an increase in recreational usage.

The presence of the lagoon has the potential to increase incident response times for those rescue organisations operating in the vicinity of the structure.

Construction of the L2 lagoon has the potential to affect sustainable estuary-based coastal tourism in a number of ways. Firstly, the construction phase for the tidal power option could coincide with other large-scale projects which may be consented in the region. This could cause a strain on local resources (including transport infrastructure and accommodation), also potentially threatening coastal tourism. Patterns of sediment transport and deposition would be altered throughout much of the study area and this could potentially alter the sediment type and/or morphology of existing pleasure beaches. Should these beaches diminish and/or become muddier, sustainable estuary based tourism could be adversely affected. A large reduction in the population of estuary waterbirds at the Gwent Levels owing to the loss of intertidal habitat area has the potential to adversely affect the sustainable estuary-based tourism sector. The lagoon option also has the potential to affect coastal tourism through adversely impacting the aesthetic appeal of this part of Estuary.

Alternative Option L3d: Bridgwater Bay Lagoon

Modelling output from the Hydraulics and Geomorphology topic paper suggests that should the L3d lagoon be constructed, some of the aggregate sites located in the study area may experience a reduction in potential net sediment flux. Should these changes occur, it may be the case that existing extraction licence conditions would require revision. However, some uncertainty surrounds this assessment.

Peak flow speeds within Bridgwater Bay may increase with the presence of the lagoon. This may be undesirable for small craft users as well as bathers at pleasure beaches impounded by the option.

The presence of the lagoon has the potential to increase incident response times for rescue organisations operating within the bay.

Construction of the L3d lagoon has the potential to affect sustainable estuary-based coastal tourism in a number of ways. Firstly, the lagoon could alter the aesthetic appeal of Bridgwater Bay, potentially making it a less attractive location to visit. The construction phase for the tidal power option could also coincide with other large-scale projects which may be consented in the region. This could cause a strain on local resources (including transport infrastructure and accommodation), also potentially threatening coastal tourism. Patterns of sediment transport and deposition would be altered throughout much of the study area and this could potentially alter the sediment type and/or morphology of existing pleasure beaches. Should these beaches diminish and/or become muddier, sustainable estuary based tourism could be adversely affected. A large reduction in the population of estuary waterbirds in Bridgwater Bay (resulting from disturbance due to construction/ decommissioning activities) also has the potential to adversely affect nature based tourism. Finally, the presence of the L3d lagoon also has the potential to reduce bathing water quality at Weston.

Modelling results from the Marine Water Quality topic suggest that the L3d lagoon would inhibit the dispersion of the thermal plume from Hinkley nuclear power station, resulting in changes to plume characteristics. Should Hinckley ‘C’ new build nuclear power station be consented, it is also possible that contaminates (in particular hydrazine and boric acid) may not be so readily flushed from the power station outfall(s) if the L3d option were in place. Finally, development of the L3d option in conjunction with other large-scale energy projects would provide a large influx of power to the national grid, potentially delivering a power surplus to the region and also requiring extensive reinforcements to the national grid.

The L3d option would traverse a number of telecommunication cable routes which come ashore at Brean and these cables would be at risk from enhanced basal scour due to high flow speeds nearby to the cables.

Assumptions, Limitations and Uncertainty

Predictions of long-term morphological changes of the Estuary have been used to help identify some of the possible effects on (*inter alia*) the aggregate, waste disposal and energy industry. However, the models used to predict long-term morphological changes incorporate several uncertainties and assumptions regarding the input parameters and interactions between certain model variables. (These uncertainties are not confined to this model but are instead inherent to other models used to inform this topic. They have been considered in detail within the relevant topic papers).

The formation and propagation of tidal bores are sensitive to a number of factors including tidal range, current velocity and seabed morphology. Whilst it is highly probable that the barrage options would all prevent the formation of the Severn Bore, more detailed modelling analyses are required to confidently address the impact from the lagoon options.

The navigational assessment used to consider possible disruption to the aggregate 'dredging cycle' – (the 12 hour tidally controlled cycle which is critical to the successful extraction and unloading of aggregate material) - has only been undertaken qualitatively. The assessment involves no quantitative modelling of vessel transit times from reserve site to landing wharf although such information would be desirable in future studies.

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

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

The process of scheme optimisation occurred in 2009 and this led to the inclusion of modifications designed specifically to reduce adverse effects on the Other Sea Uses receptors. The finalised option design for B3 includes 2 small locks to accommodate small recreational craft and smaller commercial vessels whilst the original alignment of the B4 barrage was altered to avoid the military exercise area near Redwick.

Many of the adverse effects on the Other Sea Uses receptors arise as a consequence of changes to water levels (e.g. reduction in waterbird populations due to reduction in inter tidal area; loss of Severn Bore; reduction in performance of waste outfalls). Potential mechanisms for preventing or reducing some of these effects include:

- Operational management of the barrage/lagoon regime;
- Mechanical pumping of water through the tidal power structure to increase water levels; and
- Altering the type, size, position and number of sluices/ turbines.

There are a number of measures which could be implemented to maintain the viability of existing facilities. These include:

- The mechanical pumping of waste outfalls experiencing reduced performance;
- Beach recharge at pleasure beaches experiencing diminished sand transport;
- Alterations to power station water abstraction facilities affected by changed water levels;
- Improvements to the foundations of structures at risk from undermining (e.g. outfalls, slipways etc.); and
- The dredging of mooring sites/ marinas which experience increased siltation rates.

Many of the potential adverse affects on receptors could be addressed by relocating affected sites/ infrastructure. These proposals include:

- The relocation of cables and pipelines which would traverse tidal power options and/or be at risk of scour;

- The realignment of power station water abstraction facilities which could be affected by option development (e.g. possible changes to the thermal plume from Hinkley nuclear power station); and

- The relocation of existing marine rescue stations to new sites to ensure emergency incident response times are not increased

In addition to the above, several other receptor-specific measures have been identified:

Construction of the L3d lagoon option would cause changes to the spatial extent of the effluent plume from Weston-super-Mare Waste Water Treatment Works, potentially affecting bathing water quality at Weston. However, the Water Quality topic notes that this adverse effect could be reduced through more stringent controls on inputs from Weston-super-Mare Waste Water Treatment Works.

Tidal power generation in the Severn Estuary would deliver a large input of power to the national grid and new build nuclear power stations may also be consented at Hinckley and/ or Oldbury. Research undertaken for the Grid Studies report demonstrates that existing grid infrastructure would not be able to accommodate this increased power input. However, grid reinforcement works would be implemented to address this issue.

The construction phase for the tidal power options could coincide with other large-scale projects which may be consented in the region and this could cause strain on local resources (including transport infrastructure and accommodation), potentially threatening coastal tourism. However, this adverse effect could be greatly reduced by timing the project construction period to avoid other large construction projects. Similarly, close co-ordination between construction operations and the activities of stakeholders would greatly reduce other potentially significant effects which have been highlighted (e.g. military activity at Redwick).

Other relevant measures to prevent or reduce effects identified elsewhere in the SEA include ways to reduce the aesthetic impact from the tidal power options as well as measures to minimise impacts on waterbird populations. The implementation of these measures has the potential to lessen the impact on sustainable estuary-based tourism.

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.

A number of the alternative options have the potential to adversely affect aggregate extraction sites and/or dredge material disposal sites within the Estuary. New sites could potentially be characterised elsewhere within the study area (although further research would be required to ascertain whether alternative sites would be economically viable).

Measures have been proposed for the creation of freshwater wetland habitat close to Severn Estuary, and managed re-alignment adjoining the Severn Estuary. These measures have the potential to lessen the impact on waterbird populations which in turn, may reduce the impact on nature-based tourism within the Estuary.

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 summary:

SEA Objective 1: To avoid adverse effects on the aggregate extraction industry

An increase in siltation rates at existing aggregate sites has the potential to impede extraction operations whilst a more mixed sand/mud resource may also incur additional expense to process. However, these potential adverse effects may largely be overcome through the provision of specialist equipment to facilitate the extraction/ resource sorting process.

The greatest threat to the aggregate industry comes from the potential of the B3 option to disrupt the Estuary dredging cycle. With the B3 option, lock transit times may be up to one hour although this disruption may be partially reduced via (*inter alia*) coordination and prior notification of dredger arrival times at the barrage. Nevertheless, as a result of the above the B3 option scores a major negative performance against the SEA Objective.

The proposed site of the L2 option is situated on (or in very close proximity to) a number of existing reserve sites, resulting in a loss of area available for aggregate extraction. It may be possible to expand existing licence areas/ quotas to partially offset this effect (although this may be incompatible with existing policy and guidelines). Accordingly, the L2 option scores a minor negative performance against the SEA Objective.

All of the options have the potential to alter net sediment flux within the study area. This could affect the resupply of some aggregate reserve sites (although much uncertainty is associated with this assessment). However, should existing reserve sites within the Estuary or inner Bristol Channel be greatly affected, new locations for aggregate extraction could potentially be established in the outer Bristol Channel (although further research would be required to ascertain whether new, deeper-water sites would be economically viable).

SEA Objective 2: To avoid adverse effects on marine waste disposal sites and infrastructure

All of the tidal power options have the potential to alter the balance of erosion and accretion within the intertidal zone and this could cause undermining or smothering of waste outfall structures. The B3 option poses the greatest risk whilst the threat from the lagoon options is much less as fewer outfall structures are sited within the impounded areas. In addition, changes to water levels may adversely affect the performance of gravity driven outfalls. However, all adverse effects could be prevented or greatly reduced, either through modifying the elevation and/or foundations of existing outfall structures or through the installation of mechanical pumping facilities at existing gravity driven outfalls.

All of the barrage options would be likely to modify peak flow speeds at existing dredge waste disposal sites. A marked reduction in flow speeds may mean certain disposal sites are no longer suitable to receive material. The proposed site for the L2 option is located within 500m of the Newport dredge disposal site, potentially rendering it unusable. However, should any of these sites become unsuitable following the development of a barrage and/or lagoon, new sites could potentially be characterised, either within the Estuary or out in the Bristol Channel. Temporary disposal sites could also be characterised to accommodate the (short term) increase in waste material arising from the increased siltation rates that are likely to follow initial operation of the tidal power options.

Accordingly, all options are considered to have no effect on the SEA objective.

SEA Objective 3: To avoid adverse effects on marine recreational users

The Severn Estuary is regarded as a particularly hostile environment for recreational users, primarily owing to the immense tidal range and strong currents. However, implementation of the barrages and L2 lagoon option has the potential to create more favourable conditions for most marine recreational users leading to an increase in marine recreational usage of the Estuary. Conversely, peak flow speeds may increase within the L3d option, potentially making conditions less amenable for most users.

All of the tidal power options may cause localised increases in sedimentation which may adversely impact both marinas and other small craft mooring locations within the Estuary. However, should the viability of any mooring location be compromised by an increase in siltation, dredging could easily be undertaken to remediate the problem.

Long-term morphological changes to the Estuary could result in the undermining of existing coastal structures used for recreational purposes (e.g. launching slipways). However, structural modifications to existing facilities may greatly reduce any adverse effects.

As a result of the above, the B3 option scores a major positive performance against the SEA Objective. The B4, B5 and L2 options deliver a minor positive performance against the SEA Objective whilst the L3d options scores a minor negative performance against the SEA Objective.

SEA Objective 4: To avoid adverse effects on sustainable estuary-based tourism in both the South Wales and South West England Regions

All of the tidal power options have the potential to have both a positive and negative influence on sustainable estuary based tourism. Each option could become a visitor attraction although all the options have the potential to have an adverse effect on the aesthetics of the Estuary, both during the construction/ decommissioning phases and during operation. Measures to partly reduce the visual impact of the tidal power structures have been identified (e.g. use of appropriate materials and lighting etc) whilst timing the project construction period to avoid other large construction projects being undertaken at the same time (e.g. Hinkley C nuclear power station) may serve to reduce the demand on local resources and infrastructure.

The extent of intertidal mud and sand flats would be reduced by the construction of all options and this has the potential to adversely impact nature based tourism through a reduction in estuary waterbird populations. However, measures have been identified which could greatly reduce the loss of intertidal area (and hence reduce the impact on waterbird populations).

All of the tidal power options have the potential to reduce sediment supply to sandy pleasure beaches within the study area as well as increasing mud deposition at these sites. Any reduction in beach sediment supply could potentially be countered through a coordinated programme of beach replenishment. However, should sandy pleasure beaches become ‘muddier’, it would be hard to restore them to their natural state.

Accordingly all options score both minor negative and minor positive performance against the SEA Objective.

SEA Objective 5: To avoid adverse affects on military activity in the region

During the construction phase for the B4 option, it is probable that construction plant would require regular access to the Military practice area near Redwick. However, close coordination between the barrage construction company and the MOD regarding the scheduling of practice firing and the use of the practice area by commercial vessels would greatly reduce disruption to military activity in this area. No other effects on Military activity are identified.

All options are considered to have no effect on the SEA objective.

SEA Objective 6: To avoid adverse effects on the energy industry

All of the tidal power options would alter water levels within the Estuary and these changes have the potential to adversely affect power station water abstraction facilities. However, any adverse effects would be preventable through structural and/or mechanical amendments to existing water abstraction facilities.

Construction of the L3d lagoon option would be likely to alter the characteristics of the thermal plume from Hinkley nuclear power station. However, adverse effects to Hinkley B could be greatly reduced by phasing the construction timetable for the lagoon to take into account the closure of the power station in 2016. Should a new nuclear power station be consented at Hinkley (Hinkley 'C'), cooling water intake/ outfalls could be relocated away from the lagoon to prevent the thermal plume becoming constrained against structure.

All options are therefore considered to have no effect on the SEA objective.

SEA Objective 7: To avoid adverse effects on seabed cables in the region

Both the B3 barrage and L3d lagoon options have the potential to adversely affect telecommunication cables in the study area. This is because basal shear stress would be greatly increased in the vicinity of the tidal power turbines and this increases the likelihood of basal scour around the cables. However, adverse effects on these cables may be greatly reduced through the implementation of scour protection measures or prevented through the re-siting of cable routes.

Accordingly, all options are considered to have no effect on the SEA objective.

SEA Objective 8: To minimise adverse effects on the Severn Bore

All three barrage options would prevent the formation of a 'surfable' Severn Bore. No realistic measures to maintain the bore have been identified.

Since neither the L2 nor L3d lagoons would greatly alter tidal characteristics outside of the impounded area, it is unlikely that the frequency and magnitude of the bore would be greatly altered with either of these options. (However, more detailed modelling would be required to address this issue in full).

Because of the above, all the barrage options score a major negative performance against the SEA Objective whilst the lagoon options are considered to have no effect on the SEA objective.

Plan Implementation

Legislation and policy compliance

This paper 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.

The Cultural Tourism Strategy for Wales (2003) and the associated Action Plan provides a framework for action by Wales Tourist Board and its partners to develop Wales' potential as a cultural tourism destination. The South East Wales Strategic Tourism Framework (2008) also contains key guiding sustainable principles, one of which is to promote local economic prosperity. The tidal power options have the potential to reduce the aesthetic appeal of the Estuary and place a high demand on local infrastructure during the construction phase, potentially adversely affecting sustainable estuary-based

tourism. However, construction of the barrages and L2 lagoon options would be likely to create more favourable conditions for recreational users of the Estuary.

Development of the B3 option has the potential to adversely affect the viability of aggregate sites within the study area. However, a key aspect of the Interim Marine Aggregates Dredging Policy (IMADP) is that aggregate dredging will progressively, over the next ten years, become focused in areas offshore and to the west of the Bristol Channel. Should the development of the B3 option adversely affect the viability of resource sites in the Bristol Channel (through disruption to the dredging cycle), it may become problematic to realise the aims of IMADP.

The L3d option also has the potential to reduce bathing water quality at Weston-Super-Mare, possibly contravening Directive 2006/7/EC concerning the management of bathing water quality.

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.

A number of the receptors considered in the Other Sea Uses Topic have the potential to be adversely affected by morphological change to the intertidal zone resulting from the implementation of a tidal power option. Ongoing monitoring of cross-shore profile should be carried out following the development of any tidal power option so as to identify areas of enhanced change. This monitoring may be undertaken directly through traditional beach survey methods and/or remotely through the use of Light Detection and Ranging (LIDAR) techniques. A programme of beach sediment sampling should also be implemented since modelling results from the hydraulics and geomorphology topic suggest that reduced flow velocities resulting from the barrage options have the potential to increase mud deposition at existing pleasure beaches (e.g. Brean, Weston and Sand Bay).

Possible increases in siltation rates following the implementation of a tidal power option have the potential to adversely affect the viability of small craft mooring sites and marinas. Monitoring of siltation rates at these mooring locations is desirable in order to gauge the extent of possible change.

Modelling results from the Water Quality Topic suggest that development of the L3d option has the potential to reduce bathing water quality at Weston. In order to verify this prediction and establish the significance of the effect, monitoring of the microbiological (Faecal Coliforms) and physicochemical parameters of bathing waters at Weston should be undertaken.

Development of the B3 option would be likely to greatly alter the environmental characteristics at existing dredge waste disposal sites within the study area. This may necessitate closure of, or a revision to existing licensing conditions at some sites. However, in order to identify the most appropriate course of action a programme of monitoring would be required. This monitoring programme would need to consider the physio-chemical and biological characteristics of the water-column/ seabed at existing waste disposal sites as well as identify whether any changes to constituent fluxes have occurred.