DECC

SEVERN TIDAL POWER - SEA TOPIC PAPER

Resources and Waste

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ABBREVIATIONS

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The following abbreviations are used in this Topic Report:

BERR	Department for Business, Enterprise and Regulatory Reform
CCW	Countryside Council for Wales
CDE waste	Construction, demolition and excavation waste
C&D waste	Construction and demolition waste
DCLG	Department for Communities and Local Government
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EIA	Environmental Impact Assessment
EC	European Commission
EU	European Union
GHG	Greenhouse Gases
GIS	Geographical Information System
GW	Gigawatts
MW	Megawatt
NPS	National Policy Statement
ODPM	Office of the Deputy Prime Minister
PPG	Planning Policy Guidance
PPS	Planning Policy Statements
RAWP	Regional Aggregate Working Party
SDC	Sustainable Development Commission
SEA	Strategic Environmental Assessment
STP	Severn Tidal Power
t	tonnes
TWh	Terrawatt hours
TAN	Technical Advice Note
UKCIP	United Kingdom Climate Impacts Programme
WAG	Welsh Assembly Government
WEEE	Waste electronic and electrical equipment

NON TECHNICAL SUMMARY

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Introduction

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

Consultation

The following consultation activities have been undertaken:

- Scoping consultation in January 2009
- Technical Workshops held in June and December 2009

SEA Objectives

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

- To promote sustainable use of resources
- To reduce waste generation and disposal, and achieve sustainable management of waste

Baseline Environment

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

The baseline is described in terms of the receptors identified for this topic. For the purposes of this topic paper, the resource receptors that are being studied are defined as the natural resources that will be used in the project. In the scoping paper prepared for the first phase of this SEA, a single resource receptor was identified: resource availability. To facilitate the more detailed assessment required in Phase 2 of the SEA, this single receptor has been split into the four key resources that will be used in the construction of any of the options. The key resource receptors that have been identified in conjunction with the design and engineering development of the options are:

- Aggregates and concrete,
- Steel,
- Energy (including fuels and electricity), and
- Water.

The Phase 1 scoping report identified the waste receptor as waste management facilities. To facilitate the more detailed assessment required in Phase 2 of the SEA, this single receptor has been split into the types of waste treatment and disposal facilities that will be used during the construction, operation and decommissioning of any of the options. The waste receptors to be assessed for this topic paper have been identified as:

- Sites for reuse opportunities (on-site or off-site), such as other construction projects or habitat enhancement projects,
- Treatment and recycling facilities,
- Energy recovery, and
- Landfill.

Baseline environment up to 2009
The UK is generally self-sufficient in its demand for aggregate and embankment materials. Some 280 million tonnes per year are consumed, from land and marine sources, as well as some 70 million tonnes of secondary and recycled aggregate. Wales and the South West of England produce in the order of 50 million tonnes per year.

Global steel production was 1,341 million tonnes in 2007, following rapid growth since the turn of the century from production of under 800 million tonnes per annum in the 1990s. China produced nearly 500 million tonnes (37 per cent) of the world's steel in 2007. The UK's steel production is small: 1 per cent of global production (14.3 million tonnes in 2007), of which it exported 7.7 million tonnes. The UK consumed 14.3 million tonnes, of which it imported 6.5 million tonnes.
The UK's energy consumption in 2008 was 165 million tonnes of oil equivalent, of which just 3 per cent was used by the construction industry (0.5 million tonnes), compared with the domestic sector (46 million tonnes) and the transport sector (59 million tonnes).

In the vicinity of the Severn Estuary, Welsh Water manages water resources across Wales, with South West Water, Severn Trent and Bristol Water being responsible on the English side of the estuary. Together the water companies supply over 3 million m3 per day. Households consume about half of the water supplied, about 150 litres per person per day, which has been relatively constant over the last five years, whereas industrial and commercial demand has decreased.

Construction and demolition companies in Wales produced 12.2 million tonnes of construction and demolition waste in 2005/06, and a further 90 million tonnes per year in England.

The STP study area loosely corresponds to the EA's reporting areas of Wales, the South West of England and the West Midlands. There are 137 landfills across the three areas, which include hazardous, non-hazardous and inert waste landfills. The 28 incinerators are generally smaller industrial facilities, which are unlikely to be accessible for STP project waste, although they do include a number of municipal waste incinerators in the English regions. It is worth noting that there are no hazardous waste landfills in Wales. The 289 treatment facilities include a range of activities such as recycling (eg plastics, metals, glass), composting, processing (eg concrete crushing, dismantling old cars), treatment (eg cleaning of contaminated soil, refining waste oil), some of which may be more relevant to the STP project than others.

Future baseline during construction: 2014-2020
Wales and the South West of England produce in the order of 50 million tonnes of aggregates per year and regional aggregate working party data indicate that the regions have extensive land banks of sand, gravel and crushed rock. Policy drivers such as the Quality Protocols and the Aggregates Levy are acting to increase the production of demand for secondary and recycled aggregates rather than virgin aggregates.

Global steel production has been rising exponentially, increasing from 720 million tonnes per annum in 1992 to 1,341 million tonnes in 2007. Much of the increased production and demand has been in developing countries including China and India, which have recently experienced economic booms. Steel production is carbon-intensive and therefore production locations and costs may be influenced by environmental legislation.

National energy policy, including the Renewable Energy Strategy, will affect the energy supply mix, rather than its availability. Transport and construction operations are likely to continue to be predominantly fossil-fuel based during the construction phase.

Population pressures, which will increase demand, and the hotter drier summers and warmer wetter winters caused by climate change, which will affect seasonal availability, are seen as the key risks to the security of water supply in the medium to long term.

The Welsh Assembly Government is proposing that by 2019/20, 90 per cent of non-hazardous and inert construction and demolition waste should be recycled, recovered, or reused. In addition, it is proposing that by 2015/16, there should be landfill diversion of 50 per cent of 2007 levels, and 75 per cent by 2019/20. The Strategy for Sustainable Construction sets a target of a 50% reduction of construction, demolition and excavation waste to landfill by 2012 compared to 2008 levels.

Future baseline during operation 2020-2140, decommissioning and longer term trends
No policy exists that looks sufficiently into the future to give an understanding of the baseline during operation and beyond. However if it would seem reasonable to assume that sustainability and climate change will continue to be key policy drivers, in which case increasing preference for secondary and recycled aggregates, recycled steel, and low carbon energy is likely.

Key Environmental Issues and Problems
There are a number of existing or potential environmental issues associated with the resources required for an STP project or with waste disposal.

Whilst aggregates are plentiful in the UK, there is an environmental cost associated with their extraction, and increased demand, such as for an STP project, could lead to the development of new quarries or dredging areas. Government policy, which aims to reduce demand for virgin aggregates, is to encourage the production of secondary and recycled aggregates through tools such as the Quality Protocols and the Aggregates Levy.

Demand for water is expected to increase due to population growth, while at the same time there is the potential for a reduced supply or greater seasonal fluctuations due to climate change.

There is a shortage of waste sites, and developing new facilities can be a slow process. There are only three operational hazardous waste facilities in and around the study area – all in England. Waste management requirements are also becoming more rigorous through EU, Welsh and English legislation and policy, particularly to divert waste from landfill.

Evaluation of Plan Alternatives

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

This topic has also used the following specific assessment methods.

The effects of the options on the resource receptors have been determined by assessing the availability of the resource against the demand created by each of the STP alternative options. Where possible, comparison has been made with other large scale construction projects.

In terms of the effects on the waste receptors, the types and amounts of key waste streams likely to be produced throughout the STP project lifecycle has been assessed. The types of waste facilities / sites required to manage the different waste streams and their availability has been assessed to determine whether existing facilities / sites would be required.

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

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

Assessment of Likely Significant Effects on the Environment

The likely significant effects on the environment from the alternative options would be:

- A direct effect on the aggregates and embankment materials receptor, for all the alternative options except the B5 Beachley barrage as each STP alternative would require aggregates and embankment materials sourced within Great Britain and from Europe.
- An indirect effect on the aggregates and embankment materials receptor, for all the alternative options, from additional quarrying and dredging requirements to meet demand, as well as transport.
- A far-field effect on the aggregates and embankment materials receptor, for all the alternative options except the B5 Beachley barrage, as each STP alternative would require armour stone imported from Europe.
- A cumulative effect on the aggregates and embankment materials receptor for each alternative option, should any of the proposed projects in the vicinity of the Severn estuary be undertaken at the same time as the STP project.
- A direct effect on the sites for reuse receptor, as there would be a large quantity of recycled aggregates produced during decommissioning.

Whilst demand for the other resources considered (water, energy, steel) associated with the alternative options will be high, it is not considered to be proportionately large in terms of the ability of the respective markets to supply them.

Table 1: Demand for aggregates and embankment materials compared with other large scale construction projects

Scheme	Total demand (m tonnes)	Annual demand (m tonnes)
Brean Down to Lavernock Point barrage	54.800	7.829
Shoots barrage	17.715	3.543
Beachley barrage	3.077	0.769
Welsh Grounds lagoon	73.672	14.734
Bridgwater Bay lagoon	89.706	17.941
Project		**Annual demand (m tonnes)**
Olympic Park		0.500

Table 2: Estimate of the quantity of demolition waste available for reuse as recycled aggregates

Scheme	Total demand (m tonnes)
Brean Down to Lavernock Point barrage	54.800
Shoots barrage	17.715
Beachley barrage	3.077
Welsh Grounds lagoon	73.672
Bridgwater Bay lagoon	89.706

Assumptions, Limitations and Uncertainty
There are a number of uncertainties and data gaps, including:

- Whilst the data determined through the Options Definition Report is the best available, uncertainties remain in the construction data (extent of resource requirements, dredging requirements).
- Uncertainties in decommissioning data, including the extent to which the structures would be removed.
- Energy demand data (such as for transport, concrete manufacture) has not been modelled as part of the Options Definition Report. Thus a qualitative assessment of energy use has been undertaken, with the Carbon Footprinting paper assessing energy use in greater detail.

Measures to prevent, reduce and as fully as possible offset any significant adverse effects
The measures identified to prevent or reduce likely significant adverse effects identified within this topic are described below.

Measures that were taken during optimisation included the formulation of the presumption that :

- Dredged material (sand, gravel and hard rock) would be used, where possible, in the permanent works,

- Dredged material that could not be reused for permanent works (mud, clay, soft rock) would be used for compensatory habitat, and
- Onshore cut and fill work would be designed such that no spoil would need to be disposed of.

The overall outcome of these presumptions is that all excavated and dredged material would be used onsite, rather than disposed of off-site.

Further measures to prevent or reduce the magnitude of predicted effects would be to:

- Identify opportunities to use secondary and recycled aggregates in place of virgin aggregates,
- Liaise with suppliers such as water companies, steel suppliers and aggregates bodies to secure supply, and
- Manage each phase of work to minimise waste and manage the waste that is produced as high up the waste hierarchy as possible (ie reuse, recycle, recovery, with landfill as the last resort).

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

There are no offsetting and compensation needs identified within this topic.

Assessment against SEA Objectives

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

In summary:

SEA Objective 1 – To promote sustainable use of resources
In terms of the sustainable use of resources, the differences between the alternatives are a matter of scale. In each of the alternatives, the reuse of dredged material in the permanent works would reduce demand for virgin aggregates.

The B5 Beachley barrage has the lowest demand for resources, with aggregate being supplied regionally, including armour stone, and steel rebar being supplied from within Great Britain. The B3 Brean Down to Lavernock Point Barrage and the B4 Shoots barrage would need to source aggregate from across Great Britain. Both lagoons would require increased aggregate production or international sources in order to meet demand. In each of these cases, it is likely that armour stone would be sourced from abroad.

The majority of steel for each of the alternatives would be supplied from abroad, with the exception of steel rebar, some of which could be sourced in the UK – sufficient to meet the requirements of the B5 Beachley barrage and L2 Welsh Grounds lagoon.

For each of the alternatives, water and energy demands would be supplied locally and within Great Britain respectively but requirements are small compared with existing demands. It is possible that there could be at least seasonal water shortage issues in the Severn Estuary region which could be exacerbated by construction demand and therefore early and close liaison with water companies is important to secure supply.

SEA Objective 2 – To reduce waste generation and disposal, increase reuse and recycling, and achieve the sustainable management of waste

The decision to reuse dredged material in the permanent works and to create compensatory habitat is the single largest contributor to sustainable waste management for all of the alternatives.

Each of the alternatives will required treatment, recycling, energy recovery, and landfill facilities to manage their waste streams during all phases of the project. However the types of waste and likely quantities indicate that needs should be met by existing facilities.

The largest demand for waste management is during the decommissioning phase which will generate large quantities of recycled aggregates that require reuse. The scale of these effects is proportionate to the aggregate use during construction, with the L3d Bridgwater Bay and L2 Welsh Grounds lagoons and the B3 Brean Down to Lavernock Point barrage making appreciable contributions to the local aggregate supply.

Plan Implementation

Legislation and policy compliance
This paper contains a review of legislation and policy that is specifically relevant to this topic. An assessment has been made as to whether each alternative option would be compliant with existing relevant legislation and policy.

At this level of assessment, there is no evidence to suggest that the alternatives considered would not comply with existing legislation and policy.

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

The monitoring suggestions for this topic are:

- Demand for aggregates and embankment materials during construction: Keep the level of demand under review during the detailed design of any of the alternative options to ensure adequate supply during construction;

- Demand for aggregates and embankment materials during construction: Set targets for reuse of dredged materials and use of secondary and recycled aggregates; and

- Demand for rites for reuse during decommissioning: Assess the availability and pro-actively identify sites for reuse well in advance of the decommissioning phase.

SECTION 1

INTRODUCTION

1 INTRODUCTION

1.1 Introduction

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 The Feasibility Study is 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.

1.1.3 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.

1.1.4 In parallel to the Feasibility Study, the Severn Embryonic Technologies Scheme is helping developers of emerging technologies map their development path. They are not being assessed as part of this SEA currently, as they are not at the stage whereby they can be considered reasonable alternatives.

1.1.5 The scope of the SEA, published by the Government in January 2009 (DECC, 2009a) is based on the assessment of a defined set of issues within 'topic papers'. These papers will be aggregated into 'theme' papers to ensure that the interrelationships between effects are considered and understood – see Section 1.2. The topic and theme papers will provide supporting information to the Environmental Report that is needed to fulfil the requirements of the SEA Directive.

1.1.6 This is the Resources and Waste topic paper within the Air, Climatic Factors, Resources and Waste theme. This topic paper assesses the likely significant effects from the use of resources and generation of waste associated with each of the five Severn Tidal Power (STP) alternatives being considered in this SEA. The types of resources used and waste generated will generally be the same for each alternative option, however the scale of requirements will differ.

1.1.7 The two types of receptors identified for this topic are natural resources and waste management sites or facilities. Baseline information on resources and waste relates to the likely source of resources and the location of existing waste management facilities and potential waste sites. Due to the nature of these receptors, policy and strategy at a local, regional and national level are central to establishing the future baseline.

1.1.8 The main resources required for this project include construction materials, fuels and water. The sources or receptors will be dependent on the specific material types and quantities required. Aggregates and embankment materials, particularly, will be required in large quantities and, while there is a reasonable land bank of aggregate availability within and around the study area, the scale of construction is such that sources from a wider area may be required.

1.1.9 In general across the UK, the amount of landfill space and the projected lifespan of landfills are in decline as existing landfill sites are filled, in conjunction with limited development of new landfill capacity. This is driven by the EU waste legislation, including the Landfill Directive, which aims to drive waste up the waste hierarchy through waste minimisation and increased levels of re-use, recycling and energy recovery.

1.1.10 For the Severn Tidal Power project, the key environmental issues for resources relate to the types and quantities of resources required, the source of those resources, and the effects on the landscape from the use of natural resources and their transportation.

1.1.11 The key issues for waste relate to the types and quantities of waste generated, how they will be managed, and where they will be disposed, treated, reused or recycled.

1.2 Interfaces between topics and other work conducted within Feasibility Study

1.2.1 Each SEA topic paper sits within a theme of related topics – see Table 1.1 below. The theme papers reflect the many inter-relationships associated with the Severn estuarine system, and provide an additional tier of technical reporting to ensure that the many complex issues that are not self-contained within a given topic are recognised and their implications understood.

Table 1.1: SEA themes and topics

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

1.2.2 The SEA, and its supporting studies captured within each topic paper, comprise part of the Feasibility Study. Other relevant studies within the Feasibility Study but not contained within the SEA include supply chain, electricity grid connection, and ecosystem goods and services valuation studies.

1.3 Consultation

1.3.1 Both the Feasibility Study and the SEA within it have included a programme of formal and informal consultation activities. These include the public consultation exercise in early 2009, technical workshops during both Phase 1 and 2, and informal meetings and other communications. These are summarised for this topic below.

Scoping Consultation

1.3.2 In January 2009, Government launched a consultation on the conclusions of the first phase of the Feasibility Study (DECC, 2009a). The consultation included a recommended short-list of schemes for more detailed analysis, and provided the scope of the SEA. The Government's consultation response published in July 2009 confirmed the shortlist of alternative options, and the scope of the SEA (DECC, 2009b).

1.3.3 The SEA scoping report was consulted on in early 2009, and included a scoping paper for resources and waste. The key issue raised in relation to the resources and waste topic was the strengthening of the SEA Objectives. The SEA Objectives in the scoping report were worded 'to seek to', and this has now been removed. Further details on the SEA Objectives are given in section 1.4 below.

Technical Workshops

1.3.4 A series of 'Technical Workshops' was convened during phase 1 and 2 of the Feasibility Study, principally to provide the opportunity for technical specialists across many organisations to input to the developing SEA. Table 1.2 below summarises the workshops held in support of this topic.

Table 1.2: SEA technical workshops for Resources & Waste topic

Phase, date	Workshop purpose
Phase 2, 16 June 2009	To confirm scope of SEA work planned in Phase 2 and review key aspects of assessment methodology.
Phase 2, 11 December 2009	To review preliminary findings and approaches to identifying measures to prevent, reduce and as fully as possible offset significant environmental effects.

1.3.5 The first technical workshop for the resources and waste topic was held on 16 June 2009 in Bristol, combined with the Air and Climactic Factors topic paper. The technical workshop included a discussion of the proposed work plan for the Phase 2 work, an overview of the baseline of receptors, and an initial assessment of the value and vulnerability of receptors and the thresholds of magnitude for effects.

1.3.6 Ecological Footprinting was suggested at the workshop as an alternative methodology for assessing waste and resources. Following internal discussions we decided to retain the assessment method that was proposed in the work plan, rather than use Ecological Footprinting. We considered that the proposed methodology would give a specific assessment of the likely significant effects in terms of waste generation and resource use, as required by the scoping paper, whereas Ecological Footprinting would provide an overall assessment for each alternative, therefore complementing the SEA as a whole rather than assessing the waste and resources effects specifically.

1.3.7 The second technical workshop was held on 4 December 2009 in Bristol. The workshop was used to present the baseline and future baseline, the methodology, and the initial results and assessment of significant effects. Feedback was gained on the comparison and interpretation of the results for the final paper.

1.3.8 A teleconference to update the Environment and Regional Workstreams was held on 25 November 2009, at which a first draft of the baseline, methodology and results were presented.

1.4 SEA Objectives

1.4.1 SEA Objectives are a recognised tool for comparing alternative options. This technique is proposed in the SEA Practical Guide (ODPM et al., 2005). SEA Objectives usually reflect the desired direction of change. It therefore follows that these objectives may not necessarily be met in full by a given option, but the degree to which they do will provide a way of identifying preferences when comparing options.

1.4.2 This approach requires judgments to be made on the performance of alternative options against each SEA Objective. 'Assessment criteria' and 'indicators' have also been developed to aid these judgements. The assessment criteria are a series of questions developed to guide the judgement of objective compliance. An indicator is measure of a variable over time, often used to measure achievement of objectives.

1.4.3 The SEA Objectives, 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).

1.4.4 The SEA Objectives, assessment criteria, and indicators for the Resources and Waste topic are set out in Table 1.3 below. There have been no changes from the scoping report to the assessment criteria and indicators, however the SEA Objectives have been strengthened: in the scoping report each objective was prefaced by 'to seek to' and this qualification has been removed following the consultation on the scoping report.

Table 1.3: SEA Objectives, Assessment Criteria and Indicators for Resources & Waste

SEA Objective	Assessment Criteria	Indicators
To promote sustainable use of resources	Will the option result in reduced resource requirements compared to other options? Will the option result in	Relative resource requirements for each option. Potential source of resources.

SEA Objective	Assessment Criteria	Indicators
	sustainable use of resources that are required compared to other options?	Carbon impacts of options.
To reduce waste generation and disposal, and achieve sustainable management of waste	Will the option result in reduced waste arisings compared to other options? Will the option result in reduced waste for final disposal compared to other options?	Relative quantity and type (estimate) of waste arising from each option. Relative quantity and type (estimate) of waste requiring landfill disposal for each option. Carbon impacts of options.

SECTION 2

BASELINE ENVIRONMENT

2 BASELINE ENVIRONMENT

2.1 Introduction

2.1.1 Baseline information provides the basis for predicting and monitoring environmental effects. Both qualitative and quantitative information can be used for this purpose.

2.1.2 The baseline information is described for the area that may be affected in terms of a range of 'receptors'. A receptor is an entity that may be affected by direct or indirect changes to an environmental variable. Relevant receptors were identified and consulted upon during the SEA scoping stage.

2.1.3 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. This is an especially important concept when considering dynamic systems such as estuaries that are subject to climate change effects such as sea level rise.

2.1.4 The approach taken is therefore to describe baseline information in the following stages:

- Baseline environment and receptors up to 2009, including environmental problems and opportunities;
- Future baseline during construction: 2014-2020, including anticipated problems and opportunities;
- Future baseline during operation 2020-2140, decommissioning and longer term trends, including anticipated problems and opportunities.

2.1.5 This paper describes the baseline for the relevant receptors with this topic. It will thereby inform the description of the baseline environment for the affected area as a whole, contained within the SEA Environmental Report.

2.1.6 In the scoping paper prepared for Phase 1 of this SEA, a single resource receptor was identified: resource availability. To facilitate the more detailed assessment required in Phase 2 of the SEA, this single receptor has been split into the four key resources that will be used in the construction of any of the options. . The key resource receptors that have been identified in conjunction with the design and engineering development of the options are:

- Aggregates and concrete,
- Steel,
- Energy (including fuels and electricity), and
- Water.

2.1.7 The Phase 1 scoping report identified the waste receptor as waste management facilities. To facilitate the more detailed assessment required in Phase 2 of the SEA, this single receptor has been split into the types of waste treatment and disposal facilities that will be used during the construction, operation and decommissioning of any of the options. The waste receptors to be assessed for this topic paper have been identified as:

- Sites for reuse opportunities (on-site or off-site), such as other construction projects or habitat enhancement projects,
- Treatment and recycling facilities,
- Energy recovery, and
- Landfill.

Study area

2.1.8 The SEA Directive requires Member States to determine whether plans or programmes are likely to have significant environmental effects, based on a set of relevant criteria given in Annex II of the Directive. One of the criteria is the characteristics of effects and of the area likely to be affected, in particular, 'the magnitude and spatial extent of the effects (geographical area and size of the population likely to be affected)'.

Resources

2.1.9 The study area in relation to resources varies depending on the resource, as follows:

- Aggregates and embankment materials: Great Britain,
- Steel: international,
- Energy: Great Britain, and
- Water: local.

Waste

2.1.10 The study area in relation to waste has been defined as approximately the area within a 75 mile radius from the Severn Estuary, incorporating southern Wales, the south-west of England, and the West Midlands. The extent of the study area has been determined based on both the proximity principle (DCLG 2005 and WAG 2001), which intends for communities to take responsibility for their own waste, and the logistical (including financial) constraints on transporting waste over long distances.

Resources

2.1.11 For the purposes of this topic paper, the resources that are being studied are defined as the natural resources that will be used in the project, which will be consumed predominantly during the construction phase. As indicated above, at Scoping, a single resource receptor was identified: *resource availability*. To facilitate the more detailed assessment required in this phase of work, this single receptor has been refined to consider the key resources that would be used in the construction of any of the options. The receptors for resources are generally their sources and, in most cases, are outside the local area. Table 2.1 below identifies the resource receptors that are being addressed in this report, along with a general description of each receptor.

Table 2.1: Resource Receptors

Resource Receptors	Description
Aggregates and embankment materials	Local, regional, and national sources for extraction of natural resources eg quarries; marine dredging Local, regional, and national sources for secondary and recycled aggregates eg industrial by-products; construction, demolition and excavation (CDE) waste; fly ash from coal-fired power stations; bottom ash from waste incinerators
Steel	International sources (main producers are China, Japan, Russia, USA)
Energy (including electricity, diesel, gas, fuel oil)	Sourced nationally (electricity from the national grid), and from both national and international sources (fossil fuels)
Water	Local sources

Waste

2.1.12 The scoping report identified the waste receptor as *waste management facilities*. To facilitate the more detailed assessment required in this phase of the SEA, this single receptor has been split into the types of waste treatment and disposal facilities that would be used during the construction, operation and decommissioning of any of the options. The waste receptors to be assessed for this topic paper are:

- Sites for reuse opportunities, such as other construction projects or habitat enhancement projects,
- Treatment and recycling facilities,
- Energy recovery, and
- Landfill.

2.1.13 Waste will be generated during each phase of the project (construction, operation and decommissioning) and Table 2.2 below shows the types of wastes and phases in which they could be expected to be generated, in terms of each of the waste receptors.

Table 2.2: Waste Receptors

Waste receptor	Description	Phase
Sites for reuse opportunities	Reuse of CDE waste and marine dredging materials on other construction projects or habitat enhancement projects	Construction Decommissioning
Treatment and recycling facilities	Treatment and recycling of contaminated soil, CDE waste, operational waste, WEEE	Construction Operation Decommissioning
Energy recovery	Disposal of CDE waste, operational waste	Construction Operation

Waste receptor	Description	Phase
		Decommissioning
Landfill	Potentially required for the disposal of any type of waste	Construction Operation Decommissioning

2.2 Methodologies used to develop the baseline

Sources of Data

Resources

2.2.2 The sources of data used to establish the baseline conditions for the resource receptors include relevant policy and strategy in Wales and England, as well as data sourced, from:

- Aggregates and embankment materials: DCLG, HM Revenue and Customs, regional aggregate working parties, industry associations;
- Steel: industry associations;
- Energy: HM Government, DTI, DBIS; and
- Water: WAG, Defra, Environment Agency, local water companies (Dwr Cymru Welsh Water, Bristol Water, Severn Trent Water, and South West Water), and industry associations.

2.2.3 A supply chain survey was undertaken by DECC in parallel with the SEA. The survey sought to identify key constraints in the supply chain for each of the alternative options. This topic paper has been developed in consultation with the supply chain survey to ensure consistency in sources of data and the baseline conditions for the resource receptors.

Waste

2.2.4 The sources of data used to establish the baseline conditions for the waste receptors include relevant policy and strategy in Wales and England, as well as data sourced, from:

- Welsh Assembly Government and Welsh Regional Waste Groups;
- Defra, ODPM, DCLG;
- Environment Agency; and
- Local Authorities.

Assumptions, limitations and uncertainty

2.2.5 It is important to acknowledge the assumptions, limitations and uncertainties inherent in predicting changes to complex systems at a strategic level. Where possible, generalised assumptions and approaches for dealing with uncertainty have been developed to be applied consistently across the topics, as is the case with Climate Change and Policy. Where this is not possible and topic-specific consideration is required, the assumptions, limitations and uncertainty are clearly identified. Further detail is given below.

General Climate Change Assumptions

2.2.6 In developing the future baseline projections, assumptions are made about environmental trends, and policy responses to these trends. It has been assumed that UK Climate Projections (UKCP09) central estimate projections for the medium emissions scenario apply for most topics (UKCP09, 2009).

General Assumptions Concerning Application of Government Policy

2.2.7 It also has been assumed that, in general, existing Government policies relating, for example, to climate change response and biodiversity, will continue to apply into the future. .

Topic Specific Assumptions, Limitations and Uncertainty

Resources

2.2.8 In terms of resources, the availability of such resources will depend on a number of factors including the resource type, quantity required, timing of requirement and the location where is required, as well as demands elsewhere (for example, a boom in the construction industry would increase the demand for aggregates).

Waste

2.2.9 There is a particular lack of information regarding the types, locations and capacities of future landfill sites and other waste management facilities. The sites or facilities that would be used by this project would be private sector developments, and as such the only information in the public domain is on existing facilities and central and local government waste policies.

2.2.10 As such, at this stage only broad assumptions can be made on the locations of potential sites and the waste they will accept However, it is assumed that, in general across the UK, landfill void space and projected landfill lifespan are in decline as existing landfill sites are being filled and very limited increases in future capacity being developed or permitted.

2.3 Links to existing legislation and policy

2.3.1 A review has been conducted of relevant national, regional and local policies, plans and programmes, to assist with the identification of synergies and potential inconsistencies with the Feasibility Study, and thus contributing to the development of SEA Objectives (STP, 2009a). Existing legislation and policy of particular relevance to this topic are summarised below.

2.3.2 The STP study area spans both Wales and England and, as a result, national policies and strategies on waste and resources applicable to both Wales and England must be taken into consideration, in addition to the regional and local plans for the areas covered.

Resources

2.3.3 Policy relating to natural resources is driven by the sustainable development agenda, with key themes being:

- Sustainable development: Managing natural resources to meet the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Commission 1987), and
- Resource efficiency: using natural resources in the most effective way, as many times as possible, while minimising the impact of their use on the environment (WRAP 2009).

Waste

2.3.4 Welsh and English waste policy (WAG, 2001, ODPM 2005) focuses on two key themes:

- Waste hierarchy: Waste should be managed as high up the waste hierarchy as possible, with the waste hierarchy being waste prevention, reuse, recycling, recovery and, finally, disposal as the last resort, and
- Proximity and self-sufficiency: Waste should, where possible, be treated and / or disposed of within the local region, in order to reduce the environmental cost and impact of transport.

Existing legislation and policy

2.3.5 The review of relevant national, regional and local policies, plans and programmes (PPP) identified the following as the most directly relevant plans and programmes:

- EU Waste to Landfill Directive 99/31/EC;
- EU Waste Framework Directive (91/156/EEC);
- EU Directive on Waste (2006/12/EC);
- EU Thematic Strategy on the Prevention and Recycling of Waste (European Commission, 2003);
- EU Hazardous Waste Directive 91/689/EEC;
- Wise about Waste The National Waste Strategy for Wales (Welsh Assembly Government, 2002);
- Towards Zero Waste, One Wales: One Planet, A consultation on a new waste strategy for Wales (Welsh Assembly Government, 2009);
- Technical Advice Note 21 Waste (Welsh Assembly Government, 2001);
- Minerals Technical Advice Note 1 - Aggregates (Welsh Assembly Government, 2004);
- Mineral Planning Policy Wales (Welsh Assembly Government, 2001);

- South East Wales Regional Waste Plan First Review Recommended Draft (South East Wales Regional Waste Group, 2008);

- Waste Strategy for England (Department for Environment, Food and Rural Affairs, 2007);

- Planning Policy Statement 10: Planning for Sustainable Waste Management (Department for Communities and Local Government, 2005);

- Draft Regional Spatial Strategy for the South West (2006); and

- From Rubbish to Resource - The Regional Waste Strategy for the South West Consultation Document (South West Regional Assembly, March 2004).

2.3.6 A number of other more general sustainability documents which are considered to be less specifically related to this topic area also provide some objectives which are relevant to waste and resources (for example the UK government's Sustainable Construction Strategy and Sustainable Development Strategy).

2.3.7 The review of relevant national, regional and local policies, plans and programmes (PPP) concluded that none of the PPP objectives identified show significant levels of inconsistency with each other (STP, 2009a). Waste plans in general do not have a significant influence over the STP Feasibility Study. It is noted that, construction waste may be an issue if the plan leads to the construction of a tidal structure. Waste targets during construction should be set and monitored in line with the achievement of the national and regional waste plans and strategies.

2.4 Baseline Environment

2.4.1 This SEA baseline environment describes the area that may be affected in terms of 'receptors', and has examined the potential for significant effects in relation to these. The receptors were developed during Phase 1 SEA scoping. The list of receptors was subsequently consulted upon as part of the Phase 1 consultation.

2.4.2 A review has been conducted of other projects in and around the Severn Estuary that may have an influence on the future baseline (STP, 2009b). Those projects that are considered to be reasonably foreseeable as implemented by 2014, have been considered part of the future baseline environment.

Aggregates and embankment materials

Baseline environment (up to 2009)

2.4.3 Aggregates are the most widely used construction material and account for around 85 per cent of non-energy mineral extraction in the UK (ISSB 2009). Concrete is a mixture of cement, aggregates and water, with the ratio of the components and the type of aggregates used determining strength and durability. Steel reinforcing may also be incorporated into concrete.

2.4.4 The types of aggregates and embankment materials that will be required for the STP project include:

- Sand, cement, fine and coarse aggregates (e.g. stones and gravel) for the manufacture of concrete, and

- Rock and sand for fill and embankments.

2.4.5 Local aggregate markets are preferable for construction projects, as aggregates are heavy materials that are generally required in large quantities and therefore transport costs are a major component of their cost. However, this preference for local sources is balanced by the requirement for the right types of aggregates in the right quantities, which may require sources from further afield. The choice of aggregate type and sources is also driven by purchasing policies, such as any targets for the secondary or recycled aggregates or more sustainable (non-road) transport methods.

2.4.6 The aggregate and concrete market in the UK operates at a national level, with 100 per cent of aggregates coming from within the country (QPA 2009). There are three main sources for aggregates: marine dredged sand and gravel, land-won aggregates, and secondary or recycled sources. There are over 1,300 quarries in the UK and a fleet of 25 marine aggregate dredgers, which together produced 239 million tonnes of aggregates in 2007 (QPA 2008, 2009). A further 71 million tonnes of aggregates per annum (or 25 per cent of the UK's supply) comes from recycled and secondary sources (QPA 2009).

2.4.7 Recycled aggregates are reprocessed CDE waste, such as recycled concrete from a demolition site. Secondary aggregates are by-products of industrial processes. Examples of manufactured secondary aggregates are pulverised fuel ash from coal-fired power stations and incinerator bottom ash from waste incinerators. Natural secondary aggregates include china clay sand and slate aggregate from previous quarrying and mining activities (WRAP 2009).

2.4.8 The EA and WRAP are working together to develop Quality Protocols, which 'set out the steps that must be taken for the waste to become a non-waste product or material that can be either reused by business or industry' (EA website 2009). WRAP has published a Quality Protocol for the production of aggregates from inert waste (which is calls 'recovered aggregates'). Quality Protocols have been or are being developed for wastes such as blast furnace slag, pulverised fuel ash, furnace bottom ash, and paper sludge ash, which can be used in concrete manufacture (EA 2009).

2.4.9 Wales has 54 quarries and 14 wharves for marine-dredged aggregates and South West England has 70 quarries and 8 wharves. The two regions produce nearly 20 per cent of the UK's aggregates (QPA 2009). The breakdown of Great Britain's primary aggregate production (including marine aggregates) by end-use is given in Table 2.3 below.

Table 2.3: Primary aggregate production in Great Britain by end-use (source DECC, 2010)

Region / Country	Concrete aggregates (m tonnes)	Construction uses and fill (m tonnes)	Other (road, rail, ballast) (m tonnes)	Total (m tonnes)
South West	9.5 (32.5%)	9.3 (31.9%)	10.4 (35.6%)	29.2
Wales	4.6 (22.1%)	8.5 (40.9%)	7.7 (37.0%)	20.8
England	63.3 (42.2%)	40.6 27.1%)	46.1 (30.7%)	150
Scotland	10.4 (28.1%)	12.4 (33.4%)	14.3 (38.5%)	37.1
Great Britain	78.3 (37.6%)	61.5 (29.6%)	68.3 (32.8%)	208.1

2.4.10 Cement is the binder in the concrete. It is manufactured by heating a mixture of powdered minerals (which contain the four essential elements calcium, silicon, aluminium and iron) in a cement kiln where chemical reactions take place forming a clinker.

2.4.11 There are 14 cement plants in the UK, producing around 12 million tonnes of cement per year, about 90 per cent of UK consumption (UK Cement Industry 2009). The industry uses waste-derived fuels in its cement kilns, with some 15 per cent of kiln fuel coming from waste sources in 2005, and almost 5 per cent of raw materials (1 million tonnes) were waste-derived (British Cement Association 2007).

2.4.12 It is usual for large construction projects, such as the Olympic Park and Crossrail, build on-site concrete batching plants as part of their ancillary operations.

Baseline during construction (2014 – 2020)

2.4.13 Demand for recycled and secondary aggregates has been and will continue to be driven by environmental legislation. The EU Landfill Directive is driving an increase in the cost of disposal of waste to landfill and therefore making treatment and recycling economic alternatives.

2.4.14 The Aggregates Levy is an environmental tax on virgin aggregates that has been introduced to address the environmental costs associated with quarrying that are not already covered by regulation, including noise, dust, visual intrusion, loss of amenity and damage to biodiversity. The levy, introduced in 2002, aims to bring about environmental benefits by making the price of aggregates better reflect these costs and encouraging the use of alternative materials such as recycled materials and certain waste products (HMRC 2009).

2.4.15 Quality Protocols will continue to be developed and will provide clarity and assurance for both producers and users to ensure that wastes can safely be used as aggregates or in concrete manufacture, thereby growing the market for recycled aggregates.

2.4.16 Regional Aggregate Working Parties (RAWPs) for Wales and England have operated since the 1970s, to:

> *Identify and consider likely regional problems in the supply of aggregates…, provide technical advice in relation to the supply of, and demand for construction aggregates… and undertake annual monitoring of aggregates production, by type and use, and levels of permitted reserves*. (DCLG 2009)

Wales

2.4.17 The Welsh Assembly Government published its aggregates policy 'Minerals Technical Advice Note 1: Aggregates' in 2004, which appears to be for the period to 2010, and states that:

> *Although there should be an adequate supply of aggregates, natural resources should be conserved and the use of waste products maximised in line with sustainable objectives. Therefore, while the planning system in Wales must ensure that supply is capable of meeting demand as it arises, the means of meeting that demand must be through a number of sources of supply, and not simply from primary extraction*. (WAG 2001)

2.4.18 The policy sets a target for secondary and recycled aggregate production:

A broad objective is to increase the proportion of aggregates production in Wales from secondary and recycled sources to at least 25% of total aggregates supply within 5 years. (WAG 2001 pg 157)

2.4.19 The TAN requires the two Welsh RAWPs (South and North Wales) to produce five-year Regional Technical Statements to:

Ensure that an adequate supply of primary aggregates can be maintained taking into account the sustainable objectives… for the provision of aggregates. (WAG 2001 pg 50)

2.4.20 The Minerals Technical Advice Note is supported by the Interim Marine Aggregates Dredging Policy (WAG 2004), which guides decisions on dredging applications.

2.4.21 There is currently no aggregates policy in Wales that provides the future baseline during the construction period (2014 to 2020). It would seem to be a reasonable assumption that, as a minimum, the principles in the existing policy will continue to apply.

2.4.22 The South Wales RAWP consulted its constituent authorities on its regional technical statement in early 2008, however the final statement does not appear to have been published.

2.4.23 The South Wales RAWP's monitoring figures show that the production of crushed rock aggregates is stable, at between 10 and 13 million tonnes per annum, from permitted reserves of 554 million tonnes. Sand and gravel production is more variable and was 0.24 million tonnes in 2007, from permitted reserves of 11 million tonnes. The RAWP reports the region's landbank of crushed rock as between 14 and 119 years, based on the sales and reserves of each mineral planning authority. Marine dredging dredged aggregates are consistently around 1 million tonnes per annum. Secondary aggregates in South Wales are steel/blast furnace slag, pulverised fuel ash (PFA) and slate waste, with 1.52 million tonnes used in 2007, against reserves of 22 million tonnes (South Wales RAWP 2008).

2.4.24 Therefore aggregates appear to be readily available in south Wales, and this can be expected to continue to be the case during the construction period (2014 to 2020), unless there is a shift in policy.

England

2.4.25 England's Minerals Policy Statement 1: Planning and Minerals was published in 2006 and must be taken into account in Regional Spatial Strategies (RSS) and local development documents (LDDs). In particular, regional planning bodies and local planning authorities must:

- *identify at the regional level, those minerals which are of national and regional significance and include policies for them in RSS;*
- *aim to source mineral supplies indigenously, to avoid exporting potential environmental damage, whilst recognising the primary role that market conditions play;*
- *before considering the extraction of primary materials, take account of the contribution that substitute or recycled materials, mineral products and marine-dredged aggregates would make to the supply of materials;*
- *ensure the best integration of social, environmental and economic costs and benefits is achieved, through applying the principles of sustainable*

development, by carefully considering how best to maintain an adequate and steady supply of minerals for the economy and society, commensurate with protecting the environment and securing the prudent use of natural resources, and set out policies to achieve this in RSSs and LDDs. (DCLG 2006 pg 9)

2.4.26 The policy statement sets the following policy objectives for aggregates:

- *to encourage the use, where practicable, of alternative aggregates in preference to primary aggregate;*
- *to encourage the supply of marine-dredged sand and gravel to the extent that environmentally acceptable sources can be identified and exploited, within the principles of sustainable development;*
- *to make provision for the remainder of supply to be met from land-won sand and gravel and crushed rock.* (DCLG 2006 pg 13)

2.4.27 RAWPs continue to provide technical advice to the regional planning bodies as well as undertaking annual monitoring of aggregates reserves and supply. The South West of England RAWP's monitoring figures show that the production of crushed rock aggregates and land-won sand and gravel is consistently between 20 to 25 million tonnes per annum, from permitted reserves of 905 million tonnes, and sand and gravel production is generally in the range of 4 to 5 million tonnes per annum, from permitted reserves of 49 million tonnes. The RAWP states that 'in 2006 the region's land bank of crushed rock remained at just over 42 years, when based upon the previous three years production levels, but on the same basis the land bank for sand and gravel had fallen from just over 11 years in 2005 to 10.5 years in 2006' (South West RAWP 2008).

2.4.28 Actual dredging amounts for 2006 were between 46 to 59 per cent of the quantities permitted. Secondary aggregates in the South West are primarily china clay waste, sand from the extraction of ball clay, and slate waste, with an increase in production of 14 per cent in 2006. Research undertaken for the RAWP indicates reserves of waste in available stockpiles of 150 million tonnes. (South West RAWP 2008)

2.4.29 Therefore aggregates appear to be readily available in the South West of England, and this can be expected to continue to be the case during the construction period (2014 to 2020), unless there is a shift in policy.

Baseline during operation (2020 – 2140), Decommissioning and Longer Term Trends

2.4.30 No policy exists that looks sufficiently into the future to give an understanding of the baseline during operation and beyond. However if it would seem reasonable to assume that sustainability and climate change will continue to be key policy drivers, in which case increasing preference for secondary and recycled aggregates is likely.

Steel

Baseline environment (up to 2009)

2.4.31 Steel will be used in the STP project primarily for:

- Reinforcing in concrete,
- Structures, and

- Turbines.

2.4.32 Steel is made from iron, smelted from iron ore, and blended with carbon and other metals (alloys) to create the characteristics required for the specific use (such as rust resistance, strength, hardness).

2.4.33 The steel industry operates globally. That steel is a global commodity is clearly demonstrated by the UK's import and export statistics. Although the UK produces as much steel as it uses (14.3 million tonnes in 2007), it exported 7.7 million tonnes of what was produced and imported 6.5 million tonnes of what it used. Of the steel imported, 4.8 million tonnes were sourced from EU27 countries, primarily Germany, France and Belgium (EEF 2009).

2.4.34 Global steel production was 1,341 million tonnes in 2007, following rapid growth since the turn of the century from production of under 800 million tonnes per annum in the 1990s. China produced nearly 500 million tonnes (37 per cent) of the world's steel in 2007 (EEF 2009). The UK's steel use is small: 1 per cent of global production.

2.4.35 The construction industry accounts for 29 per cent steel used in the UK. Large construction projects purchase their steel on the international market in advance of construction in order to guarantee delivery and fix the price (UK Steel 2009).

2.4.36 Four of the UK's 13 steelmaking and rolling mills are located in South Wales (UK Steel 2009).

2.4.37 Steel is readily recyclable, with 5.2 million tonnes being recycled by UK steel producers in 2007 (UK Steel 2009).

Baseline during construction (2014 – 2020)

2.4.38 Global steel production has been rising exponentially, increasing from 720 million tonnes per annum in 1992 to 1,341 million tonnes in 2007. Much of the increased production and demand has been in developing countries including China and India, which have recently experienced economic booms.

2.4.39 The UK recession has affected the construction sector, and the UK steel industry expects demand for construction steel to fall as projects that were started before the recession are completed (FT 2009).

2.4.40 The supply of steel during the construction phase of the STP project will be influenced by the domestic and global economies, which will affect steel prices and the time delay between order and delivery.

2.4.41 The global steel industry accounts for '5 to 6 per cent of man-made carbon dioxide emissions' (FT 2009b) and therefore environmental legislation, such as carbon taxes, may affect cost. It is possible that the effects of such legislation could result in the scaling back of the UK steel industry, and therefore lead to an increase in imported steel.

Baseline during operation (2020 – 2140), Decommissioning and Longer Term Trends

2.4.42 No policy exists that looks sufficiently into the future to give an understanding of the baseline during operation and beyond. However, assuming that sustainability and climate change continue to be key policy drivers, then steel prices and the quantity of recycling are likely to continue to increase.

Energy

Baseline environment (up to 2009)

2.4.43 The STP project will have the following key energy requirements:

- Construction phase: petroleum products (transportation and construction equipment), electricity (ancillary operations eg offices, lighting), natural gas (cutting and welding)
- Operational phase: electricity (parasitic load for operations such as control equipment, lighting), and
- Decommissioning: petroleum products (transportation and construction equipments), electricity (ancillary operations eg offices, lighting), natural gas (cutting and welding)

2.4.44 The UK's energy consumption in 2008 was 165 million tonnes of oil equivalent, of which just 3 per cent was used by the construction industry (0.5 million tonnes), compared with the domestic sector (46 million tonnes) and the transport sector (59 million tonnes) (DBIS 2009a). The construction industry's energy use by fuel type was:

- Petroleum products, 31%;
- Natural gas, 44%; and
- Electricity, 25%.

2.4.45 The UK has been a net importer of fuel since 2004, importing 51 million tonnes of oil equivalent (predominantly coal and natural gas) in 2008 (DBIS 2009b).

Baseline during construction (2014 – 2020)

2.4.46 The Government's 2007 Energy White Paper (DTI 2007) identifies two key drivers for national energy policy:

> *We face two long-term energy challenges:*
> - *tackling climate change by reducing carbon dioxide emissions both within the UK and abroad; and*
> - *ensuring secure, clean and affordable energy as we become increasingly* dependent on imported fuel.

2.4.47 The Government's Renewable Energy Strategy (HM Government 2009) sets a target of 15 per cent renewable energy for 2020 across the three energy sectors (heat, electricity and transport), and indicates how the target might be delivered:

> *Within the constraints for each sector, and looking at the least-cost technologies that can be delivered domestically, our analysis suggests that one way we might deliver the target would mean that, by 2020:*
> - *around 30% of our electricity supply is renewable (including 2% from small-scale generation)*
> - *12% of our heat supply is renewable*
> - *10% of our transport supply is renewable*

2.4.48 National energy policy, including the Renewable Energy Strategy, will affect the energy supply mix, rather than its availability. Transport and construction operations are likely to continue to be predominantly fossil-fuel based during the construction phase.

Baseline during operation (2020 – 2140), Decommissioning and Longer Term Trends

2.4.49 Policies such as the Government's Renewable Energy Strategy and the Low Carbon Transition Plan indicate that sustainability and climate change will continue to be key policy drivers, with fossil fuel use expected to decrease, and renewable energy supplies increasing. The Low Carbon Transition Plan aims to reduce emissions by 80 per cent by 2050.

Water

Baseline environment (up to 2009)

2.4.50 The largest requirement for water during the STP project will be for concrete manufacture in the construction phase, with about 150 litres of water being required for each cubic metre of concrete.

2.4.51 The UK water industry was privatised in 1989. There are ten water and sewerage companies and 14 water only companies that operate regionally to serve England and Wales. Together, the 26 companies supply 16 billion litres of water each day, via 335,500 km of water mains from 1,301 water treatment works. Welsh Water manages water resources across Wales, with South West Water, Severn Trent and Bristol Water being responsible on the English side of the estuary (Water UK 2008).

2.4.52 Households consume about half of the water supplied, about 150 litres per person per day, which has been relatively constant over the last five years, whereas industrial and commercial demand has decreased (Water UK 2008).

2.4.53 Water abstraction in Wales and the South West is predominantly from surface water supplies, and pressure on water supplies is increasing, through increased demand from population growth and seasonal reductions in availability as a result of climate change (Defra 2008). Environment Agency data indicate that there is limited water available for abstraction in the proximity of the estuary (EA 2009), as shown in Figure 2.1 below.

Wales

2.4.54 Welsh Water is the sixth largest of the ten water and sewerage companies in England and Wales. It supplies 850 million litres of water per day to 1.2 million households and 100,000 businesses (Welsh Water 2009).

England

2.4.55 Bristol Water supplies about 285 million litres per day to 1.1 million residents and businesses in and around the city of Bristol. Water sources include the River Severn, reservoirs in the Mendips and small wells and springs (Bristol Water 2008).

2.4.56 Severn Trent Water provides water to 7.4 million people in an area covering 21,000 square kilometres in the Midlands and mid-Wales, supplying around 1,900 million litres of water per day (Severn Trent Water 2008).

2.4.57 In 2008/09, South West Water abstracted 163,792 million litres per day of water from its 82 licensed abstraction locations, which are reservoirs and rivers (93 per cent of supplies) and groundwater aquifers (7 per cent) (South West Water 2009).

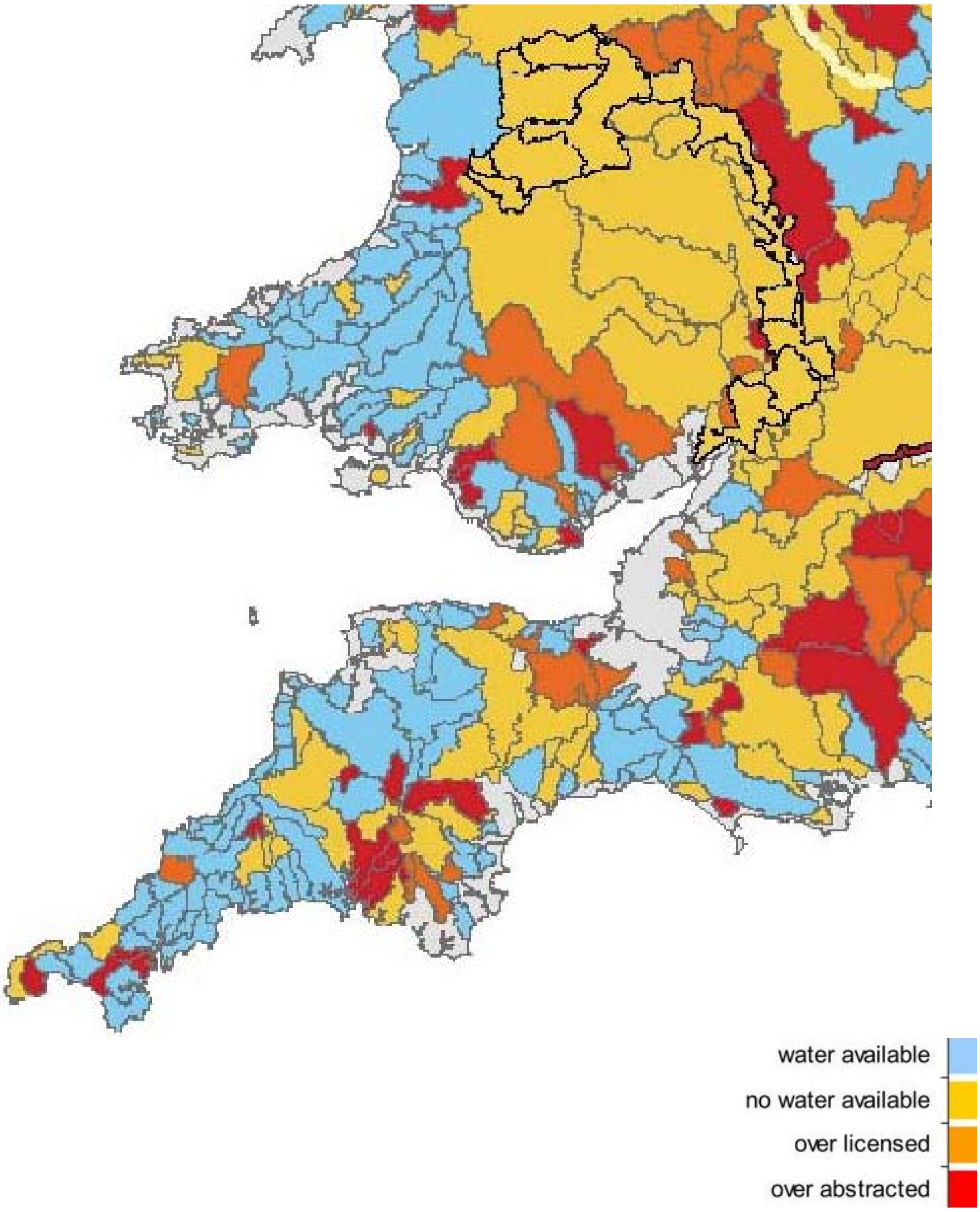

Figure 2.1: Water available for abstraction (Source: copyright Environment Agency 2009)

Baseline during construction (2014 – 2020)

2.4.58 Under the European Water Framework Directive (WFD) member states must aim to achieve 'good ecological status' for surface water and 'good status' for groundwater[1].

2.4.59 Future Water (Defra 2008) sets out the Government's strategy for securing England's water supply through to 2030. It identifies population pressures and hotter drier summers and warmer wetter winters caused by climate change as the key risks to the security of water supply. Similarly, the Welsh Assembly Government's Environment Strategy states that 'climate change is the most important pressure facing the management of our water resources in the medium to long term' (WAG 2006 pg 31) as it may affect the seasonal availability of water, as well as demand.

2.4.60 EA data indicates that there is currently a limited surplus in water supplies in the study area, as demonstrated in Figure 2.3 below. The water companies are required to develop water resource management plans which look ahead 25 years. The plans will 'ensure supplies can be maintained at an acceptable cost to the environment' by identifying 'the optimal combination of demand management and new resource development' (Defra 2008 pg 37).

2.4.61 In 2008 Welsh Water published its Water Resources Management Plan (WRMP), its strategy for managing water resources over the next 25 years. The WRMP splits Wales into 24 water resource zones and models the supply and demand for each zone over the next 25 years. Of the zones in the vicinity of the Severn estuary, the demand in the Ross on Wye zone is predicted to meet the demand in 2017, whereas the other zones are expected to have supplies in excess of demand for the entire planning period (Welsh Water 2008).

2.4.62 Bristol Water Resources Strategy (Bristol Water 2008) Bristol Water's baseline forecast shows a water deficit from 2015 and proposes a range of additional measures to be implemented in order to meet future demand of over 330 million litres a day by 2035.

2.4.63 South West Water's draft water resources plan (South West Water 2009) expects demand to fall until about 2017/18, and then begin to rise again, largely due to population growth, although a surplus of supply over demand will be maintained through until 2034/35.

2.4.64 Severn Trent Water's water resources management plan shows that its Severn water supply zone has been a net importer of water from 2006/07, and the company expects deficit to worsen to a supply shortfall of about 100 Ml/d by 2034/35 due to 'climate change driven uncertainty' and population growth (Severn Trent Water 2008).

2.4.65 Therefore availability of water could be a risk for the STP project during the construction phase. Early communication with the appropriate water companies is required in order to secure supply.

[1] Assessment of WFD compliance issues are considered within the Marine Water Quality and Marine Ecology Topic Papers.

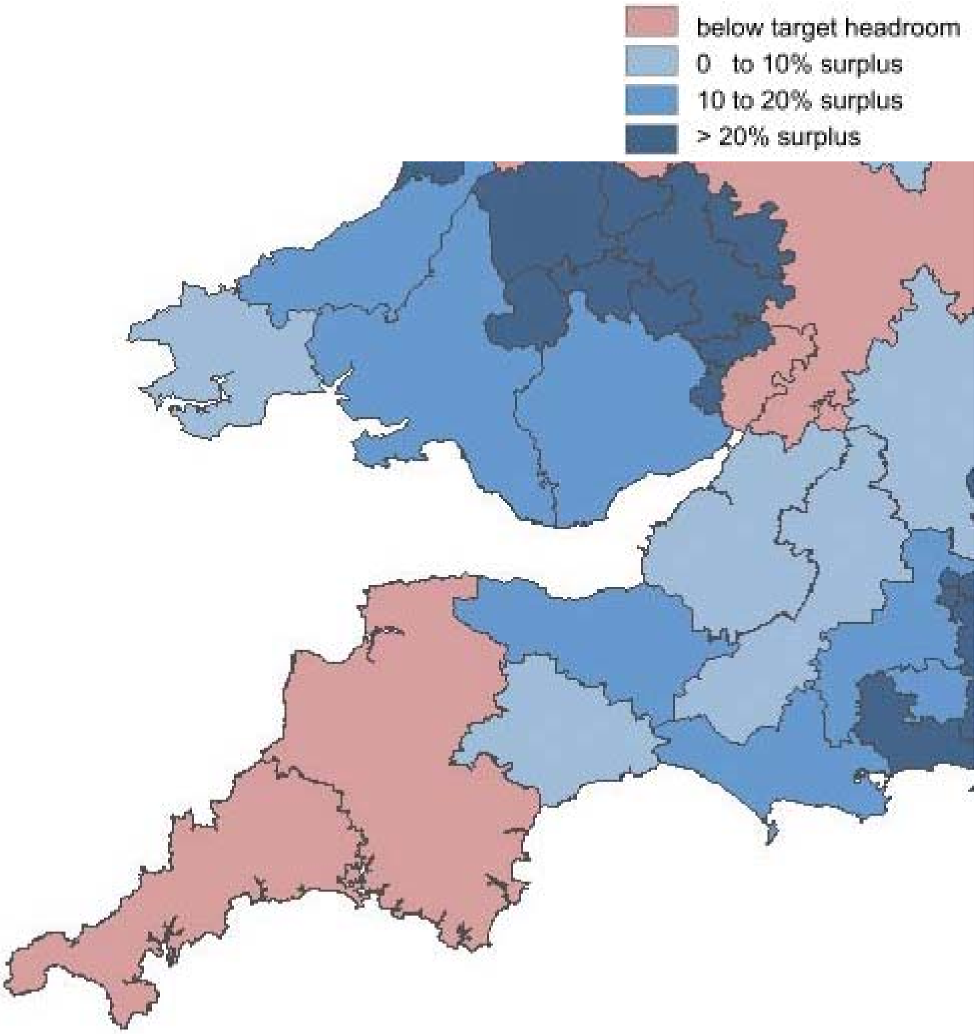

Figure 2.2: Surplus headroom (Source: Copyright Environment Agency 2009)

Baseline during operation (2020 – 2140), Decommissioning and Longer Term Trends

2.4.66 The security of the UK's water supply is expected worsen, as the impacts of climate change are more strongly felt. Water UK (2008) presents the following scenario in its sustainability report:

> *Average UK annual temperatures may rise by 2 to 3.5°C by the 2080's. (Source: The UK Climate Impacts Programme (UKCIP): UKCIP02 climate change scenarios). In general, greater warming is expected in the south east than in the north west, and there may be more warming in the summer and autumn. Annual average precipitation across the UK may decrease by up to 15% by the 2080s, and the seasonal distribution of precipitation will change significantly, with winters becoming wetter and summers drier. This could result in up to 50% less precipitation in the south east in summer, and a 30% increase in winter by 2080.*

Waste

Baseline environment (up to 2009): Waste statistics

Wales:

2.4.67 The Waste Strategy for Wales (WAG 2002) sets the following targets to reduce the amount of construction and demolition (C&D) waste going to landfill:

To re-use and recycle construction and demolition waste:

- *by 2005, to re-use or recycle at least 75% of C&D waste produced;*
- *by 2010, to re-use or recycle at least 85% of C&D waste produced.*

2.4.68 The Welsh Assembly Government's consultation (WAG 2009) on a new waste strategy states that Wales is on track to meet the 2010 target. The consultation document proposes a recycling, recovery and reuse rate for non-hazardous and inert construction and demolition waste of 90 per cent in 2019/20 and 75 per cent diversion of landfill (from 2007 baseline).

2.4.69 A survey of construction and demolition companies by Environment Agency Wales showed that Wales produced 12.2 million tonnes of construction and demolition waste in 2005/06. Sources, types and waste management methods determined by the survey are given in Table 2.4 below.

Table 2.4: Sources, types and management method for construction and demolition waste in Wales

Sources	• Civil Engineering sector (8.0 million tonnes) • Construction produced 2.2 million tonnes • Demolition (1.4 million tonnes) • General Builders (431,000 tonnes)
Types	• Aggregate (48%) • Soils (40%) • Wood (3%) • Hazardous waste such as contaminated soils and asbestos (2%) • Metals, plasterboard, plastics and paper & cardboard also arose in large quantities.
Waste Management	• Over 6.8 million tonnes (56%) re-used on site. Much of this waste being composed of aggregate and soils. • Around 1.2 million tonnes (10%) of waste went to landfill, the majority being aggregate (674,600 tonnes) and soils (110,100 tonnes).

2.4.70 The EA notes that companies reported that a lack of recycling facilities limited the opportunity for recycling.

England:

2.4.71 The Government's overall policy on waste is to set out in its sustainable development strategy, which is to reduce waste generation and increase its use as a resource. This aim is driven by EU waste legislation which sets out the waste hierarchy, shown in Figure 2.3 below.

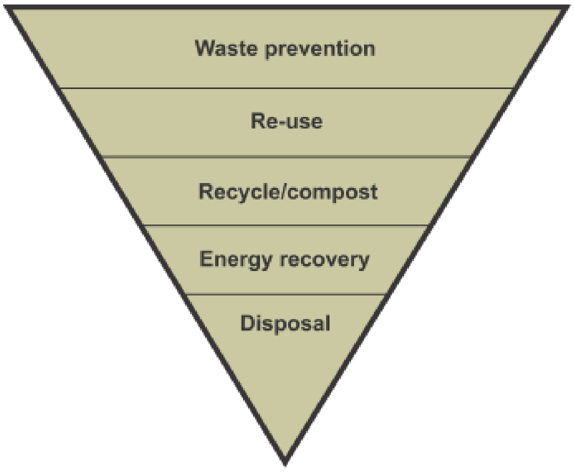

Figure 2.3: Waste Management Hierarcy (Source: Defra, 2007)

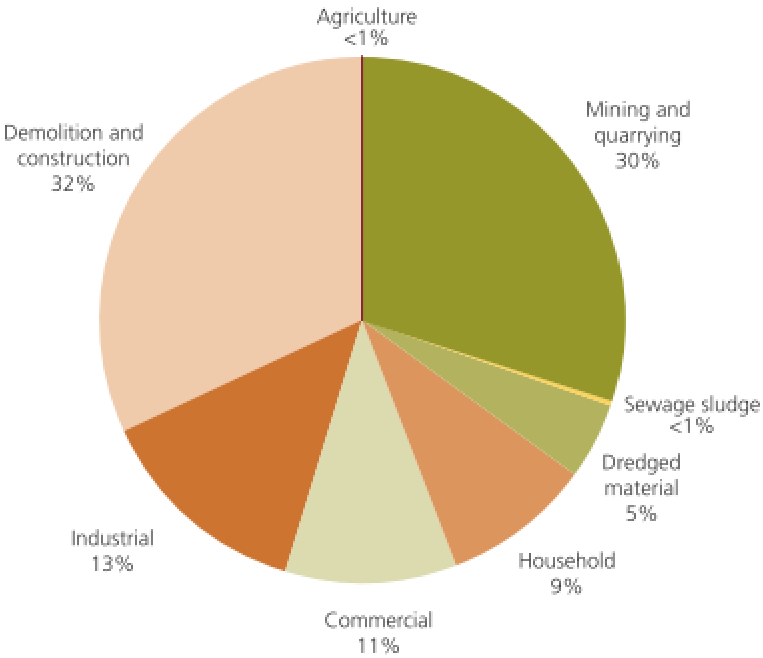

Figure 2.4: Waste sources in England (Source: Defra, 2007)

2.4.72 Figure 2.4 above indicates some 32% of waste in England comes from construction and demolition. There are limited data on the types and sources of construction demolition waste generated in England. The Strategy for Sustainable Construction states that of the 90 million tonnes of construction demolition and excavation (CDE) waste produced each year, about half is recycled as aggregates (HM Government 2008). However this would appear to be an underestimate as WRAP estimates a further 15 to 20 million tonnes of non-inert and mixed CDE waste (which is more difficult to recycle) is produced per year (cited in Defra (annex), 2007). Table 2.5 below summarises the types and quantities of CDE waste generated in England, and the management methods.

Table 2.5: Types and management method for CDE waste in England (Source: Defra, 2007)

Types	• Inert waste including aggregates and soils (90 m tonnes) • Non-inert and mixed CDE (15 - 20 m tonnes) • Hazardous waste including asbestos (1.7 m tonnes)
Waste Management	• Inert waste: o 46m tonnes recycled o 24 m tonnes used as fill and for landfill engineering o 18 m tonnes disposed of as waste

Baseline environment (up to 2009): Waste sites and facilities

2.4.73 The STP project is expected to produce a range of waste types during its construction, operation and commissioning. Types of wastes, and the types of facilities at which they would be disposed are summaries in Table 2.6 below.

Table 2.6: Types of waste and the facilities at which they are likely to be disposed

Waste sites and facilities	Likely types of waste from STP project
Sites for reuse opportunities	Reuse of CDE waste and marine dredging materials on other construction projects or habitat enhancement projects
Treatment and recycling facilities	Treatment and recycling of contaminated soil, CDE waste, operational waste, WEEE
Energy recovery	Disposal of CDE waste, operational waste
Landfill	Potentially required for the disposal of any type of waste

2.4.74 The majority of waste sites and facilities require an Environmental Permit in order to operate. The EA publishes data each year on the number of permitted facilities and annual throughput.

2.4.75 The STP study area loosely corresponds to the EA's reporting areas of Wales, the South West of England and the West Midlands. The number and types of waste facilities in the study area are given in Table 2.7 below. There are 137 landfills across the three areas, which include hazardous, non-hazardous and inert waste landfills. The 28 incinerators are generally smaller industrial facilities, which are unlikely to be accessible for STP project waste, although they do include a number of municipal waste incinerators in the English regions. It is worth noting that there are no hazardous waste landfills in Wales. The 289 treatment facilities include a range of activities such as recycling (e.g. plastics, metals, glass), composting, processing (e.g. concrete crushing, dismantling old cars), treatment (e.g. cleaning of contaminated soil, refining waste oil), some of which may be more relevant to the STP project than others.

Table 2.7: Number of permitted waste facilities operational in 2008 in the study area (Source: Environment Agency 2009)

Region / Country	Landfill	Incineration	Treatment	Metal recycling
Wales	32	4	75	148
South West	62	11	114	257
West Midlands	43	13	100	292
TOTAL	137	28	289	697

2.4.76 Landfill would be a last resort for waste from the STP project, however it is likely that a small proportion of waste will go to landfill throughout the project life. In general across the UK, landfill void-space and projected landfill lifespan are in decline as existing landfill sites are filled, with very limited increases in capacity being developed or permitted. According to the EA (2009), across England and Wales at the end of 2008 there were:

- 650 million cubic metres of available landfill capacity with 74 per cent of this available at non-hazardous sites,
- 19 million cubic metres available at hazardous waste only sites, and
- Nearly eight years of landfill life left at sites for non-hazardous wastes in England and Wales, at 2008 input rates.

2.4.77 Looking specifically at Wales and the two English regions, the life expectancy of non-hazardous landfills is approximately 11 to 17 years, which covers the bulk of the construction phase, with capacity for inert waste ranging from 8 to 18 years. Whilst there is no hazardous waste landfill capacity in Wales, there is long life expectancy for hazardous waste landfills in the two English regions. This data is shown in more detail in Table 2.8 below.

Table 2.8: Capacity of non-hazardous landfill facilities operational in 2008 in the study area (Source: Environment Agency 2009)

Region / Country	Type of waste	Landfill inputs (x 1000 tonnes)	Landfill Capacity (x 1000 m^3)	Estimated years remaining
Wales	Non-hazardous	2,164	26,813	12
	Hazardous	0	0	0
	Inert	392	3,039	8
South West	Non-hazardous	3,851	41,309	11
	Hazardous	79	4,169	53
	Inert	550	5,418	10
West Midlands	Non-hazardous	3,876	67,013	17
	Hazardous	0	130	
	Inert	655	11,694	18

2.4.78 There are limited facilities in the UK for disposal of hazardous waste, with only three operational facilities in and around the study area:

- Shepton Mallet, Somerset
- Cheltenham, Gloucestershire
- Bristol (asbestos only)

Baseline during construction (2014 – 2020)

Wales: Waste planning policy

2.4.79 The Welsh Assembly Government is proposing that by 2019/20, 90 per cent of non-hazardous and inert construction and demolition waste should be recycled, recovered, or reused. In addition, it is proposing that by 2015/16, there should be landfill diversion of 50 per cent of 2007 levels, and 75 per cent by 2019/20 (WAG 2009).

England: Waste planning policy

2.4.80 The Strategy for Sustainable Construction sets the following target:

> *By 2012, a 50% reduction of construction, demolition and excavation waste to landfill compared to 2008.*

2.4.81 Planning Policy Statement 10 (PPS10) states that:

> *Regional planning bodies and all planning authorities should, to the extent appropriate to their responsibilities, prepare and deliver planning strategies that:*
>
> - *help deliver sustainable development through driving waste management up the waste hierarchy, addressing waste as a resource and looking to disposal as the last option, but one which must be adequately catered for;*
> - *provide a framework in which communities take more responsibility for their own waste, and enable sufficient and timely provision of waste management facilities to meet the needs of their communities;*
> - *help implement the national waste strategy, and supporting targets, are consistent with obligations required under European legislation and support and complement other guidance and legal controls such as those set out in the Waste Management Licensing Regulations 1994;*
> - *help secure the recovery or disposal of waste without endangering human health and without harming the environment, and enable waste to be disposed of in one of the nearest appropriate installations;…*
> - *ensure the design and layout of new development supports sustainable waste management.*

2.5 Key Environmental Issues and Problems

2.5.1 There are a number of existing or potential environmental issues associated with the resources required for an STP project or with waste disposal.

2.5.2 There is a shortage of waste sites, in particular, there are limited facilities in the UK for disposal of hazardous waste, and developing new facilities can be a slow process. There are increasingly rigorous waste management requirements, through EU, Welsh and English legislation and policy, particularly to divert waste from landfill.

2.5.3 Whilst aggregates are plentiful in the UK, there is an environmental cost associated with their extraction, and increased demand, such as for an STP project, could lead to the development of new quarries or dredging areas. Government policy, which aims to reduce demand for virgin aggregates, is to encourage the production of secondary and recycled aggregates through tools such as the Quality Protocols and the Aggregates Levy.

2.5.4 Demand for water is expected to increase due to population growth, while at the same time there is the potential for a reduced supply or greater seasonal fluctuations due to climate change.

2.6 Value and Vulnerability of Receptors

2.6.1 The SEA seeks to identify those environmental effects which are likely to be significant. In forming a judgement on effect significance, in line with the SEA Directive, it is necessary to take into account the attributes of the affected area. In this SEA, the area likely to be affected is described in terms of receptors; and the most relevant receptor attributes are their value and vulnerability. These are defined as:

- **Value**: based on the scale of the geographic reference, rarity, importance for biodiversity, social or economic reasons, and level of legal protection;
- **Vulnerability**: the potential for a pathway for exposure of a receptor to a given environmental effect, brought about by a Severn Tidal Power option, together with the sensitivity of the receptor to that effect.

A standardised approach has been adopted across all topics of this SEA to the assignment of receptor attributes. Nonetheless this approach did allow for some flexibility to reflect the needs of each topic area. This is summarised below for this topic.

The proposed approaches for assigning value and vulnerability were developed as part of the Phase 2 work and were the subject of Phase 2 Technical Workshop 1 in June 2009. A briefing document outlining the approach for the topic was produced following the Technical Workshop and circulated to all attendees and the Statutory Authorities for their comment. This document is presented as Appendix A to this topic paper.

Value of receptors

2.6.2 The SEA process requires that a value be determined for each of the resources, with the value of a receptor being based on the scale of the geographic reference, rarity, importance for biodiversity, social or economic reasons, and level of legal protection.

Resources

2.6.3 In order to assess each resource receptor individually for each option, and then combine the results to give an overall view for the topic, the value of the resource receptors was determined to be the availability of a resource in its accepted market (be it regional, national or international). A High value resource would generally be considered scarce in its usual market, and a Low value resource would be readily available. This definition uses the market, and therefore the monetary value of the resource, as a proxy for the resource's intrinsic value. The values of the resource receptors are given in Table 2.9. Further detail on the assignment of Value is provided in Appendix A.

Table 2.9: Value of Resources Receptors

Resource Receptors	Assigned Value
Aggregates and embankment materials	Low
Steel	Low
Energy	Low
Water	High

Waste

2.6.4 In order to assess each waste receptor, the value of the receptors was determined to be the availability of waste management sites or facilities in the proximity of the estuary (south Wales, south west England, and the midlands). A High value is where waste sites or facilities are rare, and a Low value is where waste sites or facilities are readily available.

2.6.5 Table 2.10 below sets out the proposed values for the waste receptors. Further discussion on the value assigned to each receptor is provided in Appendix A.

Table 2.10: Value of Waste Receptors

Waste Receptors	Assigned Value
Sites for reuse opportunities	High
Treatment and recycling facilities	High
Energy recovery	High
Landfill	High

Vulnerability of receptors

2.6.6 The vulnerability of each receptor is the sensitivity of the receptor to a given environmental effect and its ability to recover from that effect. In terms of resources, this is defined as the impact that each STP option will have on the availability of the resource. A receptor with High vulnerability will therefore be where the STP project's demand for a resource significantly affects the availability of the resource, with corresponding definitions for Moderate, Low and No vulnerability.

Resources

2.6.7 Table 2.11 below sets out the proposed vulnerabilities for the resource receptors. Further discussion on the vulnerability assigned to each receptor is provided in Appendix A.

Table 2.11: Vulnerability of Resource Receptors

Receptor	Assigned Vulnerability
Aggregates and embankment materials	High
Steel	Low
Energy	Low
Water	High

Waste

2.6.8 There is little information available on either the quantities and types of waste to be generated by the STP project, or the availability and capacity of future waste sites and facilities, and therefore the initial assessments in this section are essentially an assessment of risk.

2.6.9 Table 2.12 below sets out the proposed vulnerabilities for the waste receptors. Further discussion on the vulnerability assigned to each receptor is provided below.

Table 2.12: Vulnerability of Waste Receptors

Waste Receptors	Assigned Vulnerability
Sites for reuse opportunities	High
Treatment and recycling facilities	Low
Energy recovery	Low
Landfill	High

SECTION 3

EVALUATION OF PLAN ALTERNATIVES

3 EVALUATION OF PLAN ALTERNATIVES

3.1 Introduction

3.1.1 The SEA Directive requires the preparation of an Environmental Report on the 'likely significant effects' of implementing the plan, and reasonable alternatives. The main purpose of this topic paper is to inform the SEA Environmental Report and its assessment of likely significant environmental effects. This is by providing an assessment of effects in relation to the topic paper's relevant receptors. The Environmental Report will then consolidate the individual topic assessments to provide a description of all likely significant effects across the affected area.

3.1.2 The SEA Directive instructs that SEA is to be based on information that can reasonably be required, taking into account *inter alia* current knowledge and methods of assessment.

3.1.3 For the purposes of this SEA, the plan alternatives are the shortlisted options currently under consideration following the phase 1 consultation (DECC, 2009a). These are described as the alternative options in this document.

3.2 Assessment Methodology

3.2.1 The SEA Directive specifies in Annex II the criteria that should be taken into account when determining the likely significant effects of the plan. The criteria for identifying these significant effects are defined in the Directive in relation to determining whether an SEA is needed. These criteria will also be adopted for this assessment. In line with the SEA Regulations, the Practical Guide advises the use of these criteria for assessing significant environmental effects.

3.2.2 This topic paper therefore considers, the characteristics of the effects and of the area (i.e. relevant receptors) likely to be affected, having regard, in particular, to:

- the probability, duration, frequency and reversibility of the effects;
- the cumulative nature of the effects;
- the transboundary nature of the effects;
- the risks to human health or the environment (for example, due to accidents);
- the magnitude and spatial extent of the effects (geographical area and size of the population likely to be affected);
- the value and vulnerability of the area likely to be affected due to:
    - special natural characteristics or cultural heritage;
    - exceeded environmental quality standards or limit values; or
    - intensive land-use; and

- the effects on areas or landscapes which have a recognised national, Community or international protection status.

3.2.3 The SEA Directive (Annex I) also states that these effects should include secondary, cumulative, synergistic, short, medium and long-term permanent and temporary, positive and negative effects. The Practical Guide recognises that some of these terms are not always mutually exclusive and for the avoidance of doubt, within this SEA the following approaches are adopted.

3.2.4 Indirect effects are those which are not a direct result of a Severn Tidal Power alternative option, but occur away from the original effect or as a result of a complex pathway. There are many such interactions within estuarine systems that need to be taken into account in this assessment. The SEA does not use the term 'secondary effects' as this is covered by indirect effects.

3.2.5 There is the potential for effects to extend large distances from the Severn estuary. The assessments of these 'far field' effects will have greater uncertainty attached and are described separately.

3.2.6 Cumulative effects arise, for instance, where several developments each have insignificant effects but together have a significant effect. The plans and projects taken into account in the cumulative effects assessment have been identified and agreed (STP, 2009b). These are discrete projects or programmes which are expected to be implemented during the planned Severn Tidal Power project construction period (2014-2020) or during the operation period (2020-2140).

3.2.7 For simplicity, this SEA does not use the term 'combined' effects, as these are considered to be included within cumulative effects, nor does it use the term 'synergistic' effects, as these are considered within direct, indirect and cumulative effects.

3.2.8 A major tidal power scheme may facilitate or attract other developments, which may themselves pose significant environmental effects. These developments are described as 'consequential developments'. The types of consequential development considered throughout the assessment have also been identified (STP, 2009b). These consequential developments are not well-defined and only a concise high level qualitative assessment of the likely effects is possible.

3.2.9 The effects of the options on the resource receptors have been determined by assessing the availability of the resource against the demand created by each of the STP alternative options. Where possible, comparison has been made with other large scale construction projects.

3.2.10 In terms of the effects on the waste receptors, the types and amounts of key waste streams likely to be produced throughout the STP project lifecycle has been assessed. The types of waste facilities / sites required to manage the different waste streams and their availability has been assessed to determine whether existing facilities / sites would be required.

3.2.11 More detail on the methodology used for assessing the effects in relation to resources and waste is given in Appendix B.

3.3 Alternative Options

3.3.1 Five options for the development of tidal power using the tidal range of the Severn Estuary have been identified as the preferred candidates for more detailed study. The five options comprise three tidal barrages and two tidal lagoons. The details of these options are described below.

Alternative Option B3: Brean Down to Lavernock Point Barrage (commonly known as Cardiff to Weston)

3.3.2 B3 'Brean Down to Lavernock Point' barrage is the largest of the barrage short-listed options being an approximately 16km long structure impounding the Bristol Channel between Lavernock Point near Cardiff and Brean Down, adjacent to Weston-Super-Mare. The deepest point of this barrage location is at its centre, reaching between 30 to 40m deep. The chosen variant (original) functions in ebb only mode. In total there are 216 Bulb-Kapeller type turbines with a rated output of 40MW. The estimated annual energy output for the variant (including 5% outages) is 15.1 to 17.0 TWh/year.

3.3.3 Key features include a total of 129 caissons of which 29 are plain caissons, 46 are sluice caissons and 54 are turbine caissons, spread across the length of the barrage. The central point includes a 778m long embankment flanked by two sets of the turbine caissons. The barrage also includes two locks, one main shipping lock towards Lavernock Point side and a small ship lock towards Brean Down.

Alternative Option B4: Shoots Barrage

3.3.4 The B4 Shoots Barrage is an approximately 7km long structure impounding the Inner Bristol Channel between land adjacent to West Pill on the Welsh side and Severn Beach on the English side. The proposed structure comprises a combination of embankments within the shallow water and caissons within the deeper channel. Variant 3 was chosen as the short-listed option. It operates in ebb only mode with 30 Bulb-Kaplan type turbines, with a rated output of 35MW. The estimated annual energy output for the variant (including 5% outages) is 2.7 to 2.9 TWh/year.

3.3.5 The barrage consists of a total of 46 caissons (6 plain, 25 sluice and 15 turbine/sluice caissons), enclosed on both sides by 2 embankments totalling approximately 5km (3km approximate length of embankment to the Welsh Side and 2.2km approximate length to the English side). A 40m wide shipping lock has been placed at the deepest section of the channel.

Alternative Option B5: Beachley Barrage

3.3.6 The B5 Beachley Barrage is the smallest of the short-listed barrage schemes. It is a 2km long structure running from Beachley on the Welsh side of the River Severn to land directly to the east on the English side. The original variant was chosen as the short-listed option, operating in ebb only mode with 50 Straflo type turbines with a rated output of 12.5 MW. The estimated annual energy output for the variant (including 5% outages) is 1.4 to 1.6 TWh/year.

3.3.7 Its key features include a total of 31 caissons (9 plain, 9 sluice and 13 turbine/sluice) spread across approximately 1.5km of the length of the barrage and flanked by two embankments. A 40m wide shipping lock is located on the English side of the barrage.

Alternative Option L2: Welsh Grounds Lagoon

3.3.8 L2 Welsh Grounds Lagoon is the largest of the lagoon short-listed options with an approximate length of 28km starting from land adjacent to the mouth of the River Usk, running in a general easterly direction across an area referred to as Welsh Grounds, continuing to the south of Denny Island and reaching land fall adjacent to the Second Severn Crossing. L2 variant 8 was based on a turbine selection proposed by the Fleming group. It was unique in this respect compared to other variants whose turbine selections have all been made by PB. Variant 8 operates in ebb only mode with 40 Bulb Turbines with a rated output of 25MW. The estimated annual energy output for the variant (including 5% outages) is 2.6 to 2.8 TWh/year.

3.3.9 Key features include a total of 32 caissons (8 plain, 14 sluice & 10 turbine caissons), and one shipping lock.

Alternative Option L3d: Bridgwater Bay Lagoon

3.3.10 L3d Bay Lagoon is a land connected tidal lagoon comprising approximately 16km long embankment, proposed to run from land falls at Brean Down in the north to just east of Hinckley Point in the south. The short-listed Variant 9 option is the only scheme to operate in ebb & flood mode, with a total of 144 Bulb-Kaplan turbines with a rated output of 25MW. The estimated annual energy output for this variant (including 5% outages) is 5.6 to 6.6 TWh/year.

3.3.11 Key features include a total of 42 caissons (6 plain and 36 turbine caissons), a 40m wide shipping lock and approximately 12km of embankment.

3.4 Summary of Potentially Significant Issues

3.4.1 During Phase 1 SEA Scoping, a review was conducted of the environmental issues that should be considered within the scope of the SEA (DECC, 2009a). The scope of issues was for the most part confirmed through the Government response to the consultation (DECC, 2009b). These issues formed the starting point for the assessment of likely significant environmental effects, and are discussed further for this topic below.

3.4.2 The potentially significant effects identified during scoping are given in Table 3.1 below.

Table 3.1: Potentially significant effects identified at Scoping

Potential Environmental Changes associated with Severn Tidal Power Development	Potentially significant issues
Potential for depletion of natural resources in the UK. Potential for depletion of landfill void space, leading to reduced future disposal capacity. Landfill disposal of biodegradable waste will contribute to carbon emissions. Management of waste and resources from the development could result in adverse effects resulting from transportation of material.	Landfill disposal capacity in the study area and the UK as a whole is scarce and depleting. Resource availability may be limited, depending on the type and quantity required.

3.5 Assessment of Likely Significant Effects on the Environment

3.5.1 This section considers, within this topic, the likely significant effects on the environment for each alternative option. These may arise from direct, indirect, far-field, cumulative and consequential development effects during construction, operation and decommissioning phases.

3.5.2 A description of the effects is give below and is summarised for each alternative option in Tables 3.7 to 3.11.

Direct Effects

Construction Phase

Aggregates and embankment materials

3.5.3 Each of the STP alternative options requires aggregates and embankment materials during the construction phase, therefore there is a direct effect on this receptor. Construction periods range from four to six years depending on the scheme and, although there would be some fluctuation in demand during the construction period, the average annual demand enables comparison with aggregate supply and with other projects.

3.5.4 The average annual demand ranges from less than 1 million tonnes per year for the B5 Beachley barrage up to 18 million tonnes per year for the L3d Bridgwater Bay lagoon, with the total demand ranging from 3 million tonnes to 89 million tonnes, as is shown in Table 3.2. The demand for each alternative option is dependent on both the structure length and also the method of construction, with embankments requiring a greater volume of material than caisson construction. This is demonstrated by the requirements for the L3d Bridgwater Bay lagoon compared with the B3 Brean Down to Lavernock Point barrage: although their lengths are similar, the lagoon would require approximately 60 per cent more aggregates and embankment materials than the barrage.

3.5.5 The annual demand of between 0.8 and 18 million tonnes per year compares with regional (Wales and the South West of England) annual production of primary aggregates in the order of 50 million tonnes (ie 1.5 to 36 per cent of production) and nationally of 210 million tonnes (ie 0.4 to 9 per cent of production). A more detailed breakdown is given in Appendix B.

Table 3.2: Demand for aggregates and embankment materials

Scheme	Total demand (m tonnes)	Construction period (years)	Annual demand (m tonnes)	Overall length of structure (km)
Brean Down to Lavernock Point barrage	54.800	6	9.133	15.8
Shoots barrage	17.715	4	4.429	8
Beachley barrage	3.077	4	0.769	2
Welsh Grounds lagoon	73.672	5	14.734	28.4
Bridgwater Bay lagoon	89.706	5	17.941	16.3

3.5.6 The projected demand for aggregates and embankment materials for any of the STP alternatives is higher than the demand for the Olympic Park development in London.

Whilst the B5 Beachley barrage is on a comparable scale, the requirements for the other alternatives are vastly in excess of the Olympic Park project. It is worth noting that, in order to meet its sustainability objectives, 70 per cent of the aggregates being used in the Olympic Park development are expected to be from recycled or secondary sources, and some 99 per cent of aggregates will use more sustainable modes of transport: 25 per cent by water and 74 per cent by rail.

3.5.7 Demand for virgin aggregate would be offset to some extent by reusing suitable dredged material (sand, gravel and hard rock). Based on a conservative assumption of reusing 80 per cent of sand and gravel (DECC, 2010), between 28 and 61 per cent of the barrage requirements could be met from dredged materials, although only 0 to 5 per cent of the lagoon requirements could be met. This variation is due to the differing types and quantities of dredged materials for the alternative options. For example the dredged material for the L3d Bridgwater Bay lagoon would be predominantly mud and therefore not reusable in the permanent works, whereas dredging for the B3 Brean Down to Lavernock Point barrage would supply some 61 per cent of the aggregate and embankment materials requirements. Dredged sand and gravel would be used for embankment construction and caisson ballast, and hard and soft rock would be used for fill materials (DECC, 2010).

3.5.8 Thus the net annual demand for primary aggregates and embankment materials would range from 0.4 million tonnes for the B5 Beachley barrage to nearly 18 million tonnes for the L3d Bridgwater bay lagoon. Table 3.3 summarises the total and net demand for each of the alternative options.

Table 3.3: Demand for aggregates and embankment materials

Scheme	Total annual demand (m tonnes)	Net annual demand (m tonnes)	Proportion of materials sourced from dredging
Brean Down to Lavernock Point barrage	9.133	3.6	61%
Shoots barrage	4.429	3.2	28%
Beachley barrage	0.769	0.4	50%
Welsh Grounds lagoon	14.734	13.9	5%
Bridgwater Bay lagoon	17.941	17.9	0

3.5.9 As is shown in Appendix B, the demand for aggregates for all but the B5 Beachley barrage would require a large increase in supply regionally or shipping in of aggregates from elsewhere in the UK or abroad (DECC, 2010), with the Ld3 Bridgwater bay lagoon requiring a third of the UK's annual supply. The cumulative demand of an STP project over and above usual supply would therefore be likely to require an expansion of dredging or quarrying activities, or at the very least long-distance transport of large quantities of aggregates.

3.5.10 It is considered that the supply of aggregates and embankment materials to meet the needs of any of the alternative options would have significant direct environmental effects.

Steel

3.5.11 There is an effect on the steel receptor as each of the STP alternative options would require steel sourced from Great Britain and internationally.

3.5.12 It is anticipated that the UK steelworks would supply up to 0.06 million tonnes per year of rebar for any of the alternatives (DECC, 2010), which would entirely meet the needs of the B4 Shoots and B5 Beachley barrages and the L2 Welsh Grounds lagoon, with the B3 Brean Down to Lavernock Point barrage and the L3d Bridgwater Bay lagoon requiring additional rebar to be imported. It is assumed that all of the major steel components (gates, cranes, etc) including the turbines would be supplied from the Far East (DECC, 2010). Table 3.4shows the anticipated quantity of steel for each option, and its likely sources. A more detailed breakdown of the steel requirements for each alternative option is given in Appendix B.

Table 3.4: Total demand for steel and its likely sources

Scheme	UK-sourced steel (rebar) (m tonnes)	Internationally sourced steel (m tonnes)
Brean Down to Lavernock Point barrage	0.42	1.873
Shoots barrage	0.17	0.177
Beachley barrage	0.08	0.104
Welsh Grounds lagoon	0.29	0.108
Bridgwater Bay lagoon	0.30	0.823

3.5.13 The annual demand for rebar, when compared with other large scale construction projects, is very high for the B3 Brean Down to Lavernock Point barrage and the L3d Bridgwater Bay lagoon. The requirements for the two smaller barrages and the L2 Welsh Grounds lagoon are on a scale that is comparable to the Second Severn Crossing and Crossrail.

3.5.14 The level of demand for steel during construction for any of the alternative options would not be large compared with current supplies and therefore there would not be expected to be a significant environmental effect.

Energy

3.5.15 There is a direct effect on the energy receptor as each STP alternative option would require energy during construction. Due to the uncertainties that would be inherent in extrapolating the construction data, the energy demand has not been quantified but has instead been assessed as being proportional to the inputs for each option, such as resource use and transport and construction traffic. The resource requirements shown in Table 3.2, toTable 3.5 indicate that the B3 Brean Down to Lavernock Point barrage and the L2 Welsh Grounds lagoon would have higher energy demands than the other options, and further qualitative discussion in given in Appendix B.

Table 3.5: Construction inputs as a proxy for energy demand

Scheme	Total concrete (m tonnes)	Number of vehicles operating on-site 24/7	Indicative number of vehicles to and from site each day
Brean Down to Lavernock Point barrage	20.680	350	760
Shoots barrage	2.332	60	360
Beachley barrage	1.159	40	317
Welsh Grounds lagoon	3.675	90	481
Bridgwater Bay lagoon	6.337	155	578

3.5.16 It is difficult to precisely quantify the energy demand for any of the alternative options but, based on the fact that the construction industry as a whole uses just 3 per cent of the UK's energy consumption, it is unlikely that the construction of one of the alternative options would have a significant environmental effect on this receptor. The level of demand for energy during construction for any of the alternative options would not be large compared with current supplies and therefore there would not be expected to be a significant environmental effect.

Water

3.5.17 There is a direct effect on the water receptor as each STP alternative option would require water sourced locally. The main requirement for water is in concrete manufacture, with other uses (such as welfare facilities and wheel washes) considered to be minor. The water requirement for each option, given in Table 3.6 below, ranges from 48 to 509 m^3 per day, depending on the option, however these requirements are small compared with the current daily water production by the water companies in the region, which is in the order of 3 million m^3.

Table 3.6: Demand for water during construction

Scheme	Total water use (m^3)	Average daily water demand (m^3)
Brean Down to Lavernock Point barrage	1,301,623	509
Shoots barrage	133,948	73
Beachley barrage	69,435	48
Welsh Grounds lagoon	183,085	100
Bridgwater Bay lagoon	373,528	205

3.5.18 It is also possible that not all water requirements would be for potable water and therefore water may be abstracted from rivers, estuaries or underground sources, which is managed by the EA through a licensing system (EA, 2010). Abstracted water could then be treated onsite as appropriate.

3.5.19 Whilst there are predicted medium to long term supply issues of potable associated with population growth and climate change, it is unlikely that water supply would be a constraint on any of the alternatives. Early communication with the water companies and the EA to secure supply is essential. The scale of demand for water, and its strict management through the water companies or the EA licensing system means that there are no likely significant environmental effects for any of the alternative options.

Waste receptors

3.5.20 There would be expected to be no direct effect on the sites for reuse opportunities receptor from any of the STP alternative options, as all dredged material would be reused onsite either in the permanent works, replacing virgin aggregate, or to construct intertidal habitat. Sand, gravel and hard rock (limestones) would be reused in the permanent works and mud, soft clay and soft rock (mudstones) would be reused for habitat development, as is shown in Table 3.7 below. Further details on the total quantities of dredged material and their use in the permanent works or intertidal habitat are given in Appendix B.

3.5.21 The 'Topographic modification to reduce intertidal loss from Severn Tidal Power options' paper has identified the suitable locations for creating new and replacement intertidal habitat for each of the alternative options. The amount of dredged material that is suitable for habitat creation is much less than could potentially be used, were all the identified sites to be developed, This would also enable material that is dredged during operation to be used for habitat creation.

3.5.22 Each of the STP alternative options would have an effect on the treatment and recycling facilities receptor, as they would require treatment and recycling facilities for waste such as steel formwork. Steel formwork for recycling would be in the order of 7,000 tonnes to 43,000 tonnes. Recycled steel is a valuable commodity to the UK steel market. Currently some 5.2 million tonnes of steel are recycled each year in the UK (EEF, 2009) and therefore the effects of the alternative options are not considered to be significant.

3.5.23 Each of the STP alternative options would have an effect on the energy recovery facilities receptor, as they would require energy recovery facilities located regionally for waste such as timber formwork and from offices and canteens. The quantity of timber formwork waste would range from 2,500 to 28,000 over the construction period.

3.5.24 Several energy from waste facilities are currently being proposed in the study area and in addition there is growing demand for waste wood as a fuel. The anticipated level of waste from the STP alternative options would not be considered to have a significant environmental effect in comparison with the scale of energy recovery facilities that are being developed, such as the proposed 750,000 tonne per year capacity merchant energy-from-waste facility in South Wales (Let's Recycle, 2009).

3.5.25 There is likely to be an effect on the landfill receptor from each of the STP alternative options, as they would require landfills located regionally for wastes that cannot be managed at treatment, recycling or energy recovery facilities, such as hazardous wastes. Quantities have not been estimated but are not expected to be large, as landfill disposal is seen as the 'last resort' option for waste management.

Operational Phase

3.5.26 Direct effects on the resource receptors would be expected during the operational phase, as there would be an ongoing demand for aggregates and embankment materials, steel, energy and water to support maintenance and operations. Data on the quantities required is not available however it is not expected that these be likely to have significant environmental effects, as the scale of demand on an annual basis would likely be only a fraction of that required during construction. .

3.5.27 Likewise, there would be direct effects on the waste receptors during operation. Sites for reuse opportunities would be required for disposal of maintenance dredging during operation. Treatment and recycling facilities would be required for waste such as steel components replaced during maintenance and energy recovery would be the likely disposal route for waste from offices and canteens. Landfill may be required for wastes that cannot be managed at treatment, recycling or energy recovery facilities, such as hazardous wastes.

3.5.28 The effect on the waste receptors was not able to be assessed as there is no data available on the extent of wastes, including dredged materials, other than the replacement of steel turbines, which would be easily and readily recycled as recycled steel is a valuable commodity.

Decommissioning Phase

3.5.29 Some direct effects on the resource receptors would be expected during the decommissioning phase, as there could be a requirement for temporary steel structures, as well as energy and water. There is no direct effect on the aggregates and embankment materials receptor as it is not expected that any of these materials would be required during decommissioning.

3.5.30 The most significant direct effect during decommissioning would be for sites for reuse opportunities, as there would be a large quantity of recycled aggregates produced during decommissioning, depending on the decommissioning approach taken. This could range from 'complete removal of the structures above foundation level' to 'removal of the sluice gates and turbines to allow natural tidal levels to be restored' (Parsons Brinckerhoff, 2009). Were complete removal sanctioned, then the quantity of recycled aggregates for which reuse opportunities need to be found could be comparable to the quantity of aggregates and embankment materials used to construct the option (as shown in Table 3.3).

3.5.31 Treatment and recycling facilities would be required for waste such as steel components. Energy recovery facilities would be required for waste from temporary timber structures and office and canteen waste. Landfill would be required for wastes that cannot be managed at treatment, recycling or energy recovery facilities, such as hazardous wastes.

Indirect Effects

3.5.32 During the construction phase, there could be an indirect effect on the aggregates and embankment materials receptor from the STP alternatives, should new quarrying or marine dredging areas be opened up to supply the project.

3.5.33 Furthermore, there would be indirect effects in relation to the transport requirements for aggregates and embankment materials. DECC (2010, pg 50) states that improvements to the local transport infrastructure would be required, although this could be reduced through the use of sea and rail transport.

3.5.34 The aggregate and embankment materials would generally be sourced within Great Britain, although the lagoon schemes may require some materials to be imported. Armour stone, which ranges from 8 to 18 per cent of the total demand for aggregates and embankment materials would generally be imported due to insufficient quality and stocks in the UK (other than for the B5 Beachley barrage, which has a relatively small demand and may be wholly supplied by Glensanda in Scotland) (DECC, 2010).

3.5.35 The scale of demand for aggregates and embankment materials (for example the L3d Bridgwater bay lagoon would require as much as 85 per cent of the UK's annual production of sand and gravel (DECC, 2010)) is such that significant indirect environmental effects are considered likely for all of the alternative options. This would be due to the effects of additional quarrying or dredging, as well as transport of the materials.

3.5.36 There would be no indirect effects on steel, energy, water or any of the waste receptors during the construction phase.

3.5.37 No indirect effects would be expected from any of the alternative options on any of the receptors during the operational or decommissioning phases.

Far-field Effects

3.5.38 During the construction phase, there would be a far-field effect on the aggregates and embankment materials and steel receptors from the STP alternatives, as imported materials would be required.

3.5.39 The demand for armour stone is high for all of the alternative options bar the B5 Beachley barrage. Due to the amount and quality required, this stone would be likely to be imported, from Norway or northern Europe (DECC, 2010), and the scale of demand is such that significant far-field environmental effects are likely.

3.5.40 There would be no far-field effects on energy, water or any of the waste receptors during the construction phase.

3.5.41 Steel such as replacement turbines would also be required during operation, which would create a far-field effects. No far-field effects would be expected from any of the alternative options on any of the receptors during the decommissioning phase.

Cumulative Effects

3.5.42 There are a number of proposed civil engineering projects in the vicinity of the Severn Estuary that could potentially be under construction during a similar timeframe to an STP project. Some but not all of the proposals have planning permission. These projects would all require the same resources and waste facilities as an STP project and therefore could create a cumulative effect. These projects include:

- Bristol Port Deep Sea Container Terminal,
- Nuclear power stations (Oldbury and Hinkley Point),
- Severnside Airport,
- Highways projects, including the new M4,
- Flood risk management works,
- Further wave and tidal power developments in the Severn Estuary, and
- Combined cycle gas turbine power stations at Baglan Bay and Pembroke.

3.5.43 The key constraint during construction for an STP project would be the availability of aggregates and embankment materials, and this would be exacerbated were these projects to be under construction at the same time as all have a high demand for the same materials. There is likely to be significant cumulative environmental effects for any of the alternative options from aggregates and embankment materials, should some or all of these projects be constructed at the same time as the STP project. However it is worth noting that DECC (2010, pg 50) considers that 'the possibility of other major projects is not a significant constraint on supply to the Severn Tidal Power schemes'.

3.5.44 The cumulative effect of steel and energy demands is unlikely to be concern, as the combined demand would still be only a fraction of what is available. It is not possible from the information available to determine the extent of the cumulative effect in relation to water, but water is a expected to become a more limited resource and therefore availability could prove to be an area of concern.

3.5.45 Flood management projects proposed by flood risk strategies for the Severn Estuary, Parrett Estuary and other catchment areas could be beneficial for the STP project as they may offer sites for reuse of dredged materials during both construction and operation phases.

Consequential Development Effects

3.5.46 No consequential development effects would be expected from any of the alternative options on any of the receptors during any of the phases.

Summary of Likely Significant Effects on the Environment

3.5.47 The following summarises the likely significant effects (direct, indirect, far-field, cumulative and consequential development effects) of the alternative options on the receptors during construction, operation and decommissioning phases.

3.5.48 The likely significant effects on the environment from the alternative options would be:

- A direct effect on the aggregates and embankment materials receptor, for all the alternative options except the B5 Beachley barrage as each STP alternative would require aggregates and embankment materials sourced within Great Britain and from Europe.
- An indirect effect on the aggregates and embankment materials receptor, for all the alternative options, from additional quarrying and dredging requirements to meet demand, as well as transport.
- A far-field effect on the aggregates and embankment materials receptor, for all the alternative options except the B5 Beachley barrage, as each STP alternative would require armour stone imported from Europe.
- A cumulative effect on the aggregates and embankment materials receptor for each alternative option, should any of the proposed projects in the vicinity of the Severn estuary be undertaken at the same time as the STP project.
- A direct effect on the sites for reuse receptor, as there would be a large quantity of recycled aggregates produced during decommissioning.

3.5.49 Whilst demand for the other resources considered (water, energy, steel) associated with the alternative options will be high, it is not considered to be proportionately large in terms of the ability of the respective markets to supply them.

Assumptions, Limitations and Uncertainties

3.5.50 There are a number of uncertainties and data gaps associated with the assessment of effects. These include:

- The data for resource use have been sourced from DECC's Supply Chain Study Report (2010) and the Options Definition Report (2009). In particular, DECC's report goes into significant detail on the types and quantities of aggregate required for each of the alternative options as well as potential sources. The data in this topic paper has been kept consistent with the DECC report. Data on steel and water requirements were both sourced from the Options Definition Report. Where necessary, data such as the quantity (tonnes) of formwork and turbines has been calculated from the measurement (volume and number respectively) that was available.

- Whilst the data determined through the Options Definition Report is the best available, uncertainties remain in the construction data (extent of resource requirements, dredging requirements).

- Data on energy consumption were not central to the Options Definition Report and therefore this report undertakes a qualitative assessment based on the energy uses such as concrete manufacture and transport. For a more detailed assessment of energy and carbon impacts, the reader is referred to the Carbon Footprinting paper.

- Waste quantities have not been specifically determined in the Options Definition Report and therefore have been calculated in terms of the resource inputs: for example the amount of formwork required as a resource would be essentially unchanged as the amount of formwork requiring treatment or disposal. This approach has enabled assessment of materials that would form the largest waste streams, and for the purpose of the assessment it has been assumed that other waste streams such as office and canteen waste would be relatively minor.

- Assessment of the decommissioning process of each alternative option contains a large number of uncertainties, including extent of decommissioning (i.e. complete or partial dismantling) and method of decommissioning, (i.e. demolition or materials recovery and reuse). For the purposes of this assessment, it has been assumed that the decommissioning shall be undertaken as a complete dismantling of the entire barrage/lagoon structure. For the purpose of clarity, the decommissioning phase has been assumed to be a reversal of the construction phase.

Table 3.7: Assessment summary for B3 Brean Down to Lavernock Point barrage

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
Resources										
Aggregates and embankment materials	**Construction** Demand for aggregates and embankment materials for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*UK sources*	*Negative*	*Uncertainties in the data for both construction requirements and amount and type of dredged materials*	*Yes*
	Construction Development of new quarries or marine dredging areas	*Indirect*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*Work not yet undertaken to ascertain the extent of new development potentially required*	*Yes*
	Construction Demand for aggregates and embankment materials for construction, especially armour stone, from abroad	*Far-field*	*High*	Long term	*Irreversible; permanent*	*Low*	*Trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*Yes*
	Construction Demand for aggregates and embankment materials, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*Yes*
	Operation Demand for aggregates and embankment materials for maintenance	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*UK sources*	*Negative*	*No data for operation / maintenance requirements*	*No*
Steel	**Construction** Demand for steel for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Construction Demand for steel for construction from abroad	*Far-field*	*High*	Long term	*Irreversible; permanent*	*Low*	*Trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*No*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
	Construction Demand for steel, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Operation Demand for steel for maintenance / replacement	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*No data for operation / maintenance requirements*	*No*
	Decommissioning Demand for temporary steel structures	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*No data for decommissioning requirements*	*No*
Energy	**Construction** Demand for energy for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data available on energy demand*	*No*
	Construction Demand for energy, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data available on energy demand*	*No*
	Operation Demand for energy for operation and maintenance	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data for operation / maintenance requirements*	*No*
	Decommissioning Demand for energy during decommissioning	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data for decommissioning requirements*	*No*
Water	**Construction** Demand for water for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Construction Demand for water, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Operation Demand for water for maintenance and operation	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*No data for operation / maintenance requirements*	*No*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
	Decommissioning Demand for water during decommissioning	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*No data for decommissioning requirements*	*No*
Waste										
Sites for reuse	**Operation** Demand for sites for reuse for dredged materials	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*Regional*	*Negative*	*Limited data on dredged waste during operation phase*	*Yes*
	Decommissioning Demand for sites for reuse of recycled aggregates from removal of the structures	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*Regional*	*Negative*	*Effect is dependent on extent of decommissioning*	*Yes*
Treatment and recycling facilities	**Construction** Demandfor treatment and recycling facilities	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Operation Demandfor treatment and recycling facilities	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Decommissioning Demandfor treatment and recycling facilities	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
Energy recovery	**Construction** Demandfor energy recovery	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Operation Demandfor energy recovery	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Decommissioning Demandfor energy recovery	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
Landfill	**Construction** Demandfor landfill	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Operation Demandfor landfill	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Decommissioning Demandfor landfill	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*

Table 3.8: Assessment summary for B2 Shoots Barrage

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
Resources										
Aggregates and embankment materials	**Construction** Demand for aggregates and embankment materials for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*UK sources*	*Negative*	*Uncertainties in the data for both construction requirements and amount and type of dredged materials*	*Yes*
	Construction Development of new quarries or marine dredging areas	*Indirect*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*Work not yet undertaken to ascertain the extent of new development potentially required*	*Yes*
	Construction Demand for aggregates and embankment materials for construction, especially armour stone, from abroad	*Far-field*	*High*	Long term	*Irreversible; permanent*	*Low*	*Trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*Yes*
	Construction Demand for aggregates and embankment materials, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*Yes*
	Operation Demand for aggregates and embankment materials for maintenance	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*UK sources*	*Negative*	*No data for operation / maintenance requirements*	*No*
Steel	**Construction** Demand for steel for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Construction Demand for steel for construction from abroad	*Far-field*	*High*	Long term	*Irreversible; permanent*	*Low*	*Trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Construction	*Cumulative*	*High*	Long term	*Irreversible;*	*Low*	*UK sources and*	*Negative*	*Uncertainties in*	*No*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
	Demand for steel, in conjunction with other proposed civil engineering projects				*permanent*		*trans-boundary*		*the data for construction requirements*	
	Operation Demand for steel for maintenance / replacement	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*No data for operation / maintenance requirements*	*No*
	Decommissioning Demand for temporary steel structures	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*No data for decommissioning requirements*	*No*
Energy	**Construction** Demand for energy for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data available on energy demand*	*No*
	Construction Demand for energy, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data available on energy demand*	*No*
	Operation Demand for energy for operation and maintenance	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data for operation / maintenance requirements*	*No*
	Decommissioning Demand for energy during decommissioning	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data for decommissioning requirements*	*No*
Water	**Construction** Demand for water for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Construction Demand for water, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Operation Demand for water for maintenance and operation	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*No data for operation / maintenance requirements*	*No*
	Decommissioning Demand for water	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*No data for decommissioning*	*No*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
	during decommissioning								*requirements*	
Waste										
Sites for reuse	**Operation** Demandfor sites for reuse for dredged materials	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*Regional*	*Negative*	*Limited data on dredged waste during operation phase*	*Yes*
	Decommissioning There is a demand for sites for reuse of recycled aggregates from removal of the structures	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*Regional*	*Negative*	*Effect is dependent on extent of decommissioning*	*Yes*
Treatment and recycling facilities	**Construction** Demandfor treatment and recycling facilities	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Operation Demandfor treatment and recycling facilities	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Decommissioning Demandfor treatment and recycling facilities	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
Energy recovery	**Construction** Demandfor energy recovery	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Operation Demandfor energy recovery	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Decommissioning Demandfor energy recovery	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
Landfill	**Construction** Demandfor landfill	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities*	*No*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
									are based on resource use.	
	Operation Demandfor landfill	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Decommissioning Demandfor landfill	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*

Table 3.9: Assessment summary for B5 Beachley Barrage

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
Resources										
Aggregates and embankment materials	**Construction** Demand for aggregates and embankment materials for construction from UK sources	Direct	High	Long term	Irreversible; permanent	High	UK sources	Negative	Uncertainties in the data for both construction requirements and amount and type of dredged materials	Yes
	Construction Development of new quarries or marine dredging areas	Indirect	High	Long term	Irreversible; permanent	Low	UK sources	Negative	Work not yet undertaken to ascertain the extent of new development potentially required	No
	Construction Demand for aggregates and embankment materials for construction, especially armour stone, from abroad	Far-field	High	Long term	Irreversible; permanent	Low	Trans-boundary	Negative	Uncertainties in the data for construction requirements	No
	Construction Demand for aggregates and embankment materials, in conjunction with other proposed civil engineering projects	Cumulative	High	Long term	Irreversible; permanent	Low	UK sources and trans-boundary	Negative	Uncertainties in the data for construction requirements	Yes
	Operation Demand for aggregates and embankment materials for maintenance	Direct	High	Long term	Irreversible; permanent	High	UK sources	Negative	No data for operation / maintenance requirements	No
Steel	**Construction** Demand for steel for construction from UK sources	Direct	High	Long term	Irreversible; permanent	Low	UK sources	Negative	Uncertainties in the data for construction requirements	No
	Construction Demand for steel for construction from abroad	Far-field	High	Long term	Irreversible; permanent	Low	Trans-boundary	Negative	Uncertainties in the data for construction requirements	No

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
	Construction Demand for steel, in conjunction with other proposed civil engineering projects	Cumulative	High	Long term	Irreversible; permanent	Low	UK sources and trans-boundary	Negative	Uncertainties in the data for construction requirements	No
	Operation Demand for steel for maintenance / replacement	Direct	High	Long term	Irreversible; permanent	Low	UK sources and trans-boundary	Negative	No data for operation / maintenance requirements	No
	Decommissioning Demand for temporary steel structures	Direct	High	Long term	Irreversible; permanent	Low	UK sources and trans-boundary	Negative	No data for decommissioning requirements	No
Energy	**Construction** Demand for energy for construction from UK sources	Direct	High	Long term	Irreversible; permanent	Low	UK sources	Negative	No data available on energy demand	No
	Construction Demand for energy, in conjunction with other proposed civil engineering projects	Cumulative	High	Long term	Irreversible; permanent	Low	UK sources	Negative	No data available on energy demand	No
	Operation Demand for energy for operation and maintenance	Direct	High	Long term	Irreversible; permanent	Low	UK sources	Negative	No data for operation / maintenance requirements	No
	Decommissioning Demand for energy during decommissioning	Direct	High	Long term	Irreversible; permanent	Low	UK sources	Negative	No data for decommissioning requirements	No
Water	**Construction** Demand for water for construction from UK sources	Direct	High	Long term	Irreversible; permanent	Low	Local	Negative	Uncertainties in the data for construction requirements	No
	Construction Demand for water, in conjunction with other proposed civil engineering projects	Cumulative	High	Long term	Irreversible; permanent	Low	Local	Negative	Uncertainties in the data for construction requirements	No
	Operation Demand for water for maintenance and operation	Direct	High	Long term	Irreversible; permanent	Low	Local	Negative	No data for operation / maintenance requirements	No

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
	Decommissioning Demand for water during decommissioning	Direct	High	Long term	Irreversible; permanent	Low	Local	Negative	No data for decommissioning requirements	No
Waste										
Sites for reuse	**Operation** Demandfor sites for reuse for dredged materials	Direct	High	Long term	Irreversible; permanent	High	Regional	Negative	Limited data on dredged waste during operation phase	Yes
	Decommissioning Demandfor sites for reuse of recycled aggregates from removal of the structures	Direct	High	Long term	Irreversible; permanent	High	Regional	Negative	Effect is dependent on extent of decommissioning	Yes
Treatment and recycling facilities	**Construction** Demandfor treatment and recycling facilities	Direct	High	Long term	Irreversible; permanent	Low	Regional	Negative	No waste data. Assumptions on waste quantities are based on resource use.	No
	Operation Demandfor treatment and recycling facilities	Direct	High	Long term	Irreversible; permanent	Low	Regional	Negative	No waste data. Assumptions on waste quantities are based on resource use.	No
	Decommissioning Demandfor treatment and recycling facilities	Direct	High	Long term	Irreversible; permanent	Low	Regional	Negative	No waste data. Assumptions on waste quantities are based on resource use.	No
Energy recovery	**Construction** Demandfor energy recovery	Direct	High	Long term	Irreversible; permanent	Low	Regional	Negative	No waste data. Assumptions on waste quantities are based on resource use.	No
	Operation Demandfor energy recovery	Direct	High	Long term	Irreversible; permanent	Low	Regional	Negative	No waste data. Assumptions on waste quantities are based on resource use.	No
	Decommissioning Demandfor energy recovery	Direct	High	Long term	Irreversible; permanent	Low	Regional	Negative	No waste data. Assumptions on waste quantities are based on resource use.	No
Landfill	**Construction**	Direct	High	Long term	Irreversible;	Low	Regional	Negative	No waste data.	No

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
	Demandfor landfill				permanent				Assumptions on waste quantities are based on resource use.	
	Operation Demandfor landfill	Direct	High	Long term	Irreversible; permanent	Low	Regional	Negative	No waste data. Assumptions on waste quantities are based on resource use.	No
	Decommissioning Demandfor landfill	Direct	High	Long term	Irreversible; permanent	Low	Regional	Negative	No waste data. Assumptions on waste quantities are based on resource use.	No

Table 3.10: Assessment summary for L2 Welsh Grounds Lagoon

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
Resources										
Aggregates and embankment materials	**Construction** Demand for aggregates and embankment materials for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*UK sources*	*Negative*	*Uncertainties in the data for both construction requirements and amount and type of dredged materials*	*Yes*
	Construction Development of new quarries or marine dredging areas	*Indirect*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*Work not yet undertaken to ascertain the extent of new development potentially required*	*Yes*
	Construction Demand for aggregates and embankment materials for construction, especially armour stone, from abroad	*Far-field*	*High*	Long term	*Irreversible; permanent*	*Low*	*Trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*Yes*
	Construction Demand for aggregates and embankment materials, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*Yes*
	Operation Demand for aggregates and embankment materials for maintenance	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*UK sources*	*Negative*	*No data for operation / maintenance requirements*	*No*
Steel	**Construction** Demand for steel for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Construction Demand for steel for construction from abroad	*Far-field*	*High*	Long term	*Irreversible; permanent*	*Low*	*Trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*No*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
	Construction Demand for steel, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Operation Demand for steel for maintenance / replacement	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*No data for operation / maintenance requirements*	*No*
	Decommissioning Demand for temporary steel structures	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*No data for decommissioning requirements*	*No*
Energy	**Construction** Demand for energy for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data available on energy demand*	*No*
	Construction Demand for energy, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data available on energy demand*	*No*
	Operation Demand for energy for operation and maintenance	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data for operation / maintenance requirements*	*No*
	Decommissioning Demand for energy during decommissioning	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data for decommissioning requirements*	*No*
Water	**Construction** Demand for water for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Construction Demand for water, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Operation Demand for water for maintenance and operation	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*No data for operation / maintenance requirements*	*No*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
	Decommissioning Demand for water during decommissioning	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*No data for decommissioning requirements*	*No*
Waste										
Sites for reuse	**Operation** Demandfor sites for reuse for dredged materials	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*Regional*	*Negative*	*Limited data on dredged waste during operation phase*	*Yes*
	Decommissioning Demandfor sites for reuse of recycled aggregates from removal of the structures	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*Regional*	*Negative*	*Effect is dependent on extent of decommissioning*	*Yes*
Treatment and recycling facilities	**Construction** Demandfor treatment and recycling facilities	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Operation Demandfor treatment and recycling facilities	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Decommissioning Demandfor treatment and recycling facilities	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
Energy recovery	**Construction** Demandfor energy recovery	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Operation Demandfor energy recovery	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Decommissioning Demandfor energy recovery	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
Landfill	**Construction** Demandfor landfill	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Operation Demandfor landfill	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Decommissioning Demandfor landfill	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*

Table 3.11: Assessment summary for L3d Bridgwater Bay Lagoon

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
Resources										
Aggregates and embankment materials	**Construction** Demand for aggregates and embankment materials for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*UK sources*	*Negative*	*Uncertainties in the data for both construction requirements and amount and type of dredged materials*	*Yes*
	Construction Development of new quarries or marine dredging areas	*Indirect*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*Work not yet undertaken to ascertain the extent of new development potentially required*	*Yes*
	Construction Demand for aggregates and embankment materials for construction, especially armour stone, from abroad	*Far-field*	*High*	Long term	*Irreversible; permanent*	*Low*	*Trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*Yes*
	Construction Demand for aggregates and embankment materials, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*Yes*
	Operation Demand for aggregates and embankment materials for maintenance	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*UK sources*	*Negative*	*No data for operation / maintenance requirements*	*No*
Steel	**Construction** Demand for steel for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Construction Demand for steel for construction from abroad	*Far-field*	*High*	Long term	*Irreversible; permanent*	*Low*	*Trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*No*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
	Construction Demand for steel, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Operation Demand for steel for maintenance / replacement	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*No data for operation / maintenance requirements*	*No*
	Decommissioning Demand for temporary steel structures	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources and trans-boundary*	*Negative*	*No data for decommissioning requirements*	*No*
Energy	**Construction** Demand for energy for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data available on energy demand*	*No*
	Construction Demand for energy, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data available on energy demand*	*No*
	Operation Demand for energy for operation and maintenance	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data for operation / maintenance requirements*	*No*
	Decommissioning Demand for energy during decommissioning	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*UK sources*	*Negative*	*No data for decommissioning requirements*	*No*
Water	**Construction** Demand for water for construction from UK sources	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Construction Demand for water, in conjunction with other proposed civil engineering projects	*Cumulative*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*Uncertainties in the data for construction requirements*	*No*
	Operation Demand for water for maintenance and operation	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*No data for operation / maintenance requirements*	*No*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
	Decommissioning Demand for water during decommissioning	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Local*	*Negative*	*No data for decommissioning requirements*	*No*
Waste										
Sites for reuse	**Operation** Demandfor sites for reuse	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*Regional*	*Negative*	*Limited data on dredged waste during operation phase*	*Yes*
	Decommissioning Demandfor sites for reuse	*Direct*	*High*	Long term	*Irreversible; permanent*	*High*	*Regional*	*Negative*	*Effect is dependent on extent of decommissioning*	*Yes*
Treatment and recycling facilities	**Construction** Demandfor treatment and recycling facilities	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Operation Demandfor treatment and recycling facilities	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Decommissioning Demandfor treatment and recycling facilities	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
Energy recovery	**Construction** Demandfor energy recovery	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Operation Demandfor energy recovery	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Decommissioning Demandfor energy recovery	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
Landfill	**Construction** Demandfor landfill	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities*	*No*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
									are based on resource use.	
	Operation Demandfor landfill	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*
	Decommissioning Demandfor landfill	*Direct*	*High*	Long term	*Irreversible; permanent*	*Low*	*Regional*	*Negative*	*No waste data. Assumptions on waste quantities are based on resource use.*	*No*

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

3.6.1 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 (Annex I). These measures are considered within this topic, and thereby inform the overall assessment of such measures within the SEA Environmental Report.

3.6.2 In this SEA, and in line with UK practice, these measures are split into those measures to prevent or reduce effects, and measures to as fully as possible offset any significant adverse effects on the environment.

Measures to prevent or reduce effects

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

3.6.4 During optimisation a series of presumptions were developed around the use of materials in the options. This included the following:

- Dredged material (sand, gravel and hard rock) would be used, where possible, in the permanent works,
- Dredged material that could not be reused for permanent works (mud, clay, soft rock) would be used for compensatory habitat, and
- Onshore cut and fill work would be designed such that no spoil would need to be disposed of.

3.6.5 The overall outcome of these presumptions is that all excavated and dredged material would be used onsite, rather than disposed of off-site.

3.6.6 Further measures to prevent or reduce the magnitude of effects resulting from the options would be to:

- Identify opportunities to use secondary and recycled aggregates in place of virgin aggregates,
- Liaise with suppliers such as water companies, steel suppliers and aggregates bodies to secure supply, and
- Manage each phase of work to minimise waste and manage the waste that is produced as high up the waste hierarchy as possible (ie reuse, recycle, recovery, with landfill as the last resort).

Measures needed to offset effects

3.6.7 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).

3.6.8 The need for offsetting measures will be identified within this topic. However, it will not be possible to describe full details of offsetting measures, such as geographic locations, at this strategic level. Therefore, generic suggestions will be made. Compensation measures are even more indefinite in scope, being dependent on preceding tests within the Habitats Directive. Thus it will only be possible to describe the need for such measures under the Habitats Directive, rather than scope them in any detail. A separate Compensation Workstream has been tasked by DECC to consider compensation requirements as part of the Feasibility Study.

3.6.9 There are no offsetting and compensation needs identified within this topic.

Assumptions, Limitations and Uncertainty

3.6.10 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 the measures. These issues are discussed for this topic below.

3.6.11 There are a number of uncertainties and data gaps, including:

- Whilst the data determined through the Options Definition Report is the best available, uncertainties remain in the construction data (extent of resource requirements, dredging requirements).
- Uncertainties in decommissioning data, including the extent to which the structures would be removed.
- Energy demand data (such as for transport, concrete manufacture) has not been modelled as part of the Options Definition Report. Thus a qualitative assessment of energy use has been undertaken, with the Carbon Footprinting paper assessing energy use in greater detail.

3.6.12 It is assumed that all caissons would be constructed within the Severn estuary as, although they could be constructed elsewhere and shipped to sit, this decision has not yet been taken and assuming local production presents the most conservative view.

SECTION 4

ASSESSMENT AGAINST SEA OBJECTIVES

4 ASSESSMENT AGAINST SEA OBJECTIVES

4.1 Introduction

4.1.1 While not specifically required by the SEA Directive, the Practical Guide (ODPM et al., 2005) recommends that SEA Objectives are used to compare the effects of alternative options. The SEA Objectives, assessment criteria and indicators were drafted and consulted upon as part of the Phase 1 SEA scoping stage.

4.1.2 SEA Objectives reflect a desired direction of change. It therefore follows that these objectives may not necessarily be met in full by a given alternative option, but the degree to which they do will provide a way of identifying preferences when comparing alternative options.

4.1.3 This topic paper informs the Environmental Report and its assessment of alternative options against SEA Objectives. This is by providing an assessment specifically in relation to the topic's SEA Objectives. The Environmental Report will then consolidate each topic assessment to provide a description of the assessment in relation to all SEA Objectives.

4.2 Assessment Methodology

4.2.1 An SEA Objective compliance methodology requires judgements to be made on the performance of alternative options against each SEA Objective. The 'assessment criteria' and 'indicators' which accompany the SEA Objectives aid these judgements. The effects on receptors presented in section 3 are aggregated and related back to the SEA Objectives so that the environmental performance of each alternative option can be compared.

4.2.2 The SEA Objectives assessment summary table (Table 4.1) shows how each alternative option performs over its entire life-cycle against each SEA Objective, and whether this is major or minor, positive or negative or a combination of the two. For instance, some receptors covered by an SEA Objective may benefit from an alternative option, whereas others would be adversely affected. Furthermore, the judgement of whether the alternative option performance is minor or major depends on the number or proportion of receptors for each objective that are significantly affected, and their value. In addition to the SEA Objectives assessment summary table, the SEA Objectives are also discussed in relation to assessment criteria and indicators.

4.2.3 It recognised that there is a degree of judgement related to alternative option performance, and the assessment criteria are intended as an aid to these judgements. This activity has also been informed by inputs from the Technical Workshops and the Environment and Regional Workstreams.

4.3 Objectives-led Assessment Summary

4.3.1 Table 4.1 sets out the summary of the SEA Objectives assessment which is described in detail below.

SEA Objective 1 – To promote sustainable use of resources

4.3.2 In terms of the sustainable use of resources, the differences between the alternatives are a matter of scale. In each of the alternatives other than the L3d Bridgwater Bay lagoon, the reuse of dredged material in the permanent works would reduce demand for virgin aggregates.

4.3.3 The B5 Beachley barrage has the lowest demand for resources, with aggregate being supplied regionally, including armour stone, and steel rebar being supplied from within Great Britain.

4.3.4 The B3 Brean Down to Lavernock Point Barrage and the B4 Shoots barrage would need to source aggregate from across Great Britain. Both lagoons would require increased aggregate production or international sources in order to meet demand. In each of these cases, it is likely that armour stone would be sourced from abroad.

4.3.5 The majority of steel for each of the alternatives would be supplied from abroad, with the exception of steel rebar, some of which could be sourced in the UK – sufficient to meet the requirements of the B5 Beachley barrage or the L2 Welsh Grounds lagoon.

4.3.6 For each of the alternatives, water and energy demands would be supplied locally and within Great Britain respectively but requirements are small compared with existing demands.

4.3.7 Therefore the alternative options promote the sustainable use of resources through the onsite reuse of all dredged material, as the single largest waste stream in the project is used to reduce the single largest resource demand and therefore lessen the environmental effects of both aggregate supply and waste disposal.

SEA Objective 2 – To reduce waste generation and disposal, increase reuse and recycling, and achieve the sustainable management of waste

4.3.8 The ability to reuse dredged material in the permanent works and to create compensatory habitat is the single largest contributor to sustainable waste management for all of the alternatives.

4.3.9 The largest demand for waste management is during the decommissioning phase which will generate large quantities of recycled aggregates that require reuse. The scale of these effects is proportionate to the aggregate use during construction, with the L3d Bridgwater Bay and L2 Welsh Grounds lagoons and the B3 Brean Down to Lavernock Point barrage making large contributions to the local aggregate supply, although the extent is dependent on the decommissioning route that is pursued.

4.3.10 Each of the alternative options would require treatment, recycling, energy recovery, and landfill facilities to manage their waste streams during all phases of the project. However the types of waste and likely quantities indicate that needs should be met by existing facilities and policy drivers (such as site waste management plans during construction) and price drivers (such as landfill tax) will help to ensure waste is sustainably managed.

Assumptions, Limitations and Uncertainty

4.3.11 In undertaking the assessment of the alternative options against the SEA objectives, there are assumptions, limitations and uncertainties, particularly as there is a degree of judgement related to option performance. These issues are discussed for this topic below.

4.3.12 There are a number of uncertainties and data gaps associated with the assessment of effects. These include:

- Whilst the data determined through the Options Definition Report is the best available, uncertainties remain in the construction data (extent of resource requirements, dredging requirements).
- Uncertainties in decommissioning data, including the extent to which the structures would be removed.
- Energy demand data (such as for transport, concrete manufacture) has not been modelled as part of the Options Definition Report. Thus a qualitative assessment of energy use has been undertaken, with the Carbon Footprinting paper assessing energy use in greater detail.

Table 4.1 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	?

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**
To promote sustainable use of resources	Aggregates and embankment materials; Steel; Energy; Water	-	-	0	-	-
		Aggregate demand during construction phase would still likely be high, even with prevention and reduction strategies in place.	Aggregate demand during construction phase would still likely be high, even with prevention and reduction strategies in place.		Aggregate demand during construction phase would still likely be high, even with prevention and reduction strategies in place.	Aggregate demand during construction phase would still likely be high, even with prevention and reduction strategies in place.
To reduce waste generation and disposal, increase reuse and recycling, and achieve the sustainable management of waste	Sites for reuse; Treatment and recycling facilities; Energy recovery; Landfill	0	0	0	0	0
		Waste would be managed in accordance with the waste hierarchy and the greatest quantities of waste (dredged materials during construction and recycled aggregates from decommissioning) would be reused.	Waste would be managed in accordance with the waste hierarchy and the greatest quantities of waste (dredged materials during construction and recycled aggregates from decommissioning) would be reused.	Waste would be managed in accordance with the waste hierarchy and the greatest quantities of waste (dredged materials during construction and recycled aggregates from decommissioning) would be reused.	Waste would be managed in accordance with the waste hierarchy and the greatest quantities of waste (dredged materials during construction and recycled aggregates from decommissioning) would be reused.	Waste would be managed in accordance with the waste hierarchy and the greatest quantities of waste (dredged materials during construction and recycled aggregates from decommissioning) would be reused.

SECTION 5

PLAN IMPLEMENTATION

5 PLAN IMPLEMENTATION

5.1 Introduction

5.1.1 This section assesses whether each alternative may be compliant with existing legislation and policy relevant to this topic as set out in section 2.3. This section also sets out suggestions for the framework for the monitoring of the plan against the predicted effects within this topic. It will thereby inform the development of the overall monitoring suggestions contained within the SEA Environmental Report.

5.2 Legislation and policy compliance

5.2.1 Identification of compliance with existing legislation and policy is not a requirement of the SEA Directive but will assist with suggestions to Government by DECC. The assessment considers legislation and policy relevant to this topic; and does not consider the overall consenting route that would apply to alternative options. Consenting is the subject of a separate Feasibility Study workstream.

5.2.2 This strategic environmental assessment of resources and waste has found no evidence to suggest that the alternatives considered would not comply with existing legislation and policy.

5.3 Monitoring of significant environmental effects

5.3.1 The SEA Directive requires that monitoring measures 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.

5.3.2 The Severn Tidal Power Feasibility Study SEA alone does not identify a preferred alternative option, but supports the wider decision making framework. Thus the monitoring is not prejudicial on the implementation of any alternative option. Below is a high level framework for monitoring, which can be applied to all of the Severn Tidal Power Schemes under consideration. The framework for this topic includes a brief description of monitoring proposed and the relationship between proposed monitoring, predicted likely significant environmental effects and receptors affected.

5.3.3 The monitoring suggestions for the Resources and Waste topic are summarised in Table 5.1 below.

Table 5.1: Suggestions for monitoring of significant environmental effects

Significant Effect	Relevant receptor	Description of monitoring
Demand during construction	Aggregates and embankment materials	Keep the level of demand under review during the detailed design of any of the alternative options to ensure adequate supply during construction
Demand during construction	Aggregates and embankment materials	Set targets for reuse of dredged materials and use of secondary and recycled aggregates
Demand during	Sites for reuse	Assess the availability and pro-actively

Significant Effect	Relevant receptor	Description of monitoring
decommissioning		identify sites for reuse well in advance of the decommissioning phase

5.4 Areas for further research

5.4.1 The suggestions for further research for the Resources and Waste topic are:

- Aggregates and embankment materials: investigate the potential for secondary and recycled aggregates to be used instead of primary aggregates;
- Water: further investigate the water demand for the project, particularly potable / non-potable to enable identification of potential sources;
- Waste: ensure further development of Topographic Modification takes into account volumes of waste generated during construction & operations.

SECTION 6

GLOSSARY

6 GLOSSARY

Term	Definition
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 environmental 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.
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.
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).
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

Term	Definition
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)
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.
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.
Irreversible	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.
Measures to prevent or reduce effects	Measures to prevent or reduce any significant adverse effects on the environment.
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.
Permanent effect	An effect which will last at least for 50 years.
Phase 1	The current stage of the STP Feasibility Study - i.e. the Decision Making

Term	Definition
	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'.
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.
Receptor	An entity that may be affected by direct or indirect changes to an environmental variable.
Reversible	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.
Severn Tidal Power Study Area	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. Study areas for individual topics for Phase 2 may extend beyond this area and these are defined separately according to topic.
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).
Sluice caissons	Prefabricated concrete structures placed into the water to house a sluice.
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.

Term	Definition
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.
Tidal prism	The difference between the mean high-water volume and the mean low-water volume of an estuary
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 (10^{12} 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)
Variant	A modified version of the original shortlisted scheme.

SECTION 7

REFERENCES

7 REFERENCES

Bristol Water Plc, Draft Water Resource Plan April 2008 Bristol Water, (2008),

Bristol Plc Draft Water Management Plan. Available at. http://www.bristolwater.co.uk/pdf/environment/w2008/WRP%202010%20v1.1%20D%20REP.pdf [Accessed on 16.07.09]

British Cement Association (BCA), 2007, Working towards sustainability 2: Second report from the UK cement industry on its progress towards sustainability, May 2007

Brundtland Commission 1987

Department of Communities and Local Government (DCLG), 2009, Regional Aggregate Working Parties, http://www.communities.gov.uk/planningandbuilding/planning/planningpolicyimplementation/managedaggregatessupply/regionalaggregateworking/, [Accessed 26 August 2009]

DCLG, 2006, Minerals Policy Statement 1: Planning and Minerals, November 2006

DECC, 2009a. Severn Tidal Power Phase 1 Consultation. Issued 26 January, DECC, London.

DECC, 2009b. Severn Tidal Power Phase 1 Consultation Government Response. Issued 15 July, DECC, London.

DECC 2010. Supply Chain Report, compiled for Severn Tidal Power Feasibility Study, Final Issued 26 January.

Department of Environment, Food and Rural Affairs (Defra), 2008a, 'Future Water: The Government's water strategy for England', February 2008

Defra, 2007, Waste Strategy for England

Defra, 2008b, Waste Infrastructure Delivery Programme, Residual Waste Procurement Pack Module 1: Options Appraisal and the Determination of the Reference Project for the Outline Business Case, June 2008

Department for Business, Innovation and Skills (DBIS), 2009a, 'Energy statistics: Total energy', Annual Tables: Digest of UK Energy Statistics (DUKES) Aggregate energy balances, http://www.berr.gov.uk/energy/statistics/source/total/page18424.html, [Accessed 30 June 2009]

DBIS), 2009b, 'Energy statistics: Total energy', Annual Tables: Digest of UK Energy Statistics (DUKES) Aggregate energy balances, Imports and exports of fuels DUKES G.1http://www.berr.gov.uk/energy/statistics/source/total/page18424.html, [Accessed 30 June 2009]

Department of Trade and Industry (DTI), 2007, Meeting the Energy Challenge A White Paper on Energy, May 2007

DTZ, Regional Economic Impact Study, Severn Estuary Tidal Power Steering Group (January 2009) (available at http://decc.gov.uk/en/content/cms/consultations/stp_phase1/stp_phase1.aspx)

Environment Agency (EA), 2009, Water for people and the environment: Water Resources Strategy for England and Wales, March 2009

Environment Agency Wales Construction And Demolition Waste Arising Survey 2005-06 http://www.environment-agency.gov.uk/research/library/publications/33979.aspx

EA, 2009, Quality protocols, http://www.environment-agency.gov.uk/business/topics/waste/32154.aspx

EA, 2008, Water Resources in England and Wales – Current State and Future Pressure, December 2008

Environment Agency, 2010, Water Abstraction, http://www.environment-agency.gov.uk/business/topics/water/32020.aspx [Accessed 5 February 2010]

EEF, 2009, 'UK Steel Key Statistics 2008', http://www.eef.org.uk/uksteel/steel/about+the+industry/facts/Facts_figures.htm, [Accessed 30 June 2009]

Financial Times (FT), 2009a, Construction steel market faces drop-off, http://www.ft.com/cms/s/0/4d8686f2-91a0-11de-879d-00144feabdc0.html?nclick_check=1 [Accessed 26 August 2009]

FT, 2009b, Climate change poses stern challenge, http://www.ft.com/cms/s/575e8b6e-7304-11dc-abf0-0000779fd2ac,dwp_uuid=cbee30bc-7249-11dc-b7ff-0000779fd2ac,Authorised=false.html?_i_location=http%3A%2F%2Fwww.ft.com%2Fcms%2Fs%2F1%2F575e8b6e-7304-11dc-abf0-0000779fd2ac%2Cdwp_uuid%3Dcbee30bc-7249-11dc-b7ff-0000779fd2ac.html&_i_referer=http%3A%2F%2Fwww.ft.com%2Freports%2Fsteel2007 [Accessed 26 August 2009]

Highways Agency (2010). *Severn Tidal Power Construction Impact Study*. Draft Issue 2, February 2010.

HM Government, 2009, The UK Renewable Energy Strategy, July 2009

HM Revenue and Customs, 'FAQ: Aggregates Levy', http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageExcise_FAQs&propertyType=document&columns=1&id=HMCE_PROD_008552 [Accessed 26 August 2009]

Iron and Steel Statistics Bureau (ISSB), 2009, http://www.issb.co.uk/
Mineral Products Association (MPA), 2009a, website

Let's Recycle, 2009, Covanta unveils plans for £400m Welsh EfW plant, http://www.letsrecycle.com/do/ecco.py/view_item?listid=37&listcatid=359&listitemid=10961, [Accessed 05 February 2010]

MPA, 2009b, 'In your area', http://www.mineralproducts.org/qua_yourarea01.htm,

MPA, 2009c, website http://www.cementindustry.co.uk/

National Grid (2010), Severn Tidal Grid Impact Report, January 2010.

ODPM, Scottish Executive, Welsh Assembly Government and Department of the Environment in Northern Ireland, 2005. A Practical Guide to the Strategic Environmental Assessment Directive. ODPM, London.

ODPM, 2005b, Planning Policy Statement 10: Planning for Sustainable Waste Management', July 2005

Parsons Brinckerhoff, 2009,Strategic environmental assessment of proposals for tidal power development in the Severn Estuary – Options definition report, Version 2 – Interim Options Definition, Volumes 1-3, Draft December 2009

Quarry Products Association, 2008, Sustainable Development Report 2008, December 2008

Severn Tidal Power, 2009a. STP SEA Policy, Plan and Programme Review. ENVIRON (PB/BV Consortium) Paper. July 2009.

Severn Tidal Power, 2009b. Cumulative Effects & Consequential Developments. PB/BV Consortium Paper. July 2009.

Severn Tidal Power, 2009c. Options Definition Report. Version 1- Preliminary Options definitions for Review and Assessment. PB/BV Consortium Paper. July 2009.

Severn Tidal Power, 2010. Options Definition Report. Version 2 – Interim Options Definition. PB/BV Consortium Paper. January 2010.

Severn Trent Water, 2008, Water Resources Management Plan 2009 Draft Version May 2008

South Wales RAWP, 2008, Annual Report 2007, published December 2008

South West RAWP, 2008, Annual Report: 2006, published 2008

South West Water, 2009, Annual Report and Financial Statements 2009

South West Water, 2009, 2nd Draft Water Resources Plan 2010-2035, January 2009

The Concrete Centre, 2009, 'Concrete Credentials: Sustainability', http://www.concretecentre.com/main.asp?page=728&mode=search&publication_id=682, 2009

UKCP09, 2009. UK Climate Projections, 2009. Website: http://ukclimateprojections-ui.defra.gov.uk/ui/admin/login.php published 18 June 2009, Crown Copyright 2008.

UK Steel, 2009, 'Where steel is made in the UK', http://www.eef.org.uk/uksteel/steel/about+the+industry/facts/Where_steel_is_made_in_the_UK.htm, [Accessed 30 June 2009]

Water UK, 2008, Sustainable Water: State of the Water Sector Report 2008

Welsh Water, 2008, Draft Resources Management Plan

Welsh Water, 2009, Report and Accounts 2009

WAG, 2001, Technical Advice Note (Wales) 21: Waste, November 2001

WAG, 2004, Interim Marine Aggregates Dredging Policy, November 2004

WAG, 2006, Environment Strategy for Wales, 2006

WAG Wise about Waste: The National Waste Strategy for Wales

WAG, 2009, Towards Zero Waste

WRAP, 2009, www.wrap.org.uk

SECTION 8

APPENDICES

8 APPENDICES

Appendix A Value, vulnerability and threshold for magnitudes of effect

Appendix B Methodology for assessment of effects

APPENDIX A

VALUE, VULNERABILITY AND THRESHOLD FOR MAGNITUDES OF EFFECT

Briefing Paper Ref	Baseline Receptor: Value, Vulnerability and Thresholds for Magnitude of Effect
Status	Template for use in report writing
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Summary

The Strategic Environmental Assessment for the Severn Tidal Power Feasibility Study is founded on the assessment of effects upon receptors; to inform the identification of those effects which are likely to be significant.

In forming a judgement on effect significance, it is necessary to assign attributes to each receptor, some of the most important of these being their value and vulnerability. In addition, it is necessary to take the magnitude of effect into consideration. In advance of identifying the effects of the short-listed options, it is necessary to determine the thresholds for this magnitude of effect.

This document sets out the proposed levels of both value and vulnerability of those receptors under consideration during the Phase 2 assessment as well as proposed thresholds for magnitude of effect.

This document follows a Technical Workshop with statutory and key consultees, which was held to discuss the process and approach documented here. The feedback and discussion points provided during the Technical Workshop have been considered in this document.

1 OVERVIEW

1.1 Introduction

The Severn Tidal Power (STP) Strategic Environmental Assessment (SEA) is founded on the assessment of effects upon receptors; to identify those effects which are likely to be significant. A receptor is defined as an entity that may be affected by direct or indirect changes to an environmental variable.

In forming a judgement on effect significance, it is necessary to assign attributes to each receptor, some of the most important of these being their value and vulnerability. One purpose of this document is to set out the proposed levels of both value and vulnerability to those receptors under consideration during the Phase 2 assessment.

In addition, when forming a judgement of effect significance, it is necessary to take the magnitude of effect into consideration. In advance of identifying the effects of the short-listed options, it is necessary to determine the thresholds for this magnitude of effect. This document sets out the proposed thresholds for magnitude of effect for those receptors under consideration during the Phase 2 assessment.

1.2 Requirements of the Strategic Environmental Assessment Directive

When determining the likely significance of effects on the environment, the Annex II of the Strategic Environmental Assessment Directive includes the following criteria (as presented in Phase 2 SEA Env. 4 Process Note p11)[1]:

> Characteristics of the effects and of the area likely to be affected, having regard, in particular, to;
>
> (a) the probability, duration, frequency and reversibility of the effects;
> (b) the cumulative nature of the effects;
> (c) the transboundary nature of the effects;
> (d) the risks to human health or the environment (for example, due to accidents);
> (e) **the magnitude** and spatial extent **of the effects** (geographical area and size of the population likely to be affected);
> (f) **the value and vulnerability of the area likely to be affected due to** -
> (i) special natural characteristics or cultural heritage;
> (ii) exceeded environmental quality standards or limit values; or
> (iii) intensive land-use; and
> (g) the effects on areas or landscapes which have a recognised national, Community or international protection status.

[1] Parsons Brinckerhoff Ltd in association with Black & Veatch Ltd (2009) *Phase 2 SEA: Env. 4 Process Note*

For each receptor, an assessment will therefore be provided that reviews the effects against these criteria. In many cases this will be based on qualitative rather than quantitative information and where necessary make use of expert judgement. The findings will be reviewed at a Technical Workshop in each case.

1.3 Definitions of Value and Vulnerability

The Strategic Environmental Assessment Directive does not define value or vulnerability. For the purpose of the Severn Tidal Power Feasibility Study SEA, the following definitions are being used.

- **Value** the value of a receptor is based on the scale of the geographic reference, rarity, importance for biodiversity, social or economic reasons, and level of legal protection.
- **Vulnerability** the potential for a pathway for exposure of a receptor to a given environmental effect, together with the sensitivity of the receptor to that effect. (The sensitivity is the tolerance of a receptor to a given environmental effect and its ability to recover from that effect).

It is not readily possible to develop a 'one size fits all' definition that applies consistently to all topics of the STP SEA. Therefore specific definitions and judgements on receptor value and vulnerability have been developed for each topic in consultation with the relevant technical groups.

A guideline framework for these classifications is provided in Table 1.1 below:

Table 1.1 Guidelines for identifying receptor value and vulnerability

	Sample receptor definitions	
	Value	**Vulnerability**
High	e.g. receptor is rare, important for social or economic reasons, legally protected, of international or national designation.	e.g. potential pathways for environmental change exist between options (sources) and receptors, receptor is in declining condition, dependent on a narrow range of environmental conditions.
Moderate*	N/A	e.g. few pathways for environmental change exist between options (sources) and receptors, receptor is only expected to recover from disturbance over a prolonged period of time, if at all.
Low	e.g. receptor is common, of local or regional designation.	e.g. limited or no pathways from between options and receptors, receptor is in stable or favourable condition and dependent on a wide range of environmental conditions.
None	N/A	e.g. no pathways exist between environmental changes and receptors, receptor is insensitive to disturbance.

*'Moderate' vulnerability will only be assigned if analysis of receptors indicates that it is essential to make a further distinction between High and Low vulnerability attributes,

For each receptor, an assessment will therefore be provided that reviews the effects against these criteria. In many cases this will be based on qualitative rather than quantitative information and where necessary make use of expert judgement. The findings will be reviewed at a Technical Workshop in each case.

1.4 Definitions of Thresholds for Magnitude of Effect

The magnitude of the effect considers the receptor affected and categorises this as high, medium, low or very low. The Strategic Environmental Assessment Directive does not provide classification thresholds. Therefore specific definitions on classification thresholds for magnitude of effect have been developed for each topic receptor in consultation with the relevant technical groups.

Guidelines for determining thresholds for magnitude of effect are provided in Table 1.2 below. It should be noted that the thresholds may be quantitative or qualitative. The guidelines are primarily focused on the natural environment and should be adapted for other topics as appropriate.

Table 1.2 Guidelines for determining thresholds for magnitude of effect

	Magnitude of effect			
Classification	**High**	**Medium**	**Low**	**Very Low**
Quantitative Guideline	90%+ of receptor or capacity of estuary to support receptor affected	50-90% of receptor or capacity of estuary to support receptor affected	10-50% of receptor or capacity of estuary to support receptor affected	<10% of receptor or capacity of estuary to support receptor affected
Qualitative Guideline (note that these are primarily focused on the natural environment and should be adapted for other topics as appropriate)	A permanent or long-term effect on the extent or size or integrity of a site, habitat, species assemblage or community, population or group. If adverse, this is likely to threaten its sustainability/favourable conservation status; if beneficial, this is likely to enhance its conservation status.	A permanent or long-term effect on the extent or size or integrity of a site, habitat, species assemblage or community, population or group. If adverse, this is unlikely to threaten its sustainability sustainability/favourable conservation status; if beneficial, this is likely to be sustainable but is unlikely to enhance its conservation status.	A permanent or long-term reversible effect on a site, habitat, species assemblage or community, population or group whose magnitude is detectable but will not threaten its integrity.	A short-term but reversible effect on the extent or size or integrity of a site, habitat, species assemblage or community, population or group that is within the normal range.

It should be noted that the thresholds for magnitude of effect may differ for each receptor or group of receptor.

2 ASSIGNING VALUE

2.1 Resources

For the purposes of this topic paper, the resources that are being studied are defined as the natural resources that will be used in the project. In the scoping paper prepared for the first phase of this SEA, a single resource receptor was identified: *resource availability*. To facilitate the more detailed assessment required in Phase 2 of the SEA, this single receptor has been split into the four key resources that will be used in the construction of any of the options. . The key resource receptors that have been identified in conjunction with the design and engineering development of the options are:

- Aggregates and concrete,
- Steel,
- Energy (including fuels and electricity), and
- Water.

The SEA process requires that a value be determined for each of the resources, with the value of a receptor being based on the scale of the geographic reference, rarity, importance for biodiversity, social or economic reasons, and level of legal protection.

In order to assess each resource receptor individually for each option, and then combine the results to give an overall view for the topic, the value of the resource receptors was determined to be the availability of a resource in its accepted market (be it regional, national or international). A High value resource would generally be considered scarce in its usual market, and a Low value resource would be readily available. This definition uses the market, and therefore the monetary value of the resource, as a proxy for the resource's intrinsic value.

An alternative option for valuing the receptors, Ecological Footprinting, was suggested at the Technical Workshop. This will be investigated further during the course of the research to determine whether it is more appropriate.

Based on the above guidance and information, Table 2.1 below sets out the proposed values for the resource receptors. Further discussion on the value assigned to each receptor is provided below.

Table 2.1 Resource Receptor Value

Receptor	Proposed Value
Aggregates and concrete	Low
Steel	Low
Energy	Low
Water	High

2.1.1 Aggregates and Concrete

In accordance with the definition of 'value', above, the value of aggregates and concrete is based on their market availability. Research undertaken to determine the baseline indicates that while local aggregate markets are preferable, particularly in relation to transport costs, the aggregate and concrete market in UK operates at a national level, with 100 per cent of aggregates coming from within the country[i].

The UK produces around 210 million tonnes of aggregates per year from land and marine sources, and a further 67 million tonnes of aggregates per annum from recycled and secondary sources. There are over 1,300 quarries in Britain and a fleet of 25 marine aggregate dredgers. Wales and South West England together have 124 quarries and 22 wharves for marine dredged aggregates. They produce nearly 20 per cent of the UK's aggregates.[ii]

These data indicate that aggregates and concrete are readily available in the UK and therefore the value is Low.

2.1.2 Steel

Steel is an international market, with the UK importing 55 per cent of the 14.3 million tonnes of steel used domestically in 2007[iii]. Large construction projects purchase their steel on the international market in advance of construction in order to guarantee delivery and fix the price. Four of the UK's steelmaking and rolling mills are located in south Wales[iv].

Steel is readily available in the UK, and therefore the value is Low.

2.1.3 Energy

Energy, including electricity, natural gas and petroleum products, are bought and sold nationally in the UK.

The UK's energy consumption in 2007 was 165 million tonnes of oil equivalent, of which just 3 per cent was used by the construction industry, compared with the domestic sector (44m tonnes) and the transport sector (60m tonnes)[v]. The construction industry's energy use by fuel type was:

- Petroleum products, 31%
- Natural gas, 43%
- Electricity, 26%

Energy requirements would be readily addressed by the national energy market, giving a Low value.

2.1.4 Water

Water markets in the UK are privatised and operate regionally. Welsh Water manages water resources across Wales, with South West Water, Severn Trent and Bristol Water being responsible on the English side of the estuary.

Water abstraction in Wales and the South West is predominantly from surface water supplies, and pressure on water supplies is increasing, through increased demand from population growth and seasonal reductions in availability as a result of climate change.[vi] Environment Agency data indicate that there is limited water available for abstraction in the proximity of the estuary[vii].

These data indicate that the value of water is High.

2.2 Waste

The Phase 1 scoping report identified the waste receptor as *waste management facilities*. To facilitate the more detailed assessment required in Phase 2 of the SEA, this single receptor has been split into the types of waste treatment and disposal facilities that will be used during the construction, operation and decommissioning of any of the options. The waste receptors to be assessed for this topic paper have been identified as:

- Sites for reuse opportunities (on-site or off-site), such as other construction projects or habitat enhancement projects,
- Treatment and recycling facilities,
- Energy recovery, and
- Landfill.

The SEA process requires that a value be determined for each of the waste receptors, with the value of a receptor being based on the scale of the geographic reference, rarity, importance for biodiversity, social or economic reasons, and level of legal protection.

In order to assess each waste receptor, the value of the receptors was determined to be the availability of waste management sites or facilities in the proximity of the estuary (south Wales, south west England, and the midlands). A High value is where waste sites or facilities are rare, and a Low value is where waste sites or facilities are readily available.

Based on the above guidance and information, Table 2.2 below sets out the proposed values for the waste receptors. Further discussion on the value assigned to each receptor is provided below.

Table 2.2 Waste Receptor Value

Receptor	Proposed Value
Sites for reuse opportunities	High
Treatment and recycling facilities	High
Energy recovery	High
Landfill	High

The availability of waste sites and facilities in the UK is determined through the planning process. Waste planning policy in both England and Wales requires local and regional planning authorities to identify in their development plan documents sites and areas that are suitable for waste management facilities.[viii,ix]

Whilst regional level strategies are generally in place, local waste plans are in many cases less developed. Furthermore, planning is widely considered a key risk in delivering new waste facilities[x].

Further work will also be undertaken to assess the hazardous waste likely to be generated and how it will affect these receptors.

Due to limited availability of sites and the planning risks associated with developing new facilities, the value of all types of waste sites / facilities is considered to be High.

3 ASSIGNING VULNERABILITY

3.1 Resources

The vulnerability of each receptor is the sensitivity of the receptor to a given environmental effect and its ability to recover from that effect. In terms of resources, this is defined as the impact that each STP option will have on the availability of the resource. A receptor with High vulnerability will therefore be where the STP project's demand for a resource significantly affects the availability of the resource, with corresponding definitions for Moderate, Low and No vulnerability.

Based on the above guidance and information, Table 3.1 below sets out the proposed vulnerabilities for the resource receptors. Further discussion on the vulnerability assigned to each receptor is provided below.

Table 3.1 Resource Receptor Vulnerability

Receptor	Proposed Vulnerability
Aggregates and concrete	High
Steel	Low
Energy	Low
Water	High

3.1.1 Aggregates and Concrete

Construction of one of the STP options could require between 1 million and 10 million tonnes of aggregate and concrete per year during the construction period. This represents up to 2 per cent of the national supply or up to 20 per cent of the regional supply of aggregates.

Initial research indicates that the demand for aggregates for any of the STP options is far in excess of other large construction projects currently or previously undertaken in the UK. For example, the STP project would require 10 or 100 times more aggregates than the Second Severn Crossing.

Thus, whilst aggregates and concrete are readily available in the UK, the scale of the STP options and their demands on local and national supplies mean that the vulnerability is High.

3.1.2 Steel

Of the 14.3 million tonnes of steel used in the UK in 2007, the STP options would use in the order of 12,000 to 112,000 tonnes per annum, 0.08 to 0.8 per cent of annual consumption. The vulnerability of steel is Low.

3.1.3 Energy

Data on the energy demands of the STP options is not currently available. However, as the construction industry used just 3 per cent of UK energy in 2007, and an STP project would represent a fraction of the total construction industry, it is assumed that the energy requirements would be readily addressed by the national energy market, giving a Low vulnerability.

3.1.4 Water

The principal demand for water would be for concrete production: about one-third of concrete is water, by weight. The water required for a STP project could be in the order of 1,000,000 m^3 per year during construction. Whilst this is only a small fraction of the current use in Wales and the South West pressure on water supplies through population growth and climate change suggest that the vulnerability of water is High.

3.2 Waste

The vulnerability of each waste receptor is the impact that each STP option would have on the availability of waste management sites and facilities. A receptor with High vulnerability will therefore be where the STP project's demand for a type of waste management site or facility is likely to be in excess of what is available, with corresponding definitions for Moderate, Low and No vulnerability.

There is little information available on either the quantities and types of waste to be generated by the STP project, or the availability and capacity of future waste sites and facilities, and therefore the initial assessments in this section are essentially an assessment of risk.

Based on the above guidance and information, Table 3.2 below sets out the proposed vulnerabilities for the waste receptors. Further discussion on the vulnerability assigned to each receptor is provided below.

Table 3.2 Waste Receptor Vulnerability

Receptor	Proposed Vulnerability
Sites for reuse opportunities	High
Treatment and recycling facilities	Low
Energy recovery	Low
Landfill	High

Where on-site reuse is not possible, off-site opportunities such as other construction projects (eg flood defences) and habitat enhancement projects may be suitable. However identification of such opportunities that are to be available in the timeframe that is suitable for the STP project is likely to be difficult, and therefore the vulnerability of such sites is considered High.

European waste management legislation is driving demand for treatment and recycling facilities. Some types of waste, such as waste electrical and electronic equipment (eg turbines) and other operational waste are likely to be accommodated within treatment and recycling facilities that already exist when the project is underway. Specialist and large-scale requirements during construction or demolition, such as for treatment of contaminated soils could be expected to be temporary facilities developed for the purposes for the project. Therefore the vulnerability of these facilities is Low.

The project's demand for energy recovery is likely to be for both construction and demolition waste (eg formwork) and operational waste. Quantities are not anticipated to be great. There are plans on both sides of the estuary for Energy-from-Waste facilities at which capacity may be available for waste from the project. Therefore the vulnerability for energy recovery is Low.

There is increasing legislative pressure to reduce the use of landfill and its availability. Its use would be the least preferred on both environmental and cost grounds, and the scenario for large landfill requirements would be if alternative reuse, treatment and recycling opportunities were not realised. Were this the case, then substantial landfill volumes would be required, making this a High vulnerability.

4 ASSIGNING THRESHOLDS FOR MAGNITUDE OF EFFECT

The magnitude of the effect considers the receptor affected and categorises this as high, medium or low. Thresholds may be quantitative or qualitative and, in the case of resources and waste, they will be qualitative. Attempts to provide quantitative thresholds would be limited by the imprecise information available.

Based on the above guidance and information, Table 4.1 below sets out the proposed thresholds for magnitude of effect for the resource receptors. Further discussion on the thresholds assigned to each receptor is provided below.

Table 4.1 Thresholds for Magnitude of Effects

	Thresholds for Magnitude of Effect			
Classification	**High**	**Medium**	**Low**	**Very Low**
Resource receptors	Resource demand is **greater than** other significant construction projects eg Crossrail, Second Severn Crossing, Olympics	Resource demand is **comparable to** other significant construction projects eg Crossrail, Second Severn Crossing, Olympics	Resource demand is **less than** other significant construction projects eg Crossrail, Second Severn Crossing, Olympics	Not applicable
Waste receptors	**Additional** waste sites / facilities are likely to be required in order to manage the waste from the project	Not applicable	**No additional** waste sites / facilities are likely to be required ie existing facilities / sites will be sufficient to manage the waste from the project	Not applicable

These thresholds have been determined based on the definitions given in section 1. For example, the high threshold reflects that the resource demands or quantity of waste being disposed of is such that it will have a permanent or long-term effect. For resource receptors, this may be in terms of additional quarrying or dredging requirements and for waste receptors, this may be the loss of amenity or 'opportunity cost' of using land for a new waste facility.

5 REFERENCES

[i] The Concrete Centre, 'Concrete Credentials: Sustainability', http://www.concretecentre.com/main.asp?page=728&mode=search&publication_id=682, 2009
[ii] Quarry Products Association 'In your area', http://www.mineralproducts.org/qua_yourarea01.htm, accessed 30 June 2009
[iii] EEF, 'UK Steel Key Statistics 2008' http://www.eef.org.uk/uksteel/steel/about+the+industry/facts/Facts_figures.htm, accessed 30 June 2009
[iv] UK Steel, 'Where steel is made in the UK', http://www.eef.org.uk/uksteel/steel/about+the+industry/facts/Where_steel_is_made_in_the_UK.htm, accessed 30 June 2009
[v] Department for Business, Innovation and Skills (BIS) 'Energy statistics: Total energy', Annual Tables: Digest of UK Energy Statistics (DUKES) Aggregate energy balances, http://www.berr.gov.uk/energy/statistics/source/total/page18424.html, accessed 30 June 2009
[vi] Defra, 'Future Water: The Government's water strategy for England', February 2008
[vii] Environment Agency, 'Water for people and the environment: Water Resources Strategy for England and Wales', March 2009
[viii] ODPM, 'Planning Policy Statement 10: Planning for Sustainable Waste Management', July 2005
[ix] Welsh Assembly Government, 'Technical Advice Note (Wales) 21: Waste', November 2001
[x] Defra Waste Infrastructure Delivery Programme, 'Residual Waste Procurement Pack Module 1: Options Appraisal and the Determination of the Reference Project for the Outline Business Case', June 2008

APPENDIX B

METHODOLOGY FOR ASSESSMENT OF EFFECTS

DECC

SEVERN TIDAL POWER - SEA TOPIC PAPER

Resources and Waste

Appendix B: Methodology for Assessment of Effects

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CONTENTS

SECTION 1

METHODOLOGY FOR ASSESSMENT OF EFFECTS

1 METHODOLOGY FOR ASSESSMENT OF EFFECTS

1.1 Introduction

1.1.1 The assessment of the environmental effects of resource use and waste production for the alternative options has been undertaken by first determining the extent of use or production for the alternative option and then assessing the scale of that demand in relation to the baseline. The baseline, as detailed in section 2 of the topic paper, is defined as the availability of the receptor at the given phase of the project, based on the current availability, considered in light of potential policy or other changes.

1.1.2 The thresholds for the magnitude of the effects were initially developed for the first Technical Workshop (as given in Appendix A). They were refined as the assessment progressed, and those that have been used are given in Tables 1.1 and 1.2 below. The thresholds are broadly determined as being whether the resource requirements or waste produced could be catered for within existing availability or whether the demand is such that additional availability would be required, such as new sources for aggregates or new waste facilities. Additionally the scale of effects has been considered in comparison with other major construction projects in the UK, such as Crossrail and the Olympic Park.

1.1.3 The resources that are being studied are defined as the natural resources that will be used in the project. Other resources, such as labour and vessels, have been considered elsewhere in the feasibility study but do not form part of the Resources and Waste topic. To facilitate the detailed assessment required, the resources receptor has been split into the four key resources that would be used in the construction of any of the options. These have been identified from the Options Definition work as:

- Aggregates and concrete,
- Steel,
- Energy (including fuels and electricity), and
- Water.

1.1.4 The waste receptors has been identified as the waste treatment and disposal facilities that would be used during the construction, operation and decommissioning of any of the options. The waste receptors to be assessed for this topic paper have been identified as:

- Sites for reuse opportunities, such as other construction projects or habitat enhancement projects,
- Treatment and recycling facilities,
- Energy recovery, and
- Landfill.

1.1.5 The data for resource use have been sourced from DECC's Supply Chain Study Report (2010) and the Options Definition Report (2009). In particular, DECC's report goes into significant detail on the types and quantities of aggregate required for each of the alternative options as well as potential sources. The data in this topic paper has been kept consistent with the DECC report. Data on steel and water requirements were both sourced from the Options Definition Report. Where necessary, data such as the quantity (tonnes) of formwork and turbines has been calculated from the measurement (volume and number respectively) that was available.

1.1.6 Data on energy consumption were not central to the Options Definition Report and therefore this report undertakes a qualitative assessment based on the energy uses such as concrete manufacture and transport. For a more detailed assessment of energy and carbon impacts, the reader is referred to the Carbon Footprinting paper.

1.1.7 Waste quantities have not been specifically determined in the Options Definition Report and therefore have been calculated in terms of the resource inputs: for example the amount of formwork required as a resource would be essentially unchanged as the amount of formwork requiring treatment or disposal. This approach has enabled assessment of materials that would form the largest waste streams, and for the purpose of the assessment it has been assumed that other waste streams such as office and canteen waste would be relatively minor.

1.2 Definitions of Thresholds for Magnitude of Effect

1.2.1 The thresholds of magnitude of effect (as in Appendix A) were initially developed for the first Technical Workshop. They were refined as the assessment progressed, as presented in Tables 1.1 and 1.2 below.

1.2.2 The magnitude of the effect considers the receptor affected and categorises this as high, medium, low or very low. The Strategic Environmental Assessment Directive does not provide classification thresholds. Therefore specific definitions on classification thresholds for magnitude of effect have been developed for each topic receptor in consultation with the relevant technical groups.

1.2.3 The magnitude of the effect considers the receptor affected and categorises this as high, medium or low. Thresholds may be quantitative or qualitative and, in the case of resources and waste, they will generally be qualitative. Attempts to provide quantitative thresholds would be limited by the imprecise information available.

1.3 Resource Receptors

1.3.1 The thresholds for assessing the magnitude of effect for the resource receptors are set out in Table 1.1, below. These thresholds have been determined based on the definitions given in Appendix A (Section 1.1). For example, the high threshold reflects that the resource demands are such that it will have a permanent or long-term effect. For resource receptors, this may be in terms of additional quarrying or dredging requirements.

Table 1.1 Thresholds for Magnitude of Effects for Resource Receptors

Classification	Thresholds for Magnitude of Effect			
	High	Medium	Low	Very Low
Resource	The resource	The resource	The resource	Not applicable

Classification	Thresholds for Magnitude of Effect			
	High	Medium	Low	Very Low
receptors	demand is greater than can be met by the usual market that would supply the resource for UK projects.	demand will have a significant impact on the usual market that would supply the resource for UK projects.	demand can be easily met by the usual market that would supply the resource for UK projects.	
	Resource demand is greater than other significant construction projects.	Resource demand is comparable to other significant construction projects.	Resource demand is less than other significant construction projects.	

1.4 Waste Receptors

1.4.1 The thresholds for assessing the magnitude of effect for the waste receptors are set out in Table 1.2, below. These thresholds have been determined based on the definitions given in Appendix A (Section 1.1). For example, the high threshold reflects that the quantity of waste to be managed is such that it will have a permanent or long-term effect. For waste receptors, this may be the loss of amenity or 'opportunity cost' of using land for a new waste facility.

Table 1.2 Thresholds for Magnitude of Effects for Waste Receptors

Classification	Thresholds for Magnitude of Effect			
	High	Medium	Low	Very Low
Waste receptors	Additional waste sites / facilities are likely to be required in order to manage the waste from the project.	Not applicable	Existing facilities / sites will be sufficient to manage the waste from the project, ie no additional waste sites / facilities are likely to be required.	Not applicable

SECTION 2

RESOURCES

2 RESOURCES

2.1 Introduction

2.1.1 The key resource receptors have been identified through the SEA process. These are given in Table 2.1 below.

Table 2.1 Resource receptors and their likely sources

Resource Receptors	Likely sources
Aggregates and Embankment Materials	Local, regional, and national and international (European) sources for extraction of natural resources eg quarries; marine dredging Local, regional, and national sources for secondary and recycled aggregates eg industrial by-products; construction, demolition and excavation (CDE) waste; fly ash from coal-fired power stations; bottom ash from waste incinerators International sources for armour stone (Norway)
Steel	National and international sources (the top eight exporters in 2008 were China, Japan, EU27, Ukraine, Russia, South Korea, Turkey, Taiwan)
Energy (including electricity, diesel, gas, fuel oil)	Sourced nationally (electricity from the national grid), and from national and international sources (fossil fuels)
Water	Local sources

2.1.2 In parallel with the SEA, DECC has undertaken a supply chain study to identify the constraints in terms of resources and equipment supply for the STP alternatives. The report is based on a survey of suppliers of various resources and equipment, including vessels, aggregates and embankment materials, caisson construction yards, concrete, and mechanical and electrical equipment.

2.1.3 The supply chain study assesses the availability of resources and equipment against the demands of each of the STP alternatives. The data on which the survey has been based have been produced by Parsons Brinckerhoff as part of the Options Definition process. The data and assumptions in this topic paper have been developed in consultation with DECC's supply chain study and the options definition process to ensure consistency across the STP reporting.

2.2 Aggregates and Embankment Materials

Construction phase

2.2.2 Aggregates for concrete and materials for constructing embankments constitute the greatest resource demand for any of the STP alternatives. The types of aggregates and embankment materials that would be required are:

- Concrete aggregates – for structures, ballast and pre-cast armour units;
- Crushed rock – for embankment fill;
- Sand and gravel – for embankment and breakwater fill and sand ballast; and
- Armour stone and rock armour – for embankment and breakwater slope protection.

2.2.3 The demand for these materials in UK construction projects would generally be expected to be supplied from UK-based quarrying or marine dredging activities. Secondary and recycled aggregates are contributing an increasing proportion to the UK's aggregate requirements, however further work would be required to assess their suitability for the STP alternatives, as the quality demanded by the environment and conditions may mean they are unsuitable. For the purposes of this study, it is assumed that no secondary or recycled materials would be used, other than those dredged as part of the construction works.

2.2.4 There is also the opportunity for reuse of dredged material within the STP alternatives. Significant quantities of materials would be dredged during the construction and an assessment has been made to the extent that the materials can be reused in the construction. It has been assumed that 100 per cent of sand and gravel would be reused in the permanent works for embankment fill and ballast. A proportion of hard rock would also be reused in the permanent works.

2.2.5 Mud and silt and soft rock, and any remaining sand and gravel and hard rock would be used in the construction of compensatory habitat to avoid disposal off site.

2.2.6 Onshore construction would be designed to provide a balance between cut and fill with the exception that there may be a surplus of topsoil which would be made use of in other schemes and not disposed of. Therefore onshore excavation has not been included in this assessment.

2.2.7 Tables 2.2 to 2.6 below identify the projected demand for each type of aggregate and embankment material, and show the average annual demand as a proportion of forecast supplies in Wales, the South West and Great Britain.

Table 2.2 Demand for aggregates for concrete (structures, ballast and pre-cast armour units) (Source: DECC, 2010)

Scheme	Total demand (m tonnes)	Average annual demand (m tonnes)	Proportion of annual forecast production		
			Wales	South West	Great Britain
Brean Down to Lavernock Point barrage	11.71	1.95	39%	19.5%	2.4%
Shoots barrage	1.28	0.32	6.4%	3.2%	0.4%
Beachley barrage	0.64	0.16	3.2%	1.6%	0.2%
Welsh Grounds lagoon	2.02	0.40	8.1%	4.0%	0.5%
Bridgwater Bay lagoon	6.06	1.21	24.3%	12.1%	1.5%

Table 2.3 Demand for aggregates for embankment and breakwater fill, sand ballast, and seabed (sand, gravel and crushed rock) (Source: DECC, 2010)

Scheme	Total demand (m tonnes)	Average annual demand (m tonnes)	Proportion of annual forecast production		
			Wales	South West	Great Britain
Brean Down to Lavernock Point barrage	33.33	5.56	61.7%	55.6%	8.8%
Shoots barrage	14.25	3.56	39.6%	35.6%	5.7%
Beachley barrage	2.20	0.55	6.1%	5.5%	0.9%
Welsh Grounds lagoon	60.36	12.07	134.1%	120.7%	19.2%
Bridgwater Bay lagoon	76.31	15.26	169.6%	152.6%	24.2%

Table 2.4 Demand for armour stone (Source: DECC, 2010)

Scheme	Total demand (m tonnes)	Average annual demand (m tonnes)	Proportion of annual forecast production for the UK
Brean Down to Lavernock Point barrage	9.76	1.63	81.3%
Shoots barrage	2.18	0.55	27.3%
Beachley barrage	0.24	0.06	3.1%
Welsh Grounds lagoon	11.29	2.26	113%
Bridgwater Bay lagoon	7.33	1.47	73.3%

Table 2.5 Demand for sand and gravel for embankment and breakwater fill, sand ballast, and seabed (sand, gravel and crushed rock), allowing for reuse of dredged material (Source: DECC, 2010)

Scheme	Total demand (m tonnes)	Reuse of dredged material (m tonnes)	Average annual demand (m tonnes)	Proportion of annual forecast production		
				Wales	South West	Great Britain
Brean Down to Lavernock Pt barrage	27.65	33.25	0	0	0	0
Shoots barrage	9.66	4.97	1.17	391%	58.6%	9.0%
Beachley barrage	1.72	1.54	0.045	15.1%	2.3%	0.3%
Welsh Grounds lagoon	39.71	3.99	7.14	2381%	357%	55.0%
Bridgwater Bay lagoon	55.31	0	11.06	3688%	553%	85.1%

Table 2.6 Proportion of aggregates and embankment materials sourced from dredging (Source: DECC, 2010)

Scheme	Total demand (m tonnes)	Total dredged material (m tonnes)	Quantity of dredged material reused (m tonnes)	Net demand for materials (m tonnes)	Proportion of materials sourced from dredging
Brean Down to Lavernock Point barrage	54.800	94.803	33.25	21.55	61%
Shoots barrage	17.715	19.656	4.97	12.745	28%
Beachley barrage	3.077	9.772	1.54	1.537	50%
Welsh Grounds lagoon	73.672	14.371	3.99	69.682	5%
Bridgwater Bay lagoon	89.706	13.211	0	89.706	0

2.2.8 It is notable that the demand for sand and gravel for the B3 Brean Down to Lavernock Point barrage would be met entirely from the dredging works for the scheme. Crushed rock would be supplied from regional sources, and concrete and primary aggregates from sources within Great Britain. The armour stone would be likely to be sourced from northern Europe.

2.2.9 For the B4 Shoots barrage, concrete aggregates and crushed rock could be supplied regionally, with primary aggregates and sand and gravel likely to be from national sources. The large armour stone may be sourced nationally but may be supplemented by sources from northern Europe.

2.2.10 The data indicate that the requirements for all aggregate and embankment materials for the B5 Beachley barrage could be supplied from regional sources (Wales and the South West), with the exception of armour stone, which could be supplied from UK sources, possibly Scotland.

2.2.11 The L2 Welsh Grounds lagoon places a high demand on aggregates and embankment materials. Aggregates for concrete would be able to be supplied regionally, with primary aggregates and crushed rock coming from national sources, although the demand for primary aggregates represents a significant proportion of the forecast production. While a proportion of sand and gravel would be supplied from national sources, the demand is such that alternative supplies would be required such as an increase in extraction (dredging), increased use of recycled and secondary sources, or importing from abroad. The armour stone would be sourced from northern Europe.

2.2.12 The greatest demand for resources is from the L3d Bridgwater Bay Lagoon, although it is not the longest structure. Only aggregates for concrete would conceivably be supplied by regional suppliers. Primary aggregate and crushed rock would be able to be sourced nationally, although the demand for primary aggregate is high compared even with national production. As with the L2 Welsh Grounds lagoon, the high demand for sand and gravel would require additional sources to be identified, either nationally or abroad. The armour stone would be sourced from northern Europe.

Table 2.7 Demand for concrete compared with other significant construction projects (Source: DECC, 2010; Severn River Crossing plc; ERM)

Scheme	Total concrete (m tonnes)	Construction years	Average annual demand (m tonnes)
Brean Down to Lavernock Point barrage	20.680	6	3.447
Shoots barrage	2.332	4	0.583
Beachley barrage	1.159	4	0.290
Welsh Grounds lagoon	3.675	5	0.735
Bridgwater Bay lagoon	6.337	5	1.267
Project	**Total concrete (m tonnes)**	**Construction years**	**Average annual demand (m tonnes)**
Second Severn Crossing	0.480	4	0.120
Crossrail	1.650	8	0.206

2.2.13 Concrete is prepared by combining aggregates, cement and water (and reinforcing material if required). The size of aggregate used and the ratio of the ingredients determine the properties of the concrete (such as strength). The quantity of concrete required during construction gives an indication of the scale of each of the STP alternatives. As is shown in Table 2.7, the two smaller barrages would utilise a similar amount of concrete each year to other significant construction projects such as the Second Severn Crossing and Crossrail, whereas the concrete required for the B3 Brean Down to Lavernock Point barrage and the two lagoons is vastly in excess of the other significant projects: with demand as much as ten times greater than the Second Severn Crossing for the L3d Bridgwater Bay lagoon and B3 Brean Down to Lavernock Point barrage.

Table 2.8 Demand for aggregates and embankment materials compared with other significant construction projects (Source: DECC, 2010; Olympic Delivery Authority, 2007)

Scheme	Total demand (m tonnes)	Annual demand (m tonnes)
Brean Down to Lavernock Point barrage	54.800	9.133
Shoots barrage	17.715	4.429
Beachley barrage	3.077	0.769
Welsh Grounds lagoon	73.672	14.734
Bridgwater Bay lagoon	89.706	17.941
Project		**Annual demand (m tonnes)**
Olympic Park		0.500

2.2.14 The projected demand for aggregates and embankment materials for any of the STP alternatives is higher than the demand for the Olympic Park development in London, as shown in Table 2.8. Whilst the B5 Beachley barrage is on a comparable scale, the requirements for the other alternatives are vastly in excess of the Olympic Park project. It is worth noting that, in order to meet its sustainability objectives, 70 per cent of the aggregates being used in the Olympic Park development are expected to be from recycled or secondary sources, and some 99 per cent of aggregates will use more sustainable modes of transport: 25 per cent by water and 74 per cent by rail.

Operational phase

2.2.15 There is expected to be minimal demand for aggregates and embankment materials during the operational phase, such as for maintenance and repairs of embankments, breakwaters or caissons. Therefore there are not likely to be any significant effects on this receptor during this phase for any of the alternatives.

Decommissioning phase

2.2.16 There is expected to be a minimal demand for aggregates and concrete during the decommissioning phase, such as for construction of temporary access roads. Therefore there are not likely to be any significant effects on this receptor during this phase for any of the alternatives.

2.3 Steel

Construction phase

2.3.2 Steel is required in the project for:

- Rebar for reinforced concrete,
- Formwork,
- Structural steelwork, such as bridges, and
- Turbines.

2.3.3 The quantities of steel estimated to be required for each alternative option are given in Tables 2.9 and 2.10, and range from 184,000 tonnes for the B5 Beachley barrage to 2.293 million tonnes for the B3 Brean Down to Lavernock Point barrage.

Table 2.9 Requirements for steel (Source: Parsons Brinckerhoff, 2009; DECC, 2010)

Scheme	Caissons fabricated steelwork (m tonnes)	Steelwork for sluice and lock gates, cranes, etc (m tonnes)	Formwork (m tonnes)	Rebar (m tonnes)	Turbines (m tonnes)
Brean Down to Lavernock Point barrage	0.146	0.200	0.043	1.55	0.354
Shoots barrage	0.066	0.065	0.008	0.17	0.038
Beachley barrage	0.022	0.047	0.007	0.08	0.028
Welsh Grounds lagoon	0.026	0.045	0.015	0.29	0.022
Bridgwater Bay lagoon	0.080	0.050	0.025	0.87	0.098

Table 2.10 Demand for steel and its likely sources

Scheme	UK sourced steel (rebar) (m tonnes)	Internationally sourced steel (m tonnes)	Total steel demand (m tonnes)
Brean Down to Lavernock Point barrage	0.42	1.873	2.293

Shoots barrage	0.17	0.177	0.347
Beachley barrage	0.08	0.104	0.184
Welsh Grounds lagoon	0.29	0.108	0.398
Bridgwater Bay lagoon	0.30	0.823	1.123

2.3.4 The UK currently produces around 1.112 million tonnes of rods and bars, such as reinforcing bars (rebar), for domestic or international customers. This is forecast to grow to 1.5 million tonnes per year (DECC, 2009). It is anticipated that the UK steelworks would supply up to 0.06 million tonnes per year of rebar for any of the alternatives. As shown in Table 2.10, this would entirely meet the needs of the B4 Shoots and B5 Beachley barrages and the L2 Welsh Grounds lagoon, with the B3 Brean Down to Lavernock Point barrage and the L3d Bridgwater Bay lagoon requiring additional rebar to be imported. The likely sources would be any of the largest exporters, which are China, Japan, EU27, Ukraine, Russia, South Korea, Turkey, and Taiwan.

2.3.5 It is assumed that all of the major steel components (gates, cranes, etc) including the turbines would be supplied from the Far East.

2.3.6 The amount of steel produced globally was 1,341 million tonnes in 2007 and therefore the demands of any of the STP alternatives are of a negligible scale and therefore not likely to have a significant effect on the receptor.

2.3.7 The limitation with steel will be the capacity of the specialist suppliers to supply the fabricated steel. It should be noted however that early ordering will be required to ensure delivery on time and to secure favourable pricing, as is standard practice for large construction projects.

Table 2.11 Demand for steel rebar compared with other significant construction projects (Source: DECC, 2010; Severn River Crossing plc; ERM)

Scheme	Total demand (m tonnes)	Annual demand (m tonnes)	Proportion of annual forecast production for the UK
Brean Down to Lavernock Point barrage	1.55	0.22	14.8%
Shoots barrage	0.17	0.03	2.2%
Beachley barrage	0.08	0.02	1.4%
Welsh Grounds lagoon	0.29	0.06	3.9%
Bridgwater Bay lagoon	0.87	0.17	11.5%
Project	**Total demand (m tonnes)**	**Annual demand (m tonnes)**	**Proportion of annual forecast production for the UK**
Second Severn Crossing	0.03	0.008	<1%
Crossrail	0.14	0.018	1.4%

2.3.8 The annual demand for rebar, when compared with other significant construction projects, is very high for the B3 Brean Down to Lavernock Point barrage and the L3d Bridgwater Bay lagoon. The requirements for the two smaller barrages and the L2 Welsh Grounds lagoon are on a scale that is comparable to the Second Severn Crossing and Crossrail, as is shown in Table 2.11.

Operational phase

2.3.9 There is expected to be a low demand for steel during the operational phase, such as for maintenance, repairs and replacement of equipment. Major turbine refurbishment would be incurred every 40 years, with each refurbishment period taking two to six years, depending on the number of turbines, and the quantity of steel that would be required is shown in Table 2.12 below. However the limiting factor for refurbishment will be international capacity to supply the components rather than the availability of steel. Therefore there are not likely to be any significant effects on this receptor during this phase for any of the alternatives.

Table 2.12 Quantity of steel required during operational phase

Scheme	Turbines (m tonnes)
Brean Down to Lavernock Point barrage	0.496
Shoots barrage	0.053
Beachley barrage	0.039
Welsh Grounds lagoon	0.031
Bridgwater Bay lagoon	0.137

Decommissioning phase

2.3.10 There is expected to be a minimal demand for steel during the decommissioning phase, such as for construction of temporary structures. Therefore there are not likely to be any significant effects on this receptor during this phase for any of the alternatives.

2.4 Energy

Construction phase

2.4.2 During the construction phase, the energy demands of any of the alternatives would include:

- Fossil fuels for:
  - Transport of materials to site (by road, rail or sea), staff to and from site, and waste off-site;
  - Dredgers;
  - Transporting caissons, equipment and other material into place (by sea);
  - On-site vehicle operation such as light and medium vans, JCBs, forklifts, small cranes, pick up trucks, flat bed vans, cherry pickers, vibrating rollers;
- Electricity for:
  - Welfare facilities, offices and site lighting;

- Operation of concrete batching plant(s); and

- Natural gas for:
  - Tools and equipment such as for cutting, welding, burning etc.

2.4.3 It is difficult to precisely quantify the energy demand for any of the alternatives but, based on the fact that the construction industry as a whole uses just 3 per cent of the UK's energy consumption, it seems fair to assume that at most the construction of one of the STP alternatives would not be likely to be any significant effects on this receptor during this phase for any of the alternatives.

2.4.4 Data on energy use is not available and therefore a qualitative assessment has been undertaken, on the premise that the energy use for each option would be proportional to the inputs of each phase, such as transport requirements and resource use.

2.4.5 Tables 2.13 and 2.14 show the anticipated mode and distance of transportation for the resources, and the construction traffic movements for each option. The B3 Brean Down to Lavernock Point barrage and the L3d Bridgwater Bay lagoon, which have the higher resource demands, unsurprisingly also have the higher transportation demands and therefore energy use for transport.

Table 2.13 Transport of resources

Resource	Source	Mode of transport	Average distance travelled (miles)
Aggregates and embankment materials	Wales	Rail	75
	England	Rail	150
	Scotland	Sea	850
	Europe	Sea	1,250
Armour stone	Scotland	Sea	850
	Norway	Sea	1,250
Cement	UK	Rail	100
Steel (rebar)	UK	Rail	100
	International	Sea	7,500
Steel (other)	Far East	Sea	12,000

Table 2.14 Construction traffic assumptions

Scheme	Number of vehicles operating on-site 24/7	Indicative number of vehicles to and from site each day
Brean Down to Lavernock Point barrage	350	760
Shoots barrage	60	360
Beachley barrage	40	317
Welsh Grounds lagoon	90	481
Bridgwater Bay lagoon	155	578

2.4.6 In terms of resource use, Table 2.15 shows the scale of resource use compared with UK production as a whole. The average annual demand for aggregates and embankment materials and steel represents only a small fraction of the total UK production for these materials. As discussed earlier, demand for these resources could not be met from UK sources alone, but due to quality requiremnts, however the table illustrates that the scale of demand is relatively low on a national bassis and therefore it seems reasonable to assume that the energy demands would be at a comparable level.

2.4.7 Even the alternative with the largest demand for resources would be using less than 10 per cent of UK production. If is assumed that the amount of energy used for construction is proportional to the amount of resources used, then it would seem to indicate that the overall energy demand for the construction of any scheme would be a relatively small fraction of the UK construction industry's energy demand, even allowing for the amount of material that is being imported.

Table 2.15 Demand for steel and aggregates and embankment materials as a proportion of UK production

Scheme	Steel		Aggregates and embankment materials	
	Average annual demand (m tonnes)	Proportion of UK annual production	Average annual demand (m tonnes)	% of UK annual production
Brean Down to Lavernock Point barrage	0.328	2%	9.133	4%
Shoots barrage	0.087	0%	4.429	2%
Beachley barrage	0.046	0%	0.769	0%
Welsh Grounds lagoon	0.080	1%	14.734	7%
Bridgwater Bay lagoon	0.225	2%	17.941	9%

Operational phase

2.4.8 While there is expected to be a demand for electricity during the operational phase, to operate the equipment, this would be a 'parasitic load' on the electricity produced by the scheme and would be allowed for in the design. There would also be other relatively small demands such as transport of staff to and from the site, and around the site. A larger demand might be pumping of outfalls to reduce flooding risk, however this is not able to be quantified at this time. Therefore there are not likely to be any significant effects on this receptor during this phase for any of the alternatives.

Decommissioning phase

2.4.9 Demand for energy during decommissioning would be expected to be similar to during construction, with the key differences being that there would be no concrete production or dredging, but there would instead be breaking out of the concrete caissons and digging out of the sand ballast.

2.4.10 It is assumed that the government's low carbon policies would have worked, and therefore there would be an 80 per cent reduction in carbon from the energy, compared with the construction phase.

2.5 Water

Construction phase

2.5.2 The predominant demand for water during construction would be for making concrete. It is assumed that other uses, such as welfare facilities and wheel washes, would represent insignificant volumes and therefore water use for concrete production is considered the key determinant for this resource.

Table 2.16 Demand for water as a proportion of concrete (Source: Parsons Brinckerhoff, 2009)

Scheme	Total concrete (m tonnes)	Total water use (m^3)	Average annual water demand (m^3)	Average daily water demand (m^3)
Brean Down to Lavernock Point barrage	8.401	1,301,623	216,937	594
Shoots barrage	0.946	133,948	33,487	92
Beachley barrage	0.469	69,435	17,359	48
Welsh Grounds lagoon	3.675	183,085	36,617	100
Bridgwater Bay lagoon	6.337	373,528	74,706	205

Table 2.17 Total water demand supplied by water companies in the STP study area

Water company	Quantity of water supplied per day (m^3)
Welsh Water	850,000
Bristol Water	285,000
Severn Trent Water	1,900,000
South West Water	164,000

2.5.3 The STP alternatives would use, on average, between 50 and 500 m^3 of water per day for concrete manufacture. In contrast, the amount of water that the water companies in the STP study area supply is in the order of hundreds of thousands or millions of cubic meters per day. The B3 Brean Down to Lavernock Point barrage daily demand represents less than 1 per cent of South West Water's daily supply alone.

Operational phase

2.5.4 There is expected to be a minimal demand for water during the operational phase, such as for welfare facilities. Therefore there are not likely to be any significant effects on this receptor during this phase for any of the alternatives.

Decommissioning phase

2.5.5 There is expected to be a minimal demand for water during the decommissioning phase, such as for welfare facilities and wheel washes. Therefore there are not likely to be any significant effects on this receptor during this phase for any of the alternatives.

SECTION 3

WASTE

3 WASTE

3.1 Introduction

3.1.1 The key resource receptors have been identified through the SEA process. These are given in Table 3.1 below.

Table 3.1 Waste receptors and when they are expected to be generated during the project life

Waste receptor	Description	Phase
Sites for reuse opportunities	Reuse of CDE waste and marine dredging materials on other construction projects or habitat enhancement projects	Construction Decommissioning
Treatment and recycling facilities	Treatment and recycling of contaminated soil, C&D waste, operational waste, WEEE	Construction Operation Decommissioning
Energy recovery	Disposal of C&D waste, operational waste	Construction Operation Decommissioning
Landfill	Potentially required for the disposal of any type of waste	Construction Operation Decommissioning

3.2 Sites for reuse opportunities

Construction phase

3.2.2 Extensive dredging is required for the development of any of the alternatives. The nature of the estuary and the location of the dredging mean that there will be a range of dredged materials including:

- Mud and soft clay;
- Sand and gravel;
- Soft rock (mudstone); and
- Hard rock (limestone).

3.2.3 The development of the STP feasibility study is premised on all dredged materials being beneficially reused on site. It is assumed that all sand and gravel and hard rock would be reused in the permanent works. Likewise, a proportion of the soft rock would be used in the permanent works. Mud and silt would not be suitable for use in the permanent works and they, along with the remainder of the soft rock, would be used in the construction of compensatory habitat to avoid disposal off site. Table 3.2 shows the amount of aggregates and embankment materials that would be required and the amount of material that would be dredged. Of the dredged material, between 0 and 33 per cent are able to be reused in the permanent works. This meets between 0 and 61 per cent of the demand for aggregates. The wide range of reuse is due to the differing nature and quality of the dredged materials, with the dredging for the lagoons expected to produce primarily mud and silt, which is not suitable for the permanent works.

3.2.4 Onshore construction would be designed to provide a balance between cut and fill with the exception that there may be a surplus of topsoil which we should assume would be made use of in other schemes and not disposed of.

3.2.5 This fundamental decision to manage the largest waste stream in its entirety on site means that no sites for reuse opportunities would be required outside of the project and therefore there are no significant impacts on this receptor.

Table 3.2 Proportion of aggregates and embankment materials sourced from dredging

Scheme	Total demand (m tonnes)	Total dredged material (m tonnes)	Dredged material that is reused (m tonnes)	Net demand (m tonnes)	% of dredged materials that are reused	% of virgin replaced by dredged materials
Brean Down to Lavernock Point barrage	54.800	94.803	33.25	21.55	33%	61%
Shoots barrage	17.715	19.656	4.97	12.745	25%	28%
Beachley barrage	3.077	9.772	1.54	1.537	15%	50%
Welsh Grounds lagoon	73.672	14.371	3.99	69.682	28%	5%
Bridgwater Bay lagoon	89.706	13.211	0	89.706	0	0

3.2.6 The 'Topographic modification to reduce intertidal loss from Severn Tidal Power options' paper has identified the most suitable locations for creating new and replacement intertidal habitat for each of the alternative options. The amount of dredged material that is suitable for habitat creation is much less than could potentially be used, were all the identified sites to be developed (as shown in Table 3.3 below), This would also enable suitable material that is dredged during operation to be used for habitat creation.

Table 3.3 Estimated volume of dredged material required to modify the topography to create new or recreated intertidal habitat compared with the volume available (Source: PB-BV, 2010)

Scheme	Estimate of dredged material suitable to use to create intertidal habitat (m^3)	Estimate of dredged material required to create new or recreated intertidal habitat (m^3)
Brean Down to Lavernock Point barrage	24,300,000	184,300,000

Shoots barrage	6,100,000	42,240,000
Beachley barrage	1,400,000	40,925,000
Welsh Grounds lagoon	5,250,000	62,200,000
Bridgwater Bay lagoon	7,960,000	38,700,000

3.2.7 The amount of dredged material given in Tables 3.2 and 3.3 above enables reuse of 100 per cent of the dredged materials: sand, gravel and hard rock (limestones) would be reused in the permanent works and mud, soft clay and soft rock (mudstones) would be reused for habitat development.

Operational phase

3.2.8 The Options Definition Review has identified that no maintenance dredging would be required during the operational life of the project. for either of the lagoon options. The barrage options would require dredging to maintain access to the ports, and B4 Shoots barrage and B5 Beachley barrage would additionally require dredging to maintain energy yields. The dredged materials are likely to consist primarily of mud and silt, and therefore they would not be suitable for maintenance on the permanent structures but, as discussed in the previous section, could be used for habitat development elsewhere.

3.2.9 The maintenance dredging required for each alternative option is summarised in Table 3.4 below.

Table 3.4 Dredging requirements in the operational phase

Scheme	Dredging requirements
Brean Down to Lavernock Point barrage	No maintenance dredging would be required to preserve energy yield over the life of the scheme. The only dredging required would be to maintain port accesses.
Shoots barrage	Maintenance dredging would be required to preserve energy yield over the life of the scheme. Dredging to preserve energy yield would not be additional to dredging for maintenance of navigation channels and would be carried out routinely through the year requiring several days dredging per month. A precautionary assessment of dredging volume would be to assume that the full volume of sediment deposited is dredged 30-40M m^3 per decade.
Beachley barrage	Maintenance dredging would be required to preserve energy yield over the life of the scheme. Dredging to preserve energy yield would not be additional to dredging for maintenance of navigation channels and would be carried out routinely through the year requiring several days dredging per month. A precautionary assessment of dredging volume would be to assume that the full volume of sediment deposited is dredged 20M m^3 per decade.

Welsh Grounds lagoon	No maintenance dredging would be required to preserve energy yield during a 120 year design life.
Bridgwater Bay lagoon	No maintenance dredging would be required to preserve energy yield during a 120 year design life.

3.2.10 The quantity of dredging required (20 to 40M m^3 per decade) equates to 2 to 4M m^3 per year. For comparison, Bristol Ports currently dredges 1.5 to 2M m^3 per year, which it dredges over two to three days each month. There are a number of disposal sites within the Severn estuary for dredged material. These are dispersive sites and therefore rely on the prevailing hydrodynamic conditions to flush the spoil from the estuary. It is likely that maintenance dredging material could continue to be deposited at the existing dispersal sites for all but the B3 Brean Down to Lavernock Point barrage. However, with B3 Brean Down to Lavernock Point barrage the flow regime would be greatly altered which would affect the rate at which deposited material would be dispersed from the disposal sites. Further details are available in the Other Sea Uses topic paper

Decommissioning phase

3.2.11 It is assumed that the decommissioning of any of the STP alternatives would require the entire removal of the barrage or lagoon structure. This would generate large quantities of concrete and embankment materials as demolition waste. This waste would be available for reuse as recycled aggregates. The quantity of waste would be similar to the amount of aggregates and embankment materials used in the construction, as is shown in Table 3.5 below.

Table 3.5 Estimate of the quantity of demolition waste available for reuse as recycled aggregates

Scheme	Total demand (m tonnes)
Brean Down to Lavernock Point barrage	54.800
Shoots barrage	17.715
Beachley barrage	3.077
Welsh Grounds lagoon	73.672
Bridgwater Bay lagoon	89.706

3.3 Treatment and recycling

Construction phase

3.3.2 Other than dredged materials, the largest waste stream during construction is expected to be the formwork used for constructing the caissons. About 75 per cent of the formwork is expected to be constructed from steel, with the remaining 25 per cent made of timber. As steel is 100 per cent recyclable and is a valuable commodity, it is expected that all steel formwork will be recycled. The quantity of steel formwork for each option ranges from 8,000 to 43,000 tonnes and is shown in Table 3.6 below.

3.3.3 There are a number of steel mills in the UK, including in south Wales, which would be likely to receive the waste for recycling.

Table 3.6 Quantity of steel formwork for recycling

Scheme	Formwork (m tonnes)
Brean Down to Lavernock Point barrage	0.043
Shoots barrage	0.008
Beachley barrage	0.007
Welsh Grounds lagoon	0.015
Bridgwater Bay lagoon	0.025

3.3.4 Some 14.3 million tonnes of steel was produced in the UK in 2007, including 5.2 million tonnes of recycled steel. The quantity of steel formwork requiring recycling is less than 1 per cent of the domestic market for recycled steel and therefore there is not expected to be any significant effects on this receptor.

<u>Operational phase</u>

3.3.5 The main demand for treatment and recycling during the operational phase would be the recycling of equipment and components that are replaced as part of both routine and major maintenance. These components and pieces of equipment will be predominantly steel and therefore would have a value in the recycling market. The quantities (shown in Table 3.7 below) are likely to be easily accommodated with the UK's steel mills. Therefore there are not likely to be any significant effects on this receptor during this phase.

Table 3.7 Quantity of steel for recycling

Scheme	Turbines (m tonnes)
Brean Down to Lavernock Point barrage	0.496
Shoots barrage	0.053
Beachley barrage	0.039
Welsh Grounds lagoon	0.031
Bridgwater Bay lagoon	0.137

3.3.6 Turbines would undergo a major refurbishment every 40 years, during which as much as 70 per cent of the turbine components may be replaced. The refurbishments would occur over a two to six year timetable. The quantities are likely to be easily accommodated with the UK's steel mills. Therefore there are not likely to be any significant effects on this receptor during this phase.

<u>Decommissioning phase</u>

3.3.7 The main demand for treatment and recycling during the decommissioning phase would be expected to be the recycling of equipment, such as steel structures, control equipment and the turbines. This equipment will be predominantly steel and therefore would have a value in the recycling market. The quantities (given in Table 3.8) are not likely to require additional recycling facilities as steel can be easily stockpiled or sent abroad for recycling. Therefore there are not likely to be any significant effects on this receptor during this phase.

Table 3.8 Quantity of steel for recycling

Scheme	Caissons fabricated steelwork (m tonnes)	Steelwork for sluice and lock gates, cranes, etc (m tonnes)	Rebar (m tonnes)	Turbines (m tonnes)
Brean Down to Lavernock Pt barrage	0.146	0.200	1.55	0.354
Shoots barrage	0.066	0.065	0.17	0.038
Beachley barrage	0.022	0.047	0.08	0.028
Welsh Grounds lagoon	0.026	0.045	0.29	0.022
Bridgwater Bay lagoon	0.080	0.050	0.87	0.098

3.4 Energy recovery

Construction phase

3.4.2 Other than dredged materials, the largest waste stream during construction is expected to be the formwork used for constructing the caissons. About 75 per cent of the formwork is expected to be constructed from steel, with the remaining 25 per cent made of timber. Waste wood has a value as a fuel and therefore it is expected that all timber formwork would be sent to an energy recovery facility. The quantity of timber formwork for each option ranges from 2,500 to 28,000 tonnes and is shown in Table 3.9 below.

Table 3.9 Quantity of timber formwork for treatment

Scheme	Formwork (tonnes)
Brean Down to Lavernock Point barrage	28,113
Shoots barrage	3,870
Beachley barrage	2,499
Welsh Grounds lagoon	6,184
Bridgwater Bay lagoon	10,146

3.4.3 In addition to the timber formwork, waste that is similar to household waste such as canteen and office waste would be suitable for energy recovery.

3.4.4 There are several energy recovery facilities proposed to be operational by the construction phase in the vicinity of the STP study area, which would be likely to receive the waste for recycling, including both publicly and privately funded facilities.

3.4.5 The Landfill Directive is driving the development of waste treatment facilities and therefore it is likely that at least some of these plans will come to fruition. The facilities would be expected to operate for at least 25 years and thus would also be available to accept waste during the early part of the construction phase.

3.4.6 Therefore there are not likely to be any significant effects on this receptor during this phase for any of the alternatives.

Operational phase

3.4.7 There is expected to be a minimal demand for energy recovery during the operational phase, such as for the disposal of non-recyclable maintenance waste and non-recyclable canteen and office waste. Therefore there are not likely to be any significant effects on this receptor during this phase for any of the alternatives.

Decommissioning phase

3.4.8 There demand for energy recovery during the decommissioning phase would be similar to the construction phase, and could include wastes such as timber formwork or temporary structures, and office and canteen waste. Therefore there are not likely to be any significant effects on this receptor during this phase for any of the alternatives.

3.5 Landfill

Construction phase

3.5.2 There is expected to be a minimal demand for landfill during the operational phase, and it would be expected to be used only for waste that cannot be reused, treated, recycled or disposed of at an energy-from-waste facility, such as some hazardous wastes. Therefore there are not likely to be any significant effects on this receptor during this phase for any of the alternatives.

Operational phase

3.5.3 There is expected to be a minimal demand for landfill during the operational phase, and it would be expected to be used only for waste that cannot be reused, treated, recycled or disposed of at an energy-from-waste facility, such as some hazardous wastes. Therefore there are not likely to be any significant effects on this receptor during this phase for any of the alternatives.

Decommissioning phase

3.5.4 There is expected to be a minimal demand for landfill during the decommissioning phase, and it would be expected to be used only for waste that cannot be reused, treated, recycled or disposed of at an energy-from-waste facility, such as some hazardous wastes. Therefore there are not likely to be any significant effects on this receptor during this phase for any of the alternatives.

SECTION 4

REFERENCES

4 REFERENCES

DECC, 2010, Severn Tidal Power Supply Chain Survey Report, January 2010

ERM, undated, Crossrail Environmental Statement Volume 1 Chapter 2 Project Description, pg 35 [Accessed 5 November 2009] http://www.crossrail.co.uk/the-railway/getting-approval/parliamentary-bill/crossrail-bill-documents/environmental-statement#asset/3814

Olympic Delivery Authority, 2007, Olympic, Paralympic and legacy transformation planning applications: Vol 12B Environmental Statement Part 2 Background to and description of proposals, February 2007 [Accessed 5 November 2009] http://planning.london2012.com/upload/publicaccessODAlive/07-02-06%20Vol12B%20ES%20Part%202%20(322).pdf

Parsons Brinckerhoff, 2009,Strategic environmental assessment of proposals for tidal power development in the Severn Estuary – Options definition report, Version 2 – Interim Options Definition, Volume 2 Appendix D, December 2009

Parsons Brinckerhoff and Black + Veatch, 2010, Severn Tidal Power SEA, Topographic modification to reduce intertidal loss from Severn Tidal Power options, Preliminary investigation of technical feasibility, February 2010

Severn River Crossing plc, 'History and Statistics of the Second Severn Crossing' [Accessed 5 November 2009] http://www.severnbridge.co.uk/history_ssc.shtml

Aggregates industries UK, Olympics Aggregates