



# SEVERN TIDAL POWER - SEA THEME PAPER

## Society & Economy Theme Effects & Interrelationships

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## **ABBREVIATIONS**





## ABBREVIATIONS

The following abbreviations are used in this Report:

ABP	Associated British Ports
AOD	Above Ordnance Datum
AONB	Areas of Outstanding Natural Beauty
BAP	Biodiversity Action Plan
BERR	Department for Business, Enterprise and Regulatory Reform
BGS	British Geological Survey
BMAPA	British Marine Aggregates Producers Association
CCW	Countryside Council for Wales
CD	Chart Datum
CHaMP	Coastal Habitat Management Plan
cSAC	Candidate Special Area of Conservation
DC	District Council
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DSCT	Deep Sea Container Terminal
dwt	Dead Weight Tonnage
EIA	Environmental Impact Assessment
EC	European Commission
EHO	Environmental Health Office
EIA	Environmental Impact Assessment
END	Environmental Noise Directive
EU	European Union
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GIS	Geographical Information System
GOSW	Government Office for the South West
GVA	Gross Value Added
GW	Gigawatts
ha	Hectare
HGV	Heavy Goods Vehicle
H&G	Hydraulics and Morphology
HRA	Habitats Regulations Assessment
Hz	Hertz
IMD	Index of Multiple Deprivation
JSA	Job Seekers Allowance
LAD	Local Authority District
LIDAR	Light Detection and Ranging
LNR	Local Nature Reserve
MCA	Maritime and Coastguard Agency
MFA	Marine and Fisheries Agency
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
MOD	Ministry of Defence
MSOA	Middle Layer Super Output Area
MW	Megawatt
M&E	Mechanical and Electrical
NERC	Natural Environment and Rural Communities Act

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NNR	National Nature Reserve
NP	National Park
NPS	National Policy Statement
NSR	Noise Sensitive Receptors
OD	Ordnance Datum (Newlyn)
ODPM	Office of the Deputy Prime Minister
ONS	Office for National Statistics
OSU	Other Sea Uses
PEXA	United Kingdom Hydrographic Office Practice and Exercise Area Charts
PPG	Planning Policy Guidance
PPS	Planning Policy Statements
ppt	Parts per thousand
PRoW	Public Rights of Way
PSU	Practical Salinity Units
REIS	Regional Economic Impact Study
RNLI	National Lifeboat Institute
RSS	Regional Spatial Strategy
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SDC	Sustainable Development Commission
SEA	Strategic Environmental Assessment
SLR	Sea Level Rise
SOA	Super Output Area
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
STP	Severn Tidal Power
SW	South West
SWO	South West Observatory
SWRA	South West Regional Assembly
SWRDA	South West Regional Development Agency
TAN	Technical Advice Note
TWh	Terrawatt hours
UK	United Kingdom
UKCP	UK Climate Projections
UKCIP	United Kingdom Climate Impacts Programme
UN	United Nations
VDV	Vibration Dose Value
WAG	Welsh Assembly Government
Wm	Frequency Weighting
WFD	Water Framework Directive
ZTV	Zone of Theoretical Visibility

## **NON TECHNICAL SUMMARY**



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## NON TECHNICAL SUMMARY

### Feasibility Study and Purpose of the SEA

In January 2008, Government announced a two-year feasibility study on harnessing the renewable energy from the tidal range in the Severn Estuary. This work is being carried out by a cross-Government team led from the Department for Energy and Climate Change (DECC). The aim of the Severn Tidal Power (STP) Feasibility Study is to investigate whether Government could support a tidal power scheme in the Severn and, if so, on what terms.

The Feasibility Study has been split into two phases: Phase 1 examined the scope of work and analysis required to make an evidence-based decision on whether to support a tidal power project in the Severn and what potentially feasible schemes exist for converting this energy. Phase 1 ended with the publication of the consultation document in January 2009. Phase 2 began in early 2009 and has involved work on environmental, regional, economic, commercial, technical and regulatory issues to inform the study conclusions including whether any of the potential schemes are feasible.

A Strategic Environmental Assessment (SEA) is being carried out in support of the Feasibility Study, in accordance with EU Directive 2001/42/EC (the SEA Directive), implemented in England and Wales through the Environmental Assessment of Plans and Programmes Regulations (SI 2004/1633 and Welsh SI 2004/1656), to predict and analyse the environmental effects of alternative short-listed Severn tidal power options over their entire lifetime, in order to inform decision making at the end of the Feasibility Study.

### Purpose of the Theme Papers

The SEA Directive requires that 'the likely significant effects on the environment... and the interrelationship[s]' are described (SEA Directive Annex 1 (f)). The theme papers summarise the interrelationships between related topics and thereby ensure that the many complex issues that are not self-contained within a given topic are recognised and their implications understood. The theme paper also examines the interrelationships between this and other themes within the STP SEA. This is the Society & Economy theme paper, covering the Communities, Navigation, Noise & Vibration and Other Sea Uses topics.

The theme papers also assist the Environmental Report to meet the requirements of the SEA Directive by collating the difficulties (such as technical deficiencies or lack of know-how) encountered in compiling the required information (SEA Directive Annex 1 (h)).

Each theme paper therefore provides an integrated summary across the theme, drawing on information presented in its topic papers. Each theme paper also considers, in less detail than for the alternative short-listed options, the likely significant effects on the environment of the variations of alternative options referred to as combination and multiple basin options.

### Society & Economy Baseline Environment and Significant Effects

The focus of the Society & Economy theme is the human environment. This paper therefore describes the environment from the human perspective and focuses on the activities of the human population around the Severn Estuary and how the alternative options might affect those activities through the environmental changes described, both in terms of the topics listed above and topics grouped in other themes.

There are five shortlisted alternative options that have been assessed for their likely significant effects. These alternative options are: B3: Brean Down to Lavernock Point Barrage (also known as the Cardiff to Weston Barrage); B4: Shoots Barrage; B5: Beachley Barrage; L2: Welsh Grounds Lagoon; and L3d: Bridgwater Bay Lagoon.

## Baseline

The area around the estuary is largely rural, with concentrations of population around the urban areas of Barry, Cardiff, Newport, Chepstow, Gloucester, Sharpness, Bristol, Avonmouth, Weston Super Mare and Bridgwater. The rural areas include large swathes of the low-lying land around the estuary (the Gwent and Somerset Levels on the Welsh and English sides of the Severn Estuary respectively) and are largely given to agricultural use.

In terms of access to recreation and tourism, a wide range of recreational activities occur throughout the study area, including walking (e.g. the proposed All-Wales Coastal Path, the Severn Way, and Offa's Dyke Path), boating, bathing, wildfowling, bird watching and fishing. Specific examples include Cosmeston Lakes, Newport Wetlands Reserve, Slimbridge Reserve, Brean Down, Flat and Steep Holm and the rivers Usk and Wye. The Glamorgan Heritage Coast extends west from the Vale of Glamorgan side of the study area; there are a further two Heritage Coast designations in the proximity (The Gower and Exmoor).

Tourism is one of the largest employment sectors in the Severn Estuary. Each year over 7.5 million visits are made to Somerset, Avon and South East Wales by UK residents alone, together bringing over £1 billion to the region. Employment in tourism exceeds 70,000 in the Study Area and accounts for over 7% of total employment and generates 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.

Within the Study Area over 45,000 persons are employed in construction, some 5% of the total workforce.

There are five ports within the study area for the Society & Economy theme: Bridgwater, Bristol, Cardiff, Newport and Sharpness. The ports and especially the Port of Bristol are also important economic activities employing around 6,000 including indirect employment in port service industries such as transport services. The marine aggregates industry employs an estimated 1,100 persons in the Study Area. Commercial and other employment generating fishing and angling employs relatively few persons, estimated to be less than 100.

Other uses of the estuary include marine waste disposal, telecommunications (a small number of telecommunications cables enter the Bristol Channel from the Atlantic. A number of cables come ashore at Oxwich Bay and at Brean Down) and military use.

Noise in the estuarine environment is fairly local in nature as the water is too shallow to support long range propagation. Aquatic noise sources include impact noise, seismic (generating low frequency noise by movement of the seabed); as well as biological and anthropogenic noise. On land, the noise climate is varied, transportation noise and industrial being the largest noise producers. Residential dwellings are the most sensitive to noise, particularly at night where it is desirable to prevent sleep-disturbance.

## Likely Significant Effects Identified

The Society & Economy theme has identified effects on a range of receptors within the human environment. This includes effects on the ports, marine aggregates industry, marine waste disposal, and tourism and recreation.

The construction phase of all of the alternative options considered in the feasibility study will require significant labour input. This will result in an increase in construction job demand in the area for the construction period. Much of this demand is considered likely to be served from within the twelve Local Authorities bordering the estuary, although some will inevitably be drawn from further afield. It is considered that whilst the alternative options will serve as a draw for in-migration during the

construction period, this should not over-burden community services and facilities, although some localised increases in demand are likely. It is anticipated, based on the experience of similarly large-scale construction projects (the Channel Tunnel, 2012 Olympics Development and large-scale nuclear power developments), that majority of in-migrant labour will be accommodated in local B&B, self catering or short-term rental accommodation. As a consequence, a purpose-built construction labour camp is not anticipated to be needed. For each of the alternative options, whilst the numbers required for construction phase employment are large (ranging from 3000-10,000 full-time equivalent jobs (FTE) depending on the Option), based on the experience of other major projects, there are not anticipated to be significant effects to the local population as a result. Further detail is provided in the Communities topic paper.

The assessment of effects on health and quality of life has focussed on identifying the areas of population most likely to be affected by the construction of the alternative options. This has been done using Middle Layer Super Output Areas (MSOA) to estimate the areas affected based on assumed land take requirements for each alternative option. The assumed land take includes:

- Permanent access road (for operation and maintenance).
- Permanent export cable reserve.
- 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. These are likely to include: buildings (sub-stations, etc), road materials and possibly materials for part of the upper part of the embankment, cable drums and electrical equipment (switchgear, etc).

This approach is intended to allow a conservative estimate of the areas affected to be obtained to ensure the area affected is not underestimated. Using this approach significant adverse effects are predicated for the MSOAs affected by the B3, L2 and L3d alternative options (see below).

Effect	Option				
	B3 Brean Down to Lavernock Point Barrage	B4 Shoots Barrage	B5 Beachley Barrage	L2 Welsh Grounds Lagoon	L3d Bridgwater Bay Lagoon
Effect on health & quality of life	significant adverse effects on health and quality of life of the population of Monmouthshire 009 and Newport 015		significant adverse effects on health and quality of life of the population of the West Somerset 004 and Sedgemoor 002		significant adverse effects on health and quality of life of the population of the Vale of Glamorgan 008 and Sedgemoor 002 MSOA

The effects of the alternative options on navigation through the estuary, is considered in some detail, particularly with regard to the use of the estuary for commercial shipping. A range of physicochemical effects have been predicted using models which could affect navigation, including:

- Reduced high water levels (B3, B5, L3d)
- Increased low water levels upstream of Barrage (B3)
- Increased peak water velocities at sluice gates and turbine blocks (B3, B4, B5)
- Reduced peak water velocity throughout the estuary and Bristol Channel (B3, L3d)
- Short term sediment deposition in navigation channels and immediate approach channels following completion of the Barrage (B3, B4, B5, L3d)
- Long term morphological change in navigation channels and immediate approach channels (All Options)

During the construction period shipping traffic within the estuary is anticipated to increase as a result of delivery of caissons and materials to the construction sites. In addition, the presence of an additional locked structure across the estuary navigation (as is the case for alternative options B3, B4, B5 and L3d) will result in an increase in transit time to each of the affected ports, and could potentially affect response times for marine rescue organisations.

The Communities topic also considers effects on the ports in terms of potential employment effects. Based on the Regional Economic Impact Study undertaken by DTZ in 2008/9 and updated for 2010, it is envisaged that there will be adverse effects on the ports as a result of the construction phase of the schemes, continuing into operation, largely as a result of the perceived blockage to transit through the estuary, rather than the direct and indirect navigational effects described above, which can largely be prevented or reduced. This is predicted to be significant in the case of the B3 alternative option in particular, with potential losses in trade predicted in the REIS that could amount to employment reductions of up to around 1,850 FTE being during construction and up to some 4,200 FTE lost by the end of the operational phase.

Potentially significant effects on the marine aggregates, marine waste disposal, tourism, recreation and energy sector receptors have also been identified. For marine aggregates, in the case of B3 there is the possibility that the 12-hour extraction cycle could be interrupted with effects on the efficacy of operations within the estuary. If this happens, there could be a resultant effect upon employment within this sector. There are also potential adverse effects on access to licensed extraction grounds (L2) and uncertain effects upon recharge of deposits within the estuary.

Marine waste disposal effects include physical effects upon the performance of waste outfalls, such as tide-locking or undermining of outfall structures; and changes in current resulting in existing waste disposal grounds becoming unsuitable. Other physicochemical effects predicted included changes to power station thermal plume characteristics (L3d), local morphological changes up estuary of the barrage affecting the integrity of power station intake and outfall structures and erosion of the sub-tidal environment causing cable scour.

Effects on the Tourism receptor include a reduced aesthetic appeal of the Estuary, the alternative option becoming a visitor attraction (particularly for the barrage options), reduction or redistribution of bird populations (affecting ornithological tourism), detrimental impact to sandy pleasure beaches, and (in the case of L3d) change to spatial extent of the contaminant plume from Weston Super Mare waste water treatment works, affecting bathing water quality at Weston. These are anticipated to have a corresponding effect upon tourism employment.

Significant effects predicted in relation to the recreation receptors across the study area include complete loss of the Severn Bore phenomenon in the case of the three barrage options, undermining of structures used for marine recreation (slipways for example) and potential siltation affecting the viability of marinas or moorings. Changes to the hydrodynamic environment are predicted, which could benefit marine recreation in the case of B3 and L2 in particular, where more benign conditions are anticipated within the impounded areas; conversely the L3d alternative option is predicted to result in localised increases in peak water velocity which is likely to adversely affect marine recreation in Bridgwater Bay.

Adverse effects are predicted in relation to fisheries within the study area. This is likely to result in adverse effects upon fishery dependent employment – notably in the recreational/tourism Atlantic salmon and Sea trout angling and heritage (elver) industries, where complete loss of the industry is predicted for all alternative options. Whilst this does not account for a large amount of jobs (estimated at about 40 jobs), the effect is considered to be significant as it amounts to the loss of a sector.



## Difficulties Encountered

The Study is strategic in nature and consequently so are the methods used to predict effects. Some uncertainty is therefore carried through the assessment, from the project assumptions made, to the specific modelling parameters used. General difficulties (such as technical deficiencies or lack of know-how) encountered include:

The Society & Economy theme topics derive much of their information on effects from the SEA's Physicochemical and Biodiversity themes. The nature of the environmental assessment means that any difficulties that arise in the hydraulics and geomorphology (H&G) assessment are carried through to other topics within the Physicochemical and Biodiversity themes and also on to subsequent topics reliant on use of that information for their assessment.

Inevitably given the long time periods involved, for the future baseline predictions, the nearer term predictions are more certain than estimations into the future. Therefore the baseline during the construction phase has greater certainty than that during the operational life of a scheme.

Lack of information for some areas has by necessity been addressed through the use of case studies, preferably of analogous projects. Where this has not been possible, assumptions have been derived and tested through the assessment process or a data gap is recorded.

## Interrelationships

For the purposes of undertaking the SEA, the effects on the environment of the Severn Estuary have been considered within sixteen topics based around its various natural and human environment functions. These sixteen topics have been arranged within five themes, of which Society & Economy is one.

Many of the interrelationships within the Society & Economy theme have been addressed through the transfer of information at different stages in the assessment process. In a similar way to the interaction of humans in the estuarine environment, the Communities topic has been informed by assessment information emerging from the other three topics within the theme, together with a range of topics contained within other themes.

Between Navigation and Other Sea Uses, all uses of the estuary navigation are considered, and this assessment is taken on through the Communities topic to give the "end-user" effect; i.e. the effect on the relevant sectoral receptor, specifically the ports, marine aggregates industry or tourism. In a similar way, the indirect effects on the power generation industry and marine waste disposal sectors are considered through Communities as employment effects.

Noise & Vibration provides the Communities topic with data enabling a judgement on the scale of direct effect upon the local population linked with the physical proximity of the options to local population receptors. This is considered alongside contributions from other parts of the SEA (such as Landscape & Seascape and Air & Climatic Factors), allowing a judgement on the cumulative effects of any of the options upon the identified population receptors.

Many of the interrelationships between the Society & Economy theme and other themes are also the function of the transfer of information at different stages in the assessment process as a result of the organisation of the SEA topics. Being the end-point in terms of a pathway of inter-related physical and biological effects, the Society & Economy theme is informed by most of the other topics in some way.

The Physicochemical theme supplies the basic building blocks in terms of predicting the water level sediment transport and water quality changes associated with all five alternative options. The

changes predicted are in turn used by the Navigation and Other Sea Uses topics to predict how the receptors contained within their respective topic areas will be affected.

Navigation through the estuary is determined by a range of elements, most importantly the water depth, currents and velocities. Data on water levels, water velocity and sediment movement from the H&G topic; and data on salinity, an important determinant for buoyancy, from the Marine Water Quality topic was essential for interpreting the operational effect on Navigation.

Receptors within the Other Sea Uses topic are subject to a range of physicochemical processes, simply because of their location within the estuary; for example, buried cables and pipelines which are subject to either sediment deposition or scour; marinas for smaller or recreational vessels and tourist beach destinations both of which could be affected by changes in the estuarine sediment regime. Other receptors have been sited within the estuary specifically to take advantage of conditions therein; examples of this include marine waste disposal – either in the form of outfalls or dredging disposal grounds taking advantage of the dilution and dispersal opportunities offered by the dynamic estuarine environment. Again, the assessment of the effects on the receptors utilised modelling output from both the H&G and Marine Water Quality topics.

Data from the Physicochemical theme (Flood Risk & Land Drainage topic), Landscape & Historic Environment theme and Air & Climatic Factors, Resources & Waste theme directly inform the assessment of health and quality of life effects for the Communities topic MSOA receptors. This topic also informs the Freshwater Environment & Associated Interfaces topic in terms of changes in soil water content/waterlogging, which in turn informs the operational land-use assessment within the Communities topic.

Within the Biodiversity theme, the Migratory & Estuarine Fish topic has undertaken extensive work to investigate and assess the likely significant effects of the alternative options upon the fish populations within the estuary. This in turn supports the assessment of effects upon both commercial and recreational fishing activities.

Effects on wildlife tourism and recreation considered in the Other Sea Uses and Communities topics are reliant on the information on designated sites, habitats and species provided by the Biodiversity theme topics; together with the information from the Landscape & Historic Environment theme on the landscape and heritage functions of recreational areas and of the estuary as a whole. There are also links between the Terrestrial & Freshwater Ecology topic and Communities topic with respect to landuse effects.

The Resources & Waste topic shares information with the Other Sea Uses topic in relation to marine aggregates dredging and marine waste disposal. The construction phase of the alternative options will in every case increase demand for dredged aggregate; and in operation may affect the accessibility of any remaining supply and of existing disposal grounds.

### **Measures to Prevent, Reduce and as Fully as Possible Offset any Significant Adverse Effects**

The identification of measures necessary to prevent or reduce effects, and more detailed consideration of engineering design requirements, was carried out as the outputs of studies undertaken during the SEA became available. For example, measures include:

- Operational management of barrage and lagoon/regime
- Freshwater and seawater level management
- Permanent works for dredging and sedimentation management
- Re-routing of drainage channels/outfalls
- Adjustment to locks (both in structure and at ports)
- Minor alignment adjustments to mitigate access issues

- Location of material sources
- Adjusting on-shore working locations/compounds
- Modification to port infrastructure (such as altering dock levels)
- Topographic Modification

A summary of the measures proposed within the Society & Economy theme is provided in this paper. Detail of specific measures relating to specific topics can be found in the relevant topic paper.

### **SEA Objective Compliance**

The SEA Objectives were drafted and consulted upon as part of the Phase 1 SEA scoping stage. This theme paper identifies any interactions or inconsistencies between topics within this theme with regards to the assessment against SEA Objectives. The assessment against SEA Objectives assumes that measures identified to prevent or reduce adverse effects are in place.

The majority of the SEA Objectives identified for the Society & Economy theme score neutrally in terms of performance. There are some exceptions, where an option either performs positively or negatively with regard to an Objective. These are as follows:

*Objective SE1: To create employment opportunities accessible to all*

All alternatives will create local employment opportunities accessible to all, with B3 and L3d generating significantly more employment during construction and operation than L2, B4 and B5.

*Objective SE2: To avoid adverse effects on the local and regional economy*

B3 is expected to have adverse effect on the Severn Estuary ports, on salmon and sea trout tourism fishing; on heritage (elver) fishing; and on tourism at Brean Beach and Lavernock Point. B4, B5, L2 and L3d are expected to have adverse effects on salmon and sea trout tourism fishing and on heritage (elver) fishing. The fishery effects are not readily mitigable.

*Objective Nav2: To avoid adverse effects on the integrity of existing and proposed port operations*

An increase in total transit time is expected for vessels navigating through the lock structures of the B3, B4, B5 Barrages and L3d Lagoon.

*Objective OSU1: To avoid adverse effects on the aggregate extraction industry*

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, 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 very close 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.

*Objective OSU3: 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. As a result, 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.

*Objective OSU4: 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. In addition, 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.

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).

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

*Objective OSU 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. Because of this, all the barrage options score a major negative performance against the SEA Objective.

## **Implementation**

Monitoring suggestions for the Society & Economy theme include:

- Ports employment
- Mean rod catches
- Noise and vibration
- Air quality
- Traffic movement
- Peak water velocities post construction
- Tide level post construction
- Sediment deposition both within the estuary navigation and in marinas
- Transit time (pre and post construction)
- Cross shore profile changes and sediment types
- Microbial and physicochemical parameter of bathing waters (e.g. at Weston-super-Mare)
- Re-assessment/ monitoring of the physicochemical and biological characteristics of the water-column/ seabed at existing waste disposal sites as well as changes to constituent fluxes.

A number of further studies are suggested to support the development of Severn Tidal Power, should the decision be to proceed:

- 
- Further modelling work would be needed to improve and refine the model for the following:
    - the velocity predictions near the turbine blocks;
    - sediment flux within the study area.
  - Modelling to understand the implications for the Severn Bore from lagoon construction
  - Modelling analyses of the risk of morphological change factors such as water depth, waves and sediment supplies to determine the implications for pleasure beaches from the development of STP options
  - 3d modelling of the implications for power station thermal plumes from the development of STP options
  - Monitoring of the baseline noise environment in order to quantify the underwater noise environment.
  - Collection of data on the economic contribution and direct and indirect employment generation of salmon and salmon trout fishing on the rivers Usk, Wye and Severn.
  - Study on shipping transit times within the estuary.



SECTION 1

## **INTRODUCTION**







## 1 INTRODUCTION

### 1.1 Background

1.1.1 The Government announced a two-year feasibility study on harnessing the renewable energy from the tidal range in the Severn Estuary in January 2008. This work is being carried out by a cross-Government team led from the Department for Energy and Climate Change (DECC), including representatives of the Welsh Assembly Government (WAG) and the South West Regional Development Agency (SWRDA), taking external advice as necessary and engaging stakeholders and the wider public. The aim of the Severn Tidal Power (STP) Feasibility Study is to investigate whether Government could support a tidal power scheme in the Severn and, if so, on what terms.

1.1.2 Any project to generate power from the tidal range of the Severn Estuary will need to meet the following objectives:

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

1.1.3 The Feasibility Study has been split into two phases:

- Phase One: Examining the scope of work and analysis required to make an evidence-based decision on whether to support a tidal power project in the Severn and what potentially feasible schemes exist for converting this energy. Phase one ended with the publication of the consultation document in January 2009.
- Phase Two: Work on environmental, regional, economic, commercial, technical and regulatory issues to inform the study conclusions including whether any of the potential schemes are feasible. This is the current stage.

### 1.2 Purpose of the SEA

1.2.1 A Strategic Environmental Assessment (SEA) is being carried out in support of the Feasibility Study, in accordance with EU Directive 2001/42/EC (the SEA Directive), implemented in England and Wales through the Environmental Assessment of Plans and Programmes Regulations (SI 2004/1633 and Welsh SI 2004/1656), to predict and analyse the environmental effects of alternative short-listed Severn tidal power options over their entire lifetime, in order to inform decision making at the end of the Feasibility Study.



### 1.3 Purpose of the Theme Papers

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

1.3.2 The theme papers therefore summarise the interrelationships between related topics (see Table 1.1 below) and thereby ensure that the many complex issues that are not self-contained within a given topic are recognised and their implications understood. This approach emerged from the SEA scoping phase to allow related topics to interact and interface more effectively. Each theme paper also examines the interrelationships between this theme and other themes within the STP SEA.

**Table 1.1 SEA themes and topics**

SEA Theme	SEA Topics
Physicochemical	Hydraulics & Geomorphology Marine Water Quality Freshwater Environment & Associated Interfaces Flood Risk & Land Drainage
Biodiversity	Marine Ecology Waterbirds Migratory & Estuarine Fish Terrestrial & Freshwater Ecology
Landscape & Seascape and Historic Environment	Landscape & Seascape Historic Environment
Air & Climatic Factors and Resources & Waste	Air & Climatic Factors (including Carbon Footprint) Resources & Waste
Society & Economy	Communities Navigation Other Sea Uses Noise & Vibration

1.3.3 Furthermore, the theme papers will also assist the Environmental Report to meet the requirements of the SEA Directive by collating the difficulties (such as technical deficiencies or lack of know-how) encountered in compiling the required information (SEA Directive Annex 1 (h)).

1.3.4 The theme paper provides an integrated summary across the theme, drawing on information presented in its topic papers. Each theme paper presents a review of the environmental baseline and considers the environmental effects for the topics within this theme, taking into account the interrelationships between them and identifying difficulties in compiling the information and uncertainties in the assessment. However, no substantive analysis is undertaken within each theme papers that is not already contained within its topics.

1.3.5 Each theme paper also considers the likely significant effects on the environment of the variations of alternative options referred to as combination and multiple basin options.



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- 1.3.6 The focus of the Society & Economy Theme is the human environment. This paper therefore describes the environment from the human perspective and focuses on the activities of the human population around the Severn Estuary and how the alternative options might affect those activities through the environmental changes described, both in terms of the topics listed above and topics grouped in other themes.



SECTION 2

**APPROACH**





## 2 APPROACH

### 2.1 Overall approach adopted in the SEA

2.1.1 The assessment process involved the collection of information and the development of SEA objectives, definition of alternatives and identification of significant environmental effects. Measures to prevent, reduce and as fully as possible offset significant adverse effects on the environment were developed, and proposals reviewed in the light of identified significant environmental effects. A more detailed description of the purpose of each SEA task and the STP SEA approach is given in the SEA Environmental Report (STP, 2010b)

### 2.2 SEA Objectives

2.2.1 SEA Objectives are a recognised tool for comparing alternative options. SEA Objectives, and associated assessment criteria and indicators were drafted and consulted upon as part of the Phase 1 SEA scoping stage. The Government response to the consultation for the most part confirmed the SEA Objectives and in some cases made some minor modifications (DECC, 2009b).

2.2.2 The SEA Objectives for this theme, as amended in response to the Scoping consultation, are set out in Table 2.1.

**Table 2.1 SEA Objectives within Society & Economy Theme**

Topic	SEA Objective
<i>Communities (formerly Society and Economy)</i>	
SE.1	To create employment opportunities accessible to all.
SE.2	To avoid adverse effects on the local and regional economy.
SE.3	To promote the development of sustainable communities.
SE.4	To avoid adverse effects on physical and mental health.
SE.5	To avoid adverse effects on access to community services and facilities.
SE.6	To promote access to recreational facilities and open space <i>(revised to improve coverage of non-estuary tourism related issues)</i>
SE.7	To avoid adverse effects on existing, proposed and committed land uses.
SE.8	To seek opportunities to improve degraded environments.
SE.9	To avoid adverse effects on the housing market.
<i>Noise &amp; Vibration</i>	
NV.1	To avoid adverse effects of negative noise and vibration on (humans) noise sensitive receptors.
NV.2	To avoid adverse effects on the acoustic quality of the marine environment.
NV.3	To avoid adverse effects on noise (vibration) sensitive receptors.
NV.4	To avoid adverse effects through vibration.
<i>Other Sea Uses</i>	
SU.1	To avoid adverse effects on the aggregate extraction industry.
SU.2	To avoid adverse effects on marine waste disposal sites and

Topic	SEA Objective
	infrastructure.
SU.3	To avoid adverse effects on the commercial fishing industry.
SU.4	To avoid adverse effects on marine recreational users.
SU.5	To avoid adverse effects on sustainable estuary-based tourism in both the South Wales and South West England Regions.
SU.6	To avoid adverse effects on military activity in the region.
SU.7	To avoid adverse effects on the energy industry.
SU.8	To avoid adverse effects on seabed cables in the region.
SU.9	To minimise adverse effects on the Severn Bore ( <i>new objective, Severn Bore will be assessed within the 'Hydraulics and Geomorphology' topic and is also relevant in relation to 'Landscape and seascape'.</i> )
<i>Navigation</i>	
N.1	To avoid adverse effects on Severn Estuary Navigation arising from sedimentation, geomorphology, water density, and water levels.
N.2	To avoid adverse effects on the integrity of existing and proposed port operations.

## 2.3 Alternative Options for Tidal Power

2.3.1 At the beginning of Phase 2, five alternatives for the development of tidal power using the tidal range of the Severn Estuary were identified as the preferred candidates for more detailed study. The five options comprise three tidal barrages and two tidal lagoons (STP 2009d). These alternative options and key parameters associated with alternative options are set out in Table 2.2.

**Table 2.2 Alternative options**

Alternative	Location	Length (approx)	Operating mode	Turbine type	No. turbines	Annual energy output	Caissons	Locks
B3: Brean Down to Lavernock Point Barrage (also known as Cardiff to Western)	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	28km	Ebb only	Bulb	40 (25MW)	2.6 to 2.8 TWh/year	32	1





Alternative	Location	Length (approx)	Operating mode	Turbine type	No. turbines	Annual energy output	Caissons	Locks
	Crossing							
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

2.3.2 Variations in the alternative options have also been considered. Whilst at this stage none of these constitute alternative options under the feasibility study, initial consideration has nonetheless been given to their potential effects. The variations considered included multiple basins and combinations of the five short-listed alternative options. Multiple basin variants are configured with the aim of providing continuous power to better align energy yield with peak demand.

2.3.3 Following an evaluation process (considering energy yield, costs, programme and opportunities for optimisation) one multiple basin and two combinations of options were identified for further high level review. These have not been considered to the same level of detail as the short listed alternatives. If any of the variations are found to have advantages over the alternatives, then further assessment would be required.

2.3.4 The multiple basin option variant identified for high-level consideration of environmental effects is a double basin version of the L3d Bridgwater Bay lagoon (with pumping).

2.3.5 Both of the potential combinations of options include the standard single basin L3d option, with the assumption that it would generate with an ebb/flood configuration. A combination of L3d (ebb/flood) with B3 Brean Down to Lavernock Point barrage (ebb only) were identified for consideration; as has a combination of L3d (ebb/flood) with B4 Shoots barrage (ebb only).

## 2.4 Technical studies within the theme

2.4.1 In general the topic assessments were based upon desk based study. This drew upon information from a range of sources including other topic papers, other work undertaken on behalf of the Feasibility Study Workstreams, publicly available data bases and informal consultation with stakeholders.

2.4.2 The scope of each topic was consulted on as part of the Phase 1 consultation; this included the receptors and likely significant effects anticipated. During the Phase 2 work receptors were refined in discussion with the Feasibility Study Environmental and Regional Workstreams.

2.4.3 The assessment of likely significant environmental effects considered direct, indirect, cumulative, and far-field effects that could occur during construction, operation or decommissioning of each alternative option. Consideration was also given to the potential for effects arising from consequential development. The significant effects identified in each of the Society & Economy Theme topic are summarised in Section 3 of this report.

2.4.4 Given the range of issues covered within this theme, each topic developed their own specific methodologies to enable them to assess effectively the likely effects within



the overall SEA framework. A summary for each is provided below. Detailed explanations of the methodologies applied are provided within each of the respective topic papers. An explanation of the overarching SEA framework is provided in the SEA Environmental Report (STP, 2010b).

### Communities

#### Receptors

- 2.4.5 The Communities topic has two main receptor groups. These are the local population and land use receptors, referred to as spatial receptors, and the economic sector activity, referred to as sectoral receptors.

#### Study Area

- 2.4.6 This broadly comprises the 12 estuarine Local Authority Districts (LADs) bordering the Severn Estuary and River Severn, from the Vale of Glamorgan in the west to Gloucester in the east on the north side of the estuary/river, and from West Somerset in the west to Stroud in the east on the south side.

- 2.4.7 Within this geographic area, the study area was refined to the Middle Layer Super Output Areas (MSOAs) to ensure the coverage of more localised socio-economic aspects. The MSOAs have a minimum population size of 5,000 persons (7,500 average). This refinement provides better resolution of the populations likely to be affected by the physical presence of an option. MSOAs were selected as these enable the identification of a consistent spatial unit on both sides of the estuary.

- 2.4.8 Two general approaches were elaborated to interpret and adapt the baseline information for the assessment of the Communities effects. The first required collation of local authorities' demographic and employment indicators to be able to assess key socio-economic issues. This includes Nomis data on employment, economically active, Job Seekers Allowance (JSA) subscriptions and employment rates by gender. The 2017 employment estimates applied National Statistics LAD project population growth rates to the LAD "in employment" estimates (i.e. employment expanded as per projection population growth). This data was then used as a basis for assessing the various employment linked effects anticipated for each option.

- 2.4.9 The second approach cross-referenced GIS databases collated for the SEA against the "physical impact" study area. This study area takes in the MSOAs falling within a physical impact buffer based around the landfall positions for each option. By cross referencing the GIS against these study areas it was possible to gauge the extent of the potential physically affected populations for each option.

- 2.4.10 Like many topics, the Communities paper draws on the findings of a large number of other papers from within the SEA and also from other studies within the Feasibility Study, notably the Regional Economic Impact Study (REIS) Update (STP Regional Workstream, 2010), the Supply Chain Study (DECC, 2010) and the Options Definition Report (ODR) (STP, 2010a).

#### Navigation

- 2.4.11 The receptors included within the navigation topic comprise the main Port and Harbour Authorities which would be impounded by one or more of the STP options



and hence which could be significantly affected by changes to the environmental conditions in the estuary. These have been identified to be:

- Bristol Port Company, comprising Portbury and Avonmouth Docks at the Port of Bristol
- Associated British Ports, incorporating the commercial ports of Cardiff and Newport
- Gloucester Harbour Trustees, comprising Sharpness Dock and the Gloucester Sharpness Canal which links Sharpness Dock with Gloucester Docks and the rest of the inland waterway system
- Port of Bridgwater, comprising Dunball Wharf and Combwich Wharf accessed from the River Parrett.

2.4.12 The scope of the Navigation topic comprises consideration of direct and indirect changes that alternative options for tidal power generation may bring about to navigational conditions in the Severn Estuary, with particular regard to:

- Tidal water levels
- Water velocity
- Mud and sand transport
- Morphological evolution
- Water density
- Transport and transit times
- Construction related navigation issues.

2.4.13 The potential effects of the alternative STP options on current environmental conditions experienced within the Severn Estuary is assessed based on the results of the modelling undertaken by Black and Veatch, HR Wallingford and ABPmer within the Physicochemical theme (Hydraulics & Geomorphology topic (STP 2009c) and Marine Water Quality topic (STP 2010j). Data regarding current port operations was sourced through direct consultation with the main Port and Harbour Authorities.

2.4.14 The potential effects of changes to the current tidal regime, salinity and changes to bed level on navigation have been determined by analysing the total available depth of water against vessel draught and additional clearance requirements. The data illustrates the number of tides within a typical year which reach selected tidal levels for different durations at the entrance to each of the main ports. The analysis indicates the percentage of vessels which would be affected by a change in tidal levels, increase in draught, or change in available depth of water. However, the overall magnitude of effect has been derived from considering the minimum depth of water required by the vessel of largest draught which can currently navigate into the impounded docks of each port. This methodology not only provides a worst case scenario, but it also accommodates for the future baseline scenario whereby the percentage of larger vessels may increase whilst remaining within the current size limitations presented by the impounded docks.



### Other Sea Uses

2.4.15 The Other Sea Uses topic examines effects on a range of receptors reliant on the normal functioning of the Severn Estuary to operate. These include:

- Aggregate Extraction
- Marine Waste Disposal Sites and Infrastructure
- Marine Recreational Users (including bore surfing)
- Marine and Coastal Rescue Organisations
- Sustainable estuary-based tourism in both the South Wales and South West England Regions
- Military activity
- Energy Industry
- Seabed cables and Pipelines

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

- The Marine Ecology topic (Severn Tidal Power, 2010i)
- The Waterbirds topic (Severn Tidal Power, 2010q)
- The Resources and Waste topic (Severn Tidal Power, 2010p)

2.4.17 Expert judgment was then applied to interpret how the 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.

### Noise & Vibration

2.4.18 The Noise & Vibration topic study area was defined on a geographical basis (as noise spreads geographically from a noise source). A study area of 2km was considered sufficient for the purposes of the assessment of significant noise effects. The topic considered both underwater and land-based noise effects.

2.4.19 Noise and vibration has the potential to affect people, wildlife and in extreme cases buildings. The potential effects range from mild irritation to structural damage. Describing receptors and assessing their sensitivity in the manner prescribed under the SEA Objectives is necessarily complex.

2.4.20 On land, receptors have been summarised as either residential, or non-residential. This is due to the way in which noise affects the residential environment more in the evening and night, and non-residential receptors (schools, hospitals, workplaces,



open air amenities etc.) are generally more affected during the daytime. This definition does not extend to the marine receptors.

- 2.4.21 This topic has used the following data collection and assessment methods.
- A literature review in order to identify the availability of information relative to tidal technology & underwater noise levels.
  - The number of sensitive receptors that will be affected by noise & vibration associated with the alternatives will be identified using the landfall footprint of the proposals;
  - Estimation of the number of properties to significant levels of noise & vibration in line with guidance and codes of practice for each option;
  - Identification of areas where noise & vibration increases could require measures to prevent or reduce adverse effects;
  - Identify buildings likely to be exposed to perceptible vibration as a result of the alternatives
- 2.4.22 Professional judgement was then applied in determining the significance of the noise and vibration effect upon the receptors.
- Difficulties encountered
- 2.4.23 The Study is strategic in nature and consequently so are the methods used to predict effects. Some uncertainty is therefore carried through the assessment, from the project assumptions made, to the specific modelling parameters used. General difficulties (such as technical deficiencies or lack of know-how) encountered include:
- 2.4.24 The nature of the environmental assessment means that any uncertainty arising in the hydraulics and geomorphology assessment is carried through to other topics within the physicochemical theme and also on to subsequent topics reliant on use of that information for their assessment.
- 2.4.25 Inevitably given the long time periods involved, for the future baseline predictions, the nearer term predictions are more certain than estimations into the future. Therefore the baseline during the construction phase has greater certainty than that during the operational life of a scheme.
- 2.4.26 Lack of information for some areas has by necessity been filled through the use of case studies, preferably of analogous projects. Where this has not been possible, assumptions have been derived and tested through the technical workshop process or a data gap is recorded.
- 2.4.27 Specific key difficulties encountered within the Society & Economy theme topics are summarised below. For a full description of assumptions, limitations and uncertainties relating to the Society & Economy theme topics please refer to the relevant topic paper.



### Communities

- 2.4.28 The REIS Medium Impact scenario (DTZ, 2009) used for the ports employment assessment is a scenario but is considered to be the best indicator of effect at the present time. Likewise for the “Reasonable Growth” scenario adopted from the REIS Update work (STP Regional Workstream, 2010) as the basis for the ports’ future baseline. These effects are assumed to be independent of navigation effects.
- 2.4.29 The long term baseline (2020 – 2140) for Atlantic salmon and sea trout reported in the SEA Migratory and Estuarine Fish Topic Paper shows substantial declines in modelled mean rod catches in the rivers Usk, Wye and Severn under each of the four different climate change assumptions adopted. The Communities Topic Paper assumes Atlantic salmon and sea trout fishing supported employment is directly dependent upon fish catches in each of the three rivers and the assumption made is that employment levels will vary with catch levels.
- 2.4.30 There is uncertainty about the climate change assumptions adopted in the modelling of future mean rod catches of Atlantic salmon and sea trout. The Communities Topic Paper adopts the best case assumption whilst recognising that the adverse effect could be greater than the case used as the basis for employment projection

### Navigation

- 2.4.31 The assessment of effects from short term sediment deposition assumes that the majority of deposition will occur within a neap-spring-neap cycle after impoundment and that the Barrage would be completed at an instant in time. In reality, the rate and distribution of sediment deposition is largely dependent of the construction methodology and phasing.
- 2.4.32 Whilst the complex nature of the Phase 2 H&G modelling allows extensive analysis of potential effects to water velocities within the estuary, the sensitivity of the model can affect results in close to specific features, such as close to the turbine blocks or close to land forms. Only data regarding peak water velocities has been used to inform the assessment, whereas in reality vessels may not typically navigate during the state of the tide when these peak velocities occur. Further detailed analysis is suggested should STP be developed further to determine accurately potential changes to water velocities at different states of the tide and in particularly sensitive locations.
- 2.4.33 Potential effects to transit time through the lock structures are based on qualitative assessment only as the nature of the effect is highly dependent on the size of vessel, the state of the tide, the operation of the lock gates and the coordination of vessels at the lock structure. It is suggested that further quantitative assessment is undertaken should STP be taken forward, once these factors are more clearly defined.

### Other Sea Uses

- 2.4.34 Predictions of long-term morphological changes of the Estuary have been used to help predict some of the possible affects 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).



- 2.4.35 The modelling output from the hydraulics and geomorphological topic papers does not permit the identification of spatial and temporal changes in intertidal sediment type. Accordingly, it is not possible to identify which (if any) sandy pleasure beaches may become muddier following the development of each tidal power option. Similarly, it is not possible to determine the ongoing spatial extent and magnitude of sediment 'mixing' at the aggregate sites during the operational phase. (A more mixed sand/mud resource may incur additional expense to process).
- 2.4.36 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 considered likely that the barrage options will all prevent the formation of the Severn Bore, more detailed modelling analyses are required to confidently address the impact from the lagoon options.
- 2.4.37 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.

#### Noise

- 2.4.38 The most significant issues relating to the noise and vibration assessment is the lack of information available. Particularly this applies to:
- The underwater baseline environment;
  - Manufacturers information relating to the underwater turbines required for the options; and
  - Previous tidal power schemes (e.g. La Rance); these have not included an assessment of the effect of the noise associated with the scheme. They therefore have not produced an underwater noise impact assessment.

## **2.5 Consultation**

- 2.5.1 Both the Feasibility Study and the SEA within it have included a programme of formal consultation and opportunities for informal comment. These include the public consultation exercise in early 2009, technical workshops during both Phase 1 and 2, dialogue with key stakeholders and other communications. These are detailed in the topic papers and summarised in the SEA Environmental Report (STP, 2010b).





SECTION 3

**SOCIETY & ECONOMY BASELINE  
ENVIRONMENT AND SIGNIFICANT EFFECTS**





### **3 SOCIETY & ECONOMY BASELINE ENVIRONMENT AND SIGNIFICANT EFFECTS**

#### **3.1 Introduction**

3.1.1 This section summarises the current state, characteristics and evolution of the environment without an STP option for the topics within this theme.

3.1.2 This section also considers, within this theme, the likely significant effects on the environment for each alternative option and the interrelationships between these effects (SEA Directive Annex 1 (f)). These effects may arise from direct, indirect, far-field, cumulative and consequential development effects during construction, operation and decommissioning phases and may include secondary, cumulative, synergistic, short, medium and long-term permanent and temporary, positive and negative effects (SEA Directive Annex 1 (f)).

3.1.3 This section also considers the difficulties encountered in compiling the required information (SEA Directive Annex 1 (h)) and the level of certainty in the assessment of effects.

#### **3.2 Current state, characteristics and evolution of environment**

3.2.1 Baseline information provides the basis for predicting and monitoring environmental effects. Alternative options considered within this Feasibility Study would only be developed several years into the future and would have a long life. It is therefore necessary to project a 'future baseline' against which to compare effects, rather than using the present day baseline.

3.2.2 The focus of the Society & Economy Theme is the human environment. This paper therefore describes the environment from the human perspective and focuses on the activities of the human population around the Severn Estuary and how the alternative options might affect those activities through the environmental changes described, both in terms of the topics listed above and topics grouped in other themes.

3.2.3 Historically, the area around the estuary has also been a focus for industrial activity, particularly in the past 200 years, with developments including the steelworks at Llanwern, power generation at Aberthaw, Uskmouth, Hinkley and Oldbury, and chemical works at Barry. Concentrations of industrial activity were also developed around the ports, including Avonmouth, Barry, Bristol Cardiff, Newport, Portbury, and Sharpness.

3.2.4 Whether this industry attracted population, or was located to population centres in response to the advantages leant by existing road, rail and other infrastructure is moot from the perspective of describing the existing baseline for this study. What is important is the legacy of this industrial history on the human environment. It has resulted in an environment of conflicts and contrasts, with both active and declining industrial sites situated both adjacent to and within clear view of expanses of agricultural land, salt marsh and intertidal mud flats, conservation designations and public access routes. Against this, there remains the backdrop of the estuary itself from the broad expanses of the upper Bristol Channel at the western end of the study area to the more riverine Tidal River Severn sections towards Newnham in Gloucestershire.



Baseline environment (up to 2009)

- 3.2.5 The study area for the Society & Economy topics starts with the twelve local authority districts bordering the estuary and river from the Vale of Glamorgan to Gloucester on the north side and from Stroud to West Somerset on the south side of the river/estuary. From the Phase 1 work undertaken, none of the options is expected to affect communities bordering the River Severn above Gloucester, and none of the options is expected to affect communities bordering the Bristol Channel to the west of the Vale of Glamorgan on the Welsh side or west of West Somerset on the English side of the estuary.
- 3.2.6 The area around the estuary is largely rural, with concentrations of population around the urban areas of Barry, Cardiff, Newport, Chepstow, Gloucester, Sharpness, Bristol, Avonmouth, Weston Super Mare and Bridgwater. The rural areas include large swathes of the low-lying land around the estuary (the Gwent and Somerset Levels on the Welsh and English sides of the Severn Estuary respectively) and are largely given to agricultural use.
- 3.2.7 The proximity of these areas to the aforementioned urban areas elevates their importance in terms of tranquillity and recreational access, providing as they do locally accessible “wild” areas away from the urban centres. For example, the Newport Wetland Reserve managed by RSPB.
- 3.2.8 In Wales the MSOAs with the highest percentage of the most deprived ten percent in Wales, for access to services deprivation, are located outside of the study area. In SW England access deprivation has increased within the region between 2000 and 2007 for a number of services. Within the study area the local areas (MSOAs) suffering relatively high deprivation are concentrated in Cardiff and Bristol, with pockets of deprivation in Newport, Gloucester, North Somerset and Sedgemoor.
- 3.2.9 In terms of access to recreation and tourism, a wide range of recreational activities occur throughout the study area, including walking (e.g. the ongoing development of the All-Wales Coastal Path, Offa’s Dyke Path and the Severn Way), boating, bathing, wildfowling, bird watching and fishing. Specific examples include Cosmeston Lakes, Newport Wetlands Reserve, Brean Down, Flat and Steep Holm and the rivers Usk and Wye. The Glamorgan Heritage Coast extends west from the Vale of Glamorgan side of the study area; there are a further two Heritage Coast designations in the proximity (The Gower and Exmoor).
- 3.2.10 Historically Wales was considered a country of mining and heavy industry, but the economy is now more diversified with growth in many sectors, including manufacturing; electricity, gas and water supply; wholesale and retail trade; hotels and restaurants; and real estate, renting and business activities. The key business sectors in the South West of England are primarily service-based industries, with the fastest growing being business services, other services, education, and hotels and catering.
- 3.2.11 Tourism is one of the largest employment sectors in the Severn Estuary. Each year over 7.5 million visits are made to Somerset, Avon and South East Wales by UK residents alone, together bringing over £1billion to the region. Employment in tourism exceeds 70,000 in the Study Area and accounts for over 7% of total employment and generates 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.



- 3.2.12 Within the Study area over 45,000 persons are employed in construction, some 5% of the total workforce.
- 3.2.13 The ports and especially the Port of Bristol are also important economic activities employing around 6,000 including indirect employment in port service industries such as transport services. The marine aggregates industry (another important Severn Estuary activity) employs an estimated 1,100 persons in the Study Area. Commercial and other employment generating fishing and angling employs relatively few persons, estimated to be less than 100.
- 3.2.14 Access to the ports is tidally restricted, with water levels within the ports (apart from Bridgwater) being contained by lock gates and controlled by impounding pumps. Navigation to the ports is often reliant on the incoming high tides and the lock gates to the ports are usually only operated for a few hours on either side of the high tide.
- 3.2.15 Ship movement data gathered from the ports indicates that they receive approximately 4,200 commercial vessels each year, with daily averages ranging between 7 and 15 vessels per day.
- 3.2.16 Pilotage to the main commercial ports within the estuary is compulsory for the majority of large vessels. The pilot station for the ports is located at Barry. A summary of the number of vessels typically received by each port each year, the maximum size of vessel which can be received and the transit time required to navigate the largest vessels from the pilot station into the impounded docks is provided in Table 3.1 below.

**Table 3.1: Summary of shipping data and transit time estimates provided by the Port & Harbour Authorities**

Port	Annual vessels received (no.)	Maximum size of vessel				Transit time
		Length (m)	Beam (m)	Draught (m)	Deadweight tonnage (tonnes)	
Bristol (Portbury)	800	300	41.0	14.5	130,000	2 – 2½ hrs
Bristol (Avonmouth)	900	210	30.0	11.0	35,000	2 – 2½ hrs
Cardiff	1100	198	27.0	10.37	35,000	1 – 2 hrs
Newport	1120	244	30.1	10.5	40,000	1½ - 2 hrs
Sharpness	160	140	16.5	6.5	10,000	3 – 3½ hrs
Bridgwater	35	-	-	3.0-5.5	-	-

- 3.2.17 Marine aggregate extraction is currently licensed at 10 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.
- 3.2.18 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 available dilution and dispersion provided by the high tidal range. In addition a number of power stations abstract and discharge large volumes of cooling water from/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.
- 3.2.19 A small number of telecommunications cables enter the Bristol Channel from the Atlantic. A number of cables come ashore at Oxwich Bay and at Brean Down.
- 3.2.20 There is limited military activity in the study area with an underwater explosives site near Weston-super-Mare, naval activity west of Bridgwater Bay and a military practice area near Redwick.
- 3.2.21 The study area is made up of a combination of urban and rural areas, with a mixture of residential, industrial and commercial uses. The noise climate is varied, transportation noise and industrial being the largest noise producers. The closer a receptor is to these sources, the more they will be affected by noise. Conversely, the further a receptor is from these noise sources, the less they will be affected by noise. Residential dwellings are the most sensitive to noise, particularly at night where it is desirable to prevent sleep-disturbance.
- 3.2.22 The Severn Estuary is an active natural estuarine environment with strong tidal changes (having the second largest tidal range in the world) moving large volumes of water. It is also a relatively busy commercial shipping channel and has a number of leisure and fishing vessels using the area.
- 3.2.23 Underwater noise in the estuarine environment is fairly local in nature as the water is too shallow to support long range propagation. Noise sources include impact noise (breaking waves and water hitting solid surfaces such as rocks); bubble noise (noise generated through processes such as rain hitting the surface or breaking waves. The oscillation of these bubbles occurs in the range of 15Hz-300kHz); turbulent noise (generated by surface disturbance and in particular for the Severn estuary, tidal flow); seismic (generating low frequency noise by movement of the seabed); as well as biological and anthropogenic noise.
- 3.2.24 The resulting effect is that noise in the estuary will vary greatly with each contributing noise source. The noise sources can be continuous, intermittent or transient, and may vary with the tide, diurnally, weekly, monthly, seasonally or annually. These variables are infinite, resulting in great uncertainties in prediction.
- 3.2.25 *Future baseline during construction (2014-2020), operation (2020-2140) and decommissioning*
- 3.2.26 In general, dramatic changes to the land use around the estuary is not anticipated. Future land use across the area is guided by various Planning documents on one hand and existing land use is governed and guided by conservation designations on the other hand. Broadly, speaking, for Wales, this is led by the Wales Spatial Plan and the various Local Development Plans developed by their respective local authorities. Within South West England, the higher level planning document is the Regional Spatial Strategy, which informs the development of the Local Development Frameworks of the local authorities. Guided and governed by this framework, there are a number of known proposed developments likely to be completed by 2020, including the Severn Power development at the former Uskmouth A site.
- 3.2.27 The 2017 population in the study area is projected to be 2.2 million persons. Between 2017 and 2031 population growth is projected to continue at an average of 0.9%/year for the study area as a whole to a 2031 projected total of 2.5 million persons. There are no UK projections of future population beyond 2081.



- 3.2.28 Future noise sources contributing to the non-residential environment will result in changes of 1-3dB if the source of this noise increased in size significantly. Air quality in the potential construction period is predicted to be good, and is thought it will continue to be so at least until the early part of the operational period.
- 3.2.29 There will be little noticeable change to the landscape around the estuary with current land-uses continuing and major landmarks such as the bridges and power stations remaining unchanged. In the period beyond 2020, landscape change is likely to remain heavily related to development around the estuary.
- 3.2.30 Access within and around the estuary is not anticipated to alter dramatically, although it is likely that localised changes associated with development and economic fluctuations will take place. There exists a proposal for a Severn Sea Ferry to convey passengers between Welsh and English ports across the Estuary. This is planned to be operating as early as 2010/2011.
- 3.2.31 Between 2009 and 2020 tidal flood risk for the majority of properties will remain low. Where the risk of tidal flooding is higher and funding allows, properties are likely to receive improved protection through state (or private) intervention. In the operating period studies have shown that, if there was no active response, predicted sea level rise would cause flood risk to increase and lowland areas to suffer greatly increased flooding. However, it is assumed that state intervention through investment in flood defences and other flood management methods would be justified to mitigate the majority of this risk.
- 3.2.32 Given the relativistic nature of social and economic deprivation there will always be communities relatively worse off. What is unknown and cannot be predicted is whether the presently identified communities with high levels of deprivation will continue to be so in the longer term. They are assumed to be to 2020 but no assessment can be made into the more distant future.
- 3.2.33 Over the past 60 years the real growth in economic productivity in the UK has averaged 2.1%/year. If this continues into the future the local economies in the study area will grow at around 2%/year plus the growth in population. Extrapolating this out to 2140 will give huge but misleading estimates of future economic welfare and will ignore the effects of major future external impacts such as climate change. It will ignore also the impact on future incomes of meeting presently unforeseen spending commitments, private and public, and would give a very misleading idea of any level of future free resources. Whilst productivity improvements are expected to continue, in the absence of insight into future social and economic commitments it is not possible to assess the impact of future levels of income. For this reason it is not possible to project an economic baseline to 2140.
- 3.2.34 There are no direct official estimates of future employment numbers so we have used population growth projections to estimate future sector employment on the assumption that as local populations grow local economies and economic sectors expand broadly in proportion. This being the case tourism and construction employment in the study area is expected to grow around 9% up to 2017 and a further 60% to 2140.
- 3.2.35 The above method has also been applied to Marine Aggregates projected employment to 2017 and to 2140, although it is acknowledged that the Interim Marine Aggregate Dredging Policy 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..





- 3.2.36 Future employment in commercial and other employment generating fishing and angling is expected to continue at less than 100 throughout the period to 2140 with employment in salmonid tourism fishing declining over time in response to climate change placing pressures on the fish populations within the estuary and its tributaries.
- 3.2.37 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 will 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 and port approaches and channels need to be maintained for safety grounds.
- 3.2.38 Direct and indirect employment at the Severn Estuary ports (Bristol, Cardiff, Newport and Sharpness) is estimated at some 6,000 in 2008 growing to 6,200 in 2017 and 7,000 in 2047 (STP Regional Workstream REIS Update, 2010). There are no more distant employment estimates (i.e. beyond 2047).
- 3.2.39 UK shipping is forecast to grow as an economic, low carbon method of national and international trade. Through discussion with the main Port and Harbour Authorities it was confirmed that there would be capacity for growth within the ports within the vessel size limits which can currently be received. It is therefore predicted that shipping activity to the ports will increase during the operational period of the proposed STP option. This increase is likely to include an increase in the number of ship movements as well as an increase in the percentage of larger vessels entering the ports.
- 3.2.40 Current limitations to the maximum size of vessel which can enter the impounded docks of each port will remain unchanged and discussion with the main Port and Harbour Authorities confirmed that there are no known plans for development of existing infrastructure at each of the ports which would enable larger vessels to enter the ports. It is assumed that current restrictions to the size of vessel which can navigate through The Shoots, as defined by the New Severn Bridge (Restriction of Navigation) Regulations 1993, will not change.
- 3.2.41 The Bristol Port Company lodged a Harbour Revision Order with the DfT for the construction of a Deep Sea Container Terminal (DSCT) in July 2008 which would increase the size and number of vessels received by the Port of Bristol. However, at the time of writing the approval of the DSCT has not been made and the assessment has therefore been based on the limitations set by current port facilities. The potential implications of the DSCT are considered within the Cumulative Effects section of the Navigation and Communities topic papers and in the Phase 2 REIS (Regional Workstream, 2010).
- 3.2.42 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
- 3.2.43 Noise is considered a pollutant and unlike many other pollutants, noise is generally anticipated to continue to grow. In particular it is expected that transportation noise will grow, affecting receptors around major transportation routes. Whilst local changes may bring about isolated reductions in noise, e.g. the introduction of a by-





pass or the closing of an industrial facility the general trend for the study area is for noise levels to gradually increase over time.

- 3.2.44 Without an understanding of the current marine noise baseline environment, a future noise baseline cannot be suggested. However, with increasing populations, increasing affluence and increasing commercial shipping activity associated with the ports, increasing anthropogenic noise is likely to be the trend.

#### Longer Term Trends

- 3.2.45 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 and this is potentially beneficial to the tourism industry as well as marine recreational users.

### **3.3 Significant environmental effects of the Short Listed options**

- 3.3.1 This section considers, within this theme, the likely significant effects on the environment and the certainty of this assessment for each alternative option and the interactions between these effects. The full methodology for identifying these significant environmental effects is set out in the Environmental Report.
- 3.3.2 Consideration has also been given to the potential effects of combination options and multiple basin options although this has not been subject to the same level of detailed assessment as the individual shortlisted options.

#### Communities

- 3.3.3 All of the Options are predicted to have adverse effects on resident populations in the vicinity of the landfall points, the affected MSOAs are indicated in Figure 3.1. . This will result from the cumulative effects of the general physical and visual disruption associated with a construction project of this scale. The effects are likely to include increased HGV traffic movements along the local road network, associated with this it is anticipated that there will be localised increase in noise effects and a reduction in air quality, which could be compounded through congestion at pinch points in the local road network. Overall this could have a detrimental effect upon the quality of life for those affected. This is anticipated to be significant for those affected by the B3, L2 and L3d Options (see Table 3.2). It is however, possible to reduce and in some cases prevent these effects from being realised; further explanation of how is given after the summaries below.

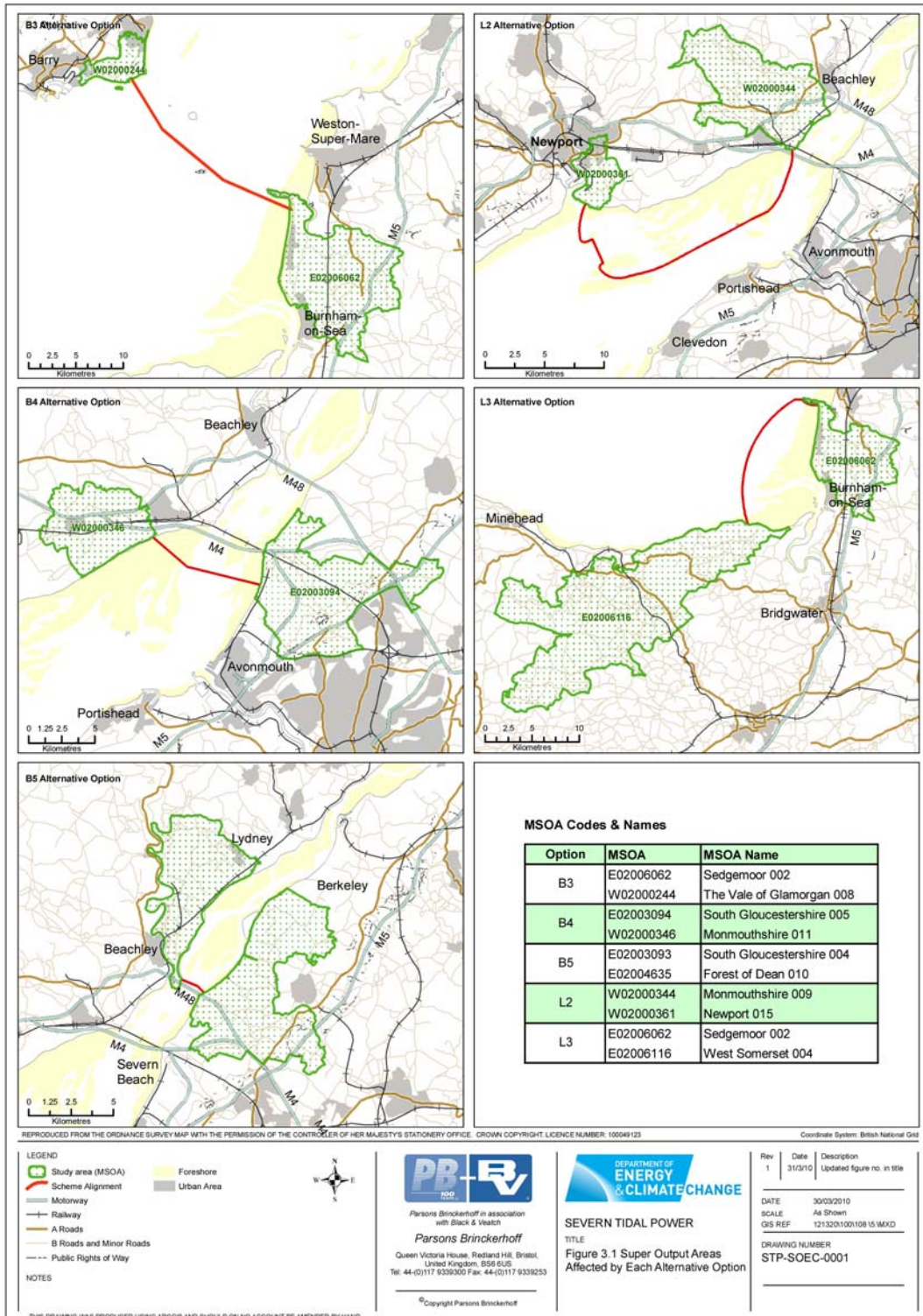


Figure 3.1: Middle Layer Super Output Areas (MSOAs) potentially affected by STP alternative options



- 3.3.4 Other significant effects result from the interaction of the significant effects noted in other topic papers with the sectoral receptors. This includes losses incurred in the natural fisheries (Migratory & Estuarine Fish topic STP, 2010k), changes in the conditions of navigation (Navigation topic, STP 2010l ) and disturbance of other estuarine activities (Other Sea Uses topic, STP 2010n).
- 3.3.5 In each case, whilst the numbers required for construction phase employment are large (ranging from 3000-10,000FTE depending on the Option) based on the experience of other major projects, there are not anticipated to be significant effects to the local population as a result. Further detail is provided in the Communities topic paper.
- 3.3.6 Table 3.2 summarises the significant environmental effects identified in relation to Communities for each option.

**Table 3.2: Summary of Significant Communities Effects for each Alternative Option**

Effect	Option				
	B3 Brean Down to Lavernock Point Barrage	B4 Shoots Barrage	B5 Beachley Barrage	L2 Welsh Grounds Lagoon	L3d Bridgwater Bay Lagoon
Construction Employment	Construction employment 7,500 – 8,500 FTE/year during 4 peak years of construction plus 750 – 1,000 FTE permanent operational employment.	Construction employment 2,000 – 3,000 FTE/year during 3 peak years of construction plus 100 – 200 FTE permanent operational employment.	Construction employment 1,500 – 3,000 FTE/year during 3 peak years of construction plus 80 – 100 FTE permanent operational employment.	Construction employment 3,000 – 4,000 FTE/year during 4 peak years of construction plus 120 – 180 FTE permanent operational employment.	Construction employment 4,000 – 6,000 FTE/year during 5 peak years of construction plus 200 – 300 FTE permanent operational employment.
Effects on Ports During Construction	Significant adverse effect of around 1,850 FTE being lost during construction and 4,200 FTE lost during operation				
Effects on Ports During Operation					
Effect on recreational / tourism fisheries employment.	Reduction in salmon and sea trout fisheries employment and heritage (elver) fisheries supported employment	Reduction in salmon and sea trout fisheries employment and heritage (elver) fisheries supported employment	Reduction in salmon and sea trout fisheries employment and heritage (elver) fisheries supported employment	Reduction in salmon and sea trout fisheries employment and heritage (elver) fisheries supported employment	Reduction in salmon and sea trout fisheries employment and heritage (elver) fisheries supported employment



Effect	Option				
	B3 Brean Down to Lavernock Point Barrage	B4 Shoots Barrage	B5 Beachley Barrage	L2 Welsh Grounds Lagoon	L3d Bridgwater Bay Lagoon
Effects on Marine Aggregates Industry	Relocation of Marine Aggregate dredging downstream of B3 may affect the dredging cycle and reduce activity and employment in the industry			Possible effects on Marine Aggregates dredging cycle for Bedwyn Sands and North Middle Ground extraction.	
Effect on tourism	The location of the B3 structure at Brean Beach and Lavernock Point is expected to have adverse effect on local tourism at each of these locations				The location of the L3d structure at Brean Beach is expected to have adverse effect on local tourism at this location.
Effect on health & quality of life	significant adverse effects on health and quality of life of the population of the Vale of Glamorgan 008 and Sedgemoor 002 MSOA			significant adverse effects on health and quality of life of the population of Monmouthshire 009 and Newport 015	significant adverse effects on health and quality of life of the population of the West Somerset 004 and Sedgemoor 002

### Navigation

- 3.3.7 During the construction and decommissioning phases of all of the STP options, the most significant risks are associated with navigational safety from construction activities and construction traffic. Deep water navigation channels and lock systems will enable vessels to navigate to the main commercial ports, but poor construction phasing and poor coordination of construction traffic could have a significant negative effect on the safety of vessels.
- 3.3.8 Table 3.3 summarises the significant environmental effects identified in relation to navigation for each option.



Table 3.3: Summary of significant Navigation effects for each Option

Effect	Option				
	B3 Brean Down to Lavernock Point Barrage	B4 Shoots Barrage	B5 Beachley Barrage	L2 Welsh Grounds Lagoon	L3d Bridgwater Bay Lagoon
<i>Construction Phase</i>					
Risks to the ability of vessels to navigate safely through the estuary	High negative effect to the ports of Bristol, Cardiff, Newport and Sharpness	High negative effect to Sharpness Dock, Low negative effect to the ports of Bristol, Cardiff and Newport;	High negative effect to Sharpness Dock, Low negative effect to the ports of Bristol, Cardiff and Newport	Low negative effect to the ports of Bristol, Cardiff, Newport and Sharpness	Low negative effect to the Port of Bridgwater, Very low to the ports of Bristol, Cardiff, Newport and Sharpness
Ability of vessels to navigate through the new navigation channel at low and mid tides	High negative effect to the Port of Bristol, Medium negative effect to the ports of Cardiff and Newport				
Increased transit time through lock structures	Low negative to the ports of Bristol, Cardiff, Newport and Sharpness	Low negative effect to Sharpness Dock.	Low negative effect to Sharpness Dock.		Low negative effect to the Port of Bridgwater
<i>Operational Phase</i>					
Increased transit time through lock structures	Medium negative effect to the ports of Bristol, Cardiff, Newport and Sharpness	Medium negative effect to Sharpness Dock	Medium negative effect to Sharpness Dock		
Reduced high water levels	High negative effect to the ports of Bristol, Sharpness and Bridgwater, Medium negative effect to the Port of Newport; Low negative effect to the Port of Cardiff		Medium negative effect to Sharpness Dock		High negative effect to the ports of Bridgwater and Sharpness, Medium negative effect to the ports of Bristol, Cardiff and Newport
Increased low water levels upstream of Barrage	Low positive effect to the ports of Bristol, Cardiff, Newport and Sharpness;				



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Effect	Option				
	B3 Brean Down to Lavernock Point Barrage	B4 Shoots Barrage	B5 Beachley Barrage	L2 Welsh Grounds Lagoon	L3d Bridgwater Bay Lagoon
Increased peak water velocities at sluice gates and turbine blocks	Medium negative effect to the ports of Bristol, Cardiff, Newport and Sharpness	High negative effect to Sharpness Dock;	High negative effect to Sharpness Dock		
Reduced peak water velocity throughout the estuary and Bristol Channel	Medium positive effect to the ports of Bristol, Cardiff, Newport and Sharpness				within the Lagoon: High negative effect to the Port of Bridgwater
Short term sediment deposition in navigation channels and immediate approach channels following completion of the Barrage	High negative effect to the ports of Bristol, Cardiff and Newport	High negative effect to Bristol Port, Very low negative effect to Sharpness Dock;	Low negative effect to Sharpness Dock		Short term sediment deposition within the Lagoon: High negative effect to the Port of Bridgwater
Long term morphological change in navigation channels and immediate approach channels	High negative effect to the ports of Bristol, Cardiff, Newport and Sharpness.	High negative effect to Sharpness Dock	High negative effect to Sharpness Dock	Long term morphological change in the Mid Severn: High negative effect to the Port of Bristol	Long term morphological change within the Lagoon: Medium negative effect to the Port of Bridgwater
<i>Decommissioning Phase</i>					
Risks to the ability of vessels to navigate safely through the estuary	High negative effect to the ports of Bristol, Cardiff, Newport and Sharpness;	High negative effect to Sharpness Dock, Low negative effect to the ports of Bristol, Cardiff and Newport	Low negative effect to the ports of Bristol, Cardiff and Newport	Low negative effect to the ports of Bristol, Cardiff, Newport and Sharpness	Low negative effect to the Port of Bridgwater, Very low to the ports of Bristol, Cardiff, Newport and Sharpness
Increased transit time through remaining lock structures	Low negative to the ports of Bristol, Cardiff, Newport and Sharpness	Low negative effect to Sharpness Dock.	Low negative effect to Sharpness Dock		
<i>Cumulative Effects</i>					
Risks to the ability of large vessels to navigate safely to the DSCT during the construction phase and decommissioning	High negative effect to the DSCT				

## SECTION 3



Effect	Option				
	B3 Brean Down to Lavernock Point Barrage	B4 Shoots Barrage	B5 Beachley Barrage	L2 Welsh Grounds Lagoon	L3d Bridgwater Bay Lagoon
phase					
Increased transit time through lock structures with additional movements to DSCT	Low negative effect to DSCT, Medium negative effect to existing impounded ports upstream of the Barrage				
Ability of large vessels to navigate through the new navigation channel from Lavernock Point lock following short term sediment deposition and long term morphological change	High negative effect to the DSCT, Medium negative effect to the Port of Bristol				
Short term sediment deposition and long term morphological change combined with reduced high water levels in approach channels	High negative effect to the ports of Bristol, Cardiff, Newport and Sharpness		Reduced high water levels combined with short term sediment deposition: Medium negative effect to Sharpness Dock Reduced high water levels combined with long term morphological change: High negative effect to Sharpness Dock.		Reduced high water levels combined with short term sediment deposition and long term sediment accretion: High negative effect to Bridgwater
Increased peak water velocities at sluice gates and turbine blocks	Medium negative effect to the DSCT				
Reduced peak water velocity throughout the estuary and Bristol Channel	Medium positive effect to the DSCT				



### Other Sea Uses

3.3.9 There are a range of significant environmental effects identified across the Other Sea Uses topic. The cause of the effects identified range from the presence of the physical structure of the option, to effects relating to changes in the tidal range and mean water level. Effects are also identified as a result of the potential changes to the sediment transport dynamics across the estuary.

3.3.10 The effects themselves range across the identified receptors and include

- Disruption to the marine aggregates industry operation within the estuary;
- Adverse effects on the integrity and performance of waste outfalls;
- Loss of the Severn Bore phenomenon;
- Construction disruption affecting tourism;
- Localised erosion of buried cables and pipelines;
- Changes to geomorphology and water quality affecting existing power stations.

3.3.11 The significant effects are summarised for each receptor group in Table 3.4 below.





Table 3.4: Summary of significant effects to Other Sea Uses topic receptors

Effect	Alternative Option				
	B3 Brean Down to Lavernock Point Barrage	B4 Shoots Barrage	B5 Beachley Barrage	L2 Welsh Grounds Lagoon	L3d Bridgwater Bay Lagoon
<b>Marine Aggregates</b>					
Disruption to 12 hour extraction cycle	Yes – during (potentially) construction & operation			No – only a max 30 min lock transit time and little/ no other commercial traffic operating in this area	
Disruption of access to licensed extraction grounds	Yes (Holm Sands)			Yes – during construction and operation	
Reduced sand supply to aggregate reserve sites	Yes	Yes	Yes	Yes	Yes
<b>Marine Waste Disposal</b>					
Reduced performance of gravity driven outfalls	Yes - >50% of existing outfalls could be affected	Yes – between 20 and 50% of existing outfalls could be affected	Yes – between 20 and 50% of existing outfalls could be affected		
Reduction upstream current speeds making disposal sites for dredged material unsuitable	Yes - >50% dredged material disposal sites could be affected			Yes – 20 to 50% of dredged material disposal sites could be affected	
Erosion of intertidal areas upstream of structure, causing outfall undermining	Yes – 20 to 50% outfalls could be undermined	Yes – 20 to 50% outfalls could be undermined			
<b>Recreation</b>					
Loss of Severn Bore	Yes	Yes	Yes		
Creation of a more benign hydrodynamic environment	Yes			Yes	

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Effect	Alternative Option				
	B3 Brean Down to Lavernock Point Barrage	B4 Shoots Barrage	B5 Beachley Barrage	L2 Welsh Grounds Lagoon	L3d Bridgwater Bay Lagoon
Increased peak flow velocities within Bridgwater Bay					Yes
Increased siltation affecting viability of marinas/ moorings	Yes	Yes	Yes		
Undermining of coastal structures used for marine recreation (e.g. slipways)	Yes				
<b>Rescue Organisations</b>					
Increased incident response times	Yes	Yes	Yes	Yes	Yes
<b>Tourism</b>					
Reduced aesthetic appeal of the Estuary, impacting tourism	Yes	Yes		Yes	Yes
Tidal Power Option becoming a visitor attraction	Yes	Yes	Yes		
Disruption to bird population, impacting ornithological tourism	Yes	Yes		Yes	Yes (but only during construction phase)
Detrimental impact to sandy pleasure beaches, impacting tourism	Yes	Yes	Yes	Yes	Yes
Construction phase coinciding with other large projects causing strain on infrastructure, impacting coastal tourism	Yes	Yes	Yes	Yes	Yes
Change to spatial extent of contaminant plume from Weston Super Mare waste water treatment works, affecting bathing water quality at Weston					Yes
<b>Cables &amp; Pipelines</b>					
Erosion of sub tidal environment causing cable scour					Yes
<b>Energy</b>					
changes to power station thermal plume characteristics					Yes

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Effect	Alternative Option				
	B3 Brean Down to Lavernock Point Barrage	B4 Shoots Barrage	B5 Beachley Barrage	L2 Welsh Grounds Lagoon	L3d Bridgwater Bay Lagoon
Local morphological changes up estuary of the barrage affecting the integrity of power station intake and to outfall structures	Yes				
<i>Military</i>					
Disruption to military practice areas		Yes			



### Noise & Vibration

- 3.3.12 No significant anthropogenic noise effects have been identified for any of the Alternative Options. That is not to say there would not be any noise effects at all, only that they are not considered to be significant in the language of the SEA Directive. For detail of the noise effects predicted, please see the Noise & Vibration topic paper. Specific consideration of the potential effects of noise on fish is provided within the Migratory & Estuarine Fish topic paper and annexes.

## **3.4 L3d – Multiple Basin Arrangement**

- 3.4.1 As described in 2.3.4, L3d Bridgwater Bay Lagoon option was identified as a multiple basin option variant for high-level consideration of environmental effects (this variant has not been subject to the modelling undertaken for the five alternative options). This variant is a double basin version of the L3d lagoon (with pumping).

- 3.4.2 The double basin concept splits the L3d lagoon into a high basin to the south and a low basin using a rockfill dividing wall with its landfall at Berrow. This variant employs two powerhouses, one between the high and low basins and a second between the low basin and the sea. Each basin would experience a tidal range, but the high basin water levels would always be kept above those of the low basin. Pumping is used to raise water levels in the high basin and lower them in the low basin to increase power output. The option variant would utilise single direction turbines (in contrast to the ebb/flood generation of the standard L3d alternative option).

- 3.4.3 There are a number of likely effects assumed for the multiple basin option:

### Communities

- 3.4.4 Construction costs are predicted to be higher for the multiple basin scheme, it therefore follows based on the overall assumptions, that construction labour requirements will be higher. This is likely to result in a slight increase in construction employment opportunities.
- 3.4.5 The installed capacity will be lower, although the generation time will be extended. This means that overall the multiple basin variant is unlikely to require greater staff numbers than the single basin L3d Bridgwater Bay lagoon option, but with a lower capacity it may require fewer staff.
- 3.4.6 The additional civil engineering requirements (i.e. the dividing wall with landfall at Berrow) means that there will be further temporary landtake associated with the multiple basin variant. It is anticipated that the total additional requirement will not be greater than 7ha, however the distribution of the land requirements may mean that the areas currently identified at the Hinkley and Brean landfalls change slightly. For the permanent works, it is assumed that there would be no net increase in total permanent land requirements (5ha), however the required facilities may be split between the three landfall points to better serve the requirements of the two powerhouses.
- 3.4.7 The additional civil engineering works implies that there will be a need for additional HGV movements to site during construction, exacerbating the significant adverse affect on the MSOAs affected.



### Navigation

- 3.4.8 Navigation effects will be broadly similar to the single basin L3d option; there may be slightly more potential for disruption from construction/decommissioning phase shipping, and during operation there would remain an additional lock to transit through to the port of Bridgwater. However, there should not be a difference in lock transit time. The southern basin, through which navigation would be maintained, is likely to have more stable higher water levels owing to the operational requirements of a multiple basin option; this could increase the window for navigation to the port of Bridgwater.

### Other Sea Uses

- 3.4.9 For Other Sea Uses the effects identified for L3d effects would still apply:

- Marine Aggregates: Reduced sand supply to aggregate reserve sites;
- Recreation: Increased peak flow velocities within Bridgwater Bay;
- Rescue Organisations: Increased incident response times;
- Tourism: Reduced aesthetic appeal of the Estuary, impacting tourism;
- Tourism: Disruption to bird population, impacting ornithological tourism (construction phase effect);
- Tourism: Detrimental impact to sandy pleasure beaches, impacting tourism;
- Tourism: Construction phase coinciding with other large projects causing strain on infrastructure, impacting coastal tourism;
- Tourism: Change to spatial extent of contaminant plume from Weston Super Mare waste water treatment works, affecting bathing water quality at Weston;
- Cables and pipelines: Erosion of sub tidal environment causing cable scour; and
- Energy: changes to power station thermal plume characteristics.

- 3.4.10 Of these there may be a slight increase in the magnitude of effect for recreation and tourism. For recreation, the introduction of the additional dividing structure, pumping and the relocated powerhouse is likely to lead to further areas of localised increased velocities and turbulence within the basin. The tourism effect is likely to be felt through the more extensive and potentially longer construction phase disruption; affecting the aesthetics of the area and disturbing both the human and bird populations.

### Noise

- 3.4.11 During construction, the additional works means that there may be a slight increase in the noise effects upon noise sensitive receptors; particularly for the new landfall at Berrow. Noise effects during operation are not likely to be much different to the single basin variant of L3d, assuming that the submergence of turbines attenuates the noise generated with respect to human receptors.



### 3.5 Combinations

3.5.1 As described in 2.3.5 above, two potential combinations of schemes have been identified for high-level consideration. These two combinations of options have not been subject to modelling at this stage, but have undergone an evaluation process (considering energy yield, costs, programme and opportunities for optimisation). The two potential combinations are:

- A combination of L3d Bridgwater Bay Lagoon (ebb/flood) with B3 Brean Down to Lavernock Point barrage (ebb only); and
- A combination of L3d (ebb/flood) with B4 Shoots barrage (ebb only).

3.5.2 L3d and B3 would be constructed sequentially due to the large amount of resources required to build either of these alternative options. Either option could be constructed first.

3.5.3 L3d and B4 could be constructed either sequentially or concurrently. The operating rules and forms of construction for the combined options are assumed for the purpose of this high-level review to be the same as those for the individual alternative option.

#### L3d Bridgwater Bay Lagoon and B3 Brean Down to Lavernock Point Barrage

3.5.4 The sequential construction of L3d and B3 would result in all of the significant effects described above for the two alternative options individually. However, the extended construction period would mean that for some receptors, the effect would be either greater or last longer during this phase.

#### Communities

3.5.5 Effects will be as described as for both B3 and L3d above. Effects associated with some elements of construction, such as caisson construction yard, although not spatially determined at this stage may be extended for the duration of both schemes in the event of contiguous construction of the two options – this will extend caisson yard employment and the associated effects on services and facilities. It is also possible that an extended construction period resulting from contiguous construction of the two options may encourage slightly more workers to relocate with their families – although in line with the findings of the Communities topic paper, this would still not be anticipated to have a significant adverse effect on the receiving local authority districts.

3.5.6 The ports employment effects ultimately would be anticipated to be as predicted for B3, although should the L3d alternative option be the first to be constructed, it might be anticipated that the reductions would first follow the L3d prediction, before increasing to the losses predicted for B3 in the next phase of the construction.

3.5.7 The effects on fishing employment would similarly depend on the sequencing of the options, although ultimately the outcome would be the same as described for B3 above.

3.5.8 The MSOAs around Brean Down are likely to be affected for the entire duration of the sequential construction period as this constitutes landfall for both L3d and B3. The MSOAs at the Lavernock Point and Hinkley Point landfalls are less likely to be affected for the entire duration, although the construction phase effects could be



extended slightly, depend on the timing of mobilisation/demobilisation works around the estuary.

- 3.5.9 Should construction not be phased to run contiguously, there may be additional land take effects at the Brean Down landfall beyond those identified for the B3 or L3d options.

#### Navigation

- 3.5.10 The effects for Navigation would be as described for B3 and L3d individually above.

#### Other Sea Uses

- 3.5.11 The effects for Other Sea Uses receptors would be as described for B3 and L3d individually.

#### Noise

- 3.5.12 The effects for Noise & Vibration would also be as described for B3 and L3d above.

#### L3d Bridgwater Bay Lagoon and B4 Shoots Barrage

- 3.5.13 The construction of L3d and B4 combination would result in all of the significant effects described above for the two alternative options individually. However, the extended construction period would mean that for some receptors, the effect may be felt at several locations at the same time or at fewer locations but lasting for a longer time, depending on whether construction were sequential or concurrent.

#### Communities

- 3.5.14 Construction & operational effects will be as described as for both B4 and L3d above. Decommissioning effects are also likely to be similar.
- 3.5.15 For sequential construction, effects associated with some elements of construction, such as caisson construction yards, although not spatially determined at this stage may be extended for the duration of both schemes in the event of contiguous construction of the two options – this will extend caisson yard employment and the associated effects on services and facilities. It is also possible that an extended construction period resulting from contiguous construction of the two options may encourage slightly more workers to relocate with their families – although in line with the findings of the Communities topic paper, this would still not be anticipated to have a significant adverse effect on the receiving local authority districts.
- 3.5.16 For concurrent construction, it is anticipated that more caisson yards (3 or 4) would be required. The ODR V2 (STP, 2010) considers it doubtful that so many yards could be accommodated locally, if this is the case then some construction employment benefit associated with caisson construction would not be realised within the LADs around the estuary.
- 3.5.17 The distribution of the affected MSOAs around the estuary suggests it is likely that the effects on the health and quality of life of the receptors would not be different to the effects predicted for the two options individually.



#### Navigation

- 3.5.18 The effects for Navigation would broadly be as described for B4 and L3d individually above. However, during operation, a slight increase in low water and a slight reduction in high water is predicted by H&G, which may affect the requirements for measures needed to prevent or reduce the effect on the navigation (e.g. reduction in lock sill levels, increase in dock wall heights, or dredging depths).

#### Other Sea Uses

- 3.5.19 The effects for Other Sea Uses receptors would be as described for B4 and L3d individually.

#### Noise

- 3.5.20 The effects for Noise & Vibration would also be as described for B4 and L3d above.



SECTION 4

**INTERRELATIONSHIPS**



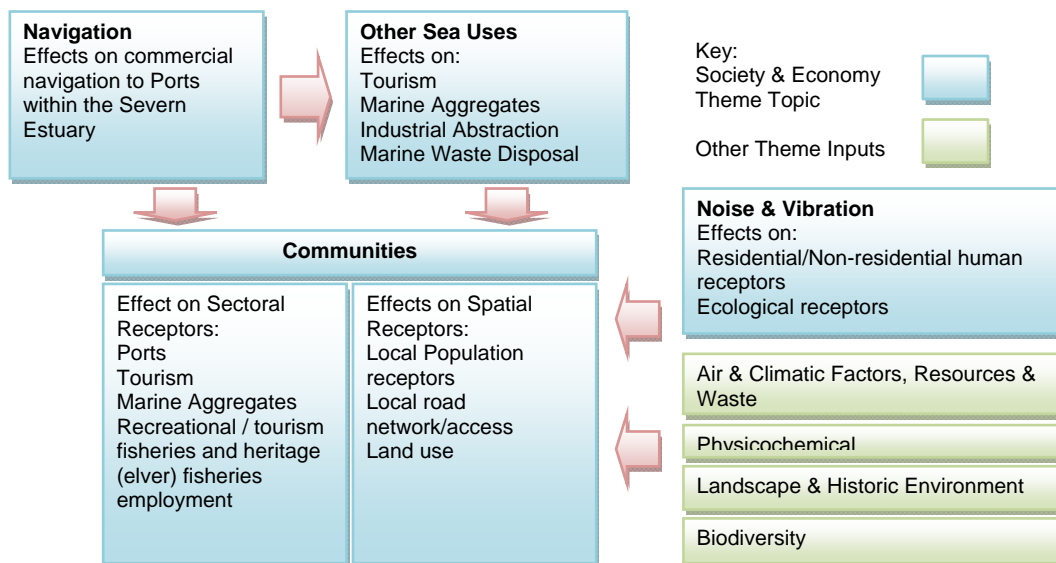
## 4 INTERRELATIONSHIPS

4.1.1 The SEA Directive requires that the interrelationships between likely significant effects are described (SEA Directive Annex 1 (f)). This theme paper therefore summarises the interactions between related topics and thereby ensures that the many complex issues that are not self-contained within a given topic are recognised and their implications understood. Each theme paper also examines the relationships between this theme and other themes within the STP SEA.

### 4.2 Interrelationships between topics within Society & Economy theme

4.2.1 As previously mentioned, the creation of the theme reporting level within the SEA reporting hierarchy for this feasibility study was an important step to aid in the clear identification and explanation of the large number of overlapping and interlinked relationships across the sixteen topics.

4.2.2 The first step in this process was the grouping of the most closely related or linked topics into the five themes. The Society & Economy theme comprises the topics which represent human activity around the estuary. Within these topics there exist a number of interrelationships, both direct and indirect, which are represented in Figure 4.1 below.



**Figure 4.1: Summary of interrelationships within the Society & Economy theme**

4.2.3 It can be seen from Figure 4.1, the Communities topic is essentially the “end-user” for information emerging from the other three topics within the theme, together with a range of topics contained within other themes. This is discussed further in 4.3 below.

4.2.4 The Navigation topic explores the potential effects of the STP alternative options upon the commercial navigation routes within the Severn Estuary. Within the Society & Economy theme there are direct links between the Navigation topic and the Other



Sea uses topic, and further indirect links between Navigation and Communities through the outputs of the Other Sea Uses Topic, as summarised in Table 4.1 below.

**Table 4.1: Summary of effects transferring between Navigation, Other Sea Uses and Communities topics**

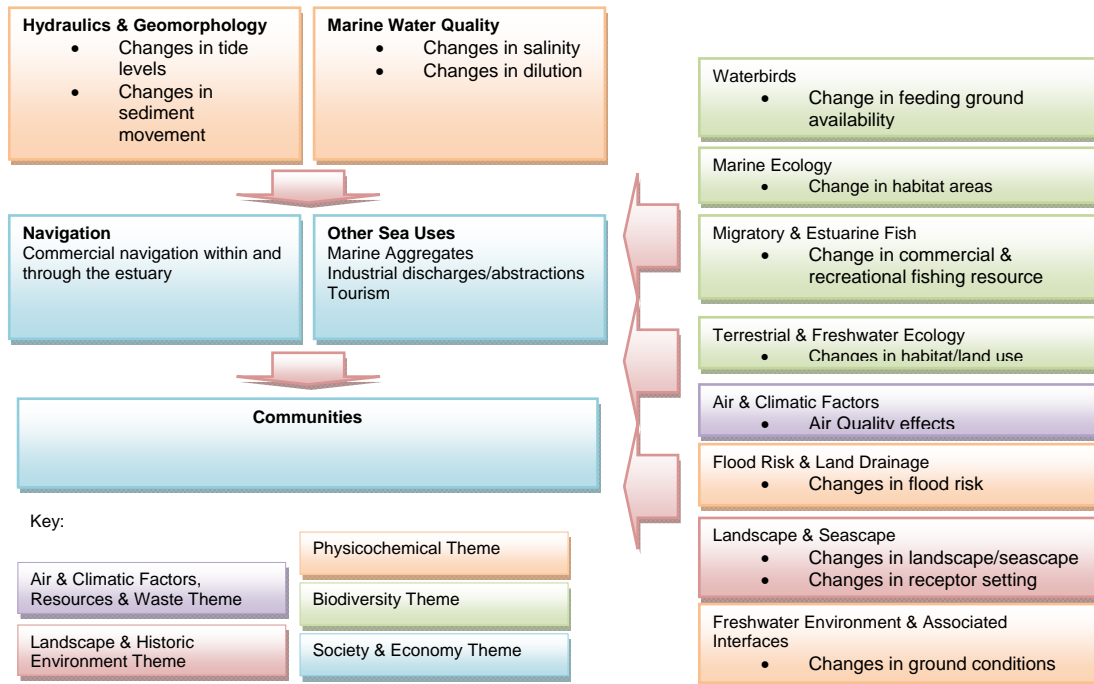
Source of effect	Nature of effect explored		
	Navigation	Other Sea Uses	Communities
<b>Construction &amp; Decommissioning Phases</b>			
Disruption/congestion	Risks to the ability of vessels to navigate safely through the estuary. Ability of vessels to navigate through the new navigation channel at low and mid tides. Increased transit time through lock structures.	Ability of aggregates interests to exploit licences within the estuary within current operating windows. Risks to the ability of recreational and rescue vessels to navigate safely through the estuary.	Changes to Port commercial activity resulting in changes in employment levels. Changes to commercial aggregate extraction operations resulting in changes to employment levels.
Materials Demand	Increased number of vessel movements within estuary for delivery of materials and installation of structural components.	Ability of recreational and rescue vessels to navigate through the new navigation channel at low and mid tides. Increased transit time through lock structures for recreational and rescue vessels.	
<b>Operational Phase</b>			
Physical presence of structure	Increased transit time through lock structures. Increased peak water velocities at sluice gates and turbine blocks. Reduced peak water velocity throughout the estuary and Bristol Channel	Ability of recreational and rescue vessels to navigate through the new navigation channel at low and mid tides.  Increased transit time through lock structures for recreational and rescue vessels.  Interruption/delay of access to marine aggregates extraction and marine waste disposal grounds.	Perceived effect on ports resulting in changes to Port commercial activity and changes in employment levels. Changes in boat-based tourism around the estuary and resulting changes to tourism employment. Changes to commercial aggregate extraction operations resulting in changes to employment levels
Change in tide levels	Reduced high water levels Increased low water levels upstream of Barrage/within lagoon		Changes to Port commercial activity resulting in changes in employment levels.
Change in water velocity/flushing.	Overall reductions in water velocities and tidal movement associated with impoundments.	Effects on power station abstractions & discharges to the estuary.	
Change in chemical composition (water quality)		Effects on power station abstractions & discharges to the estuary.	
Change in silt movement	Short term sediment deposition in navigation channels and immediate approach channels following completion of the option	Ability of aggregates interests to exploit licences within the estuary within current operating windows.	Changes to commercial aggregate extraction operations resulting in changes to employment levels.
Change in channel morphology	Long term morphological change in navigation channels and immediate approach channels:	Long term morphological changes affecting marinas.	Changes in boat-based tourism around the estuary and resulting changes to tourism employment



- 4.2.5 As shown in Table 4.1, between Navigation and Other Sea Uses, all uses of the estuary navigation are considered, and this consideration is taken on through the Communities topic to give the “end-user” effect; i.e. the effect on the relevant sectoral receptor, specifically the ports, marine aggregates industry or tourism in this case.
- 4.2.6 In a similar way, other effects identified in the Other Sea Uses topic are taken up by Communities for consideration against the appropriate sectoral receptor. In addition to marine aggregates, ports and tourism, the indirect effects on the power generation industry and marine waste disposal sectors are considered through Communities as employment effects.
- 4.2.7 Noise & Vibration provides the Communities topic with data enabling a judgement on the scale of direct effect upon the local population linked with the physical proximity of the options to local population receptors. This is considered alongside contributions from other parts of the SEA, allowing a judgement on the cumulative effects of any of the options upon the identified population receptors. Other contributors include Air & Climatic Factors, Landscape & Seascape and the Technical Note on Construction Traffic for a Severn Barrage/Lagoon (STP, 2010a).

### 4.3 Interrelationships between Society & Economy and other themes

- 4.3.1 Again, many of the interrelationships between the Society & Economy theme and other themes are reflected in the transfer of information at different stages in the assessment process. Being the end-point in terms of a pathway of inter-related physical and biological effect, means that the Society & Economy theme is “fed” by most of the other topics in some way, as is represented in Figure 4.2 below.
- 4.3.2 For example, the Hydraulics & Geomorphology (H&G) topic supplies the basic building blocks in terms of predicting the water level and sediment transport changes associated with all five alternative options. The Marine Water Quality topic takes this information and interprets the implications for the water quality parameters under consideration in the estuary. The changes predicted by the H&G and Marine Water Quality topics are in turn used by the Navigation and Other Sea Uses topics to predict how the receptors contained within their respective topic areas will be affected.
- 4.3.3 In addition, there exist many more interrelationships between the other themes which are explained in the relevant theme report. Society & Economy, representing as it does in many cases, the human “end-use” for the wide range of natural processes occurring across the estuary and its surrounding area, has only limited interactions feeding back up the chain to other themes. Where this does occur, the examination of the interrelationship is undertaken within the affected theme’s report. Interactions In terms of the STP SEA, the majority of such “feedback” effects result from measures to prevent or reduce adverse effects. More detail is provided on these measures in Section 5 below.



**Figure 4.2: Interrelationships between Society & Economy and other themes**

4.3.4 Further details on the interrelationships between Society & Economy and other themes indicated in Figure 4.2 are given below.

#### Physicochemical Theme

4.3.5 Data from the Flood Risk & Land Drainage topic directly informs the assessment of health and quality of life effects for the Communities topic MSOA receptors in terms of the numbers of properties affected by tidal flood risk both in the baseline environment and the effects with the alternative options in place. This topic also informs the Freshwater Environment & Associated Interfaces topic in terms of changes in soil water content/waterlogging, which in turn informs the operational land-use assessment within the Communities topic.

4.3.6 As described above, information from the H&G and Marine Water quality is key in terms of assessing the effects of the alternative options upon Navigation within the estuary. The Navigability of the estuary is determined by a range of elements, most importantly the water depth, currents and velocities. Data on water levels, water velocity and sediment movement from the H&G topic; and data on salinity, an important determinant for buoyancy, from the Marine Water Quality topic was essential for interpreting the operational effect on Navigation.

4.3.7 Receptors within the Other Sea Uses topic are subject to a range of physicochemical processes, simply because of their location within the estuary; for example, buried cables and pipelines which are subject to either sediment deposition or scour; marinas for smaller or recreational vessels and tourist beach destinations both of which could be affected by changes in the estuarine sediment regime. Other receptors have been sited within the estuary specifically to take advantage of conditions therein; examples of this include marine waste disposal – either in the form of outfalls or dredging disposal grounds taking advantage of the dilution and dispersal opportunities offered by the dynamic estuarine environment. Again, the assessment



of the effects on the receptors utilised modelling output from both the H&G and Marine Water Quality topics.

#### Biodiversity Theme

- 4.3.8 The Migratory & Estuarine Fish topic has undertaken extensive work to investigate and assess the likely significant effects of the alternative options upon the fish populations within the estuary. This has provided an essential input to the Communities topic to enable the assessment of effects upon both commercial and recreational/tourism fishing activities.
- 4.3.9 Similarly, effects on wildlife tourism and recreation considered in the Other Sea Uses and Communities topics are reliant on the information on designated sites, habitats and species provided by the Waterbirds, Marine Ecology and Terrestrial & Freshwater Ecology topics. There are also links between the Terrestrial & Freshwater Ecology and Communities topic with respect to landuse effects.
- 4.3.10 The Noise & Vibration topic, as well as informing the assessment in the Communities topic, informs the assessment of effects arising from the alternative options on fish and other marine species in the Migratory & Estuarine Fish and Marine Ecology topics.

#### Air & Climatic Factors, Resources & Waste

- 4.3.11 The Communities topic has assessed the effects of the alternative options upon the commercial activity of the ports. This assessment has been based upon the REIS update undertaken in February 2010 and indicates effects upon the ports for all of the options which may result in the displacement of existing ports traffic to other ports/means of transport. This displacement effect may in turn affect carbon emissions as a result of the displaced traffic and has been considered within the Carbon Footprinting element of the Air & Climatic Factors, Resources and Waste Theme.
- 4.3.12 The Air Quality element has informed the assessment of effects on the MSOA receptors within the Communities topic, contributing to the assessment of effects upon health and quality of life.
- 4.3.13 The Resources & Waste topic shares information with the Other Sea Uses topic in relation to marine aggregates dredging and marine waste disposal. The construction phase of the alternative options will in every case increase demand for dredged aggregate; and in operation may affect the accessibility of any remaining supply and of existing disposal grounds.
- 4.3.14 Siltation behind an impoundment will necessitate maintenance dredging to ensure continuation of the navigation through the estuary – this will in turn have an effect with respect to both the Air & Climatic Factors and Resources & Waste topics. Further details can be found in the relevant theme and topic papers.

#### Landscape & Historic Environment

- 4.3.15 The baseline and effects described in the Landscape & Seascape topic paper have primarily been used to describe effects upon health and quality of life within the Communities topic paper. The landscape functions of recreational areas and of the estuary as a whole as a tourism destination have also been considered in terms of



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land use and access in Communities and in tourism and recreation in Other Sea Uses,

4.3.16 Heritage features and historic landscapes have been considered alongside the landscape and nature conservation designations in the Communities topic assessment.



SECTION 5

**MEASURES TO PREVENT, REDUCE AND AS  
FULLY AS POSSIBLE OFFSET ANY  
SIGNIFICANT ADVERSE EFFECTS**





## 5 MEASURES TO PREVENT, REDUCE AND AS FULLY AS POSSIBLE OFFSET ANY SIGNIFICANT ADVERSE EFFECTS

5.1.1 The SEA Directive requires that information is provided on the measures envisaged to prevent, reduce and as fully as possible offset any significant adverse effects on the environment of implementing the plan or programme (SEA Directive Annex I). These measures are considered within this theme paper in terms of the interrelationships between topics within this theme.

5.1.2 In this SEA, and in line with UK practice, these measures are split into those to prevent or reduce effects and measures to as fully as possible offset any significant adverse effects on the environment. Offsetting measures make good for loss or damage to the environment, without directly reducing that loss/damage.

### 5.2 Measures to prevent or reduce significant adverse effects

5.2.1 The measures identified to prevent or reduce likely significant adverse environmental effects within the Society & Economy theme are described below.

5.2.2 During optimisation, the original schemes were optimised by studying a number of modifications which would have a fundamental bearing on the feasibility of the alternative options. The main measures that were taken during optimisation to prevent or reduce adverse effects on Society & Economy theme receptors are as follows:

5.2.3 The alignment of the alternative options was changed from the original schemes in order to reduce the footprint on designated habitats and habitat features, and reduce the effect on historic environment, land and seascape, and local population. Specifically, the alignment of B4 was adjusted to avoid passing through the military training ground at Redwick (an Other Sea uses topic receptor). Two small shipping locks were included in the B3 Brean Down to Lavernock Point alternative option to reduce the potential adverse effect upon small vessels sailing in the estuary.

5.2.4 Alternative operating mode (ebb and flood operation), and variation in turbine and sluice numbers were modified, generating in turn a change in tidal range impact and change in effects on habitats and habitat features, water quality, port access and flood risk (STP, 2009d).

5.2.5 Further refinement, including the introduction of measures necessary to prevent or reduce effects, and more detailed consideration of engineering design requirements, was carried out as the outputs of studies undertaken during the SEA became available. For example:

- Operational management of barrage and lagoon/ regime
- Freshwater and seawater level management
- Permanent works for dredging and sedimentation management
- Re-routing of drainage channels/outfalls
- Adjustment to locks (both in structure and at ports)



- Minor alignment adjustments to mitigate access issues
- Location of material sources
- Adjusting on-shore working locations/compounds
- Modification to port infrastructure (such as altering dock levels)

5.2.6 A summary of the measures proposed within the Society & Economy theme is provided below. Detail of specific measure relating to specific topics can be found in the relevant topic paper. An overview of the measures carried forward for all topics will be provided in the ODR – Version 3 and the SEA Environmental Report.

### Communities

5.2.7 The Communities topic has identified potentially significant effects arising from:

- Loss of employment from ports business as a result of the perceived disruption to commercial shipping in the estuary;
- Loss of recreational/tourism fishery-based employment as a result of effects on migratory and estuarine fish; and
- Cumulative construction related effects on certain MSOAs for some of the options. In the case of L3d, there is potential for further cumulative construction phase effects should the development of such an option coincide with new nuclear development at Hinkley Point.

### Loss of employment from the ports

5.2.8 Despite the measures proposed in the Navigation topic (see below), the Phase 1 REIS (DTZ, 2009) and the Phase 2 update, both suggest that there will be significant adverse effects to port business resulting from the perceived effects of the alternative options, particularly B3 Brea Down to Lavernock Point, on shipping operations within the estuary.

5.2.9 In order to prevent or reduce such losses, it is recommended that consultation measures targeted at altering the perception that the construction phase will restrict navigation to the Estuary's ports are implemented. Whilst the details of these measures will need to be defined, it is suggested that as minimum these entail discussions with both the port operators and the shipping companies using the existing navigation are targeted.

### Loss of recreational/tourism and heritage fishery based employment

5.2.10 Whilst the numbers of jobs associated with this effect are small (less than 58 FTE) This effect is predicted to be significant in the sense that it represents the loss of most, if not all of the employment in this sector depending on which option is being considered.

5.2.11 In order to prevent or reduce this effect, measures would need to ensure continued passage of migratory and estuarine fish to the fisheries. There are a number of measures proposed within the Migratory and Estuarine Fish topics paper designed to assist in this, although their efficacy will, in most cases, not be ascertained until the



alternative options themselves are developed in greater detail (i.e. detailed design stage).

- 5.2.12 As a consequence, the efficacy of any such measures in maintaining the fisheries for anglers and other users is not certain at this stage.

Construction related effects on population receptors

- 5.2.13 For all options, there will be disruption to local communities resulting from the construction of the option. For alternative options B3, L2 and L3d this is predicted to be significant for the MSOAs identified as being affected.

- 5.2.14 A large proportion of the effect will result from the disruption caused by a large increase in regular HGV traffic delivering materials to site. For example, the Highways Agency estimates a frequency of 1 movement per minute through their junction for the peak traffic associated with B3 (Highways Agency, 2010).

- 5.2.15 In order to prevent or reduce these effects the following measures are proposed:

- Reducing the number of vehicles on local roads through rationalising deliveries and use of larger vehicles. This would require consideration of logistical management, including timing and location of deliveries, and may require the use of materials transfer hubs to maximise the efficacy of the measure.
- Delivery of construction materials by alternative routes, such as by rail or by sea and maximising the use of existing temporary/permanent works arrangements. It is already planned to bring in embankment/rock fill material by rail to a railhead for transfer to ship for delivery to site. It is proposed that this approach could be extended to include other construction materials that would otherwise be brought by road. As part of this measure it is proposed that the small shipping lock for B3 and locks in L2 and L3 are utilised as a temporary dock for offloading materials for construction. The structure itself would be used as a haul road.

- 5.2.16 Both measures require forward thinking and good planning but could help streamline logistics in terms of maximising the use of available space in movement of materials (good “green” logistics).

- 5.2.17 The first measure might entail additional road improvements or construction which would themselves entail a certain level of disruption to the affected communities, and would potentially come with their own environmental effects.

- 5.2.18 The second measure would require a larger lock than planned in some instances, and would potentially need to have an extended temporary working area for a materials handling facility as part of the structure,

- 5.2.19 It is considered that second approach, if fully adopted, could be very effective in the prevention of the significant effect predicted. Partial adoption of this approach would serve to reduce the effects; the extent of this reduction will depend on how many HGVs are diverted. Given the potential benefits of such an approach, it is recommended that consideration is given to applying a similar approach to the other two options (B4 and B5) where construction effects would still be felt, but the current predicted effect arising from HGV traffic is lower.



- 5.2.20 In addition, attention to addressing these construction related effects through design informed by further environmental assessment and good management in the execution of any of the options would prevent or at least reduce the severity of other construction effects.
- 5.2.21 The implementation of other relevant measures to prevent or reduce effects identified in other themes will result also in a prevention or reduction of significant adverse effects on health and quality of life of the alternative options B3, L2 and L3d. These include measures proposed in:
- Flood Risk & Land Drainage (flood protection measures to prevent inundation and pumping to reduce effect on 'tide-locked' outfalls);
  - Air & Climatic Factors (measures to reduce the number of vehicle movements and selection of 'less-polluting' vehicles);
  - Landscape & Seascape (measures to enhance the design with a view to reducing the visual impact of the alternative options).
- 5.2.22 Topographic Modification has been identified as a means by which some of the intertidal habitat losses predicted in the Marine Ecology topic paper could be prevented or reduced. It should be noted that in addition to the reduced effects on Biodiversity theme and Other Sea Uses topic receptors, this would entail an increase in the potential construction phase employment for Communities.
- Navigation
- 5.2.23 As stated in the Navigation topic paper, it is considered possible to apply measures to prevent or reduce the physical constraints imposed by the construction and operation of the alternative options upon navigation through the estuary.
- 5.2.24 Such measures include:
- Coordination and phasing of construction/decommissioning activities and traffic to avoid or minimise congestion and any associated safety risks.
  - Improved logistics to manage the arrival and transit of vessels through locks. This will reduce potential queuing and ensure that the additional time required to navigate the locks is taken into consideration when determining windows of opportunity in scheduling.
  - Raising awareness of areas of localised high water velocities near structures through demarcation of such areas.
  - Relocation of locks on alternative options B4 and B5 to reduce the effect on navigation transiting to and from Sharpness Dock of the potential high water velocities near to sluice and turbine blocks and lock structure.
  - Dredging of approach channels to affected ports for each alternative option to remove obstructions as a result of short-term deposition following closure of the structure.



- Dredging of navigation and approach channels affected by each alternative option to remove obstruction to navigation as a result of long term accretion in shallow navigation channels,
- Dredging of the new channel to avoid disruption to navigation of deep draught vessels through the proposed deep water navigation lock from Lavernock Point for the B3 alternative option.
- Alteration of port infrastructure (i.e. reduction in sill levels) to avoid access constraints imposed by reduced navigation depth resulting from reduced high tide levels (B3, B5 & L3d).

5.2.25 It is considered that these measures if implemented would be effective in preventing or reducing the adverse effects imposed upon navigation by the alternative options.

#### Other Sea uses

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

5.2.27 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;
- Topographic Modification<sup>1</sup>;
- Mechanical pumping of water through the tidal power structure to increase water levels; and
- Altering the type, size, position and number of sluices/ turbines.

5.2.28 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;

<sup>1</sup> In order to reduce the potential loss of intertidal area, it has been proposed that a man-made bund or embankment may be placed on the seaward side of the intertidal area. This would create settlement lagoons into which, (through natural deposition and/or pumping of dredged materials), muddy sediments would be deposited. (In the majority of cases the sites identified are to replace areas that are currently intertidal that would otherwise be lost due to the option raising low water levels. However, where possible, additional intertidal sites have also been identified). This measure is described as 'topographic modification'.

Estimates presented in the Topographic Modification Feasibility Study suggest that the following amounts of intertidal area could be created (at the expense of shallow sub-tidal areas):

- B3: 10,000 ha
- B4: 2,500 ha
- B5: 2,500 ha
- L2: 5,300 ha
- L3d: 3,900 ha

This measure could greatly reduce the possible impact on nature based tourism in the Estuary through lessening the impact on waterbird populations.



- 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.
- 5.2.29 Many of the potential adverse effects 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
- 5.2.30 In addition to the above, several other receptor-specific measures have been identified:
- 5.2.31 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 Marine 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.
- 5.2.32 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 Hinkley and/ or Oldbury at some point in the future. 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. Such grid reinforcement works will entail their own environmental effects, and would need to be assessed in compliance with the appropriate contemporary legislative requirements and good practice standards.
- 5.2.33 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).
- 5.2.34 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.

### Noise & Vibration

- 5.2.1 No significant adverse effects have been identified for this topic. However it is assumed that good practice measures to prevent or reduce likely adverse environmental effects within this topic would be considered in the further development of any of the options.

## **5.3 Measures to as fully as possible offset significant adverse effects**

- 5.3.1 The identification of offsetting measures is a requirement of the SEA Directive. For the purposes of this SEA, these are measures to as fully as possible offset any significant adverse environmental effects. Such measures 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 Directive 92/43/EEC (the Habitats Directive).

- 5.3.2 In the case of effects on Society & Economy receptors, offsetting generally takes the form of some sort of financial compensation to make good for losses incurred, nuisance caused or loss of amenity. Such financial compensation is generally adopted as a last resort, once all other measures have been exhausted through examination and application during later design stages.

- 5.3.3 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).

- 5.3.4 In order to offset the effect of the predicted loss of the Atlantic salmon, sea trout and heritage (elver) fisheries it may be possible to 'buyout' the fisheries and licenses. This is discussed further in the Migratory and Estuarine Fish topic.

### Assumptions, Limitations and Uncertainty

- 5.3.5 In identifying measures to prevent, reduce and as fully as possible offset any likely significant adverse effects on the environment and making suggestions, there are some limitations, and assumptions have been made. Furthermore, particularly because the suggestions made are high level, uncertainty is inherently associated with the assessment of the effects of such measures. These issues are indicated alongside the measures where discussed above. Assumptions fundamental to the consideration of measures to prevent/reduce or offset significant effects include:

- Navigation effects can be effectively prevented or at least reduced to present a negligible effect on the ability of commercial shipping to maintain normal operations.
- Measures proposed by the Migratory and Estuarine Fish topic will be implemented effectively; however this does not guarantee the ability for angling employment to continue.



5.3.6 Limitations and uncertainties are described below:

- A number of the measures identified are likely to be extremely costly. Furthermore, quantifying exact costs associated with these measures is problematic because at this stage of the assessment it is difficult to gauge the precise spatial and temporal extent of possible change.
- It is possible that new licenses (or alterations to existing licences) could be granted to lessen the long term adverse effects on the aggregate industry. However, agreeing suitable locations for new sites may not be straightforward: The Welsh Assembly Government are keen to reduce the overall tonnage of aggregate material extracted from the Severn Estuary whilst encouraging the expansion of extraction offshore and further west. However, offshore, deep-water sites in the outer Bristol Channel may not be commercial viable for operators.
- It is possible that some of the proposed measures may themselves cause (localised) adverse effects (e.g. the relocation of existing aggregate sites and waste disposal sites) and this may rule out their implementation.
- The Topographic Modifications study (STP 2010r) has discussed the feasibility of creating new areas of intertidal habitat following the operation of a tidal power option. It should be noted that topographic modification is a relatively new concept and there remains uncertainty regarding how successfully it could be applied in the Estuary.

SECTION 6

**SEA OBJECTIVE COMPLIANCE**





## 6 SEA OBJECTIVE COMPLIANCE

### 6.1 Compliance with SEA objectives

6.1.1 The SEA Objectives which were drafted and consulted upon as part of the Phase 1 SEA scoping stage are set out in Section 2.2. This theme paper identifies any interactions or inconsistencies between topics within this theme with regards to the assessment against SEA Objectives.

6.1.2 The main outcomes from the Objective Assessment are summarised below, for a full summary of the assessment against all Society & Economy theme SEA Objectives, please see the tables presented in Appendix A to this report. Further detail can be found in the relevant topic papers if desired.

#### **B3: Brean Down to Lavernock Point Barrage**

##### Communities

6.1.3 B3 performs positively against Objective SE1, scoring major positive as a result of the construction employment generated. During operation, there is a neutral effect against this objective.

6.1.4 Conversely, a major negative score is currently attributed against Objective SE2 as a result of the predicted adverse effect on the regional ports, marine aggregates, recreational/tourism (salmon and sea trout) fishing, and heritage (elver) fishing. Even assuming the measures identified to consult with the ports and shipping lines; and the marine aggregates measures are successful, it is not certain whether the effect on the fishery can be reduced. It is therefore not possible to say that B3 will not have an adverse effect on the local and regional economy.

6.1.5 With measures to prevent or reduce adverse effects in place, B3 is predicted to have neutral performance against the other Communities Objectives.

##### Navigation

6.1.6 Assuming measures to prevent or reduce effects are successfully implemented, B3 has a neutral performance against Objective NAV1.

6.1.7 As a result of residual risks to transit time within the estuary, B3 is considered to have a minor negative performance against Objective NAV2 *“to avoid adverse effects on the integrity of existing and proposed port operations”*.

##### Other Sea Uses

6.1.8 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 OSU1.

6.1.9 B3 option scores a major positive performance against the SEA Objective OSU 3 as implementation of the alternative 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. This assumes that adverse effects arising from sedimentation and long-term morphological changes are effectively prevented through measures identified.

- 6.1.10 Against Objective OSU 4 Option B3 has the potential to have both a positive and negative influence on sustainable estuary based tourism. It could become a visitor attraction although it has the potential to have an adverse effect on the aesthetics of the Estuary, both during the construction/decommissioning phases and during operation. Measures are identified in the Landscape & Seascape topic which could reduce this adverse effect. The extent of intertidal mud and sand flats would be reduced by the alternative option 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). The alternative option also has 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.
- 6.1.11 The B3 barrage option would prevent the formation of a 'surfable' Severn Bore. No realistic measures to maintain the bore have been identified. Consequently B3 is considered to score a major negative performance against Objective OSU8.
- 6.1.12 Assuming effective implementation of identified measure to prevent or reduce adverse effects, B3 scores a neutral performance against the remaining OSU Objectives.

#### Noise & Vibration

- 6.1.13 The alternative option is considered to be compliant with the SEA Objectives identified for the Noise & Vibration topic based on the level of information available at this time. The alternative options scores neutrally against the all of the Objectives, assuming effective application of good practice measure to prevent and/or reduce noise and vibration effects.

#### **B4: Shoots Barrage**

##### Communities

- 6.1.14 B4 performs positively against Objective SE1, scoring minor positive as a result of the construction employment generated. During operation, there is a neutral effect against this objective.
- 6.1.15 Conversely, a major negative score is currently attributed against Objective SE2 as a result of the predicted adverse effect on recreational/tourism (salmon and sea trout) fishing on the rivers Wye, Severn and Usk; and heritage (elver) fishing on the rivers Wye and Severn. It is not currently certain whether the effect on the fishery can be reduced. It is therefore not possible to say that B4 will not have an adverse effect on the local and regional economy.
- 6.1.16 With measures to prevent or reduce adverse effects in place, B4 is predicted to have neutral performance against the other Communities Objectives.



### Navigation

- 6.1.17 Assuming measures to prevent or reduce effects are successfully implemented, B4 has a neutral performance against Objective NAV1.
- 6.1.18 As a result of residual risks to shipping and transit time to Sharpness, B4 is considered to have a minor negative performance against Objective NAV2 *“to avoid adverse effects on the integrity of existing and proposed port operations”*.

### Other Sea Uses

- 6.1.19 The B4 alternative option scores a minor positive performance against the SEA Objective OSU 3 as implementation of the alternative option has the potential to create more favourable conditions upstream of the structure for most marine recreational users leading to an increase in marine recreational usage on the impounded section of the estuary. This assumes that adverse effects arising from sedimentation and long-term morphological changes are effectively prevented through measures identified.
- 6.1.20 Against Objective OSU 4 Option B4 has the potential to have both a positive and negative influence on sustainable estuary based tourism. It could become a visitor attraction although it has the potential to have an adverse effect on the aesthetics of the Estuary, particularly during the construction and decommissioning phases but also during operation. Measures are identified in the Landscape & Seascape topic which could reduce this adverse effect. The extent of intertidal mud and sand flats would be reduced by the alternative option 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). The alternative option also has 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.
- 6.1.21 As with all the barrages, the B4 barrage option would prevent the formation of a ‘surfable’ Severn Bore. No realistic measures to maintain the bore have been identified. Consequently B4 is considered to score a major negative performance against Objective OSU8.
- 6.1.22 Assuming effective implementation of identified measure to prevent or reduce adverse effects, B4 scores neutrally in performance against the remaining OSU Objectives.

### Noise & Vibration

- 6.1.23 The alternative option is considered to be compliant with the SEA Objectives identified for the Noise & Vibration topic based on the level of information available at this time. The alternative options scores neutrally against the all of the Objectives, assuming effective application of good practice measure to prevent and/or reduce noise and vibration effects.



## B5: Beachley Barrage

### Communities

- 6.1.24 B5 performs positively against Objective SE1, scoring + as a result of the construction employment generated. During operation, there is a neutral effect against this objective.
- 6.1.25 A major negative score is currently attributed against Objective SE2 as a result of the predicted adverse effect on recreational/tourism (salmon and sea trout) fishing on the rivers Wye, Severn and Usk; and heritage (elver) fishing on the rivers Wye and Severn. It is not currently certain whether the effect on the fishery can be reduced. It is therefore not possible to say that B5 will not have an adverse effect on the local and regional economy.
- 6.1.26 With measures to prevent or reduce adverse effects in place, alternative option B5 is predicted to have neutral performance against the other Communities Objectives.

### Navigation

- 6.1.27 Assuming measures to prevent or reduce effects are successfully implemented, B5 has a neutral performance against Objective NAV1.
- 6.1.28 As a result of residual risks to shipping and transit time to Sharpness, B5 is considered to have a minor negative performance against Objective NAV2 *“to avoid adverse effects on the integrity of existing and proposed port operations”*.

### Other Sea Uses

- 6.1.29 The B5 alternative option scores a minor positive performance against the SEA Objective OSU 3 as implementation of the alternative option has the potential to create more favourable conditions upstream of the structure for most marine recreational users leading to an increase in marine recreational usage on the impounded section of the estuary. This assumes that adverse effects arising from sedimentation and long-term morphological changes are effectively prevented through measures identified.
- 6.1.30 Against Objective OSU 4 Option B5 has the potential to have both a positive and negative influence on sustainable estuary based tourism. It could become a visitor attraction although it has the potential to have an adverse effect on the aesthetics of the Estuary, particularly during the construction and decommissioning phases but also during operation. Measures are identified in the Landscape & Seascape topic which could reduce this adverse effect. The extent of intertidal mud and sand flats would be reduced by the alternative option 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). The alternative option also has 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.





- 6.1.31 The B5 barrage option would prevent the formation of a 'surfable' Severn Bore. No realistic measures to maintain the bore have been identified. Consequently B5 is considered to score a major negative performance against Objective OSU8.
- 6.1.32 Assuming effective implementation of identified measures to prevent or reduce adverse effects, B5 scores neutrally in performance against the remaining OSU Objectives.

#### Noise & Vibration

- 6.1.33 The alternative option is considered to be compliant with the SEA Objectives identified for the Noise & Vibration topic based on the level of information available at this time. The alternative options scores neutrally against the all of the Objectives, assuming effective application of good practice measure to prevent and/or reduce noise and vibration effects.

#### **L2: Welsh Grounds Lagoon**

##### Communities

- 6.1.34 L2 performs positively against Objective SE1, scoring minor positive as a result of the construction employment generated. During operation, there is a neutral effect against this objective.
- 6.1.35 A major negative score is currently attributed against Objective SE2 as a result of the predicted adverse effect on recreational/tourism (salmon and sea trout) fishing on the rivers Wye, Severn and Usk; and heritage (elver) fishing on the rivers Wye and Severn. It is not currently certain whether the effect on the fishery can be reduced. It is therefore not possible to say that L2 will not have an adverse effect on the local and regional economy.
- 6.1.36 With measures to prevent or reduce adverse effects in place, L2 is predicted to have neutral performance against the other Communities Objectives.

##### Navigation

- 6.1.37 Assuming measures to prevent or reduce effects are successfully implemented, L2 has a neutral performance against both Navigation Objectives.

##### Other Sea Uses

- 6.1.38 The L2 option is located on (or very close 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 Severn Estuary/Môr Hafren SAC conservation objectives and IMADP). Nevertheless, as a result of the above the L2 option scores a minor negative performance against the SEA Objective OSU1.
- 6.1.39 The L2 alternative option scores a minor positive performance against the SEA Objective OSU 3 as implementation of the alternative option has the potential to create more favourable conditions within the impounded area for most marine recreational users leading to an increase in marine recreational usage on the impounded section of the estuary.



6.1.40 Against Objective OSU 4 Option L2 has the potential to have both a positive and negative influence on sustainable estuary based tourism. It could become a visitor attraction although it has the potential to have an adverse effect on the aesthetics of the Estuary, particularly during the construction and decommissioning phases but also during operation. Measures are identified in the Landscape & Seascape topic which could reduce this adverse effect. The extent of intertidal mud and sand flats would be reduced by the alternative option 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). The alternative option also has 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.

6.1.41 As the L2 lagoon does not 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 further modelling work would be required in future in order to confirm this. The performance of this alternative option against OSU8 is therefore Uncertain.

6.1.42 Assuming effective implementation of identified measure to prevent or reduce adverse effects, L2 scores neutrally in performance against the remaining OSU Objectives.

#### Noise & Vibration

6.1.43 The alternative option is considered to be compliant with the SEA Objectives identified for the Noise & Vibration topic based on the level of information available at this time. The alternative options scores neutrally against the all of the Objectives, assuming effective application of good practice measure to prevent and/or reduce noise and vibration effects.

#### **L3d: Bridgwater Bay Lagoon**

##### Communities

6.1.44 L3d has scored a major positive performance against Objective SE1, as a result of the construction employment generated. During operation, there is a neutral effect against this objective.

6.1.45 A major negative score is currently attributed against Objective SE2 as a result of the predicted adverse effect on recreational/tourism (salmon and sea trout) fishing on the rivers Wye, Severn and Usk; and heritage (elver) fishing on the rivers Wye and Severn. It is not currently certain whether the effect on the fishery can be reduced. It is therefore not possible to say that L3d will not have an adverse effect on the local and regional economy.

6.1.46 With measures to prevent or reduce adverse effects in place, L3d is predicted to have neutral performance against the other Communities Objectives.

##### Navigation

6.1.47 Assuming measures to prevent or reduce effects are successfully implemented, L3d has a neutral performance against both Navigation Objectives.



### Other Sea Uses

- 6.1.48 The L3d option scores a minor negative performance against the SEA Objective OSU 3 as implementation of the alternative option has the potential to create increased peak flow speeds in Bridgwater Bay, making conditions potentially less favourable for most recreational users.
- 6.1.49 Against Objective OSU 4 Option L3d has the potential to have both a positive and negative influence on sustainable estuary based tourism. It could become a visitor attraction although it has the potential to have an adverse effect on the aesthetics of the Estuary, both during the construction/decommissioning phases and during operation. Measures are identified in the Landscape & Seascape topic which could reduce this adverse effect. The extent of intertidal mud and sand flats would be reduced by the alternative option 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). The alternative option also has 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.
- 6.1.50 As the L3d lagoon does not 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 further modelling work would be required in future in order to confirm this. The performance of this alternative option against OSU8 is therefore Uncertain.
- 6.1.51 Assuming effective implementation of identified measure to prevent or reduce adverse effects, L3d scores neutrally in performance against the remaining OSU Objectives.

### Noise & Vibration

- 6.1.52 The alternative option is considered to be compliant with the SEA Objectives identified for the Noise & Vibration topic based on the level of information available at this time. The alternative options scores neutrally against the all of the Objectives, assuming effective application of good practice measure to prevent and/or reduce noise and vibration effects.



SECTION 7

**IMPLEMENTATION**



## 7 IMPLEMENTATION

### 7.1 Proposals for monitoring

7.1.1 The SEA Directive requires that measures to monitor the significant environmental effects are described within the environmental reporting. Monitoring allows the actual significant environmental effects of implementing a Severn Tidal Power alternative option to be tested against those predicted.

7.1.2 This section sets out suggestions for the framework for the monitoring of the plan against the predicted significant effects within this theme which can be applied to all of the Severn Tidal Power Schemes under consideration. Table 7.1 includes a brief summary of monitoring proposed for this theme and identifies any interactions or inconsistencies between the topics within this theme.

**Table 7.1: Potential Monitoring Summary for Theme Reporting**

Monitoring proposal for significant environmental effects	Receptor	Topics covered
Monitor port employment	Ports of Bristol, Cardiff, Newport and Sharpness	Communities
Monitor mean rod catches as indicator of employment	Rivers Usk, Wye and Severn salmon and sea trout fishing and heritage (elver) fishing supported employment	Communities Marine & Estuarine Fish
Baseline monitoring programme to ensure development of suitable design elements to prevent/reduce effects and to inform construction monitoring requirements.  Construction monitoring programme to ensure efficacy of the above and identify any remedial actions required during construction phase.  This should include: Noise Air Quality Visual effects Traffic	Population within affected MSOAs	Communities Air & Climatic Factors Noise & Vibration Landscape & Seascape
Monitoring of tidal level post-construction to confirm model predictions	Ports of Bristol, Cardiff, Newport, Sharpness and Bridgwater	Navigation Communities Other Sea Uses Hydraulics & Geomorphology
Monitoring of peak water velocities post-construction to confirm model predictions	Ports of Bristol, Cardiff, Newport, Sharpness and Bridgwater	Navigation Communities Other Sea Uses Hydraulics & Geomorphology
Monitoring of peak water velocities post-construction to ensure measures to reduce risk are successful and peak water velocities are not a significant risk	Ports of Bristol, Cardiff, Newport, Sharpness and Bridgwater	Navigation Communities Other Sea Uses Hydraulics & Geomorphology
Monitoring of sediment deposition to inform level of dredging required to maintain safe access to and from the ports	Ports of Bristol, Cardiff, Newport, Sharpness and Bridgwater	Navigation Communities Other Sea Uses Hydraulics & Geomorphology
Monitoring of sediment deposition to inform	Ports of Bristol, Cardiff,	Navigation



Monitoring proposal for significant environmental effects	Receptor	Topics covered
level of dredging required to maintain safe access to and from the ports	Newport, Sharpness and Bridgwater	Communities Other Sea Uses Hydraulics & Geomorphology
Monitoring of total transit time to assess increase in transit time and success of proposed measures to reduce effect	Ports of Bristol, Cardiff, Newport and Sharpness	Navigation Communities Other Sea Uses
Ongoing monitoring of changes in cross-shore profile. May be undertaken directly (traditional beach survey methods) or remotely (LIDAR).	Marine Waste Disposal Sites and Infrastructure Marine Recreational Users Energy Industry	Navigation Communities Other Sea Uses Hydraulics & Geomorphology
Ongoing monitoring of changes in cross-shore profile and sediment type	Sustainable Estuary-Based Tourism	Navigation Communities Other Sea Uses Hydraulics & Geomorphology
Ongoing monitoring of siltation rates/ water depth at marinas and mooring sites	Marine Recreational Users	Navigation Communities Other Sea Uses Hydraulics & Geomorphology
Ongoing monitoring of the microbiological (Faecal Coliforms) and physiochemical parameters of bathing waters at Weston	Sustainable Estuary-Based Tourism Marine Recreational Users	Navigation Communities Other Sea Uses Marine Water Quality
Re-assessment/ monitoring of the physiochemical and biological characteristics of the water-column/ seabed at existing waste disposal sites as well as changes to constituent fluxes	Marine Waste Disposal Sites and Infrastructure	Navigation Communities Other Sea Uses Hydraulics & Geomorphology Marine Water Quality Resources & Waste





## 7.2 Suggestions for further research

7.2.1 This section includes some suggestions for research to support further consideration of tidal power in the Severn Estuary.

7.2.2 It is assumed that should the decision be taken to support the development of Severn Tidal Power certain further studies and refinements would be undertaken in the development of the selected option including works to develop and site the options in line with the measures identified to prevent or reduce the predicted effects.

7.2.3 In addition, a number of specific studies are recommended to fill current gaps in knowledge and to improve the resolution of the current predicted significant environmental effects. The suggestions for the Society & Economy theme are summarised below.

### *Hydraulics & Geomorphology Modelling*

7.2.4 Many of the potential effects to commercial navigation are based on the predicted effects to the estuarine environment which have been modelled by Black and Veatch, HR Wallingford and ABPmer and are discussed in detail in the H&G topic paper. The same uncertainties and limitations associated with the modelling will therefore be relevant to this assessment and are discussed in detail in the H&G topic paper. At this stage, the sensitivity of the H&G modelling is not sufficient to provide accurate results at specific locations within the estuary, such as in proximity to turbine blocks or within immediate approach channels to the ports where the magnitude of potential effects will be most critical. Further modelling work would be needed to improve the predictions should a scheme in the Severn Estuary be supported.

7.2.5 Modelling output from the Hydraulics and Geomorphology topic paper suggests that all of the tidal power options have the potential to reduce net sediment flux within the study area (albeit to varying degrees). These changes may have an adverse impact on the aggregate industry as existing reserve sites may experience a reduction in sediment re-supply. However, it should be noted though that a degree of uncertainty surrounds the nature of sediment supply to the sand banks found in the study area. It is probable that many of the sand reserves are essentially relict (finite) resources deposited during glacial times and which do not experience substantial re-supply. However, further research would be required to ascertain the extent to which this holds true for all sites in the study area.

### *The implications for the Severn Bore from lagoon construction*

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

### *The implications for pleasure beaches from the development of STP options*

7.2.7 The SANDFLOW model has been used in the Hydraulics and Geomorphology topic to consider the impacts of proposed tidal power generation options on sediment transport in the study area. This information has subsequently been used to assess potential impacts on the tourism industry through changes in the re-supply of pleasure beaches. However, the modelling analyses only relate the risk of morphological



change to changes in flow velocities, and other factors such as water depth, waves and sediment supplies are not taken into account. More detailed (site specific) modelling would be required to obtain a better understanding of exactly how pleasure beaches may be affected.

*The implications for power station thermal plumes from the development of STP options*

- 7.2.8 The thermal plume modelling results from the marine water quality modelling are based on a 2D model and these findings suggest that cooling water discharge consents are, for the most part, unlikely to be affected. However, there is a degree of uncertainty with the adopted approach and this area of interest should ideally be revisited with the use of a 3D model in future studies.

*Marine Noise Environment*

- 7.2.9 There are no significant environmental noise effects anticipated with any of the alternatives. However, the underwater assessment has been made without confirmed knowledge of the underwater baseline noise environment, and on limited information available for the noise levels of the tidal turbines. Therefore, it will be necessary to undertake monitoring of the baseline noise environment in order to quantify the underwater noise environment. This will be required in order to assess any potential effects that may arise as a result the implementation of this feasibility study.

*Implications for the future of the recreational/ tourism fishery*

- 7.2.10 There is currently a shortage of information on the economic contribution and direct and indirect employment generation of salmon and sea trout fishing on the rivers Usk, Wye and Severn. It would be beneficial to have a better understanding of these issues should one of the Barrage options be supported.

*Implications on Transit Time through the estuary*

- 7.2.11 It is recommended that further study into current transit times is undertaken to inform and enable future modelling of the transit time effects of any option supported going forward.

**7.3 Other research to inform the development of alternative options beyond the feasibility stage**

- 7.3.1 The topic papers note a number of areas requiring refinement should any of the alternative options be supported beyond the feasibility stage. In addition, further suggestions emerging from the interfaces identified within Society & Economy theme reporting have been identified. These include:

- Further study of the effects on Society & Economy theme receptors should refinement of the alternative options identify that there will be far-field flood risk effects (not anticipated at the resolution of the SEA studies);
- Should the type of consequential development likely as result of the alternative options be further refined to a level enabling such work, then consideration of the likely effects of consequential development on Society & Economy theme (and other theme) receptors should be undertaken;



- 
- The resultant effect on communities linked with recreational/tourism fishing activity should be examined in greater detail as the effects of an alternative option on the commercial and recreational fishery become better understood.



SECTION 8

**GLOSSARY**



## 8 GLOSSARY

Term	Definition
Appropriate Assessment	A process previously required by the Habitats Regulations (SI 1994/ 2716) to avoid adverse effects of plans, programmes and projects on Natura 2000 sites and thereby maintain the coherence of the Natura 2000 network and its features.  From 1 April 2010, the regulations were replaced by The Conservation Of Habitats And Species Regulations, 2010
Ancillary development	Other works beyond a Severn Tidal Power scheme but are needed to build or operate the scheme, including measures to prevent, reduce or as fully as possible offset significant environment effects, e.g. dredging, bypasses etc.
Barrage	A manmade obstruction across a watercourse to retain a head of water on the rising tide, and then run the water through turbines when the tide level drops.
Bristol Channel	The area seaward of the headlands at Lavernock Point on the Welsh coast and Brean Down on the English coast (see Severn Estuary and also Inner Bristol Channel and Outer Bristol Channel)
Bulb Kapeller type turbines	The Kapeller Bulb turbine is a turbine regulated only by its adjustable runner blades (single regulation). It has fixed wicket gates. It is adaptable to pumping as well as generation but only suited to one way generation. Kapeller Bulb turbine technology has largely been superseded by Bulb Kaplan turbines.
Bulb Kaplan turbines	The Kaplan turbine is a propeller-type water turbine that has adjustable blades and adjustable wicket gates (double regulation). It is adaptable to pumping as well as generation. Kaplan turbines are now widely used throughout the world in high-flow, low-head power production. The Kaplan turbine is an inward flow reaction turbine, which means that the working fluid changes pressure as it moves through the turbine and gives up its energy. The Kaplan turbine is suited to one or two way generation.
Bulb turbines	The generator is mounted in a bulb on the main turbine axis upstream of the runner blades for one way generation. Bulb turbines can be used for one or two way generation depending on the type (see above).
Caissons	Prefabricated concrete units used to construct parts of a barrage, lagoon or other offshore structures. Caissons can be used to house turbines, sluices or to construct navigation locks, or they may just be plain units used for impoundment construction.
Coalfield river	A river draining a coalfield valley
Coastal Squeeze	Process whereby the coastal margin is squeezed between a fixed landward boundary and the rising sea level
Compensation	Measure which makes good for loss or damage to an SAC or SPA feature, without directly reducing that loss/damage. Only used in relation to the Habitats Directive (see offsetting, below).



Term	Definition
Consequential development	It is conceivable that a major tidal power scheme will facilitate or attract other developments, which may themselves pose significant environmental effects. These developments are described as 'consequential developments'.
Cumulative effects	Effects arise, for instance, where several developments each have insignificant effects but together have a significant effect, or where several individual effects of the plan have a combined effect.
Direct effects	The original effect as a result of an option (see indirect effects)
Ebb	When the sea or tide ebbs, it moves away from the coast and falls to a lower level
Ebb mode	One way generation on ebb tides only i.e. during the period between high tide and the next low tide in which the sea is receding.
Ebb and flood mode	Two way generation during the ebb and flood tides
Effect	Used to describe changes to the environment as a result of an option (see also direct effects, indirect effects, far-field effects and cumulative effects)
Eutrophication	An increase in chemical nutrients (compounds containing nitrogen or phosphorus). This in turn can lead to 'eutrophication effects' – an increase in an ecosystem's primary productivity (excessive plant growth and decay), and further effects including lack of oxygen and severe reductions in water quality, fish, and other animal populations.
Far-field effects	Effects that are felt outside the Severn Estuary study area.
Flood	The inward flow of the tide. This is the opposite of ebb. This refers to a mode of operation for a STP alternative option
Future baseline	Baseline during construction (2014-2020) and operation (2020-2140), decommissioning and longer term trends.
Geomorphology	The study of the changing form of the estuarine environment and its components in relation to physical forcing.
Hydrodynamics / hydraulics	The science of physical forces acting on the water.
Hypertidal	A tidal range in excess of 6m.
Impoundment	A body of water, such as a reservoir, made by impounding
Indicator	A measure of variables over time, often used to measure achievement of objectives.
Indirect effects	Those effects which occur away from the original effect or as a result of a complex pathway.
Inner Bristol	The downstream limit extends from Nash Point in Wales to the west of Minehead along the English coast. The upper limit extends from Swanbridge on the Welsh





Term	Definition
Channel	coast to Brean Down along the English coast.
Irreversible	An effect that cannot be reversed. If the timescale for a receptor's return to baseline condition is greater than 50 years then it will be considered irreversible.
Lagoon(s)/ Land-connected lagoons	A man-made enclosed body of water that retains a head of water on the rising tide and then runs the water through turbines when the tide level drops. A land connected lagoon uses the shoreline to make the enclosure.
Long-listed options	All options identified in the SDC report, Call for Proposals and other strategically selected proposals as well as the Interim Options Analysis Report.
Measures to prevent or reduce effects	Measures to prevent, or reduce any significant adverse effects on the environment
Natura 2000	Natura 2000 is the European Union-wide network of protected areas, recognised as 'sites of Community importance' under the EC Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora). The Natura 2000 network includes two types of designated areas: Special Areas of Conservation (SAC) and Special Protection Areas (SPA).
Negative effects	Changes which are unfavourable for a receptor. Can sometimes be referred to as 'adverse'.
Offsetting	Measures to as fully as possible offset any significant adverse effects on the environment. Such measures will aim to make good for loss or damage to an environmental receptor, without directly reducing that loss/damage. Not used in relation to the Habitats Directive (see compensation, above).
One way generation	The operating mode whereby power is generated on only one phase of the tidal cycle. For Severn tidal power, one way generation is typically ebb mode.
Original scheme	The form of the scheme when it was shortlisted at the end of phase 1.
Outer Bristol Channel	The outer limit extends from St. Govans Head in Pembrokeshire to Hartland Point in Devon, which traditionally defines the lower limit of the Bristol Channel. The upper limit extends from Nash Point in Wales to the west of Minehead along the English coast.
Permanent effect	An effect which will last at least for 50 years.
Phase 1	The first stage of the STP Feasibility Study - i.e. the Decision Making Assessment Framework (to develop a short-list of options) and SEA Scoping.
Phase 2	The second stage of the STP Feasibility Study - i.e. short-listed options appraisal and main assessment stage of the SEA.
Positive effects	Changes which are favourable for a receptor. Can sometimes be referred to as 'beneficial'.



Term	Definition
Pumping	Operating turbines in reverse to pump water from lower to higher levels. Pumping can be used during one way generation to raise impounded water levels so that more energy can be generated when the ebb tide is receding.
Ramsar site	Ramsar sites are designated under the International Convention on Wetlands of International Importance 1971 especially as Waterfowl Habitat (the Ramsar Convention).
Receptor	An entity that may be affected by direct or indirect changes to an environmental variable.
Reversible	An effect that can be reversed. If the timescale for a receptor's return to baseline condition is less than 50 years then it will be considered reversible.
Scoping	The process of deciding the scope and level of detail of an SEA, including the environmental effects and alternatives which need to be considered, the assessment methods to be used, and the structure and contents of the Environmental Report.
SEA objective	A statement of what is intended, specifying the desired direction of change in trends.
Seabed	The areas permanently covered by the sea, i.e. Lowest Astronomical Tide. Sometimes referred to as sub-tidal.
Severn Estuary	<p>This is the physical extent of the Estuary and does not reflect the Study Area (see below) or nature conservation designations.</p> <p>Downstream limit - headlands at Lavernock Point on the Welsh coast and Brean Down on the English coast passing through the small island features of Flat Holm and Steep Holm.</p> <p>Upstream limit – Haw Bridge, upstream of Gloucester on the River Severn (based on 1 in 100 year flood risk area and also used by Shoreline Management Plan (SMP) (Gifford, 1998) and Coastal Habitat Management Plan (CHaMP) (ABPmer 2006)).</p> <p>N.B. The tidal limit, which for the Severn is at Maisemore (West Parting) and Llanthony (East Parting) weirs, near Gloucester.</p>
Severn Tidal Power Study Area	<p>The general study area used for the project broadly extends downstream on the Estuary as far as Worm's Head to Morte Point. It includes the landward fringe and tributaries such as the River Wye and the River Usk.</p> <p>Study areas for individual topics for Phase 2 may extend beyond this area and these are defined separately according to topic.</p>
Short-listed options	Options screened from long-listed options, to be taken forward for analysis in the SEA following the public consultation conducted in 2009.
Significant environmental effects	Effects on the environment which are significant in the context of a plan or programme. Criteria for assessing significance are set out in Annex II of the SEA Directive (2001/42/EC).



Term	Definition
Site of Special Scientific Interest (SSSI)	Designated under the Wildlife and Countryside Act 1981, any land considered by Natural England to be of special interest because of any of its flora, fauna, or geological and physiographical features.
Sluice caissons	Prefabricated concrete structures placed into the water to house a sluice.
Special Area of Conservation (SAC)	Strictly protected site designated under the EC Habitats Directive 92/43/EEC. Article 3 of the Habitats Directive requires the establishment of a European network of important high-quality conservation sites that will make a significant contribution to conserving the 189 habitat types and 788 species identified in Annexes I and II of the Directive (as amended). The listed habitat types and species are those considered to be most in need of conservation at a European level (excluding birds).
Special Protection Area (SPA)	Strictly protected site classified in accordance with Article 4 of the EC Directive on the Conservation of Wild Birds (79/409/EEC), also known as the Birds Directive.  They are classified for rare and vulnerable birds, listed in Annex I to the Birds Directive, and for regularly occurring migratory species.
Straflo type turbines	A more compact turbine compared to Bulb turbine technology. Instead of containing the generator in a bulb, it is located and designed for ebb only operation and not suited to pumping.
Strategic Environmental Assessment (SEA)	Term used to describe environmental assessment as applied to policies, plans and programmes. 'SEA' is used to refer to the type of environmental assessment required under the SEA Directive.
Sub tidal	Areas (particularly with reference to habitats) that lie below the level of the lowest astronomical tide.
Synergistic effects	Effects which interact to produce a total effect greater than the sum of the individual effects, so that the nature of the final impact is different to the nature of the individual effects. Included within cumulative effects (see above).
Temporary effects	An effects which only lasts part of the project lifetime, e.g. is confined to the construction period.
The Shoots	The downstream boundary extends from Undy along the Welsh coast to Severn Beach along the English coast, just to the south of the M4 motorway crossing. The upstream limit extends just to the north of the M46 motorway crossing, between Beachley on the Welsh coast and Aust on the English coast.
Tidal bore	A tidal phenomenon in which the leading edge of the incoming tide forms a wave (or waves) of water that travel up a river or narrow bay against the direction of the current.
Tidal Prism	The difference between the mean high-water volume and the mean low-water volume of an estuary



Term	Definition
Transboundary Effects	An environmental effect upon another EU Member State
Turbine caissons	Prefabricated concrete structures placed into the water to house turbines.
TWh/year	A unit used to describe how much energy generated, sold, consumed, etc. A terawatt-hour refers to generating or using power at a capacity of 1 terawatt (1012 watts) for one hour. A terawatt-hour per year means the equivalent amount of power sometime within the period of a year.
Two way generation	The operating mode whereby power is generated on both phases of the tidal cycle (ebb and flood)
Upper Severn Estuary	Upstream from the M46 motorway crossing, between Beachley on the Welsh coast and Aust on the English coast, to the tidal limit along the River Severn at Maisemere, Gloucestershire.
Variant	A modified version of the original shortlisted scheme.

SECTION 9

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SECTION 10

**APPENDICES**



## APPENDIX A





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**APPENDIX A**

Table 1: Communities Objective Assessment Summary

Table 2: Navigation Objectives Assessment Summary

Table 3: Other Sea Uses Objective Assessment Summary

Table 4: Noise & Vibration Objective Assessment Summary



### Communities SEA Objective Assessment Summary Table

#### Key

Performance is based on number or proportion of receptors linked to each SEA Objective for which significant effects have been predicted, and informed by consideration of SEA Assessment Criteria.			
Major negative performance against SEA Objective	--	Major positive performance against SEA Objective	++
Minor negative performance against SEA Objective	-	Minor positive performance against SEA Objective	+
No Effects	0	Uncertain	?

**Table 2: Communities Objective Assessment Summary**

SEA Objective	Relevant Receptors	Alternatives Performance against SEA Objectives over entire life-cycle				
		Alternative Option B3: Brean Down to Lavernock Point Barrage	Alternative Option B4: Shoots Barrage	Alternative Option B5: Beachley Barrage	Alternative Option L2: Welsh Grounds Lagoon	Alternative Option L3d: Bridgwater Bay Lagoon
SE1: To seek to create local employment opportunities accessible to all	Vale of Glamorgan, Cardiff, Newport, Monmouthshire, South Gloucestershire, Bristol, North Somerset, Sedgemoor, West Somerset (see Section 3 for receptors affected by each alternative)	++	+	+	+	++
		Construction employment 35,000 – 45,000 person years, operational employment 750 – 1,000 FTE, decommissioning employment as construction	Construction employment 10,000 – 15,000 person years, operational employment 100 – 200 FTE, decommissioning employment as construction	Construction employment 6,000 – 8,000 person years, operational employment 80 – 100 FTE, decommissioning employment as construction	Construction employment 15,000 – 20,000 person years, operational employment 120 – 180 FTE, decommissioning employment as construction	Construction employment 30,000 – 37,000 person years, operational employment 200 – 300 FTE, decommissioning employment as construction
SE2: To avoid adverse effects on the local and regional economy	Port of Bristol, Brean Beach and Lavernock Point and Rivers Usk, Wye and Severn Atlantic salmon and sea trout fishing; and Rivers Severn and Wye heritage (elver) fishing	--	--	--	--	--
		30% loss of port trade during construction, 60% loss of trade during operation, although it is assumed that some or all of this effect can be prevented/reduced through measures outlined in Section 3.12 above. Complete loss of Atlantic salmon, sea trout and heritage (elver) fishing employment.	2.5% loss of port trade during construction, 5% loss of trade during operation although it is assumed that some or all of this effect can be prevented/reduced through measures outlined in Section 3.12 above. Partial loss of Atlantic salmon, sea trout and heritage (elver) fishing employment.	2.5% loss of port trade during construction, 5% loss of trade during operation although it is assumed that some or all of this effect can be prevented/reduced through measures outlined in Section 3.12 above. Partial loss of Atlantic salmon, sea trout and heritage (elver) fishing employment.	2.5% loss of port trade during construction, 5% loss of trade during operation although it is assumed that some or all of this effect can be prevented/reduced through measures outlined in Section 3.12 above. Partial loss of Atlantic salmon, sea trout and heritage (elver) fishing employment.	2.5% loss of port trade during construction, 5% loss of trade during operation although it is assumed that some or all of this effect can be prevented/reduced through measures outlined in Section 3.12 above. Partial loss of Atlantic salmon, sea trout and heritage (elver) fishing employment.
SE3: To promote the development of sustainable communities	Vale of Glamorgan, Cardiff, Newport, Monmouthshire, South Gloucestershire, Bristol, North Somerset, Sedgemoor, West Somerset (see Section 3 for receptors affected by each alternative)	0	0	0	0	0
		See text above for discussion of in-migration effects during construction and operation	See text above for discussion of in-migration effects during construction and operation	See text above for discussion of in-migration effects during construction and operation	See text above for discussion of in-migration effects during construction and operation	See text above for discussion of in-migration effects during construction and operation
SE4: To avoid adverse effects on physical and mental health	Local population within the following MSOAs: The Vale of Glamorgan 008, The Vale of Glamorgan 006, Sedgemoor 002, North Somerset 025, North Somerset 022, North Somerset 023, Monmouthshire 010, Monmouthshire 011, South Gloucestershire 005, Monmouthshire 009, Bristol 003, Bristol 008, Forest of Dean 010, South Gloucestershire 004, South Gloucestershire 005,	0	0	0	0	0
		Likely significant adverse effects on health and quality of life of the population of the Vale of Glamorgan 008 and Sedgemoor 002 due to the cumulative effect of disruptions due to traffic and air quality and landscape issues during construction. These can be avoided or minimised through design and sequencing of construction should the alternative option be progressed. No	Some adverse effects on physical and mental health of the local population possible during construction. These can be avoided or minimised through design, sequencing of construction and management of labour should the alternative option be progressed. No operational effects anticipated.	Some adverse effects on physical and mental health of the local population possible during construction. These can be avoided or minimised through design, sequencing of construction and management of labour should the alternative option be progressed. No operational effects anticipated.	Likely significant adverse effects on health and quality of life of the population of Monmouthshire 009 and Newport 015 due to the cumulative effect of disruptions due to traffic and air quality and landscape issues during construction. These can be avoided or minimised through design and sequencing of construction should the alternative option be progressed. No	Likely significant adverse effects on health and quality of life of the population of the West Somerset 004 and Sedgemoor 002 due to the cumulative effect of disruptions due to traffic and air quality and landscape issues during construction. These can be avoided or minimised through design and sequencing of construction should the alternative option be progressed. No





SEA Objective	Relevant Receptors	Alternatives Performance against SEA Objectives over entire life-cycle				
		Alternative Option B3: Brean Down to Lavernock Point Barrage	Alternative Option B4: Shoots Barrage	Alternative Option B5: Beachley Barrage	Alternative Option L2: Welsh Grounds Lagoon	Alternative Option L3d: Bridgwater Bay Lagoon
	Monmouthshire 008, Monmouthshire 009, Newport 015, Newport 004, Newport 018, Newport 020, West Somerset 004	operational effects anticipated.			operational effects anticipated.	operational effects anticipated.
SE5: To avoid adverse effects on access to community services and facilities	Community and services facilities within the following MSOAs: The Vale of Glamorgan 008, Sedgemoor 002, Monmouthshire 011, Monmouthshire 010, South Gloucestershire 005, Forest of Dean 010, South Gloucestershire 004, Monmouthshire 009, Newport 015, West Somerset 004, Sedgemoor 002	0	0	0	0	0
		Some adverse effects on access to local communities and facilities during construction. These can be avoided or minimised through design, sequencing of construction and management of labour should the alternative option be progressed. No operational effects anticipated.	Some adverse effects on access to local communities and facilities during construction. These can be avoided or minimised through design, sequencing of construction and management of labour should the alternative option be progressed. No operational effects anticipated.	Some adverse effects on access to local communities and facilities during construction. These can be avoided or minimised through design, sequencing of construction and management of labour should the alternative option be progressed. No operational effects anticipated.	Some adverse effects on access to local communities and facilities during construction. These can be avoided or minimised through design, sequencing of construction and management of labour should the alternative option be progressed. No operational effects anticipated.	Some adverse effects on access to local communities and facilities during construction. These can be avoided or minimised through design, sequencing of construction and management of labour should the alternative option be progressed. No operational effects anticipated.
SE6: To promote access to recreational facilities and open space (revised to improve coverage of non-estuary tourism related issues)	Recreational facilities and open space within the following MSOAs: The Vale of Glamorgan 008, Sedgemoor 002, Monmouthshire 011, Monmouthshire 010, South Gloucestershire 005, Forest of Dean 010, South Gloucestershire 004, Monmouthshire 009, Newport 015, West Somerset 004, Sedgemoor 002	0	0	0	0	0
		The alternative option will not actively promote access to recreational facilities or open space, given its focus as an energy generating project.  Indeed, the proximity of the scheme may affect access to some recreational sites/open spaces during construction; however this can be avoided or reduced through design and management of construction activities.  During operation, it may facilitate or attract altered water-based recreation and tourism. A longer period of high water may increase the attraction of Weston-super-Mare as a visitor destination and calmer water in the bay may encourage greater use for recreational water sports.	The alternative option will not actively promote access to recreational facilities or open space, given its focus as an energy generating project.  Indeed, the proximity of the scheme may affect access to some recreational sites/open spaces during construction; however this can be avoided or reduced through design and management of construction activities.  During operation, the alternative option may facilitate or attract altered water-based recreation and tourism. It may add also to the existing Severn bridge visitor attractions.	The alternative option will not actively promote access to recreational facilities or open space, given its focus as an energy generating project.  Indeed, the proximity of the scheme may affect access to some recreational sites/open spaces during construction; however this can be avoided or reduced through design and management of construction activities.  During operation, the alternative option may facilitate or attract altered water-based recreation and tourism. It may add also to the existing Severn bridge visitor attractions.	The alternative option will not actively promote access to recreational facilities or open space, given its focus as an energy generating project.  Indeed, the proximity of the scheme may affect access to some recreational sites/open spaces during construction; however this can be avoided or reduced through design and management of construction activities.  During operation, the alternative option may facilitate or attract altered water-based recreation and tourism. The alternative option will create a calmed body of water which may be attractive for new recreational water sport.	The alternative option will not actively promote access to recreational facilities or open space, given its focus as an energy generating project.  Indeed, the proximity of the scheme may affect access to some recreational sites/open spaces during construction; however this can be avoided or reduced through design and management of construction activities.  During operation, the alternative option may facilitate or attract altered water-based recreation and tourism. The alternative option will create a calmed body of water which may be attractive for new recreational water sport.
SE7: To avoid adverse effects on existing, proposed and committed land uses	Existing and proposed land uses within the following MSOAs: The Vale of Glamorgan 008, Sedgemoor 002, Monmouthshire 011, Monmouthshire 010, South Gloucestershire 005, Forest of Dean 010, South Gloucestershire 004, Monmouthshire 009, Newport 015, West Somerset 004, Sedgemoor 002	0	0	0	0	0
		The effects summarised under Objective SE2 are also relevant here, with changes to economic activities likely to be translated into changes in land-use.  Although the main structure will be located offshore, the footprint of the alternative options will result in permanent land take at each landfall point. In many cases this will result in loss of undeveloped	The effects summarised under Objective SE2 are also relevant here, with changes to economic activities likely to be translated into changes in land-use.  Although the main structure will be located offshore, the footprint of the alternative options will result in permanent land take at each landfall point. In many cases this will result in loss of undeveloped	The effects summarised under Objective SE2 are also relevant here, with changes to economic activities likely to be translated into changes in land-use.  Although the main structure will be located offshore, the footprint of the alternative options will result in permanent land take at each landfall point. In many cases this will result in loss of undeveloped	The effects summarised under Objective SE2 are also relevant here, with changes to economic activities likely to be translated into changes in land-use.  Although the main structure will be located offshore, the footprint of the alternative options will result in permanent land take at each landfall point. In many cases this will result in loss of undeveloped	The effects summarised under Objective SE2 are also relevant here, with changes to economic activities likely to be translated into changes in land-use.  Although the main structure will be located offshore, the footprint of the alternative options will result in permanent land take at each landfall point. In many cases this will result in loss of undeveloped



SEA Objective	Relevant Receptors	Alternatives Performance against SEA Objectives over entire life-cycle				
		Alternative Option B3: Brean Down to Lavernock Point Barrage	Alternative Option B4: Shoots Barrage	Alternative Option B5: Beachley Barrage	Alternative Option L2: Welsh Grounds Lagoon	Alternative Option L3d: Bridgwater Bay Lagoon
		coastal areas, or agricultural land.  The land take associated with the footprint of each alternative option are not anticipated to directly affect existing, committed or proposed developments in the local area.  Potential for cumulative effects with management of coastal defences and Severn Sea Ferry projects (to be completed by 2014).	coastal areas, or agricultural land.  Potential for cumulative effects with management of coastal defences project (to be completed by 2014).  However, the land take associated with the footprint of each alternative option is not anticipated to directly affect existing, committed or proposed developments in the local area.	coastal areas, or agricultural land.  Potential for cumulative effects with management of coastal defences project (to be completed by 2014).  However, the land take associated with the footprint of each alternative option is not anticipated to directly affect existing, committed or proposed developments in the local area	coastal areas, or agricultural land.  Potential for cumulative effects with proposed projects (ongoing and to be completed by 2014); i.e. management of coastal defences, Severn Power (power station at Uskmouth), Uskmouth B power station.  However, the land take associated with the footprint of each alternative option is not anticipated to directly affect existing, committed or proposed developments in the local area	coastal areas, or agricultural land.  Potential for cumulative effects with proposed/committed projects expected to be implemented during L3d construction period (2014-2020) or operation period (2020-2140); i.e. Decommissioning of Hinkley Point A and B Nuclear plants; Development of Hinkley Point C nuclear plant; and National Grid Reinforcement for Hinkley Point C nuclear development.  It is not thought that the presence of one or other of these schemes would prevent the other from operating.
SE8: To seek opportunities to improve degraded environments	Cardiff, Newport, Bristol, North Somerset, Sedgemoor	?	?	?	?	?
		Within current terms will not directly seek opportunities to improve degraded environments. Although some minor positive effects may be realised through substantial generation of employment within accessible distances of areas of high deprivation during construction. Less substantial employment requirements during operation,  Opportunity for development/regeneration within the local area; potential for two consequential developments: altered water-based recreation and tourism and Energy intensive industry to supplement that resulting from other new nuclear energy.  Given the uncertainties associated with the above, it is not considered possible to speculate on whether the alternative options as currently described will support this Objective.	Within current terms will not directly seek opportunities to improve degraded environments. Although some minor positive effects may be realised through substantial generation of employment within accessible distances of areas of high deprivation during construction. Less substantial employment requirements during operation,  Opportunity for development/regeneration within the local area; potential for two consequential developments: altered water-based recreation and tourism and Energy intensive industry to supplement that resulting from other new nuclear energy  Given the uncertainties associated with the above, it is not considered possible to speculate on whether the alternative options as currently described will support this Objective.	Within current terms will not directly seek opportunities to improve degraded environments. Although some minor positive effects may be realised through substantial generation of employment within accessible distances of areas of high deprivation during construction. Less substantial employment requirements during operation,  Opportunity for development/regeneration within the local area; potential for two consequential developments: altered water-based recreation and tourism and Energy intensive industry to supplement that resulting from other new nuclear energy  Given the uncertainties associated with the above, it is not considered possible to speculate on whether the alternative options as currently described will support this Objective.	Within current terms will not directly seek opportunities to improve degraded environments. Although some minor positive effects may be realised through substantial generation of employment within accessible distances of areas of high deprivation during construction. Less substantial employment requirements during operation,  Opportunity for development/regeneration within the local area; potential for two consequential developments: altered water-based recreation and tourism and Energy intensive industry to supplement that resulting from other new nuclear energy  Given the uncertainties associated with the above, it is not considered possible to speculate on whether the alternative options as currently described will support this Objective.	Within current terms will not directly seek opportunities to improve degraded environments. Although some minor positive effects may be realised through substantial generation of employment within accessible distances of areas of high deprivation during construction. Less substantial employment requirements during operation,  Opportunity for development/regeneration within the local area; potential for two consequential developments: altered water-based recreation and tourism and Energy intensive industry to supplement that resulting from other new nuclear energy  Given the uncertainties associated with the above, it is not considered possible to speculate on whether the alternative options as currently described will support this Objective.
SE9: To avoid adverse effects on the housing market	Vale of Glamorgan, Cardiff, Newport, Monmouthshire, South Gloucestershire, Bristol, North Somerset, Sedgemoor, West Somerset (see Section 3 for receptors affected by each	0	0	0	0	0
		See text above for discussion of in-migration effects during construction and operation	See text above for discussion of in-migration effects during construction and operation	See text above for discussion of in-migration effects during construction and operation	See text above for discussion of in-migration effects during construction and operation	See text above for discussion of in-migration effects during construction and operation



SEA Objective	Relevant Receptors	Alternatives Performance against SEA Objectives over entire life-cycle				
		Alternative Option B3: Brean Down to Lavernock Point Barrage	Alternative Option B4: Shoots Barrage	Alternative Option B5: Beachley Barrage	Alternative Option L2: Welsh Grounds Lagoon	Alternative Option L3d: Bridgwater Bay Lagoon
	alternative)					



### Navigation SEA Objective Assessment Summary Table

#### Key

Performance is based on number or proportion of receptors linked to each SEA Objective for which significant effects have been predicted, and informed by consideration of SEA Assessment Criteria.

Major negative performance against SEA Objective	--	Major positive performance against SEA Objective	++
Minor negative performance against SEA Objective	-	Minor positive performance against SEA Objective	+
No Effects	0	Uncertain	?

**Table 3: Navigation Objectives Assessment Summary**

SEA Objective	Relevant Receptors	Alternatives Performance against SEA Objectives over entire life-cycle				
		Alternative Option B3: Brean Down to Lavernock Point Barrage	Alternative Option B4: Shoots Barrage	Alternative Option B5: Beachley Barrage	Alternative Option L2: Welsh Grounds Lagoon	Alternative Option L3d: Bridgwater Bay Lagoon
SEA Objective NAV1	To avoid adverse effects on Severn estuary navigation arising from sedimentation, geomorphology, water density, and tidal water levels	0	0	0	0	0
		Reduction in lock sill level and/or capital/maintenance dredging required to all ports to maintain access.	Increased dredging required to Bristol and Sharpness to maintain access.	Reduction in lock sill level and capital/maintenance dredging required to Sharpness to maintain access.	Increased maintenance dredging required to Bristol to maintain access.	Reduction in lock sill level and/or increased dredging required to all ports to maintain access.
SEA Objective NAV2	To avoid adverse effects on the integrity of existing and proposed port operations	-	-	-	0	0
		Dredging required for new deep water navigation channel from Lavernock Point lock Residual risks to total transit time to all ports.	Relocation of lock to west of Barrage. Residual risk of high velocities. Residual risks to total transit time to Sharpness.	Relocation of lock to west of Barrage. Residual risk of high velocities. Residual risks to total transit time to Sharpness.		



### Other Sea Uses SEA Objective Assessment Summary Table

#### Key

Performance is based on number or proportion of receptors linked to each SEA Objective for which significant effects have been predicted, and informed by consideration of SEA Assessment Criteria.			
Major negative performance against SEA Objective	--	Major positive performance against SEA Objective	++
Minor negative performance against SEA Objective	-	Minor positive performance against SEA Objective	+
No Effects	0	Uncertain	?

**Table 4: Other Sea Uses Objective Assessment Summary**

SEA Objective	Relevant Receptors	Alternatives Performance against SEA Objectives over entire life-cycle				
		Alternative Option B3: Brean Down to Lavernock Point Barrage	Alternative Option B4: Shoots Barrage	Alternative Option B5: Beachley Barrage	Alternative Option L2: Welsh Grounds Lagoon	Alternative Option L3d: Bridgwater Bay Lagoon
SEA Objective 1 To avoid adverse effects on the aggregate extraction industry	Aggregate Extraction	--	0	0	-	0
		Possible disruption to the Estuary dredging cycle. Disruption may be reduced via ( <i>inter alia</i> ) coordination and prior notification of dredger arrival times at the barrage			Likely loss of reserve areas. May be possible to expand existing licence areas/ quotas to partially offset this effect although this may be incompatible with existing Severn Estuary/Môr Hafren SAC conservation objectives and IMADP.	
SEA Objective 2 To avoid adverse effects on marine waste disposal sites and infrastructure	Marine Waste Disposal Sites and Infrastructure	0	0	0	0	0
		All significant effects relating to the smothering/ undermining of outfalls, the possible reduction in hydraulic performance of gravity driven outfalls and the possible unsuitability of existing dredge waste disposal sites can all be either prevented, reduced or offset.				
SEA Objective 3 To avoid adverse effects on marine recreational users	Marine Recreational Users	++	+	+	+	-
		Far more favourable conditions for recreational users up-estuary from the barrage Improved small craft access to the Estuary				Increased peak flow speeds in Bridgwater Bay, making conditions potentially less favourable for most recreational users
SEA Objective 4 To avoid adverse effects on sustainable estuary-based tourism in both the South Wales and South West England Regions	Sustainable estuary-based tourism in both the South Wales and South West England Regions	+/-	+/-	+/-	+/-	+/-
		All of the tidal power options may become visitor attractions (although the extent to which this may occur varies greatly between options). However, all of the options have the capacity to reduce the aesthetic appeal of the Estuary, potentially impacting coastal tourism. Considerable reduction in the extent of inter-tidal area has the capacity to adversely affect waterbird populations on the Estuary and hence income from nature based tourism. However, targeted topographic modifications to the Estuary following the implementation of any tidal power option have the potential to greatly reduce the loss of inter-tidal area. All of the options have the potential to cause deposition of mud/silt at existing sandy pleasure beaches, potentially making them (and the coastal resorts they support) less desirable. However, it is not possible to determine the spatial extent and magnitude of this effect from the hydraulics and geomorphology modelling results.				
SEA Objective 5 To avoid adverse affects on military activity in the	Military activity	0	0	0	0	0
			The B4 barrage option is situated close to the Military			



SEA Objective	Relevant Receptors	Alternatives Performance against SEA Objectives over entire life-cycle				
		Alternative Option B3: Brean Down to Lavernock Point Barrage	Alternative Option B4: Shoots Barrage	Alternative Option B5: Beachley Barrage	Alternative Option L2: Welsh Grounds Lagoon	Alternative Option L3d: Bridgwater Bay Lagoon
region			firing range near Redwick and plant are likely to require regular access to this area during the construction phase  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 should ensure this does not become a substantial issue.			
SEA Objective 6  To avoid adverse effects on the energy industry	Energy Industry	0	0	0	0	0
						During the construction phase the thermal plume from Hinkley B power station may be constrained against the L3d lagoon embankment causing a detrimental impact to the environment. However, this impact may be reduced by delaying construction of the southern end of the lagoon until the closure of Hinkley in 2016.  Should Hinkley C be consented, cooling water intakes/outfalls could be re-sited
SEA Objective 7  To avoid adverse effects on seabed cables in the region	Seabed cables and Pipelines	0	0	0	0	0
		Some cables may be at risk from undermining. However, cable scour may be reduced through the implementation of scour protection or, if necessary, the re-siting of existing routes.			Some cables may be at risk from undermining. However, cable scour may be reduced through the implementation of scour protection or, if necessary, the re-siting of existing routes.	
SEA Objective 8  To minimise adverse effects on the Severn Bore	Severn Bore	--	--	--	?	?
		The construction of any of the barrage options is highly likely to prevent or at least greatly reduce the Severn Bore. No realistic prevention or reduction measures are available.			The formation and propagation of tidal bores are sensitive to a number of factors including tidal range, current velocity and seabed morphology. More detailed modelling analyses are required to confidently address the possible impact from the lagoon options.	





### Noise & Vibration SEA Objective Assessment Summary Table

#### Key

Performance is based on number or proportion of receptors linked to each SEA Objective for which significant effects have been predicted, and informed by consideration of SEA Assessment Criteria.

Major negative performance against SEA Objective	--	Major positive performance against SEA Objective	++
Minor negative performance against SEA Objective	-	Minor positive performance against SEA Objective	+
No Effects	0	Uncertain	?

**Table 5: Noise & Vibration Objective Assessment Summary**

SEA Objective	Relevant Receptors	Alternatives Performance against SEA Objectives over entire life-cycle				
		Alternative Option B3: Brean Down to Lavernock Point Barrage	Alternative Option B4: Shoots Barrage	Alternative Option B5: Beachley Barrage	Alternative Option L2: Welsh Grounds Lagoon	Alternative Option L3d: Bridgwater Bay Lagoon
SEA Objective 1: To avoid adverse effects of negative noise and vibration on (humans) noise sensitive receptors.	Noise sensitive Receptors (NSR) Residential.  And  Noise sensitive Receptors (NSR) Non-Residential.	(0 to -) All the alternatives will meet this objective in terms of there being no significant noise effect following measures to prevent or reduce adverse effects, however, there will still be noise 'heard' which can be considered an effect, however insignificant that may be.  Has 4 NSRs within 400m, 22 NSRs within 800m, and only 1142 within 2km. Therefore very few receptors will experience high levels of noise, and relatively few will experience distant noise.	Has the greatest number of NSRs within 2km (4348), however, has no receptors within 400m, and only 48 NSRs within 800m. Thus very few receptors will experience high levels of noise.	Has 24 NSRs within 200m, 44 within 400m, 133 NSR at 800m, and 1200 at 2km. Resulting a greater number of NSRs experiencing greater noise levels, but relatively few NSRs experiencing any noise effects.	Has 89 NSRs within 400m, 149 NSRs within 800m, rising to 1250 NSRs at 2km, therefore relatively more NSRs will experience some effects from the level of noise, but a relatively low number overall	Has 10 NSRs within 200m, 18 NSRs within 800m, and only 273 NSRs within 2km resulting in few NSRs experiencing some noise effect.
SEA Objective 2: To avoid adverse effects on the acoustic quality of the marine environment.	Fish, Marine mammals and the marine environment	(? Uncertain) Following consideration and implementation of measures to prevent or reduce adverse effects, the effects of the alternatives should be reduced in significance. However, for further detailed assessment reference should be made to the Migratory & Estuarine Fish topic paper.				
SEA Objective 3: To avoid adverse effects on noise (vibration) sensitive receptors.	Noise sensitive Receptors (NSR) Wildlife	(0 to -) Following consideration and implementation of measures to prevent or reduce adverse effects, the effects of the alternatives should be reduced in significance. However, for further detailed assessment reference should be made to the Terrestrial & Freshwater Ecology topic paper.				
SEA Objective 4: To avoid adverse effects through vibration.	Noise sensitive Receptors (NSR) Residential.  And  Noise sensitive Receptors (NSR) Non-Residential.	(0 to -) All the alternatives will meet this objective in terms of there being no significant vibration effect following measures to prevent or reduce adverse effects,  There are no NSRs within close proximity to the landfall footprint therefore there will be no NSRs within a range to experience the effects of vibration	There are no NSRs within close proximity to the landfall footprint therefore there will be no NSRs within a range to experience the effects of vibration	There are 24 NSRs within 200m. It is therefore possible that some effect from vibration may result, should there be significant levels of vibration occurring. (For example during piling activities during construction). However, following measures to prevent or reduce adverse effects, these levels will not be significant	There are no NSRs within close proximity to the landfall footprint therefore there will be no NSRs within a range to experience the effects of vibration	There are 10 NSRs within 200m. It is therefore possible that some effect from vibration may result, should there be significant levels of vibration occurring. (For example during piling activities during construction). However, following measures to prevent or reduce adverse effects, these levels will not be significant