Severn Tidal Power Feasibility Study

Assessment of the Regional Economic Impacts of Tidal Power Generation in the Severn Estuary Final Report

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Introduction

The overarching aim of this study is to *"undertake an initial assessment of the potential economic impact of the proposed Severn Tidal Power project on the regional economies of Wales and the South West of England*[1]*."*

The focus of the research is to identify whether proposals defined under the Severn Tidal Power Project are expected to result in significant net positive or net negative economic effects within Wales and the South West economies.

In assessing significance, a key requirement of this study is to capture the net economic impact. Therefore, it is important to assess what proportion of the total costs or benefits associated with any of the Severn Tidal Power (STP) options are experienced by the Wales and South West economies.

Scenarios

There are uncertainties around the economic impact of the options under consideration. At this stage of the wider feasibility study, detailed information relating to the implementation of options is unavailable. With a lack of detailed information it is not possible to assess precisely how different sectors of the South West and Wales economies may respond to the implementation and development of options. Given these uncertainties, the central scenario that we present has been adjusted. This sensitivity assessment changes some key variables to show the potential parameters of impact from the worst case scenario to the best case scenario.

Clustering

Some options have been clustered together for the purpose of economic impact analysis for two reasons: firstly because they will be very similar in terms of their economic impact; and secondly because at this stage in option development, there is insufficient information available to be able to effectively distinguish their economic impact. However, it should be noted that clustering has the effect of applying STP specific estimates (e.g. construction costs) to clustered sector impacts (e.g. ports) which means that construction periods (i.e. build times) may not tally precisely to the assumed construction phase impact periods (i.e. duration of construction phase impact on a sector).

Assessing Economic Impact

For each option, we have started with the gross level of economic impact i.e. the headline impact; and accounted for additionality factors to derive the potential net economic impact on the economies of Wales and the South West of England.

The scope of this report has covered sectors of the Wales and South West economy that are expected to be most significantly impacted by the range of options. These are construction,

[1] Area of impact is the South West of England and Wales, although at times in the report this is referred to as a 'regional' impact.

transport and logistics (most significantly ports), fishing, land use & planning, tourism, accommodation, residential & population and other industries. Where possible, we have quantified impacts. However, across some areas of economic impact there is only sufficient information to enable a qualitative assessment. Therefore, when considering the net quantitative impact data summarised in this report, it is important to remember those potentially significant un-quantified economic impacts.

For each option and area of impact, we have taken a forty year reference period, which includes both the construction phase impacts (which varies by option) and the operational phase impacts. Given the uncertainties about operational impacts, we have also presented these impacts over a shorter ten year period, to show what may happen over the short term.

The figures set out below are the net economic impact of the Severn Tidal Power options on the economy of Wales and the South West of England. All Gross Value Added figures presented below are expressed as present values.

Overarching Summary

The net regional economic impact varies by STP options. In the table below, the sectors of the economy that are significantly impacted by STP options are detailed, with a summary of the direction of impact and the key factors that influence the magnitude of impact.

Area of Impact	Nature of Impact	Key Variations
Construction	The construction process leads to a **net positive economic impact** on the economies of Wales and the South West.	Variations depend on a) the level of gross spend b) the extent to which spending takes place in the region and c) the extent to which the construction process displaces (or stops) other construction projects from taking place in the region. In general, the more expensive the project, the bigger the net regional economic benefits.
Transport and Logistics (Ports)	The focus is on the negative impact caused by the disruption to ship movements as a result of both the construction process and operation of a STP option. The greater the disruption to shipping the greater the **net negative economic impact**. There may be positive impacts from the importing of construction materials.	Variations related to the proportion of port traffic a) disrupted and b) the potential for other ports to absorb these. STP options that disturb more ports (and shipping) have a greater negative impact than those that affect fewer ship movements. I.e. taking into account the location of STP option and impact on navigation routes.
Fishing	The focus is on a **negative impact** on economic agents dependent on fish populations.	Key variations are dependent on the impact of STP options on fish populations. Uncertainties and range of number of factors such as migratory cues, impact of turbines, change of habitat etc that may have a negative impact on fish mean that each STP option is assumed to have the same negative impact on fish population and therefore the agents dependent

Area of Impact	Nature of Impact	Key Variations
		on these population levels. Variations between STP options are influenced by the length of the construction period.
Land Use and Planning	The focus is on the **potential positive economic impact** of a STP option on reducing flood risk and increasing the economic viability of land and property. There are additional potential positive impacts relating to the economic value of construction infrastructure during the operation of a STP option (or post construction).	Highly uncertain area. However, the large barrage is the only option considered to have any significant impact on reducing flood risk. **This area has not been quantified.**
Tourism	The focus is on the potential **direct positive economic impact** associated with visitors to a STP option. There are other potential positive economic impacts from ancillary investment in marina developments, capitalising on reduced water turbidity and improved water access. However, as these require additional investment beyond the scope of the STP option, they have not been quantified in this report.	Variations are driven by the scale of development and the potential visible impact on Severn Estuary area. I.e. the more visible and dramatic the change in estuary, the greater the assumed impact on annual visitor numbers.
Accommodation	Accommodation **positive economic impacts** are driven by construction impacts, through the multiplier effects. Therefore, these have already been captured in the construction impacts.	Scale of employment and spend associated with the construction of a STP option. The greater the spend and labour requirements, the greater the positive impact on the accommodation sector.
Residential and Population	The focus of the impact includes the positive impact of operation employment, positive impacts associated with legacy impacts	**This area has not been quantified**
Other industries	The focus of the assessment is on other industries impacted by a STP option. The primary focus is on the **positive economic impact** associated with the operation of a STP option.	The operational impact of STP options depend on the level of spend on maintenance and operation of the option. In general, the more expensive the construction costs, the more expensive the operation and maintenance of the STP option and the greater the number of jobs sustained.

In estimating the net GVA economic impact of the STP options across the construction and operational phase, these sector level impacts have been taken into account. However, in assessing the net employment economic impacts of the STP options, there are issues in relation to a common employment denominator. For example, construction employment is calculated in 'persons years' to reflect the transitory nature of some construction functions; port impacts are captured as annual average jobs with peak employment impacts and operational impacts are captured as Full Time Equivalent (FTE) jobs. In light of these variations, DTZ have summarised net employment impacts by taking 'annual average' employment as the common denominator. Therefore, it does not take account of the potential change in employment profiles across the reference period (i.e. in some years there may be more or less employment than captured by the annual average figure).

This initial high level study suggests that there will be both gains and losses for Wales and the South West of England from the development of a STP option. However, on balance, the picture is broadly positive. Gross Value Added created during the construction phase and operational phase outweighs that lost to industries such as the ports and fishing.

The Net Economic Impact of STP Options

Notwithstanding the above point, the overall net impact of the STP options are summarised below. These summaries focus on areas that have been quantified within the report. These impacts should be considered within the wider context of the energy output of options, the environmental implications of options, the non-quantified impacts of options and the potential for further economic impacts from ancillary investment in the region.

Large Barrage: Using B3 as a representative of the large barrage options for the central scenario the net quantitative impact of all of these factors over the construction and operational stages is a benefit of £3.55 billion to the South West of England and Wales over a 40 year period. The overall employment impact during construction is a net gain of 1,500 annual average jobs[2] over the construction period, ranging from a loss of 900 jobs in the worse case scenario and a gain of 14,500 jobs in the best case scenario. During the operational phase, the impact ranges from a worse case scenario of a loss of an annual average 1,200 jobs to a gain of 900 jobs. The mid rage estimate is an annual average gain of 200 jobs because the negative impact on ports is offset by the positive impact of operating the STP option over time. Taking a shorter operational period (10 years) then the large barrage is estimated to result in an annual average loss of 1,000 jobs (within a range of minus 3,100 to +100) as the negative impact on ports is more pronounced. It should be noted that these jobs fall into different sectors, with different wage levels and different GVA impacts. Sector impacts are discussed below.

Small Barrage Using B4 as representative of a small barrage: Overall the GVA impact across both construction and operation is estimated at £620 million to the economy of Wales and the South West over a 40 year period. Combining the job gains in some sectors and job losses in other sectors, during construction, the impact ranges from a worst case scenario of a net annual average loss of 100 jobs; to a best case scenario of a net annual gain of 3,200 jobs. The mid range estimate for net employment creation in this option is 500 jobs. During the

[2] i.e. Annual average jobs mean that employment will be x,xxx jobs greater than without the development (1,500 in this example), but that this is not cumulative (i.e. does not grow by an additional x,xxx jobs each year of construction).

operational phase, the worst case scenario gives a net loss of 200 jobs per annum, and the best case scenario is a net gain of 200 jobs per annum. The mid range estimate for net employment creation in this option is 50 jobs. Taking a shorter operational period (10 years) then the small barrage is estimated to result in an annual average loss of 60 jobs (within a range of minus 400 to +200) as port losses are more pronounced over this period. It should be noted that these jobs fall into different sectors, with different wage levels and different GVA impacts.

Lagoons Overall, the L2 Lagoon is estimated to contribute £800million to the economies of Wales and the South West over the 40 year reference period (five years of construction and 35 years operation).Using L2 as representative of a lagoon, combining the job gains in some sectors and job losses in other sectors, during construction, the impact ranges from a worst case scenario of a net annual gain of 30 jobs; to a best case scenario of a net annual gain of 4,300 jobs. The mid range estimate for net employment creation in this option is an annual average of 800 jobs. During the operational phase, the worst case scenario gives a net loss of minus 200, and the best case scenario is a net gain of 200 jobs per annum. The mid range estimate for net employment creation in this option is 40 jobs. Taking a shorter operational period (10 years) then the small barrage is estimated to result in an annual average loss of 70 jobs (within a range of minus 400 to +200) as port losses are more pronounced over this period. It should be noted that these jobs fall into different sectors, with different wage levels and different GVA impacts.

Tidal Fence and Tidal Reef Options: without being able to assess the impact of these options on the port sector, it is inappropriate to summarise the overall GVA impact, and the net position is not known. However, the impact of these options on some sectors is captured below and within the main body of the report.

Economic Impacts by Sector

Construction:
The gross estimated expenditure on the construction of **large barrages** ranges from £18 billion to £30 billion over a ten year construction period. This level of spend equates to a total Gross Value Added (GVA) impact of between £7.6 billion and £12.1 billion over a ten year period. However, once the additionality factors are taken into account, net additional benefit is significantly lower, primarily because the spending on some key components (such as turbines) is unlikely to occur in the region (i.e. leakage outside the area), and the construction of a barrage will displace other existing economic activity. Taking account of these factors results in a central scenario net regional economic impact of between £1.4 billion and £2.0 billion GVA across the large barrage options.

Therefore, in terms of employment, spending circa £18 billion on the construction of a large barrage (B3) will result in the gross annual average employment of 18,000 over the seven-year build period. However, given the high level of leakage and displacement, at a Wales and South West level the net additional impact is an annual average level of employment of 3,400 jobs; equivalent to approximately seven percent of local area construction employment.

Around this central scenario, if a higher proportion of key components were supplied from within the region and if the barrage did not discourage other construction projects from taking place then the potential net regional impact is significantly greater, equating to a net GVA

benefit of £5.7 billion and an annual average employment impact of 15,700 jobs, which is equal to almost a third of local area construction employment. However, if the worst case scenario was taken, where due to the competitive nature of supply chains and contracts, less labour and materials are sourced from Wales and South West then the net economic impact of circa £0.7 billion would be felt by the economy, supporting an annual average employment level of 1,600 jobs, equivalent to around three percent of the current local area construction employment.

These impacts are similar across the other options, but vary by the overall gross construction costs, and the proportion spent on core components. Therefore, if proportionally more is spent on turbines, then the overall leakage (or loss of regional benefit) is greater as these are mainly assumed to be imported into the region in the central scenarios. Key summaries are as follows:

As with the large barrage, the net additional local impact of the construction of the **small barrage** is a positive, although less significant, impact on the South West and Wales. The annual average employment (for B4) ranges from 300 each year to 3,200 jobs each year with a central scenario of 700 annual average jobs over the five year construction period. The GVA impact ranges from £70 million to £860 million (in present values).

Construction of the **Tidal Fence** options has a slightly larger positive impact on the economies of the South West and Wales than the small barrage. Employment impacts for F1a range from an annual average employment of 400 jobs in the low scenario, to an annual average of 3,200 jobs in the high scenario over the five year construction period. The central scenario provides an annual average employment level of 900 jobs per annum. The GVA impact of construction ranges from less than £100 million in the low scenario to more than £850 million in the high scenario. The estimates for F1b are greater given the longer length of the fence and the higher construction cost estimates.

The construction impacts of the **Lagoon** options range considerably across the options, given their scale and varying construction costs. Taking L2 as a representative lagoon, (construction duration of five years) construction employment for this option ranges from an annual average of 400 jobs in the low scenario to 4,400 annual average jobs in the high scenario, with a central scenario of 1,000 annual average jobs, which is equivalent to around two percent of the current local level construction employment. The GVA impact of the construction of the lagoon options, in present values, ranges from just over £120 million in the low scenario to more than £1.1 billion in the high scenario.

Tidal Reef construction will generate annual average employment in the range of 1,000 jobs in the low scenario to an annual average of 12,100 jobs over the ten year construction period in the high scenario. The central scenario estimates an annual average employment of 1,800 jobs over a ten year construction period. The GVA impact ranges from £500 million in the low scenario, to £5.7 billion in the high scenario.

Ports

In addition to the direct employment and GVA impact of building a STP option, other sectors of the economy are also likely to be impacted by the development. Within the Bristol Channel there are four main ports which may be directly impacted by the development of a STP option.

The extent to which ports are impacted depends on whether the STP option will impact ship movements. Negative impacts will potentially occur during both construction phase and the operational phase of the STP option. Whilst there may be some positive impacts on the ports from the inflow of construction materials, this is uncertain and assumed to be offset by disruptions to the existing flow of goods.

In the main it is assumed that the **large barrage** will have a negative impact on ports by impeding ship movements, their ability to accommodate large ships and their overall competitiveness in terms of both investment potential and customer perception. Whilst there is scope for other ports within the region to absorb displaced port traffic, as we have not assessed the potential of ancillary investment, the assumed level of intra-region displacement is relatively low.

Assuming modest intra-region displacement, over the construction period, impacted ports lose an increasing proportion of their trade, up to a peak at the end of construction. The value of this loss to the regional economy ranges from a worst case scenario of £800 million to a best case scenario of a loss of £400 million over the entire construction period, with a central scenario of -£600 million GVA for the large barrage. In terms of employment losses, we have assumed that these occur in a linear fashion over the duration of the build period, peaking at 3,300 jobs or an annual average of 1,800 jobs lost over the construction period (ranging from a worst case scenario of an annual average loss of 2,400 jobs and best case scenario of an annual average loss of 1,200 jobs). This compares to a baseline estimate of direct and indirect port employment of 6,300 full time equivalent jobs for the seven main ports in the Severn Estuary. It has to be said, however, that the main detrimental impact is on the Port of Bristol and, thereby, the South West region.

Subsequent to the construction of the large barrage, it is assumed that those ports negatively impacted will not recover lost trade. However, the resources and assets of the ports may be redeployed for alternative uses. Therefore, the negative impact will not continue in perpetuity and will, over time, be diminished. In the central scenario it is assumed that from the peak of negative impact, where 60 percent of port activity is lost from the region, that over a ten year period this loss slowly diminishes in a linear fashion. The net effect of the operation of the barrage is a loss of £500 million GVA (ranging between a loss of £300 million and £1 billion) and an annual average loss of employment of 600 jobs over the thirty year period. Depending on the extent of lost trade and the scope for re-absorption of assets, this ranges from a worst case scenario where an annual average of 1,500 jobs are lost to a best case scenario where an annual average of 400 jobs are lost, mostly impacting the Bristol City Region. Over the ten year period, when the majority of losses are expected, the central scenario presents annual average losses of employment of 1,800 jobs.

The **small barrages** and **lagoons** options will have a similar but smaller impact on the ports than the large barrages. The lowest level of impact could be zero if the impact on ports upstream of the small barrages is wholly displaced within the South West and Wales (i.e. specific ports may be negatively impacted but this is absorbed by other ports in the region). The medium scenario will be a loss of £30 million of GVA during construction (ranging from £60 million to zero) and job losses will peak at 280 in the central scenario, an annual average equivalent of 170 (ranging from 330 in the worse scenario to zero in the best scenario). Over the operational phase the loss of GVA in the central scenario is estimated at £46 million, (ranging from £160 million to zero) over a forty year period and job impacts equivalent to an

annual 40 jobs per annum in the central scenario (ranging from -170 to zero). Over a ten year operational period, the jobs losses equate to an annual average loss of 430 in the worst case scenario and a loss of 150 annual average jobs in the central scenario and zero losses in the best case scenario.

We do not have sufficient information to model the potential impact of **tidal fence** or **tidal reef** on the port section and do not know how these options may impact port operations.

Fishing

We have not assessed the social value of fish or the environmental value of fish, but focused the analysis on the impact of STP on economic agents dependent on fish. In particular, this assessment has focused on the recreational salmon & sea trout angling, recreational sea angling and commercial eel fishery activity. This is because of the relative focus of these activities in the study area. STP options may have further reaching impacts if, for example, important nursery habitats are lost. There is uncertainty about the impact of any Severn Tidal Power scheme on recreational sea angling. The main variation between the high scenario (worst case) and low scenario (best case) is the value of the activity to the economies of Wales and the South West (i.e. how much value they bring to the regional economies before disruption).

During the period of construction for a **large barrage**, there will be a GVA loss from negative impacts of fishing in the South West and Wales of between £5.6 million in the low scenario and £8.2 million in the high scenario. Employment losses will range between an annual average of 30 in the low scenario and 50 in the high scenario. During the operational phase, GVA loss ranges from £17 million in the low scenario to £25.8 million in the high scenario; with employment losses of between 60 in the low scenario and 80 in the high scenario. These are the same jobs as those lost during the construction process and are not cumulative.

As with ports, the impacts of the **small barrages** and **lagoons** on fishing have been calculated in the same way. The impact during the construction period (four to five years) ranges from a loss of £3.4 million of GVA and an annual average of 30 jobs in the low scenario; to a loss of £5 million of GVA and an annual average of 50 jobs in the high scenario. During the operational period, the impact ranges from a loss of £22 million of GVA and 60 jobs in the low scenario; to a loss of £33 million and 80 jobs in the high scenario. The operational and construction job losses are the same jobs and are not cumulative.

We do not have sufficient information in relation to how a **tidal reef** or a **tidal fence** would impact fish populations and have not been able to assess the economic impact of these STP options on fishing.

Land Use and Planning

The impact of the Severn Tidal Power options on land use and planning cannot be quantified at this stage in the analysis. The main areas of economic impact will be driven by: a change in land use associated with the construction of options; a change in land use as a result of a change in flood risk (upstream and downstream); or a change in flooding frequency and associated costs to existing land users (upstream and downstream). Across all of the options,

there is potential economic benefits from the future use of infrastructure developed as part of the construction process and the future use of construction sites.

Whilst the nature of changes in flood risk is uncertain, mitigation works have been included in construction cost estimates so it is expected that the overall net additional economic impact will be positive. The potential reduction in flood risk upstream is seen as the most significant positive impact and this is only likely to be significant for a **large barrage**. A **small barrage** affects a smaller area of land and therefore any positive impacts will be more limited. There is uncertainty over the impact of other STP options on flood risk. Across all aspects of this area there remains uncertainty and land use benefits can only really be realised if the planning systems acknowledge a change in flood risk.

Tourism

The impact on the tourism sector focuses on those impacts which are not reliant on any ancillary investment (e.g. investment in new marinas). During the construction process, the main negative impacts of any Severn Tidal Power scheme will result from congestion on transport networks, and disruption to the tourism impact in specific locations. At this stage, insufficient data is available to be able to calculate potential economic impact. It is not clear what impact any Severn Tidal Power scheme will have on ornithological tourism. Once operational, a large barrage could have a positive impact on marine leisure activities because of the reduced tidal range upstream of the barrage. However, any substantial developments in marine leisure are likely to require ancillary investment and fall outside the scope of this initial assessment.

The STP option is likely to attract visitors in its own right, given the potential scale and nature of development. In estimating the potential economic impact of this across the STP options, we have used visitor numbers from comparators elsewhere. We have assumed that a large barrage will attract the greatest number of visitors based on the scale of change to the local area and the visible impact of the option. The central scenario estimates that a large barrage may attract 200,000 visitors each year.

Large barrage impact will be positive, with the high scenario generating a net additional benefit of £27 million of GVA and 130 full time equivalent jobs over a forty year period. The low scenario will generate a net additional benefit of £3.4 million of GVA and 20 jobs. Further positive impacts may occur if ancillary investment was made to capitalise on the change in marine environment and greater accessibility to the Severn Estuary (e.g. marina developments).

The impact of a **small barrage** on the tourism sector is that it will attract fewer visitors than a large barrage. The high scenario will generate £20 million of GVA and 80 jobs over a forty year period. The low scenario will generate £2.5 million of GVA and 10 jobs.

The tourism impact of all **tidal fence**, **tidal reef** and **lagoons** are assumed to be smaller based on the assumption that they will have a less visible impact on the Severn Estuary Area. For these options, the high scenario generates a positive impact of £3 million of GVA and 10 jobs. The low scenario generates an impact of £0.4 million of GVA and less than 10 jobs.

Accommodation

The impact on the accommodation (hospitality and catering) sector is based on the change in demand caused by temporary construction workers in the region, and impacts on the tourism sector. Demand generated by construction workers may displace demand that would have been generated by tourist visitors to the South West and Wales. The quantifiable benefits have already been captured as part of the multiplier included in the construction impacts. Accommodation impacts are a function of the spend on STP options and vary accordingly.

Residential Market and Population

The impact of STP on the residential market and population will be driven by: the attraction of new residents as part of the construction labour force who decide to stay; by new residents who are attracted by the opportunities for employment offered in the operation of a scheme; by new residents attracted by the change in environmental quality; and by residents who move to or leave the area of impact due to change in flood risk. At this stage in the analysis, it is not possible to quantify this impact.

Operational Impacts

The operation of STP will generate an economic impact with the creation of new jobs. The scale of job creation depends on the cost of operating STP and the level of employment that is displaced in the region (i.e. whether STP is instead of another power facility that would have otherwise employed these people.). The displacement rate is varied across the high, central and low impact scenarios.

High level estimates of the operating expenditure have been produced, with the operating costs of a **large barrage** of around £360 million p.a. The employment benefit of the large barrage ranges from 1,300 jobs in the high scenario to 400 jobs in the low scenario. The present value of the GVA generated by operation over a 40 year period (including the construction period, during which the options will not be operational) is between £1.6 billion and £4.8 billion. Over the first ten year operational period this ranges from £0.7 billion to £2.0 billion GVA.

The cost of operating a **small barrage** will be less than that for a large barrage and so the economic impact to the South West and Wales will be lower. The benefits range from a high scenario of 180 jobs to a low scenario of 60 jobs. The present value of the net additional GVA to the region of operating these options over a 40 year period (including the construction period, during which the options will not be operational) is between £250 million and £750 million. Over the first ten year operational period this ranges from £100 million to £300 million GVA.

The net additional economic impact operating the **lagoons** options range from a high scenario of 220 jobs, to a low scenario of 70 jobs. The present value of the net additional GVA to the region of operating these options over a 40 year period (including the construction period, during which the options will not be operational) is between £310 million and £920 million. Over the first ten year operational period this ranges from £100 million to £400 million GVA.

The net additional economic impact operating the **tidal fence** options range from a high scenario of 300 jobs, to a low scenario of 100 jobs. The present value of the net additional

GVA to the region of operating these options over a 40 year period (including the construction period, during which the options will not be operational) is between £430 million and £1,280 million. Over the first ten year operational period this ranges from £200 million to £500 million GVA.

The net additional economic impact operating the **tidal reef** option ranges from a high scenario of 1,300 jobs, to a low scenario of 400 jobs. The present value of the net additional GVA to the region of operating this option over a 40 year period (including the construction period, during which the option will not be operational) is between £1.5 billion and £4.4 billion. Over the first ten year operational period this ranges from £600 million to £1.9 billion GVA.

Severn Lakes (Option U1)

At present we do not have specific data on the proposed lakes scheme. For the purposes of this analysis, the Severn Lakes scheme is being treated as equivalent to the Cardiff to Weston Barrage, option B3.

This initial high level study suggests that there will be both gains and losses for Wales and the South West of England from the development of a STP option. However, on balance, the picture is broadly positive. Gross Value Added created during the construction phase and operational phase outweighs that lost to industries such as the ports and fishing.

Crynodeb Gweithredol

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Cyflwyniad

Prif nod yr astudiaeth hon yw *"cynnal asesiad dechreuol o effaith economaidd posibl prosiect Ynni'r Llanw ar Afon Hafren (Severn Tidal Power) arfaethedig ar economïau rhanbarthol Cymru a De Orllewin Lloegr*[3]*."*

Ffocws yr ymchwil yw gweld a yw'r cynigion a ddiffiniwyd o dan Brosiect Ynni'r Llanw ar Afon Hafren yn debygol o arwain at effeithiau economaidd net cadarnhaol neu effeithiau net negyddol arwyddocaol ar economïau Cymru a De Orllewin Lloegr.

Wrth asesu arwyddocâd, un o brif ofynion yr astudiaeth hon yw canfod yr effaith economaidd net. Mae'n bwysig, felly, i asesu pa gyfran o gyfanswm y costau a'r manteision sy'n gysylltiedig ag unrhyw un o ddewisiadau Ynni'r Llanw ar Afon Hafren (YLlAH) sy'n cael ei brofi gan economïau Cymru a De Orllewin Lloegr.

Senarios
Mae ansicrwydd ynghylch effeithiau economaidd y dewisiadau sydd dan ystyriaeth. Ar hyn o bryd yn ystod yr astudiaeth dichonolrwydd ehangach, nid oes gwybodaeth fanwl ar gael yn ymwneud â gweithredu'r dewisiadau. Gyda diffyg gwybodaeth fanwl, nid yw'n bosibl asesu yn union sut y bydd gwahanol sectorau o fewn economïau Cymru a De Orllewin Lloegr yn ymateb i weithredu a datblygu'r dewisiadau. Oherwydd yr ansicrwydd hwn, mae'r senario ganolog yr ydym yn ei chyflwyno wedi cael ei haddasu. Mae'r asesiad sensitifrwydd hwn yn newid rhai o'r prif ffactorau cyfnewidiol i ddangos paramedrau posibl yr effaith o'r senario gwaethaf i'r senario gorau.

Clystyru
Mae rhai dewisiadau wedi cael eu clystyru er diben y dadansoddiad effaith economaidd am ddau reswm: yn gyntaf gan y byddant yn debyg iawn o ran eu heffaith economaidd; ac yn ail, oherwydd yn y cyfnod hwn yn ystod y gwaith datblygu dewisiadau, nid oes digon o wybodaeth ar gael i fedru dynodi eu heffaith economaidd yn effeithiol. Serch hynny, dylid nodi fod clystyru yn golygu defnyddio amcangyfrifon penodol ar gyfer YLlAH (e.e. costau adeiladu) ar y cyd ag effeithiau ar sectorau wedi'u clystyru (e.e. porthladdoedd) sy'n golygu na fydd cyfnodau adeiladu (h.y. amser adeiladu) o anghenraid, yn cyd-fynd yn union â chyfnodau effaith a dybiwyd ar gyfer y cyfnod adeiladu (h.y. hyd effaith y cyfnod adeiladu ar sector).

Asesu Effaith Economaidd
Ar gyfer pob dewis, rydym wedi dechrau â lefel gros yr effaith economaidd, h.y. effaith pennawd; a chyfrifo ar gyfer ffactorau ychwanegolrwydd er mwyn cael yr effaith economaidd net posibl ar economïau Cymru a De Ddwyrain Lloegr.

Mae cwmpas yr adroddiad hwn yn ymestyn dros sectorau economi Cymru a De Ddwyrain Lloegr sy'n debygol o deimlo effaith mwyaf arwyddocaol yr amrywiaeth o ddewisiadau. Y

[3] Ardal yr effaith yw Cymru a De Orllewin Lloegr, er, ambell waith yn yr adroddiad, cyfeirir at hyn fel effaith 'rhanbarthol'.

sectorau hynny yw adeiladu, trafnidiaeth a logisteg (porthladdoedd yn bennaf), pysgota, defnydd tir a chynllunio, twristiaeth, llety, preswyl a phoblogaeth a diwydiannau eraill. Rydym wedi mesur yr effeithiau lle bo hynny'n bosibl. Serch hynny, o fewn rhai meysydd effaith economaidd, nid oes ond digon o wybodaeth ar gael ei alluogi asesiad ansoddol. Felly, wrth ystyried y data effaith fesurol net a gaiff ei grynhoi yn yr adroddiad hwn, mae'n bwysig cofio am yr effeithiau economaidd hynny sydd heb eu mesur a allai fod yn sylweddol.

Ar gyfer pob dewis a maes effaith, rydym wedi cymryd cyfnod cyfeirio deugain mlynedd, sy'n cynnwys effeithiau'r cyfnod adeiladu (sy'n amrywio yn ôl dewis) ac effeithiau'r cyfnod gweithredu. Oherwydd yr ansicrwydd ynghylch yr effeithiau gweithredu, rydym hefyd wedi cyflwyno'r effeithiau hyn dros gyfnod byrrach o ddeng mlynedd, i ddangos yr hyn a allai ddigwydd yn y tymor byr.

Y ffigyrau sydd i'w gweld isod yw effaith economaidd net dewisiadau Ynni'r Llanw ar Afon Hafren ar economi Cymru a De Ddwyrain Lloegr. Mae'r holl ffigyrau Gwerth Ychwanegol Crynswth (GYC) gaiff eu cyflwyno isod yn cael eu cyflwyno fel gwerth presennol.

Crynodeb Cwmpasol

Mae'r effaith economaidd rhanbarthol net yn amrywio yn ôl y dewis ar gyfer YLlAH. Yn y tabl isod, nodir sectorau'r economi fydd yn gweld effaith arwyddocaol gan y dewisiadau YLlAH, gyda chrynodeb o gyfeiriad yr effaith a'r ffactorau allweddol sy'n dylanwadu ar faint yr effaith.

Maes yr Effaith	Natur yr Effaith	Amrywiaethau Allweddol
Adeiladu	Mae'r broses adeiladu yn arwain at **effaith economaidd cadarnhaol net** ar economïau Cymru a De Orllewin Lloegr.	Mae amrywiaethau'n dibynnu ar a) lefel y gwariant gros b) y graddau y bydd y gwariant yn digwydd yn y rhanbarth, a c) y graddau y bydd y broses adeiladu yn disodli (neu'n atal) prosiectau adeiladu eraill yn y rhanbarth. Yn gyffredinol, po ddrutaf y bydd y prosiect, y mwyaf y bydd y manteision economaidd net i'r rhanbarth.
Trafnidiaeth a Logisteg (Porthladdoedd)	Mae'r ffocws ar yr effaith negyddol fydd yn cael ei achosi i symudiadau llongau o ganlyniad i broses adeiladu a gweithredu dewisiadau YLlAH. Po fwyaf y bydd y prosiect yn amharu ar y llongau, y mwyaf fydd yr **effaith economaidd negyddol net**. Efallai y bydd effeithiau cadarnhaol o ganlyniad i fewnforio deunyddiau adeiladu.	Mae'r amrywiaethau yn ymwneud â chyfran y traffig porthladd a) y bydd y gwaith yn amharu arno a b) y potensial i borthladdoedd eraill ymdopi ag ef. Bydd y dewisiadau YLlAH sy'n amharu ar fwy o borthladdoedd (a llongau) yn cael effaith negyddol mwy na'r rhai sy'n effeithio ar lai o symudiadau llongau. H.y. ystyried lleoliad YLlAH a'r effaith ar lwybrau mordwyo.
Pysgota	Mae'r ffocws ar yr **effaith negyddol** ar asiantau economaidd sy'n ddibynnol ar y boblogaeth bysgod.	Mae'r prif amrywiaethau'n dibynnu ar effaith dewisiadau YLlAH ar y boblogaeth bysgod. Mae ansicrwydd ynghyd â nifer o ffactorau fel llwybrau mudo, effaith y tyrbinau, newid cynefin ac ati, a allai gael effaith negyddol ar bysgod yn golygu ein bod wedi cymryd y byddai pob dewis YLlAH yn cael yr un effaith negyddol ar y

Maes yr Effaith	Natur yr Effaith	Amrywiaethau Allweddol
		boblogaeth bysgod ac felly ar y rhai hynny sy'n ddibynnol ar lefelau'r boblogaeth. Dylanwadir ar yr amrywiaethau rhwng y dewisiadau YLlAH gan hyd y cyfnod adeiladu.
Defnydd Tir a Chynllunio	Mae'r ffocws ar **effaith economaidd cadarnhaol posibl** dewisiadau YLlAH ar leihau'r perygl o lifogydd a chynyddu pa mor hyfyw yw tir ac eiddo yn economaidd. Mae agweddau cadarnhaol posibl ychwanegol yn ymwneud â gwerth economaidd y seilwaith adeiladu yn ystod cyfnod gweithredu'r dewisiadau YLlAH (neu ar ôl y gwaith adeiladu).	Maes hynod ansicr. Serch hynny, y morglawdd mawr yw'r unig ddewis sy'n cael ei ystyried fel un fyddai'n cael unrhyw effaith sylweddol ar leihau'r perygl o lifogydd. **Nid yw'r maes hwn wedi cael ei fesur.**
Twristiaeth	Mae'r ffocws ar **effaith economaidd cadarnhaol uniongyrchol posibl** sy'n ymwneud ag ymwelwyr i brosiect YLlAH. Mae effeithiau economaidd cadarnhaol posibl eraill o fuddsoddiad atodol mewn datblygiadau marina, gan fanteisio ar lai o natur gymylog i'r dŵr a gwell mynediad i'r dŵr. Serch hynny, gan y byddai angen buddsoddiad ychwanegol yn hyn o beth y tu hwnt i gwmpas y dewis YLlAH, nid ydynt wedi cael eu mesur yn yr adroddiad hwn.	Mae'r amrywiaethau'n cael eu gyrru gan faint y datblygiad a'r effaith weledol bosibl ar ardal Aber yr afon Hafren. H.y. y mwyaf gweledol a dramatig fydd y newid yn yr aber, y mwyaf y bydd yr effaith y byddid yn ei ddisgwyl ar niferoedd blynyddol yr ymwelwyr.
Llety	Bydd **effeithiau economaidd cadarnhaol** ar lety'n cael eu gyrru gan effeithiau adeiladu, trwy effaith lluoswr. Mae'r rhain, felly, wedi cael eu dal ynghyd â'r effeithiau adeiladu.	Cyfradd gyflogi a gwario fydd yn ymwneud â gwaith adeiladu'r dewisiadau YLlAH. Po fwyaf y bydd y gwariant a'r gofyn am lafur, y mwyaf fydd yr effaith gadarnhaol ar y sector llety.
Preswyl a Phoblogaeth	Mae ffocws yr effaith yn cynnwys effaith gadarnhaol cyflogi pobl ar gyfer gweithredu'r prosiect, effeithiau cadarnhaol yn ymwneud ag effeithiau'r etifeddiaeth.	**Nid yw'r maes hwn wedi cael ei fesur.**
Diwydiannau Eraill	Mae ffocws yr asesiad ar y diwydiannau eraill fydd yn cael eu heffeithio gan dewisiadau YLlAH. Bydd y prif ffocws ar yr	Mae effaith gweithredu dewis YLlAH yn dibynnu ar lefel y gwariant ar gynnal a chadw a gweithredu'r dewis. Yn gyffredinol, po ddrutaf fydd y costau adeiladu, y drutaf fydd costau

Maes yr Effaith	Natur yr Effaith	Amrywiaethau Allweddol
	effaith economaidd gadarnhaol fydd yn ymwneud â gweithredu dewisiadau YLlAH.	gweithredu a chynnal a chadw YLlAH a'r mwyaf fydd nifer y swyddi fydd yn cael eu cadw.

Wrth amcangyfrif effaith economaidd GYC net y dewisiadau YLlAH dros y cyfnod adeiladu a gweithredu, mae'r effeithiau lefel sector hyn wedi cael eu hystyried. Serch hynny, wrth asesu effeithiau economaidd cyflogaeth net y dewisiadau YLlAH, mae materion yn ymwneud â nodwedd gyflogaeth gyffredin. Er enghraifft, caiff cyflogaeth ar gyfer adeiladu ei gyfrif yn ôl 'blynyddoedd person' i adlewyrchu natur dros dro rhai o'r swyddogaethau adeiladu; caiff effeithiau ar borthladdoedd ei gyfrif fel cyfartaledd swyddi blynyddol gydag effeithiau cyflogaeth brig, a bydd effeithiau gweithredu'n cael eu cyfrif fel swyddi'n Cyfateb i Swyddi Amser Llawn (Full Time Equivalent). Yng ngoleuni'r amrywiadau hyn, mae DTZ wedi crynhoi'r effeithiau cyflogaeth net trwy gymryd 'cyfartaledd blynyddol' cyflogaeth fel nodwedd gyffredin. Nid yw felly'n ystyried y newid posibl mewn proffiliau cyflogaeth dros y cyfnod cyfeirio (h.y. mewn rhai blynyddoedd bydd mwy neu lai o swyddi na'r hyn a welir yn y ffigwr cyfartaledd blynyddol).

Mae'r astudiaeth lefel uchel ddechreuol yn awgrymu y bydd enillion a cholledion i Gymru a De Orllewin Lloegr o ddatblygu'r dewis YLlAH. Serch hynny, o gydbwyso pethau, mae'r darlun yn un cadarnhaol ar y cyfan. Bydd y Gwerth Ychwanegol Crynswth fydd yn cael ei greu yn ystod y cyfnod adeiladu a'r cyfnod gweithredu yn fwy na'r hyn fydd yn cael ei golli gan ddiwydiannau fel y porthladdoedd a physgota.

Effaith Economaidd Net y Dewisiadau YLlAH

Er gwaethaf y pwynt uchod, caiff effaith net y dewisiadau YLlAH drwyddi draw eu crynhoi isod. Mae'r crynodebau hyn yn canolbwyntio ar feysydd sydd wedi cael eu mesur o fewn yr adroddiad. Dylid ystyried yr effeithiau hyn o fewn cyd-destun ehangach faint o ynni fydd yn cael ei gynhyrchu gan y dewisiadau, y goblygiadau ar gyfer yr amgylchedd, yr effeithiau sydd heb eu mesur ar gyfer y dewisiadau a'r posibilrwydd o gael rhagor o effeithiau economaidd o ganlyniad i fuddsoddiad atodol yn y rhanbarth.

Morglawdd Mawr: Gan ddefnyddio B3 i gynrychioli'r dewisiadau morglawdd mawr ar gyfer y senario ganolig, mae effaith fesurol net yr holl ffactorau hyn dros y cyfnod adeiladu a gweithredu yn elw o £3.55 biliwn i Gymru a De Orllewin Lloegr dros gyfnod o 40 mlynedd. Mae'r effaith drwyddi draw ar gyflogaeth yn ystod y gwaith adeiladu yn gynnydd net o 1,500 o swyddi fel cyfartaledd blynyddol[4] dros y cyfnod adeiladu, gyda'r effaith yn amrywio o senario gwaethaf o golled ar gyfartaledd blynyddol o 900 swydd i gynnydd o 14,500 swydd yn y senario gorau . Yn ystod y cyfnod gweithredu, bydd yr effaith yn amrywio o senario gwaethaf o golled ar gyfartaledd blynyddol o 1,200 swydd i gynnydd o 900 swydd. Mae'r amcangyfrif canolig yn gynnydd ar gyfartaledd blynyddol o 200 swydd, gan fod effaith gadarnhaol gweithredu'r prosiect YLlAH dros amser yn gwneud iawn am yr effaith negyddol ar borthladdoedd. Gan ystyried cyfnod gweithredu byrrach (10 mlynedd) yna amcangyfrifir y byddai'r morglawdd mawr yn arwain at golled o 1,000 o swyddi fel cyfartaledd blynyddol (o

[4] h.y. mae cyfartaledd swyddi blynyddol yn golygu y bydd x,xxx swydd yn rhagor na'r hyn a fyddai heb y datblygiad (1,500 yr yr achos hwn) ond nid yw hwn yn ffigwr cronnus (h.y. nid yw'n tyfu o x,xxx swydd ychwanegol bob blwyddyn yn ystod y gwaith adeiladu).

fewn ystod o - 3,100 i +100) gan fod yr effaith negyddol ar y porthladdoedd yn fwy amlwg. Dylid nodi fod y swyddi hyn yn cwympo i wahanol sectorau, gyda gwahanol lefelau cyflog a gwahanol effeithiau GYC. Mae'r effaith ar sectorau yn cael ei drafod isod.

Morglawdd Bach Gan ddefnyddio B4 i gynrychioli morglawdd bach: Drwyddi draw, amcangyfrifir fod effaith y GYC dros y cyfnod adeiladu a gweithredu yn £620 miliwn i economi Cymru a De Orllewin Lloegr dros gyfnod o 40 mlynedd. Gan gyfuno'r cynnydd mewn swyddi mewn rhai sectorau a cholli swyddi mewn sectorau eraill, yn ystod y gwaith adeiladu, mae'r effaith yn amrywio o'r senario gwaethaf gyda cholled blynyddol net ar gyfartaledd o 100 o swyddi; i senario gorau o gynnydd blynyddol net o 3,200 o swyddi. Yr amcangyfrif canolig ar gyfer creu swyddi net ar gyfer y dewis hwn yw 500 o swyddi. Yn ystod y cyfnod gweithredu, y senario gwaethaf yw colled net o 200 o swyddi'r flwyddyn, a'r senario gorau yw cynnydd net o 200 o swyddi'r flwyddyn. Yr amcangyfrif canolig ar gyfer creu swyddi net ar gyfer y dewis hwn yw 50 o swyddi. Gan ystyried cyfnod gweithredu byrrach (10 mlynedd) yna amcangyfrifir y byddai'r morglawdd bach yn arwain at golled o 60 o swyddi fel cyfartaledd blynyddol (o fewn ystod o - 400 i +200) gan fod yr effaith negyddol ar y porthladdoedd yn fwy amlwg dros y cyfnod hwn. Dylid nodi fod y swyddi hyn yn cwympo i wahanol sectorau, gyda gwahanol lefelau cyflog a gwahanol effeithiau GYC.

Lagwnau Drwyddi draw, amcangyfrifir y byddai Lagŵn L2 yn cyfrannu £800 miliwn tuag at economïau Cymru a De Orllewin Lloegr dros y cyfnod cyfeirio o 40 mlynedd (pum mlynedd o waith adeiladu a 35 mlynedd o gyfnod gweithredu). Gan ddefnyddio L2 i gynrychioli lagwnau, gan gyfuno'r cynnydd mewn swyddi mewn rhai sectorau a cholli swyddi mewn sectorau eraill, yn ystod y cyfnod adeiladu, mae'r effaith yn amrywio o'r senario gwaethaf gyda chynnydd blynyddol net o 30 o swyddi; i senario gorau o gynnydd blynyddol net o 4,300 o swyddi. Yr amcangyfrif canolig ar gyfer creu swyddi net ar gyfer y dewis hwn yw cyfartaledd blynyddol o 800 o swyddi. Yn ystod y cyfnod gweithredu, y senario gwaethaf yw colled net o 200 o swyddi'r flwyddyn, a'r senario gorau yw cynnydd net o 200 o swyddi'r flwyddyn. Yr amcangyfrif canolig ar gyfer creu swyddi net ar gyfer y dewis hwn yw 40 o swyddi. Gan ystyried cyfnod gweithredu byrrach (10 mlynedd) yna amcangyfrifir y byddai'r morglawdd bach yn arwain at golled o 70 o swyddi fel cyfartaledd blynyddol (o fewn ystod o - 400 i +200) gan fod yr effaith negyddol ar y porthladdoedd yn fwy amlwg dros y cyfnod hwn. Dylid nodi fod y swyddi hyn yn cwympo i wahanol sectorau, gyda gwahanol lefelau cyflog a gwahanol effeithiau GYC.

Dewisiadau Ffens Llanw a Rîff Llanw: Heb fedru asesu effaith y dewisiadau hyn ar y sector porthladdoedd, nid yw'n briodol i grynhoi'r effaith drwyddi draw ar GYC, ac nid yw'n bosibl cyfrifo'r safle net. Serch hynny, mae effaith y dewisiadau hyn ar rai o'r sectorau i'w weld isod ac o fewn prif gorff yr adroddiad.

Effeithiau Economaidd yn ôl Sector

Adeiladu:
Mae'r amcangyfrif o'r gwariant gros ar adeiladu **morgloddiau mawr** yn amrywio o £18 biliwn i £30 biliwn dros gyfnod adeiladu o ddeng mlynedd. Mae'r lefel hwn o wariant yn cyfateb i effaith Gwerth Ychwanegol Crynswth (GYC) o rhwng £7.6 biliwn a £12.1 biliwn dros gyfnod o ddeng mlynedd. Serch hynny, ar ôl ystyried y ffactorau ychwanegolrwydd, mae'r budd ychwanegol net gryn dipyn yn llai, yn bennaf gan fod y gwariant ar rai o'r prif gydrannau (megis y tyrbinau) yn annhebygol o ddigwydd yn y rhanbarth (h.y. colled i'r tu allan i'r ardal), a

bydd adeiladu morglawdd yn disodli gweithgareddau economaidd eraill sy'n bodoli. Mae ystyried y ffactorau hyn yn arwain at senario ganolig ar gyfer effaith economaidd ranbarthol net o GYC o rhwng £1.4 biliwn a £2.0 biliwn trwy'r opsiynau morgloddiau mawr.

O ran cyflogaeth, felly, byddai gwario oddeutu £18 biliwn ar adeiladu morglawdd mawr (B3) yn arwain at gyfartaledd cyflogaeth blynyddol gros 18,000 dros gyfnod adeiladu o saith mlynedd. Serch hynny, oherwydd y lefelau colled i'r tu allan i'r ardal a disodli gweithgareddau eraill, ar lefel Cymru a De Orllewin Lloegr, byddai'r effaith ychwanegol net yn gyfartaledd cyflogaeth blynyddol o 3,400 o swyddi; fyddai'n cyfateb i tua saith y cant o'r swyddi adeiladu yn yr ardal leol.

O amgylch y senario ganolig hon, pe byddai cyfran uwch o'r prif gydrannau yn cael eu cyflenwi o'r rhanbarth, a phe na byddai'r morglawdd yn amharu ar gynnal prosiectau adeiladu eraill, yna byddai'r effaith rhanbarthol net posibl gryn dipyn yn uwch, gan gyfateb i fudd GYC net o £5.7 biliwn ac effaith 15,700 o swyddi ar gyfartaledd cyflogaeth blynyddol, sy'n cyfateb i bron i draean o'r swyddi adeiladu yn yr ardal leol. Serch hynny, pe byddai'r senario gwaethaf yn amlygu, oherwydd natur gystadleuol y cytundebau a'r cadwyni cyflenwi, a llai o lafur a deunyddiau yn dod o Gymru a De Orllewin Lloegr, yna byddai'r economi yn gweld effaith economaidd net o oddeutu £0.7 biliwn, gan gynnal lefel cyfartaledd cyflogaeth blynyddol o 1,600 o swyddi, sy'n cyfateb i oddeutu tri y cant o'r swyddi adeiladu presennol yn yr ardal leol.

Mae'r effeithiau hyn yn debyg trwy'r dewisiadau eraill, ond yn amrywio oherwydd y costau adeiladu gros drwyddi draw, a chyfran y gwariant ar y cydrannau craidd. Felly, os bydd cyfran uwch yn cael ei gwario ar dyrbinau, yna bydd y golled drwyddi draw (neu golli elw rhanbarthol) yn fwy gan y tybir eu bod ar y cyfan yn cael eu mewnforio i'r ardal yn y senarios canolig. Mae'r prif grynodebau fel a ganlyn:

Fel gyda'r morglawdd mawr, mae effaith leol ychwanegol net adeiladu **morglawdd bach** yn gadarnhaol, er nad yw mor arwyddocaol, ar Gymru a De Orllewin Lloegr. Mae'r cyfartaledd cyflogaeth blynyddol (ar gyfer B4) yn amrywio o 300 swydd y flwyddyn i 3,200 swydd y flwyddyn gyda senario ganolig o 700 swydd y flwyddyn ar gyfartaledd dros gyfnod adeiladu o bum mlynedd. Mae'r effaith GYC yn amrywio o £70 miliwn i £860 miliwn (mewn gwerth presennol).

Mae adeiladu'r dewisiadau **Ffens Llanw** yn cael effaith gadarnhaol ychydig yn fwy ar economïau Cymru a De Orllewin Lloegr na'r morglawdd bach. Mae effeithiau F1a ar swyddi yn amrywio o gyfartaledd cyflogaeth blynyddol o 400 o swyddi mewn senario isel i gyfartaledd blynyddol o 3,200 o swyddi yn y senario uchel dros y cyfnod adeiladu o bum mlynedd. Mae'r senario ganolig yn cynnig cyfartaledd lefel cyflogaeth blynyddol o 900 swydd y flwyddyn. Mae effaith GYC y gwaith adeiladu yn amrywio o lai na £100 miliwn yn y senario isel i dros £850 miliwn yn y senario uchel. Mae'r amcangyfrifon ar gyfer F1b yn fwy oherwydd y byddai'r ffens yn hirach a gan fod yr amcangyfrifon ar gyfer y gwaith adeiladu'n uwch.

Mae effeithiau adeiladu'r dewisiadau **Lagŵn** yn amrywio'n sylweddol dros y gwahanol ddewisiadau, oherwydd eu maint a'r amrywiaeth yn y costau adeiladu. Gan ystyried L2 i gynrychioli lagŵn (gyda chyfnod adeiladu o bum mlynedd) mae'r swyddi adeiladu ar gyfer y dewis hwn yn amrywio o gyfartaledd blynyddol o 400 o swyddi yn y senario isel i gyfartaledd blynyddol o 4,400 o swyddi yn y senario uchel, gyda senario ganolig o gyfartaledd blynyddol o 1,000 o swyddi, sy'n cyfateb i oddeutu dau y cant o lefel y swyddi adeiladu lleol ar hyn o bryd.

Mae effaith GYC adeiladu'r dewisiadau lagŵn, yn ôl y gwerthoedd presennol, yn amrywio o ychydig dros £120 miliwn yn y senario isel i dros £1.1 biliwn yn y senario uchel.

Bydd adeiladu **Rîff Llanw** yn creu cyfartaledd cyflogaeth blynyddol o oddeutu 1,000 o swyddi yn y senario isel a chyfartaledd blynyddol o 12,100 o swyddi dros gyfnod adeiladu o ddeng mlynedd yn y senario uchel. Mae'r senario ganolig yn amcangyfrif cyfartaledd cyflogaeth blynyddol o 1,800 o swyddi dros gyfnod adeiladu o ddeng mlynedd. Mae effaith GYC yn amrywio o £500 miliwn yn y senario isel, i £5.7 biliwn yn y senario uchel.

Porthladdoedd

Yn ychwanegol at gyflogi uniongyrchol ac effaith GYC adeiladu dewis YLlAH, bydd sectorau eraill o'r economi yn debygol o gael eu heffeithio gan y datblygiad. O fewn Môr Hafren mae pedwar prif borthladd a allai gael eu heffeithio'n uniongyrchol gan ddatblygu dewis YLlAH. Bydd graddau'r effaith ar y porthladdoedd yn dibynnu ar p'un ai y bydd y dewis YLlAH yn effeithio ar symudiadau llongau ai peidio. Gellid cael effeithiau negyddol yn ystod cyfnod adeiladu a chyfnod gweithredu dewis YLlAH. Lle gellid cael rhai effeithiau positif ar y porthladdoedd oherwydd llif y deunyddiau adeiladu, mae hyn yn ansicr, a thybir y bydd y ffaith fod y gwaith yn amharu ar y llif nwyddau presennol yn gwrthwneud rhywfaint ar hyn.

Ar y cyfan, tybir y bydd y **morglawdd mawr** yn cael effaith negyddol ar borthladdoedd trwy amharu ar symudiadau llongau, eu gallu i dderbyn llongau mawr a'u natur gystadleuol drwyddi draw o ran eu potensial ar gyfer buddsoddiad a chanfyddiad y cwsmer. Tra bo cyfle i borthladdoedd eraill yn y rhanbarth dderbyn y traffig porthladdoedd hwn, gan nad ydym wedi asesu'r potensial ar gyfer buddsoddiad atodol, mae lefel dybiedig y dadleoliad o fewn y rhanbarth yn gymharol isel.

Gan gymryd y bydd dadleoliad isel o fewn y rhanbarth dros y cyfnod adeiladu, bydd y porthladdoedd a effeithir yn colli cyfran gynyddol o'u masnach, gan gyrraedd ei anterth ar ddiwedd y cyfnod adeiladu. Mae gwerth y golled i'r economi rhanbarthol yn amrywio o'r senario gwaethaf o oddeutu £800 miliwn i'r senario gorau o golled o £400 miliwn dros y cyfnod adeiladu cyfan, gyda senario ganolig o golled o £600 miliwn o GYC ar gyfer y morglawdd mawr. O ran colli swyddi, rydym wedi tybio y bydd hynny'n digwydd ar ffurf linellol yn ystod y cyfnod adeiladu, gan gyrraedd uchafbwynt o 3,300 swydd neu gyfartaledd blynyddol o 1,800 swydd wedi'u colli dros y cyfnod adeiladu (gan amrywio o senario gwaethaf o amcangyfrif o golled blynyddol o 2,400 swydd a senario gorau o golli cyfartaledd blynyddol o 1,200 swydd). Mae hyn yn cymharu ag amcangyfrif o waelodlin swyddi uniongyrchol ac anuniongyrchol mewn porthladdoedd o 6,300 o swyddi'n cyfateb i swydd amser llawn yn y saith prif borthladd yn Aber yr Afon Hafren. Rhaid dweud, serch hynny, y byddai'r prif effaith negyddol ar Borthladd Bryste, ac felly, ar ranbarth De Orllewin Lloegr.

Ar ôl adeiladu'r morglawdd mawr, tybir na fydd y porthladdoedd hynny a welodd effaith negyddol o ganlyniad i'r gwaith yn adfer y fasnach a gollwyd. Serch hynny, gall adnoddau ac asedau'r porthladdoedd gael eu hadleoli at ddefnyddiau gwahanol. Felly, ni fydd yr effaith negyddol yn parhau am byth, a bydd yn lleihau dros amser. Yn y senario ganolig, tybir o anterth yr effaith negyddol, lle bydd 60 y cant o weithgaredd y porthladdoedd yn cael ei golli o'r rhanbarth, dros gyfnod o ddeng mlynedd, y bydd hyn yn lleihau'n raddol ar ffurf linellol. Bydd effaith net gweithredu'r morglawdd yn golled o £500 miliwn mewn GYC (gan amrywio rhwng colled o £300 miliwn ac £1 biliwn) a chyfartaledd blynyddol colli swyddi o 600 o swyddi

dros y cyfnod o ddeng mlynedd ar hugain. Gan ddibynnu ar faint o fasnach a gollwyd a'r cyfle ar gyfer adennill asedau, mae hyn yn amrywio o senario gwaethaf lle bydd cyfartaledd blynyddol o 1,500 o swyddi'n cael eu colli i senario gorau lle bydd cyfartaledd blynyddol o 400 o swyddi'n cael eu colli, gan effeithio'n bennaf ar Ranbarth Dinas Bryste. Dros y cyfnod o ddeng mlynedd, lle disgwylir y colledion mwyaf, mae'r senario ganolig yn cynnig cyfartaledd colled blynyddol o 1,800 o swyddi.

Bydd y dewisiadau **morgloddiau bychain** a **lagwnau** yn cael effaith debyg ond llai ar y porthladdoedd nac effaith y morgloddiau mawr. Byddai lefel isaf yr effaith yn ddim pe bai'r effaith ar borthladdoedd sydd ymhellach i fyny'r aber yn cael ei ddadleoli'n llwyr o fewn Cymru a De Orllewin Lloegr (h.y. gellid cael effaith negyddol ar rai porthladdoedd penodol, ond y bydd porthladdoedd eraill yn y rhanbarth yn gallu derbyn y gwaith). Y senario ganolig fydd colli £30 miliwn mewn GYC yn ystod y gwaith adeiladu (yn amrywio o £60 miliwn i ddim) a bydd colledion swyddi yn cyrraedd uchafswm o 280 yn y senario ganolig, gyda chyfartaledd blynyddol yn cyfateb i 170 (yn amrywio o 330 yn y senario gwaethaf, i ddim yn y senario gorau). Dros y cyfnod gweithredu, amcangyfrifir colled mewn GYC o £46 miliwn yn y senario canolig (gan amrywio o £160 miliwn i ddim) dros gyfnod o ddeugain mlynedd, gyda'r effaith ar swyddi'n cyfateb i 40 swydd y flwyddyn yn y senario ganolig (yn amrywio o -170 i ddim). Dros gyfnod gweithredu o ddeng mlynedd, byddai'r colledion swyddi'n cyfateb i gyfartaledd colled blynyddol o 430 yn y senario gwaethaf a chyfartaledd colled blynyddol o 150 o swyddi yn y senario canolig, a dim colledion yn y senario gorau.

Nid oes gennym ddigon o wybodaeth i greu model o effaith bosibl **ffens llanw** neu **rîff llanw** ar y porthladdoedd, ac nid ydym yn gwybod sut y byddai'r dewisiadau hyn yn effeithio ar waith y porthladdoedd.

Pysgota

Nid ydym wedi asesu gwerth cymdeithasol pysgod na gwerth amgylcheddol pysgod, ond wedi canolbwyntio'r dadansoddiad ar effaith YLlAH ar asiantau economaidd sy'n dibynnu ar bysgod. Yn benodol, mae'r asesiad wedi canolbwyntio ar bysgota hamdden am eog a brithyll môr, pysgota hamdden ar y môr a gweithgareddau pysgodfeydd llysywod masnachol. Mae hyn oherwydd ffocws cymharol y gweithgareddau hyn yn ardal yr astudiaeth. Gall YLlAH gael effeithiau mwy pell gyrhaeddol petai cynefinoedd magu pwysig yn cael eu colli, er enghraifft. Mae ansicrwydd am effaith cynllun Ynni'r Llanw ar Afon Hafren ar bysgota hamdden ar y môr. Y gwahaniaeth mwyaf rhwng y senario uchel (gwaethaf) a'r senario isel (gorau) yw gwerth y gweithgaredd i economïau Cymru a De Orllewin Lloegr (h.y. faint o werth maent yn ei ychwanegu i'r economïau rhanbarthol cyn yr aflonyddwch).

Yn ystod cyfnod adeiladu **morglawdd mawr**, bydd colled mewn GYC oherwydd yr effeithiau negyddol ar bysgota yng Nghymru a De Orllewin Lloegr o rhwng £5.6 miliwn yn y senario isel a £8.2 miliwn yn y senario uchel ar gyfer y morglawdd mawr. Bydd colledion swyddi yn amrywio rhwng cyfartaledd blynyddol o 30 yn y senario isel a 50 yn y senario uchel. Yn ystod y cyfnod gweithredu, bydd y golled mewn GYC yn amrywio o £17 miliwn yn y senario isel i £25.8 miliwn yn y senario uchel; gyda cholledion swyddi o rhwng 60 yn y senario isel ac 80 yn y senario uchel. Yr un swyddi yw'r rhain a'r rhai a gollwyd yn ystod y broses adeiladu ac nid yw'n ffigwr cronnus.

Fel gyda'r porthladdoedd, mae effeithiau'r **morgloddiau bach** a'r **lagwnau** ar bysgota wedi cael eu cyfrif yn yr un ffordd. Mae'r effaith yn ystod y cyfnod adeiladu (pedair i bum mlynedd) yn amrywio o golled o £3.4 miliwn mewn GYC a chyfartaledd blynyddol o 30 o swyddi yn y senario isel; i golled o £5 miliwn mewn GYC a chyfartaledd blynyddol o 50 o swyddi yn y senario uchel. Yn ystod y cyfnod gweithredu, mae'r effaith yn amrywio o golled o £22 miliwn mewn GYC a 60 o swyddi yn y senario isel; i golled o £33 miliwn mewn GYC ac 80 o swyddi yn y senario uchel. Yr un swyddi yw'r rhai yn y cyfnod adeiladu a gweithredu, ac nid ydynt yn rhai cronnus.

Nid oes gennym ddigon o wybodaeth ar gyfer sut y byddai **ffens llanw** neu **rîff llanw** yn effeithio ar y boblogaeth bysgod, ac nid ydym wedi medru asesu effaith economaidd y cynlluniau YLlAH hyn ar bysgota.

Defnydd Tir a Chynllunio

Ni ellir mesur effaith dewisiadau Ynni'r Llanw ar Afon Hafren ar ddefnydd tir a chynllunio ar hyn o bryd yn y dadansoddiad. Bydd prif feysydd yr effaith economaidd yn cael ei yrru gan: newid mewn defnydd tir yn gysylltiedig ag adeiladu'r dewis YLIAH; newid mewn defnydd tir o ganlyniad i newid yn y perygl o lifogydd (i fyny ac i lawr Afon Hafren); neu newid yn amlder llifogydd a'r costau cysylltiedig i ddefnyddwyr presennol y tir (i fyny ac i lawr Afon Hafren). Ym mhob un o'r dewisiadau, mae manteision economaidd posibl i'r defnydd yn y dyfodol o'r seilwaith a ddatblygwyd fel rhan o'r broses adeiladu a'r defnydd o safleoedd adeiladu yn y dyfodol.

Tra bo natur y newid i'r perygl o lifogydd yn ansicr, mae gwaith lliniaru wedi cael ei gynnwys yn amcangyfrifon y costau adeiladu, felly mae disgwyl i'r effaith economaidd ychwanegol net fod yn un cadarnhaol. Y lleihad posibl yn y perygl o lifogydd yn bellach i fyny'r Afon yw'r effaith cadarnhaol mwyaf arwyddocaol, er nad yw ond yn debygol o fod yn arwyddocaol gyda **morglawdd mawr**. Gan y byddai **morglawdd bach** yn effeithio ar ardal lai o dir, yna byddai unrhyw effeithiau cadarnhaol yn fwy cyfyngedig. Mae ansicrwydd ynghylch effaith dewisiadau YLlAH eraill ar y perygl o lifogydd. Mae ansicrwydd yn parhau ym mhob agwedd o'r maes hwn, ac ni all y manteision i ddefnydd tir gael eu gwireddu oni bai bod systemau cynllunio yn cydnabod y newid yn y perygl o lifogydd.

Twristiaeth

Mae'r effaith ar y sector dwristiaeth yn canolbwyntio ar yr effeithiau hynny sydd ddim yn dibynnu ar unrhyw fuddsoddiad atodol (e.e. buddsoddi mewn marinas newydd). Yn ystod y broses adeiladu, bydd prif ffeithiau negyddol unrhyw gynllun Ynni'r Llanw ar Afon Hafren yn ganlyniad i dagfeydd ar rwydweithiau trafnidiaeth, ac amharu ar effaith twristiaeth mewn rhai lleoliadau penodol. Ar hyn o bryd, nid oes digon o ddata ar gael i fedru mesur yr effaith economaidd posibl. Nid yw'n glir pa effaith fydd unrhyw gynllun Ynni'r Llanw ar Afon Hafren yn ei gael ar dwristiaeth adareg. Pan fyddai ar waith, gallai morglawdd mawr gael effaith gadarnhaol ar weithgareddau hamdden morol gan y byddai'r llanw yn cael llai o effaith yn bellach i fyny'r Afon. Serch hynny, mae unrhyw ddatblygiadau sylweddol mewn hamdden morol yn debygol o fod angen buddsoddiad atodol, gan gwympo y tu allan i gwmpas yr asesiad dechreuol hwn.

Mae'r cynllun YLlAH gaiff ei ddewis yn debygol o ddenu ymwelwyr ei hun, oherwydd maint posibl a natur y datblygiad. Wrth amcangyfrif yr effaith economaidd posibl ar gyfer y dewisiadau YLlAH, rydym wedi defnyddio niferoedd ymwelwyr o safleoedd y gellir cymharu â hwy mewn mannau eraill. Rydym wedi tybio mai'r morglawdd mawr fyddai'n denu'r nifer fwyaf o ymwelwyr yn seiliedig ar faint y newid i'r ardal leol ac effaith weledol y dewis hwnnw. Mae'r senario canolig yn amcangyfrif y gallai morglawdd mawr ddenu 200,000 o ymwelwyr y flwyddyn.

Byddai effaith **morglawdd mawr** yn un cadarnhaol, gyda'r senario uchel yn creu elw ychwanegol net o £27 miliwn mewn GYC a 130 o swyddi yn cyfateb i swyddi amser llawn dros gyfnod o ddeugain mlynedd. Byddai senario isel yn creu elw ychwanegol net o £3.4 miliwn mewn GYC ac 20 o swyddi. Gellid cael rhagor o effeithiau cadarnhaol gyda buddsoddiad atodol i fanteisio ar y newid yn yr amgylchedd morol a gwell mynediad i Aber yr Afon Hafren (e.e. datblygiadau marina).

Effaith **morglawdd bach** ar y sector twristiaeth yw y byddai'n denu llai o ymwelwyr na morglawdd mawr. Byddai senario uchel yn creu £20 miliwn mewn GYC a 80 swydd dros gyfnod o ddeugain mlynedd. Byddai senario isel yn creu £2.5 miliwn mewn GYC a 10 swydd.

Tybir y byddai effaith **ffens llanw, rîff llanw** a **lagwnau** yn llai yn seiliedig ar y dybiaeth y byddent yn cael effaith llai gweledol ar ardal Aber yr Afon Hafren. Ar gyfer y dewisiadau hynny, byddai'r senario uchel yn creu effaith cadarnhaol o £3 miliwn mewn GYC a 10 swydd. Byddai'r senario isel yn creu effaith o £0.4 miliwn mewn GYC a llai na 10 swydd.

Llety

Mae'r effaith ar y sector llety (llety ac arlwyo) yn seiliedig ar newid yn y galw wedi'i achosi gan weithwyr adeiladu dros dro yn y rhanbarth, ac effaith ar y sector twristiaeth. Gallai'r galw gan weithwyr adeiladu gymryd lle'r galw fyddai wedi cael ei greu gan ymwelwyr twristaidd i Gymru a De Orllewin Lloegr. Mae'r manteision y gellir eu mesur eisoes wedi cael eu cyfrif fel rhan o'r lluoswr sydd wedi'i gynnwys yn effeithiau'r gwaith adeiladu. Mae'r effeithiau ar lety yn rhan o'r gwariant ar ddewisiadau YLlAH, ac yn amrywio yn ôl y dewisiadau hynny.

Marchnad Breswyl a Phoblogaeth

Bydd effaith YLlAH ar y farchnad breswyl a'r boblogaeth yn cael ei yrru gan: ddenu trigolion newydd fel rhan o'r gweithlu adeiladu sy'n penderfynu aros; gan drigolion newydd sy'n cael eu denu gan y cyfleoedd gwaith a gynigir trwy weithredu'r cynllun; gan drigolion newydd sy'n cael eu denu gan y newid yn ansawdd yr amgylchedd; a gan drigolion sy'n symud neu'n gadael ardal yr effaith oherwydd y newid yn y perygl o lifogydd. Ar hyn o bryd yn y broses ddadansoddi, nid yw'n bosibl mesur yr effaith.

Effeithiau Gweithredu'r Cynllun

Bydd gweithredu YLlAH yn creu effaith economaidd gyda chreu swyddi newydd. Bydd faint o swyddi gaiff eu creu yn dibynnu ar gost gweithredu'r cynllun YLlAH a lefel y swyddi sy'n cael eu disodli yn y rhanbarth (h.y. os yw'r cynllun YLlAH yn cymryd lle cyfleuster ynni arall a fyddai wedi cyflogi'r bobl hyn fel arall.). Mae'r gyfradd ddisodli yn amrywio ar draws y senarios uchel, canolig ac isel.

Mae amcangyfrifon lefel uchel y gwariant ar weithredu wedi cael eu cynhyrchu, gyda chostau gweithredu **morglawdd mawr** oddeutu £360 miliwn y flwyddyn. Mae manteision morglawdd mawr i gyflogaeth yn amrywio o 1,300 swydd yn y senario uchel i 400 swydd yn y senario isel. Mae gwerth presennol y GYC a gynhyrchir trwy weithredu am gyfnod o 40 mlynedd (yn cynnwys y cyfnod adeiladu, lle na fydd y gwaith ar fynd) rhwng £1.6 biliwn a £4.8 biliwn. Dros ddeng mlynedd gyntaf y cyfnod gweithredu, mae hyn yn amrywio rhwng £0.7 biliwn a £2.0 biliwn mewn GYC.

Bydd cost gweithredu **morglawdd bach** yn llai na'r gost ar gyfer morglawdd mawr, ac felly bydd yr effaith economaidd ar Gymru a De Orllewin Lloegr yn llai. Mae'r manteision yn amrywio o senario uchel o 180 swydd i senario isel o 60 swydd. Mae gwerth presennol y GYC ychwanegol net i'r rhanbarth o weithredu'r dewisiadau hyn dros gyfnod o 40 mlynedd (yn cynnwys y cyfnod adeiladu, lle na fydd y gwaith ar fynd) rhwng £250 miliwn a £750 miliwn. Dros ddeng mlynedd gyntaf y cyfnod gweithredu, mae hyn yn amrywio rhwng £100 miliwn a £300 miliwn mewn GYC.

Mae effaith economaidd ychwanegol net gweithredu'r dewisiadau **lagwnau** yn amrywio o senario uchel o 220 swydd, i senario isel o 70 swydd. Mae gwerth presennol y GYC ychwanegol net i'r rhanbarth o weithredu'r dewisiadau hyn dros gyfnod o 40 mlynedd (yn cynnwys y cyfnod adeiladu, lle na fydd y gwaith ar fynd) rhwng £310 miliwn a £920 miliwn. Dros ddeng mlynedd gyntaf y cyfnod gweithredu, mae hyn yn amrywio rhwng £100 miliwn a £400 miliwn mewn GYC.

Mae effaith economaidd ychwanegol net gweithredu'r dewisiadau **ffens llanw** yn amrywio o senario uchel o 300 swydd, i senario isel o 100 swydd. Mae gwerth presennol y GYC ychwanegol net i'r rhanbarth o weithredu'r dewisiadau hyn dros gyfnod o 40 mlynedd (yn cynnwys y cyfnod adeiladu, lle na fydd y gwaith ar fynd) rhwng £430 miliwn a £1,280 miliwn. Dros ddeng mlynedd gyntaf y cyfnod gweithredu, mae hyn yn amrywio rhwng £200 miliwn a £500 miliwn mewn GYC.

Mae effaith economaidd ychwanegol net gweithredu'r dewis **rîff llanw** yn amrywio o senario uchel o 1,300 swydd, i senario isel o 400 swydd. Mae gwerth presennol y GYC ychwanegol net i'r rhanbarth o weithredu'r dewisiadau hyn dros gyfnod o 40 mlynedd (yn cynnwys y cyfnod adeiladu, lle na fydd y gwaith ar fynd) rhwng £1.5 biliwn a £4.4 biliwn. Dros ddeng mlynedd gyntaf y cyfnod gweithredu, mae hyn yn amrywio rhwng £600 miliwn ac £1.9 biliwn mewn GYC.

Llynnoedd Hafren (Dewis U1)

Ar hyn o bryd, nid oes gennym ddata penodol ar y cynllun llynnoedd a gynigir. Er dibenion y dadansoddiad hwn, mae cynllun Llynnoedd Hafren yn cael ei drin yr un fath â Morglawdd Caerdydd i Weston, dewis B3.

Mae'r astudiaeth lefel uchel ddechreuol yn awgrymu y bydd enillion a cholledion i Gymru a De Orllewin Lloegr o ddatblygu'r dewis YLlAH. Serch hynny, o gydbwyso pethau, mae'r darlun yn un cadarnhaol ar y cyfan. Bydd y Gwerth Ychwanegol Crynswth fydd yn cael ei greu yn ystod y cyfnod adeiladu a'r cyfnod gweithredu yn fwy na'r hyn fydd yn cael ei golli gan ddiwydiannau fel y porthladdoedd a physgota.

1. Introduction

This report sets out the initial findings of the regional economic impact assessment study.

There are three primary purposes of this report.

- **Firstly**, the report identifies the potential areas of economic impact that emerge as a consequence of the tidal power working options being considered.

- **Secondly**, the report presents an initial assessment of those areas of potential regional economic impact that are believed to be most significant.

- **Thirdly**, by utilising socio-economic data, and sector specific research findings, the potential scale of these impacts have, where possible, been documented.

In doing so, this report highlights those areas that have been reviewed, identifying what is now known, highlighting gaps in research that remain and future work programme that may be required to fill these gaps should the STP options be considered in greater detail in a later stage.

1.1 Background

The Secretary of State for Business, Enterprise and Regulatory Reform (BERR) announced a Severn Tidal Power (STP) Feasibility Study on 25 September 2007 to consider whether the Government could support a project which exploits the major energy generation potential of the tidal range of the Severn, and if so, on what terms.

The STP Feasibility Study is being managed by a cross-government group led by BERR (now DECC)[5], which includes the Cabinet Office, Department for Environment, Food and Rural Affairs (Defra), Department for Transport, Department for Communities and Local Government, Her Majesty's Treasury, Wales Office, the Welsh Assembly Government, and the South West Regional Development Agency.

The Study is being undertaken through a series of workstreams. The main workstreams are:

- Environmental – for example, effects on biodiversity and wildlife, flood management, geomorphology, water quality, and need for compensatory measures;
- Engineering and technical – options appraisal, costs, design and construction, grid linkage;
- Economic – financing, ownership, energy market impacts;
- Regional – impacts on business, Severn ports, regional, social and socio- economic impacts;
- Planning and consents - regulatory compliance; and
- Stakeholder engagement and communication

[5] Newly formed Department of Energy and Climate Change

This report contributes to the feasibility study by *"undertaking an initial assessment of the potential economic impact of the proposed Severn Tidal Power project on the regional economies of Wales and the South West of England"*, to the extent that information and policy guidance has been available to enable this. It is important to emphasise that we do not consider that this report provides a complete analysis of the issues involved in making a strategic, economic, commercial or financial case for the project.

The focus of the research should be to identify whether proposals defined under the Severn Tidal Power Project are expected to result in significant net positive or net negative economic effects within Wales and the South West regions, and also for sub-groups or specific industry sectors within these regions[6].

In responding to the stated research aim, DTZ is required to use the information emerging from other key workstreams being lead by DECC, with consultants employed to address key areas of research. The main other areas of work that are being undertaken include:

- Environmental (Parsons Brinkerhoff consortium)
- Engineering (Parsons Brinkerhoff consortium)
- Planning and Consents (DECC, DfT, CLG)
- Economic – including Funding and Ownership (PwC) and Energy Markets (DECC)
- Stakeholder Engagement (DECC)

In particular, emphasis has been placed on the engineering and technical information produced by the Parsons Brinkerhoff (PB) consortium and the Strategic Environmental Assessment (SEA), conducted by PB and Black and Veatch Ltd (part of the PB consortium).

DTZ has reviewed both the construction related impacts and operational related impacts of the options being considered by the wider feasibility study. DTZ has taken the lead from the PB consortium and been dependent on the information being produced by the PB consortium. This has limited the extent of analysis completed on some options, where limited or no information was available.

As the level of information relating to the options varies considerably, in this report we have highlighted where information gaps exist and the impact of this on the analysis. This also captures in the degree of certainty attributed to our assessments.

[6] Please note: in this report Wales and South West are referred to as regions, and national level impacts are UK level impacts. DTZ recognise that Wales is a nation; but the use of terminology here is to ease distinction between Wales and the South West as a reference geographic area and the UK as a wider geographic area.

1.1.1 The Options

The long list of options consists of five core barrage options and the Severn Lakes scheme, which is a barrage with additional mixed development. There are two key lagoon options, one tidal fence and a tidal reef proposal. These options vary considerably in terms of the level of background research that has been completed, the level of previous analysis that has been undertaken and the extent to which technologies have been tested. The fair basis assessment approach adopted by the consortium is designed to assess the various options without being unduly biased by the level of information available (i.e. not to exclude options purely because less is known about them).

The long list[7] of options is:

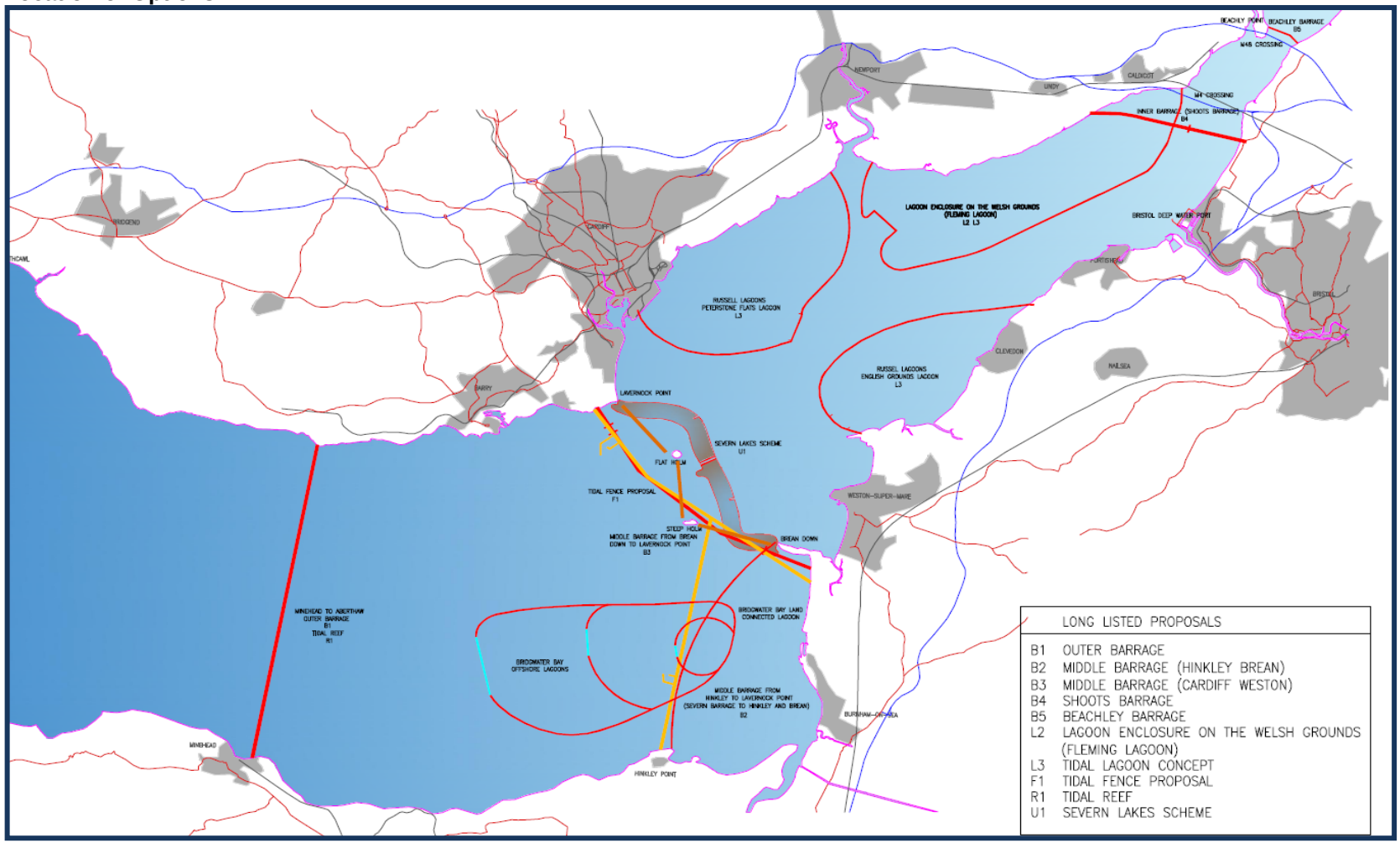
Ref	Option Name
B1	Outer Barrage from Minehead to Aberthaw
B2	Middle Barrage from Hinkley to Lavernock Point (As B3 but lands at Hinkley)
B3	Middle Barrage from Brean Down to Lavernock Point (Cardiff to Weston Barrage)
B4	Inner Barrage (Shoots Barrage)
B5	Beachley Barrage
F1	Tidal Fence Proposal
L2	Lagoon Enclosure on the Welsh Grounds (Fleming Lagoon)
L3	Tidal Lagoon Concept
R1	Tidal Reef Proposal
U1	Severn Lake Scheme

DTZ has taken the lead from the information being produced by the PB consortium. In the PB study, the Severn Lakes Scheme was not specifically considered as the study only examined potential options from an energy perspective. Should tidal power development from the Severn form part of Government's future energy policy, a privately proposed option such as Severn Lakes could be considered in the future. As DTZ does not have any information in relation to the Severn Lakes Scheme, it has not been possible to assess the potential regional economic impact of the scheme.

Whilst the report captures the detailed information with regards to the options, where appropriate, we have also clustered the options in accordance to their anticipated impacts. In the absence of detailed information in relation to the options, and their specific locations, clustering enables a high level assessment to be completed. Clustering therefore takes account of the broad characteristics of the tidal power options and combines those with similar characteristics together. This process improves the readability of the report, illustrates where options have similar high level economic impacts, and overcomes the issue in relation to gaps in detailed information relating to each individual option.

7 http://www.berr.gov.uk/whatwedo/energy/sources/renewables/explained/severntidalpower/longlistofschemes/page47488.html

Location of Options[8]



[8] IOAR v3

1.2 Method

The primary focus of this first phase of research has been on identifying and categorising the characteristics of the tidal options, drawing out from this the potential regional economic impacts that are likely to arise as a consequence. This section briefly sets out the process that DTZ has adopted to capture these potential economic impacts.

A detailed inception meeting was held with the project steering group[9]. During this inception meeting, DTZ gained a greater understanding of the scope of this study and in particular the need to focus the first phase of the study on the largest negative economic impacts that may emerge as a consequence of a tidal option. This would help to feed into the objectives of the wider DECC feasibility study, which were conveyed to us during the stakeholder event and subsequent discussions with other workstream leads.

DTZ has reviewed the information being generated in relation to the tidal options being assessed as part of this assignment. In particular DTZ has drawn from the engineering and environmental information being developed by the Parsons Brinkerhoff consortium. Information on the large barrage and small barrage is more advanced than the information relating to tidal fence, tidal reef and the Severn Lakes scheme. This has influenced the extent of analysis completed to date by DTZ on these technologies.

Our understanding of the working options has been tested with the workstream leads and client steering group. Attendance at the PB/PwC Risk Workshop and the PB/B&V Strategic Environmental Assessment (SEA) workshops has helped to inform this process.

By reviewing the background information, relating to the working options, DTZ have drawn out a long list of potential economic impacts that may emerge from the development of a tidal option. Not all of these issues are relevant to the region or this economic analysis, and a filtering process has been undertaken. The initial filtering process was completed by DTZ, based on the information obtained from the wider feasibility study. This was tested and verified in a workshop with a range of stakeholders[10].

The purpose of the workshop was to:

- Confirm which areas of potential economic impact should, due to their significance, be reviewed in greater detail;
- Confirm which areas of potential economic impact could be excluded due to their scale and significance; and
- Identify continued areas of uncertainty, where further research is required to either include or exclude potential economic impacts from further assessment in this study.

These outcomes were confirmed with the project steering group and are detailed within this report.

[9] Steering Group Comprises of Welsh Assembly Government, South West Regional Development Agency and the client steering group advisors from the DECC Central Team

[10] PB Workstream Consultants: Parsons Brinkerhoff; Black and Veatch Ltd; Government Delegates DfT, Defra, DECC Central Team, DECC economists ; Regional Economic Impact Consultancy Team DTZ, MDS Transmodal, AD Little; Client Steering Group: WAG and SWRDA

The economic impact assessment framework categorises the potential regional economic impacts by significance. There are two tests of significance, these are:

- Significance by scale of impact (overall regional impact)
- Significance by scale of activity (as a proportion of total activity)

These two measures are designed to ensure that our assessment captures not only those potential economic impacts that are important because of their overall scale, but also through their importance to a particular sector or economic activity. Some economic impacts are important because of the proportion of regional GVA or employment impacted by a tidal option. Others are important because of the proportion of a regional activity that will be impacted by a tidal option. For example, the economic impact of construction is important because of the scale of construction being considered. The economic impact on recreational fishing, whilst not significant on a regional level, maybe important at an activity level if a significant proportion of recreational fishing is impacted.

In order to assess the significance of potential impacts, DTZ has reviewed economic data in relation to the regions, the capacity of some key sectors and the relative importance of potentially impacted sectors and activity. DTZ has reviewed research documents in relation to the economic contribution of particular activities, and these are detailed in the main body of the report.

In addition to the scale of economic impact, DTZ was requested to assess the local level impacts. As no defined region has been set to capture the 'local level'[11], we have adopted two separate measures. The first defines the local area by capturing the district authorities around the Severn Estuary. These are:

- Cardiff
- Newport
- The Vale of Glamorgan
- Monmouthshire
- Gloucestershire
- South Gloucestershire
- Bristol
- North Somerset
- Sedgemoor
- West Somerset

These district authorities capture a relatively large geographic area, and large conurbations (e.g. Cardiff, Bristol, and Newport). Therefore, to add to the local level analysis, this has been complemented by reviewing the economic impacts and identifying potential local level affects on:

- Rural areas
- Urban areas

[11] This geography reflects landfall, and whilst some impacts may be concentrated in these areas, it is also probable that areas outside of these district authorities may also be impacted.

- Coastal /Market Town areas

This approach takes account of the uncertainty about the location of the tidal options and the supporting infrastructure and looks to draw out broad characteristics, suitable for this initial high level assessment, as opposed precise local area impacts.

1.2.1 Gross to Net Calculations

In order to present the regional economic impacts in a way that clearly captures the 'regional' economic implications of the tidal power options, it is important that the figures presented in this report capture the overall net economic impact.

In estimating net economic impacts, a number of elements need to be taken into account.

Broadly, these take account of the difference between the overall impact and what is actually felt in the regional economy. The key elements that need to be taken into account are detailed as follows:

	Definition
Gross Economic Impact	Overall economic impact, not accounting for any other factors.
Displacement effects	The degree to which an increase in productive capacity promoted by a STP scheme is offset by reductions in productive capacity elsewhere.
Crowding out effects	The extent to which an increase in demand occasioned by a STP scheme is offset by a decrease in private sector demand. Crowding out differs from displacement because it relates to wider economic effects. It is a macroeconomic rather than microeconomic phenomenon. It can be thought of as being 'indirect' displacement in that its effects are like displacement but it occurs through macro-economic adjustment.
Leakage effects	The proportion of outputs/outcomes which benefit those outside the intervention's target area or group.
Substitution effects	The situation in which a firm substitutes one activity for a similar activity and can be thought of as firm level displacement. I.e. a firm will substitute one activity for another in response to the STP scheme.
Multiplier effects	The second round effects on the level of economic activity (output, income or employment) associated with a policy intervention (e.g. when the employees of a new project spend their earnings and so increase consumer demand). There are several types of multiplier (income, local, long-run, short-run and supply) that are often estimated. The size of the multiplier depends on the period over which it is measured, and the geographical area considered. Input Output models can be used to capture the multiplier effects.
Net Economic Impact	The Gross Economic Impact, having accounted for the

	Definition
	elements outlined above (gross minus deadweight, displacement, crowding out, leakage, substitution plus multiplier impacts).

The terminology used above is extracted from the HM Treasury Guidelines. It is worth noting, that in general, economic impact assessment are designed to capture the benefits associated with an activity or intervention. Whilst this study does capture potential economic benefits, it also captures economic costs. Therefore care must be taken in interpreting the terminology to ensure that when 'costs' are reviewed that the reverse is also true.

These elements have been taken into account when quantifying the potential net regional economic impacts of the tidal power options on Wales and the South West of England. It is important to note that these factors are dependent on the reference area considered. For example, a regional leakage effect (e.g. benefit going to someone outside of the reference area) would be a displacement effect nationally (UK level) (i.e. benefit moving from one area to another). The reference area being reviewed in this study is Wales and the South West of England. Variances on a local level are discussed separately, but the overall net economic impact relates to the broader geographic region as a whole.

In quantifying the potential economic impacts, a range has been applied to the possible scale of impact. The assessment has focused on establishing a 'medium' impact case, which represents DTZ's best estimate, drawing upon the information available at this time as part of its desk-based assessment. 'High' and 'low' impact scenarios have been modelled around our best estimate. Given the paucity of information in a number of areas, these scenarios represent a sensitivity test across each area of identified impact. This approach has been adopted in the absence of detailed information that would otherwise enable scenarios to be developed with the application of clearly defined assumptions.

The development of scenarios is also appropriate in considering the risk for optimism bias in assessing regional economic impact. As noted in a study assessing the ex-post impact of the Channel Tunnel, there are few studies that have looked at the actual impacts of large infrastructure projects.[12] In the review of the 10 year impact of the Channel Tunnel on Kent, the study found that whilst the direct impact of the passenger, vehicle and freight movements had been experienced (although under estimated in the ex-ante assessment), neither the local area or Kent had experienced the expected economic development impact. However, the study notes that reviewing the impacts over a ten year horizon may be too early and that potential impacts may yet come to fruition. This uncertainty, as highlighted by the study, is reflected in the development of scenarios.

The baseline has been developed to take account of the most recent data. However, the baseline does not include an assessment of the future economic potential of the sectors (i.e. potential growth or reduction). Therefore, the figures present a 'here and now' snap shot of the regional economy and the sectors reviewed.

[12] Hay, Meredith and Vickerman 2004 Impact of Channel Tunnel on Kent- Summary Report September 2004; University of Kent

The scale of potential economic impact of the construction phase are presented as discounted present values; taking account of the construction duration, which varies across the options.

In assessing the scale of potential economic impact of the tidal power options over the operational period; DTZ has taken a forty year reference period[13]. Operational impacts start from the end of the construction period, and therefore vary across options. A social discount rate of 3.5% has been applied to the first 30 years (consistent with HM Treasury Green Book Guidance) and 3% for years 31-40. All monetised terms as expressed in 2008 prices. Permanent employment impacts have not been discounted and are presented in Full Time Equivalent jobs. Therefore, the economic value of activity (£) has been discounted to reflect social time preference (i.e. money today is preferred to money tomorrow), whereas full time jobs have not.

1.2.2 Areas Outside the Scope of Research

There are areas of potential economic impact that fall outside the scope of this research. These include:

- Location specific impacts- given the uncertainty about the location of the tidal options and the supporting infrastructure, no location specific assessment has been undertaken. Local area impacts have been limited to the Severn Estuary area (described above) and the local area types (rural/urban/coastal/market town);
- Economic impacts that emerge from additional ancillary investment- as these areas are uncertain, no quantification of economic impacts that emerge from additional ancillary investment have been included. However, where these economic impacts are believed to be potentially significant, these have been highlighted;
- National UK economic impacts have been excluded from the analysis as the study focuses on regional economic impacts.
- The environmental impacts that impact on an economic agent have been included, whilst the social value of the environment has been excluded. E.g. the value of fish to society is excluded, but the change in economic value of fishing has been included.
- The economic impact of providing compensatory habitat has been excluded from this assessment as the location and requirements of compensatory habitat are unclear.
- The economic impact of mitigating against potential adverse activities, that have not yet been costed or included within the overall STP construction cost estimates (e.g. fish friendly turbines and their potential impact on the fish population).

This assessment is focused on the regional economic impact of the tidal power option. In doing so, it does not review implications of environmental impacts; such as those that may be captured by a social value model (e.g. the value of non-market activity such as the loss of the Severn Bore, impact of noise pollution etc). If these elements were valued, then it is possible that a social impact model would present a different value than that captured by this economic impact assessment.

[13] In completing a Cost Benefit Analysis of the Nuclear Programme, BERR adopted a 40 year reference period.

1.2.3 Options Terminology

DTZ have reviewed the tidal options in a broad sense, to develop this initial high level economic impact assessment. To this end, terminology such as Large Barrage, Small Barrage and Lagoons have been used to represent a number of tidal power options. Therefore, unless explicitly captured separately the following interpretations can be made:

- Large Barrage: Includes B1, B2 and B3
- Small Barrage: Includes B4 and B5
- Lagoons: Include L2 and L3
- Tidal Fence: Includes: F1
- Tidal Reef: Includes R1

No detailed information has been presented in relation to the Severn Lakes scheme (U1), and therefore it has been treated as equivalent to the Cardiff to Weston Barrage, option B3[14].

1.3 Policy Context

The present study focuses upon exploring and characterising the regional economic impacts associated with options for Severn Tidal Power. However, it should be emphasised that the scheme remains first and foremost an energy project. The assessment of tidal power options in the Severn Estuary is being carried out within the context of established renewable energy policies at the level of the UK, Wales and the regions.

It is also important to recognise that the regional economic impacts identified within this study will be cross-cutting in their nature, having potential implications for a wide range of policy areas, including planning, housing, transport and freight, sustainable development, leisure and tourism, fisheries, environment and waste.

If the outcome of the feasibility study is a decision to proceed, extensive and detailed further work will be needed to plan and implement a tidal power project, and to secure the regulatory consents that would be required. The nature of this work will be wholly dependent on the choice of option. In addition to this, the construction period for any tidal power option is likely to be significant - up to ten years in the case of a large barrage option. Consequently, many impacts identified within the present study have the potential to accrue outside of the period addressed by the current strategic and policy framework.

In view of this, and of the diverse range of policy areas likely to be affected by Severn Tidal Power options, it is beyond the scope of the present study to identify in detail all specific linkages between potential effects and policies adopted at the Welsh and regional levels. However, in addition to energy strategy, it is important to review the economic and spatial strategies of Wales and the South West of England, which have the potential to be significantly impacted by tidal power options. There follows a brief outline of current policy in these areas.

[14] In completing this assessment, DTZ has been dependent on the information being produced by the other workstreams and information gaps in relation to specific schemes are beyond our control.

Wales

Renewable Energy

In the One Wales document, the Welsh Assembly Government sets out its strong commitment to tackling climate change, including actions on diversified renewable energy generation. The Renewable Energy Route Map for Wales is the first strategic step to fulfilling this commitment.

The Renewable Energy Route Map sets out proposals for moving Wales towards self-sufficiency in renewable electricity, whilst at the same time driving towards greater energy efficiency and satisfying a greater proportion of heating requirements through renewable sources. The Route Map specifically recognises the "immense potential" of marine based energy capture in the Severn Estuary to contribute to the achievement of self-sufficiency in renewable electricity within a generation.

Economic Strategy

Wales: A Vibrant Economy (WAVE) is the Welsh Assembly Government's strategic framework for economic development. The vision is of a vibrant Welsh economy delivering strong and sustainable economic growth by providing opportunities for all. The priorities in pursuit of this vision will be to:

- increase employment still further, so that over time the Welsh employment rate matches the UK average, even as the UK employment rate itself rises; and
- raise the quality of jobs, so that average earnings increase and close the gap with the UK average.

The key actions for achieving these priorities will be:

- supporting job creation and helping individuals to tackle barriers to participation in the world of work;
- investing to regenerate communities and stimulate economic growth across Wales;
- helping businesses to grow and to increase value-added per job and earnings by:
    - investing in transport networks and other economic infrastructure;
    - attracting more high value-added functions to Wales and supporting businesses and sectors with strong growth potential;
    - further improving the skills base and using opportunities created by the merger (of the Welsh Development Agency, Wales Tourist Board and ELWa with the Welsh Assembly Government) to deliver more demand-led training tailored to the needs of businesses;
    - helping businesses to become more competitive by supporting other drivers to business growth: entrepreneurship, innovation, investment and trade; and
    - ensuring that all economic programmes and policies support sustainable development, in particular by encouraging clean energy generation and resource efficiency.

A major tidal power project has the potential to help meet the Welsh Assembly Government's objectives in all of these areas.

Spatial Planning

The Wales Spatial Plan sets out a strategic framework to guide future sustainable development and policy interventions. It investigates the role of places in a wider context, going well beyond traditional land use planning. The Spatial Plan Update 2008 sets out cross-cutting, national spatial priorities. These provide the context for the application of national and regional policies for specific sectors such as health, education, housing and the economy, reflecting the distinctive characteristics of different regions of Wales, and their cross border relationships. Local Authorities, the private and third sectors, the Welsh Assembly Government and its agencies are working together in Spatial Plan Area groups to achieve the strategic vision for that Area.

The Spatial Plan vision for the South East Wales Area, known as the Capital Region, is to establish an innovative, skilled Area offering a high quality of life – international yet distinctively Welsh. It will compete internationally by increasing its global visibility through stronger links between the Valleys and the coast and with the UK and the rest of Europe, helping to spread prosperity within the Area and benefiting other parts of Wales.

There has been much success in restructuring the economy of South East Wales, but the challenge is to continue that process and enable all to share in its prosperity. Restructuring must not only help sectors move up the value chain; it must also adapt the economy to the demands and opportunities of a low carbon marketplace. The area needs to develop a stronger presence in higher value services and the knowledge economy, and to seize opportunities to create jobs in tourism, creative industries, renewable energy, recycling and waste.

The social, economic and environmental impact of a Severn tidal power project will be considered in this strategic context. Depending on the chosen option, it would have implications for housing, energy, waste, travel-to-work patterns, business supply links and transport infrastructure, which would impact on both the Capital region and the South West of England.

South West of England

Background

The South West of England benefits from a number of vibrant cities and towns which contribute significantly to the region's economic performance, culture and distinctiveness. Investment over the last decade has transformed the core of many of the region's towns into more attractive retail and cultural centres, increasingly enjoyed by residents and visitors.

There are real strengths within the South West's economy that build on the characteristics of the region, for example aerospace, marine, creative industries, environmental technologies, tourism and the food and drink sectors. Sound stewardship of this heritage is vital but the high environmental qualities of the region should be seen as a major contributor to quality of life and a direct or indirect source of employment for many people, rather than a constraint upon development.

Among the English regions, the South West has the highest percentage of land classified as 'rural'; about 56% of the population of the South West lives in rural districts. More than three million people (62% of the population) live within 10 km of the coastline and the coast continues to play a pivotal role in the region's economy. There are real opportunities to develop integrated approaches to rural development and to celebrate and implement the fifty or more town and community plans already prepared at market and coastal town level.

Momentum

Population and economic growth has the potential to erode the very quality of life that makes the region distinctive, unless it is planned for in a constructive and creative manner, with sustainable development at the heart of the strategy. There is a desire to create a region that is more sustainable than it has been, with better balanced and more sustainable communities within it.

There are a number of factors that have a particular influence on spatial development in the region. The following factors have been particularly critical to the shaping of the strategy:

- the South West's relationships with, and connectivity to, other regions: the South East, London, West Midlands and Wales being particularly important;
- the importance of sustaining the region's high quality environment and cultural assets;
- the relationship between rural and urban areas, the roles of the cities and towns and the links between them (many of which cut across administrative boundaries) and the importance of ensuring that future roles reflect function rather than size; and
- the need to plan for anticipated economic and population change.

Supporting economic growth in line with the **Regional Economic Strategy** to ensure improvements to the relative economic performance of the South West is key to this strategy.

Challenges - Growth within environmental limits

There is a tension which the **Regional Spatial Strategy** and Regional Economic Strategy must help resolve, between further population and economic growth and the imperative to reduce resource consumption and, most importantly, the decoupling of growth and CO_2 emissions. The region is rich in natural resources, with some nationally important mineral reserves and - as yet - relatively untapped potential for renewable energy.

Growing demands for built development, infrastructure, food, fresh water, natural materials and energy, seriously risk the erosion of environmental quality and the life systems on which we all depend. A central challenge for the regional strategies is to promote the sustainable approach to consumption and production advocated by the 'UK Sustainable Development Strategy' – how to "achieve more with less" so that the ecological footprint of the region is stabilised and then reduced. This is a real challenge given the likely scale of growth in the region and requires strong leadership and innovative solutions.

Energy consumption is a significant contributor to the region's eco-footprint. Reducing the level of demand for energy through improving energy efficiency is a major challenge as is the development of more renewable energy sources in the region. The **Renewable Energy Strategy for the South West** identifies three areas where a regional focus is required; i)

deploying renewable energy on the ground; ii) developing skills and awareness; and iii) building the South West renewable energy industry.

Renewable energy is an exciting economic opportunity identified in the Regional Economic Strategy; and the Regional Spatial Strategy provides targets and policy guidance policies to increase its supply. Currently, only about 3% of the region's electricity requirements are generated from renewable sources, compared to the EU 2020 Renewable Energy target of 20% by 2020. **The Road to 2020** outlines an early analysis of the possibilities for generating 15% (and 20%) of all energy consumed in the South West of England from renewables. Capturing the Severn Tidal resource is identified as a potentially important contributor to achieving these targets.

By producing more of the energy that is used within the region, and from renewable sources, the 'carbon footprint' can be reduced as well as providing economic benefits through creating jobs. Producing energy from a range of renewable resources will also contribute to resilience of supply.

Critical to achieving a more sustainable region is the continuation of the South West's relative economic prosperity. As recognised by the Regional Economic Strategy, "prosperity is measured by wellbeing as well as economic wealth". Successful economic performance would significantly boost growth in the region, with benefits in terms of prosperity, job choice and investment. However, if not managed properly the effects of growth could result in degradation of the environment, more congestion and pollution and exacerbation of economic trends that reinforce intra-regional disparities and disadvantage. Without a planned approach, recognising the importance of the 'environment driver', proposals for sustainable and thriving rural communities and an urban renaissance will not be achieved.

West of England Housing Market Area

The West of England Housing Market Area is home to over a million people and includes the strategically significant cities and towns (SSCTs) of Bristol, Bath, Weston-super-Mare and Trowbridge, as well as many smaller towns and villages. The area exhibits many of the characteristics of a 'city region', with Bristol at its centre and strong links to the other cities / towns and an extensive hinterland. The sub-region is generally prosperous with high skill and wage levels but has some substantial concentrations of deprivation, both in inner city areas and outer suburbs.

Bristol is the main focus for employment, shopping, and other high-order services. Its status as both a 'core city' and a 'science city' reflects the importance of its regional and national roles. The Bristol area contains 7.7% of the region's population and contributes approximately 12% of regional GVA. Bristol is the focus for journeys for work, shopping, education and other purposes from a wide area and this has placed increasing pressure on transport corridors around the urban area, particularly the motorways.

The economic success of the sub-region is underpinned by knowledge and technology based industries and the Universities, with Bristol International Airport and the Port also playing key roles.

Positive planning is essential if Bristol is to fulfil its strong economic potential. Housing provision needs to be in step with economic growth in both scale and timing. While the city will continue to be the economic hub for a wide hinterland, a key aim is to achieve a better balance between jobs and homes. The key strategic development issue for Bristol is to provide for growth while improving the attractiveness of the urban area as a place where people want to live, work, visit and invest.

A major strategic objective is to revitalise the South Bristol area which is characterised by some of the most significant concentrations of multiple deprivation in the region. This will require concerted action and investment across a number of policy fields including education and health, as well as transport infrastructure.

Weston-super-Mare has experienced major restructuring in local industry and the tourism sector, and its economic decline is reflected in the relatively poor state of the town centre's retail and leisure offer. Major housing development has not been accompanied by commensurate employment growth. Job growth in Bristol city centre and at Bristol North Fringe has resulted in significant levels of unsustainable out-commuting from the town with significant congestion impacts on Junction 21 of the M5.

The key strategic development issue for Weston-super-Mare is to attract new investment and jobs to the town to address imbalances between employment and housing and the resulting out-commuting flows to Bristol. Revitalisation of the town centre is also essential, by improvements to and modernisation of retail and leisure facilities and enhancement of public realm and the town's network of green infrastructure.

A list of key supporting documents can be found in Appendix 3.

2. The Economic Impact Assessment Framework

In order to capture and document the broad range of potential economic impacts emerging from an option, an economic impact assessment framework has been developed. A taxonomic approach[15] was utilised to capture the initial assessment of potential areas of economic impact. The purpose of this tool was:

- to draw out the potential areas of impact that were being identified across a broad body of research;
- to highlight those potential economic impacts that would impact on the regional economy;
- to highlight those potential impacts that would fall outside the regional economic impact assessment
- to aid filtering by highlighting those areas not considered to be significant and therefore excluded from further assessment
- to highlight areas where further research was required in order to assess the potential scale of economic impact

Therefore, the tool helped to ensure that this report was appropriately focused on those areas of economic impact believed to be significant to the regional economy.

A number of sources of information were utilised to capture the potential long list of economic impacts; including background papers; discussions with steering group and wider project board members, discussions with workstream leads and a review of the options being considered.

An initial filtering assessment was completed by DTZ and subsequently tested in a regional economic impact workshop with a board range of stakeholders. Through further iterative discussions with the regional economic impact assessment steering group a final list of eight core sub-categories was agreed.

The potential economic impacts identified as potentially significant were then arranged by these eight sub-categories. These distinguished between primary sectors (i.e. those directly impacted by the development of the tidal power option) and secondary sectors (i.e. those indirectly impacted by the tidal power options). The five primary sectors identified are: construction and engineering; transport and logistics; fishing; tourism; and land use and planning. Secondary sectors include those sectors that will be indirectly impacted by a project, through changes to the environment, construction impacts, transport impacts and electrical transmission impacts. These include accommodation, catering and other related services; population and residential impacts and industry and commerce.

Each of these sectors is covered by a chapter within this report.

This report focuses on those regional economic impacts believed to be significant (as previously defined). Those economic impacts that fall outside the scope of this study are included in the economic impact assessment framework. This includes environmental

[15] impacts were categorised across broad headings, drawing out the detail in sub-headings

impacts, national UK economic impacts and smaller, less significant impacts that do not form part of the scope of this study.

The remainder of this study focuses on the eight core categories of impacts identified above and is structured as follows:

Chapter 3 – Construction and Engineering
Chapter 4 – Transport and Logistics
Chapter 5 – Fishing
Chapter 6 – Land Use and Planning
Chapter 7 – Tourism
Chapter 8 – Accommodation
Chapter 9 – Residential and Population
Chapter 10 – Other Industries

3. Construction

3.1 Summary of Impacts

Construction expenditure will support temporary employment in the industry during the development period: the higher the development cost, the more employment will be supported. This section presents initial modelled estimates of employment supported, based on costs provided by Parsons Brinkerhoff. The following table summarises the magnitude of these construction impacts across the options.

Baseline	52,200 construction workers in the local study area (defined in para 3.2), equal to 5% of the total local workforce.
Gross Direct Effect	Ranges from 3,100 average annual gross employment during construction for Option B5: Beachley Barrage to 19,900 jobs for Option B1: Outer Barrage (annual average for 10 year construction programme). Total gross GVA ranges from £0.8bn to £12.1bn across the construction period for these projects.
Leakage	Parsons Brinkerhoff has estimated the ability of the local area to meet the construction requirements for each key phase, the remainder being leaked. On average, this ranges from 40% to 75% across the options. However, targeted skills interventions may be able to reduce this leakage rate. (This is varied in the sensitivity analysis.)
Displacement / Crowding Out	Average rate of 67% assumed, given the scale and duration of the tidal power options. (This is varied in the sensitivity analysis.)
Multiplier Effect	Welsh national multipliers for the construction industry give a supply chain impact equal to 48% of the direct effect, and wider expenditure effect of a further 31% of the direct effect (a multiplier of 1.79). The equivalent figure for the South West is 1.54. For prudence, the South West figure has been assumed at this stage.
Local Area Net Additional Impact	Ranges from an annual average of 650 net additional construction jobs for Option B5: Beachley Barrage to 3,600 jobs for Option B1 Outer Barrage. Total GVA ranges from £160million GVA (B5) and £2 billion GVA (B1)

The construction of a tidal power project would also involve significant spend on measures to address environmental effects (including Habitats Directive mitigation and compensation measures). Delivering this investment would have a direct economic impact and with innovative design and planning has the potential to generate wider benefits for the environmental economy and ecosystem services. No assessment of the economic impact of providing compensatory habitat has been included in this work due to uncertainty regarding the likely extent and location of compensatory habitats.

3.2 Regional Context

There are 52,200 workers[16] employed in the construction industry across the study area (including the district authorities of Cardiff, Newport, Vale of Glamorgan, Monmouthshire, Gloucestershire, South Gloucestershire, Bristol, North Somerset, Sedgemoor, and West Somerset). This is equal to 5% of total employment across the area, and is broadly in line with the Welsh and GB national average rates. Since 2000, the industry has grown by 30% in employment terms[17].

Construction employment across Wales is forecast to decline marginally to 2010, given the current economic conditions, then recover and grow by 7% over the following decade[18].

3.3 Areas of Impact

Construction expenditure will support temporary employment in the industry during the development period: the higher the development cost, the more employment will be supported.

The core phases of development for each option require a range of skill sets and construction tasks. Each phase varies in terms of duration and labour intensity, determining the level of employment required. This is explored further in the following section. The key elements of the construction programme defined by Parsons Brinkerhoff are:

- Site investigation, design, supervision and site overheads
- Caissons
- Embankments
- Navigation locks
- Surface buildings
- Mechanical and electrical components (including turbines)

It should be noted that this economic impact assessment is based on the best available estimates of the construction process available at this time, and are likely to change in the future. The construction impacts presented in this section are therefore intended to be indicative of the likely order of magnitude associated with the project, based on best available assumptions as presented.

The regional socio-economic analysis undertaken showed that there is a South West and Wales specialism in many of the complementary and necessary sectors and industries required to construct a project of the size of the Severn barrage or lagoon. The complementary sectors range from the provision of aggregate building materials required in the initial stages of construction, through to specialist trades and more elementary construction occupations.

[16] Source: Annual Business Inquiry 2006, via NOMIS
[17] Source: Cambridge Econometrics, Regional Forecasts
[18] Source: Cambridge Econometrics, Regional Forecasts

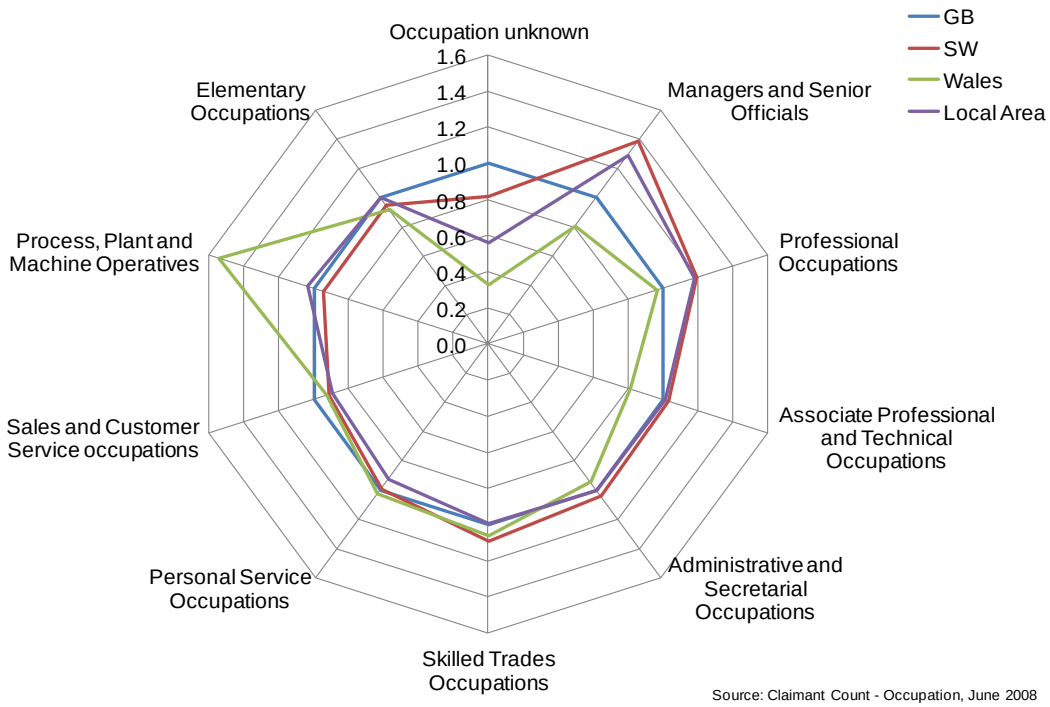
The construction process associated with each of the options being considered is likely to require substantial labour inputs. This may present opportunities for unemployed people within the region who are seeking employment.

In the South West, the largest number of claimants comes from the elementary occupations sector, followed by the sales & customer service sector, which accounts for 13,400 and 6,200 claimants in total[19]. However compared to GB trends the South West has a proportionally high incidence of managers and senior officials claiming benefits, which is proportionally 39% greater than the average in Great Britain. This trend is also reflected in the local area.

In Wales, the greatest number of claimants comes from the process, plant & machine operative and the elementary occupations. These two occupations account for 6,600 and 12,900 claimants respectively. However, proportionally, Wales has a disproportionate number of former employees from the process, plant & machine operatives occupation on benefits. This occupation is 55% over-represented compared to GB trends.

This data shows that there is a relatively high stock of unemployed labour with skills that may be relevant to a large scale infrastructure project. Between the South West and Wales there would be a total of 9,400 former skilled trades, 10,700 former process, plant & machine operatives and 26,300 former employees from elementary professions. The data indicates that this labour supply may have skills relevant to the construction sector, although relatively low skilled labour. The source of high skilled labour required is less clear. However, it should be noted that this data does not indicate the level of geographic mobility or any associated knock-on effects which could affect local labour markets as a result of a large increase in labour demand.

Figure 3.1: Claimant Count Breakdown by Occupation Location Quotient, June 2008



Source: Claimant Count - Occupation, June 2008

[19] Source: Office for National Statistics (ONS), Claimant Count June 2008, via NOMIS

Substantial materials are required to construct the options being considered. The source of origin of materials will have an impact on the degree of spend in the regional economy and the consequential economic impact of this. The impact of this specialism is estimated later in this chapter.

Given the estuary location of potential construction (across each of the options), the scope to import materials is relatively high and ship transport may be utilised in lieu of road haulage. This opens up the potential for materials to be shipped in from across the globe. This is discussed in greater detail below.

3.4 Gross Impacts

3.4.1 Employment[20]

It is possible to estimate the level of employment supported directly by the construction expenditure by applying the ratio of turnover to employment across a range of activities to the anticipated construction costs. The Office for National Statistics (ONS) publish data on turnover and employment in the Annual Business Inquiry for each construction activity e.g. Turnover per worker is £139,000 in site preparation and £149,000 in earth moving and demolition. It should be noted that these are not specific to the construction of barrages or other tidal power scheme, and thus may contain a margin of error.

Applying these rates to the total anticipated expenditure on each key phase of construction for each option yields the total number of jobs supported during each phase of the project. Figure 3.2 summarises the results for employment supported under each proposed option.

The table below captures the 10 options and sub-variants of these, developed by PB as part of the wider feasibility study. These variants capture different locations and sizes of STP options.

Figure 3.2 – Gross construction impacts, at 2008 Q1 prices

		Construction		Employment supported	
Option		**Total development cost**	**Duration (years)**	**Total person years**	**Annual average during build period**
B1	Aberthaw - Minehead Barrage	£28.7 bn	10	199,000	19,900
B2	Cardiff - Hinkley Point Barrage	£21.5 bn	8	147,600	18,500
B3	Cardiff - Weston Barrage	£18.0 bn	7	123,200	17,600
B4	Shoots Barrage	£2.5 bn	5	17,800	3,600
B5	Beachley Barrage	£1.8 bn	4	12,400	3,100
F1a	Cardiff to Weston Tidal fence	£2.5 bn	5	17,500	3,500
F1b	Aberthaw to Minehead Tidal fence	£3.9 bn	10	31,100	3,100
L2	Welsh Grounds Lagoon - Fleming	£3.1 bn	5	22,700	4,500
L3a	Russel Lagoon (English Grounds)	£2.5 bn	4	18,100	4,500
L3b	Russel Lagoon (Welsh Grounds)	£3.6 bn	5	26,100	5,200

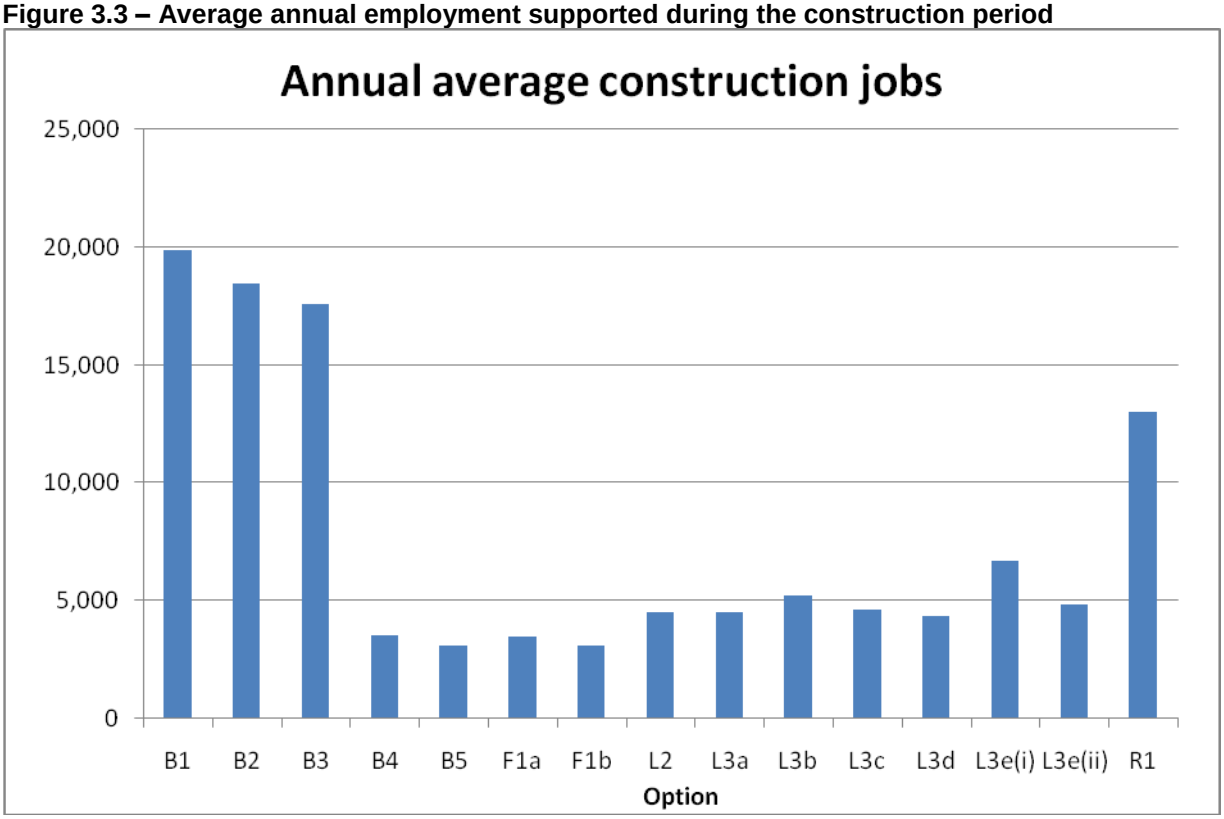
[20] All employment figures have been rounded to the nearest 100.

L3c	Russel Lagoon (Peterstone Flats)	£3.2 bn	5	23,200	4,700
L3d	Bridgwater Bay (Land Connected Lagoon)	£3.0 bn	5	21,800	4,400
L3e(i)	91sq.km Offshore Lagoon	£5.7 bn	6	40,100	6,700
L3e(ii)	50sq.km Offshore Lagoon	£3.4 bn	5	24,200	4,800
R1	Aberthaw to Minehead Tidal Reef	£17.9 bn	10	130,400	13,000

Option B1 (the outer barrage from Minehead to Aberthaw) is the most expensive option and thus generates the most employment. The £28.7 bn construction cost sustains a total of 199,000 person years of employment[21], or an annual average of 19,900 jobs over the 10 year construction period. This is followed by options B2 and R1 in terms of total employment impact. The Beachley barrage (option B5) has the lowest construction cost, thus the lowest employment impact.

The jobs created by the construction process are temporary, lasting only the duration of the development programme (operational employment impacts are discussed in chapter 10). Average annual employment figures over the construction period are presented in Figure 3.3, again demonstrating the comparatively high impact associated with barrage construction compared with a fence or lagoon option:

Figure 3.3 – Average annual employment supported during the construction period



[21] Person years are the HM-Treasury standard measure for this type of impact. For example, 10 person years could represent 1 Full Time Equivalent (FTE) job for 10 years, 10 FTE jobs for a single year, or a combination in between.

Each construction phase has a different labour intensity, and thus total employment supported will vary over the construction period. Full details are not available across all options at this stage, but based on the indicative phasing of the large and small barrage options it is assumed that peak employment will be reached in the middle of the build period, in which year employment will be double the annual average. The labour market will have to be in a position to respond to this peak in activity, either through local provision or increased migration of non-local workers.

The HM Treasury recommend applying optimism bias adjustments to construction costs in completing value for money assessments. However, as this study is not a cost benefit assessment or value for money assessment (i.e. we are not assessing the value for money of the final power outputs of the options), applying optimism bias adjustments in this instance would only act to inflate benefits (i.e. jobs supported through construction)[22].

3.4.2 GVA

Gross Value Added (GVA) is a commonly used measure of production value, capturing employment costs and profits. GVA offers a consistent way of measuring true value outcomes across industries, sectors and geographical boundaries as it excludes a number of distorting factors (such as taxes and subsidies) which are present in turnover and GDP figures. The following estimates of total GVA added to the economy over the full construction period are based on the Welsh average GVA per head across each construction discipline, applied to the total estimated employment supported. This offers a best proxy, given the South West average is of a similar order of magnitude (source: Annual Business Inquiry, ONS 2006 adjusted to 2008 prices using the HM-Treasury deflator series).

Figure 3.4 – Estimated Gross GVA impacts, £ billion (2008 prices)

Option		Total employment supported (person years)	Estimated total GVA impact £ bn	Average annual GVA impact, £ bn
B1	Aberthaw - Minehead Barrage	199,000	£12.1	£1.2
B2	Cardiff - Hinkley Point Barrage	147,600	£9.1	£1.1
B3	Cardiff - Weston Barrage	123,200	£7.6	£1.1
B4	Shoots Barrage	17,800	£1.1	£0.2
B5	Beachley Barrage	12,400	£0.8	£0.2
F1a	Cardiff to Weston Tidal fence	17,500	£1.0	£0.2
F1b	Aberthaw to Minehead Tidal fence	31,100	£1.6	£0.2
L2	Welsh Grounds Lagoon - Fleming	22,700	£1.3	£0.3
L3a	Russel Lagoon (English Grounds)	18,100	£1.0	£0.3
L3b	Russel Lagoon (Welsh Grounds)	26,100	£1.5	£0.3
L3c	Russel Lagoon (Peterstone Flats)	23,200	£1.4	£0.3

[22] It should be noted that the construction costs include a 15% contingency budget, which may mean that there is a margin of error in the estimate of supported employment (i.e. if the 15% contingency budget is not spent).

L3d	Bridgwater Bay (Land Connected Lagoon)	21,800	£1.2	£0.2
L3e(i)	91sq.km Offshore Lagoon	40,100	£2.4	£0.4
L3e(ii)	50sq.km Offshore Lagoon	24,200	£1.4	£0.3
R1	Aberthaw to Minehead Tidal Reef	130,400	£7.4	£0.7

3.5 Net Employment Impacts

3.5.1 Leakage

Leakage refers to any aspects of the assembly or construction that will take place outside the local economy. Given the scale and technical nature of this type of construction, and based on Parsons Brinkerhoff's knowledge of projects of this nature and scale, it is likely that a proportion of the activity will be contracted to international companies / workers, thus reducing the local impact.

At this stage, the final contractor profile is not known. Therefore, for the purpose of this report, Parsons Brinkerhoff have estimated the following skills profile for each stage of construction (Figure 3.5), which in turn informs estimates of local labour share and capacity to deliver:

Figure 3.5 – Estimated skill profile and job leakage rate

Construction stage	% Share of required workforce by skill level			Key skill sets	Estimated local labour share (%)
	Low Skill	Medium Skill	High Skill		
Preliminaries and Site Overheads	30%	60%	10%	General labourers / building trades / civil engineers	50%
Caissons	20%	60%	20%	General labourers / building trades / civil engineers	50%
Embankments	30%	60%	10%	General labourers / building trades / civil engineers	80%
Navigation Locks	20%	60%	20%	General labourers / building trades / civil engineers	50%
Surface Buildings	20%	70%	10%	General labourers / building trades / civil engineers	50%
Mechanical and Electrical	5%	50%	45%	Apprentices / technicians / engineers	10%
Design & Supervision	0%	0%	100%	Professional Engineers	50%
Site Investigation	10%	50%	40%	General labourers / building trades / civil engineers	25%
Contractor's Oncosts & Profit	n/a	n/a	n/a		
Ancillary Works	20%	60%	20%	General labourers / building trades and technicians / professional engineers	70%
Contingencies	n/a	n/a	n/a		

Leakage is the non-local labour share. These assumed leakages have been used to form the basis of bottom-up estimates of total leakage under current labour market conditions. Following this method, two key assembly phases in particular form the majority of value leaked from the local economy:

- Assembly of the turbine generators (and other mechanical and electrical components): the single most expensive phase of the build programme; and
- Assembly of the caissons.

However, it is possible that a proportion of this leaked activity could be captured locally, for example the development of capacity to deliver some of the larger construction components (such as turbines) locally. This could involve development of local capacity, or a local satellite operation from one of the international operators. This is further explored in the sensitivity section, where these core assumptions around leakage are varied – see section 3.6.

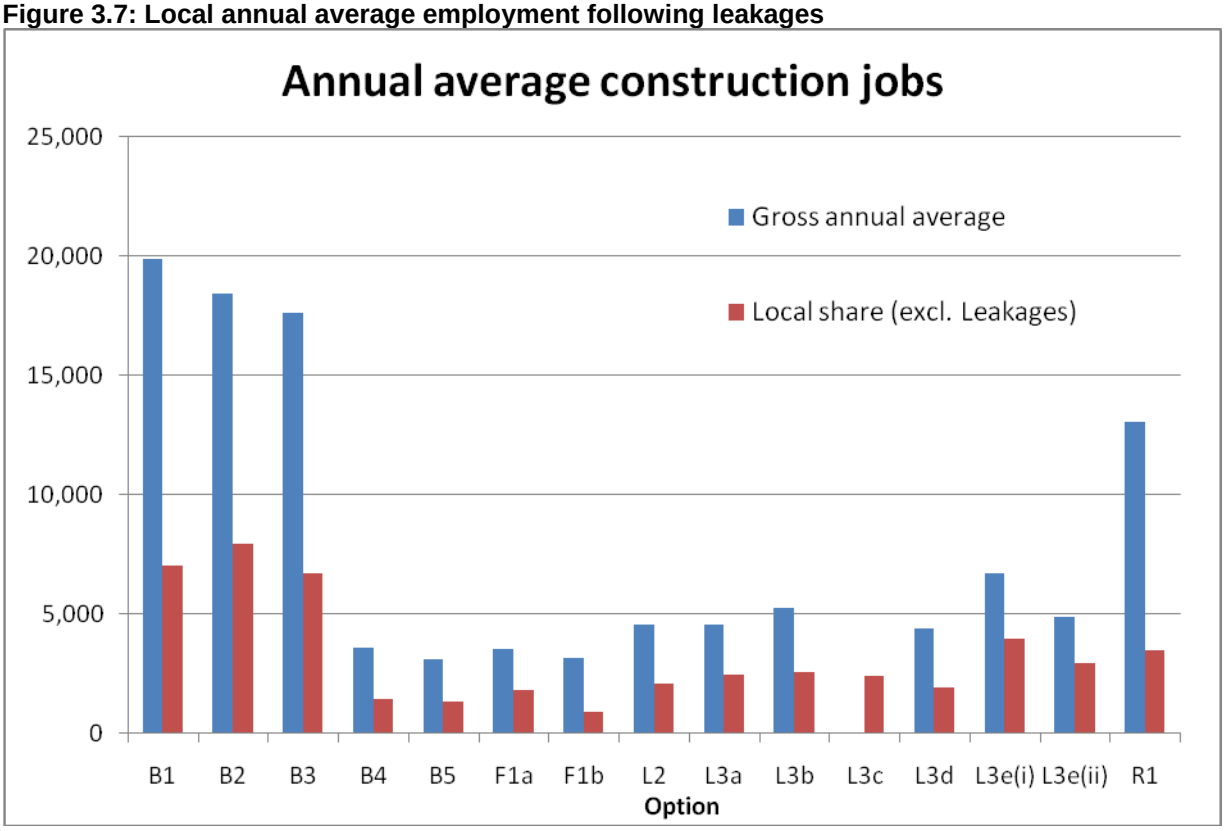
Removing these leakages from our estimate of local employment supported has a considerable impact on the build programme, and has a proportionately greater effect for the larger barrages and the tidal fence than for the smaller barrages or lagoons.

Figure 3.6 illustrates the change in total employment supported locally across the entire construction period if these leakage rates are applied. Figure 3.7 then illustrates the resultant impact on annual average employment.

Figure 3.6 – Estimated employment leakages from the local economy

		Local employment supported (Total Person Years)		
Option		**Gross employment**	**Excluding leakages**	**% employment leakage**
B1	Aberthaw - Minehead Barrage	199,000	70,200	65%
B2	Cardiff - Hinkley Point Barrage	147,600	63,500	57%
B3	Cardiff - Weston Barrage	123,200	46,800	62%
B4	Shoots Barrage	17,800	7,000	60%
B5	Beachley Barrage	12,400	5,100	59%
F1a	Cardiff to Weston Tidal fence	17,500	8,800	50%
F1b	Aberthaw to Minehead Tidal fence	31,100	8,500	73%
L2	Welsh Grounds Lagoon - Fleming	22,700	10,100	55%
L3a	Russel Lagoon (English Grounds)	18,100	9,700	47%
L3b	Russel Lagoon (Welsh Grounds)	26,100	12,800	51%
L3c	Russel Lagoon (Peterstone Flats)	23,200	11,800	49%
L3d	Bridgwater Bay (Land Connected Lagoon)	21,800	9,300	57%
L3e(i)	91sq.km Offshore Lagoon	40,100	23,700	41%
L3e(ii)	50sq.km Offshore Lagoon	24,200	14,400	40%
R1	Aberthaw to Minehead Tidal Reef	130,400	34,500	74%

Figure 3.7: Local annual average employment following leakages



3.5.2 Displacement/Crowding Out

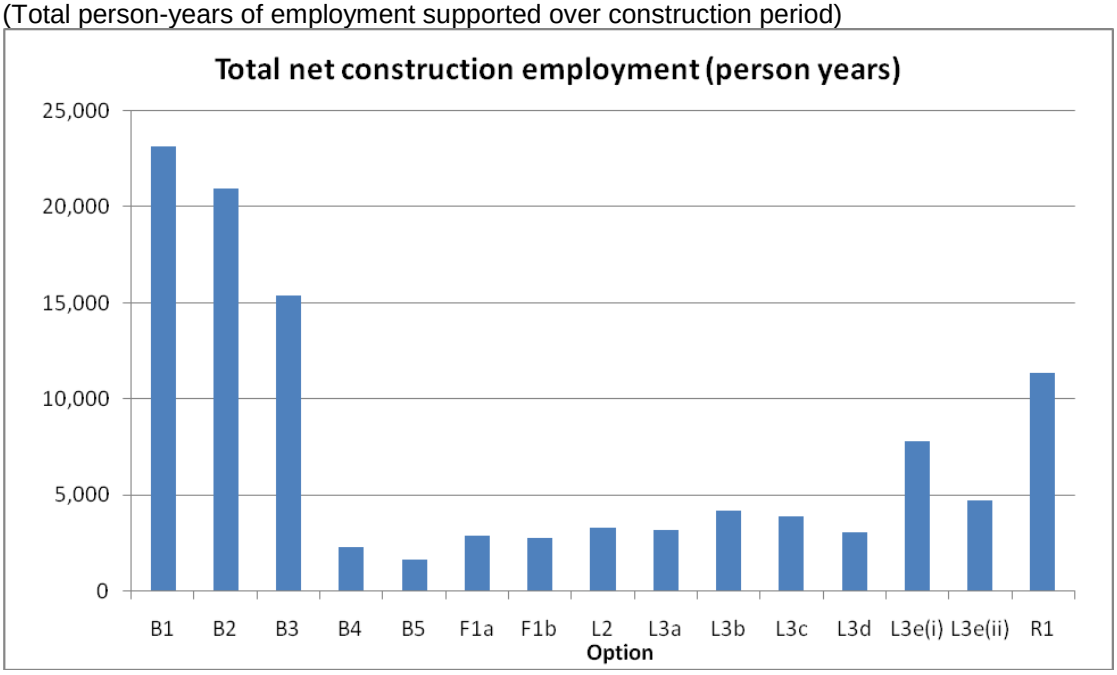
The extent to which these jobs are additional to the local economy will depend on the range of alternative construction projects undertaken over the proposed build period.

- At this stage the extent to which construction of a tidal power option would result in a delay for other local building projects is unknown. This is due to uncertainty around the way the construction would be staffed, and the unknown planning of alternative developments over the same period. Given the scale of operations, displacement or crowding out is likely to be high amongst the local workforce. However, a degree of additionality is permitted for projects which utilise more advanced or niche skill sets, as is likely to be the case for tidal power schemes.

- Guidance published by English Partnerships, based on a review of previous project appraisals, suggests that large scale national projects tend to generate additional benefits equal to a third (33%) of the estimated gross benefit i.e. displacement of 67% at the local level.

Assuming 67% displacement for local activity, Figure 3.8 presents the net local employment impacts resultant from the construction programme.

Figure 3.8 – Estimated net construction impact by option
(Total person-years of employment supported over construction period)



3.5.3 Multiplier Effects

Multiplier effects will generate further expenditure in the economy through supply chain and worker expenditure effects. The Welsh Assembly Government and South West Regional Observatory publish regional accounts which demonstrate the extent of these knock-on impacts.

Welsh national multipliers for the construction industry give a supply chain impact equal to 48% of the direct effect, and wider expenditure effect of a further 31% of the direct effect (a total multiplier of 1.79). By comparison, the South West multiplier is 1.54 for the construction industry i.e. for every 100 jobs created in barrage construction, a further 54 will be created elsewhere in the economy. To be prudent, we have applied the lower of these two multipliers (1.54) to the net direct impacts measured above. The composition of multiplier effects are explored further in chapters 8 (accommodation) and 10 (other industries).

The extent to which local industries within the study area will benefit from these knock-on impacts will depend on the local concentration of suppliers to the construction industry and provision of local consumer services i.e. the local impact will be maximised through use of local suppliers and services. Applying these multipliers to the net direct impacts gives the following estimates of total local impact:

Figure 3.9 – Estimated total net additional construction impacts for the local area

		Employment (total over the build period)		GVA, £ million	
Option		**Direct**	**Total (inc. multiplier effects)**	**Direct**	**Total (inc. multiplier effects)**
B1	Aberthaw - Minehead Barrage	23,200	35,700	£1,500	£2,300
B2	Cardiff - Hinkley Point Barrage	21,000	32,300	£1,300	£2,100
B3	Cardiff - Weston Barrage	15,400	23,800	£1,000	£1,600
B4	Shoots Barrage	2,300	3,600	£140	£220
B5	Beachley Barrage	1,700	2,600	£110	£170
F1a	Cardiff to Weston Tidal fence	2,900	4,500	£175	£270
F1b	Aberthaw to Minehead Tidal fence	2,800	4,300	£150	£225
L2	Welsh Grounds Lagoon - Fleming	3,300	5,100	£200	£310
L3a	Russel Lagoon (English Grounds)	3,200	4,900	£190	£300
L3b	Russel Lagoon (Welsh Grounds)	4,200	6,500	£250	£390
L3c	Russel Lagoon (Peterstone Flats)	3,900	6,000	£235	£360
L3d	Bridgwater Bay (Land Connected Lagoon)	3,100	4,700	£190	£290
L3e(i)	91sq.km Offshore Lagoon	7,800	12,100	£480	£730
L3e(ii)	50sq.km Offshore Lagoon	4,800	7,300	£290	£450
R1	Aberthaw to Minehead Tidal Reef	11,400	17,600	£720	£1,100

It should be noted that the multiplier effects across Wales and the South West would be greater if the region was considered in its entirety (i.e. if Wales and the South West was a single area) as opposed to solely applying the Welsh multiplier to the direct employment and GVA estimates. An assessment of Input-Output models and the relationships between the two regions suggest that the multipliers would be, on average, around 5-10 percent greater than the individual area multipliers. However, without further assessment of these, DTZ consider it prudent for this assessment to review the regional multipliers separately. At this stage we are unable to infer anything about the likely regional (i.e. Wales / South West) split of these impacts.

3.5.4 PV of economic benefits

The Present Value (PV) captures the stream of economic benefits derived during the construction period in a single figure, valued at 2008 prices. Future benefits have been discounted at 3.5% per annum in line with HM-Treasury Green Book appraisal guidance. The duration of benefits varies between options, in line with the total construction period. Figure 3.10 below summarises the present value of the total GVA impacts presented in Figure 3.9:

Figure 3.10 – Estimated total net additional construction impacts for the local area

		GVA, £ million	
Option		**Un-discounted Total**	**PV**
B1	Aberthaw - Minehead Barrage	£2,300	£2,008
B2	Cardiff - Hinkley Point Barrage	£2,100	£1,847
B3	Cardiff - Weston Barrage	£1,600	£1,409
B4	Shoots Barrage	£220	£208
B5	Beachley Barrage	£170	£159
F1a	Cardiff to Weston Tidal fence	£270	£252
F1b	Aberthaw to Minehead Tidal fence	£225	£194
L2	Welsh Grounds Lagoon - Fleming	£310	£289
L3a	Russel Lagoon (English Grounds)	£300	£280
L3b	Russel Lagoon (Welsh Grounds)	£390	£364
L3c	Russel Lagoon (Peterstone Flats)	£360	£339
L3d	Bridgwater Bay (Land Connected Lagoon)	£290	£267
L3e(i)	91sq.km Offshore Lagoon	£730	£674
L3e(ii)	50sq.km Offshore Lagoon	£450	£416
R1	Aberthaw to Minehead Tidal Reef	£1,100	£954

3.6 Sensitivity of construction impact

The values presented in this section so far present the Medium case, based on the best available data and assumptions. However, the calculation of these results is sensitive towards a number of key variables which may be prone to a margin of error. We have therefore developed alternative high and low scenarios to capture the range of likely outcomes within these assumptions.

The scenarios are defined as follows:

1) High scenario (best case)

- Leakage in relation to the turbines has been reduced from 90% (Parsons Brinkerhoff's assumption) to 20%. This recognises that the total contract value may be sufficient to justify the set up of new local operations to deliver them. This could take the form of a new company, or local satellite operation from known international contracts.

- Displacement has been reduced from 67% to 20%. This recognises the unique nature of the tidal power project. While it may displace workers from other construction projects, it is not stealing final demand from other projects (in the same way as, for example, a new housing scheme might) because it is not in direct competition. In this case, other construction operations would look to replace any staff lost to the tidal project to continue their projects, which would result in a significant in-migration of labour to Wales and SW England to meet the needs of both the tidal power project and on-going labour demand in the wider construction sector.

2) Medium scenario

- Leakage and displacement assumptions are as presented throughout this chapter.

3) **Low scenario (worst case)**

- Leakage is increased to 75% across all construction components (with turbines remaining at 90%). This recognises the likely competitive nature of any contracts tendered of this magnitude, and the possibility that non-local contractors could be more competitive to deliver the work.

- Displacement remains at 67%, as per the medium scenario.

Incorporating these scenarios to the final impact calculations results in the following impacts, indicating a significant range of outcomes around the medium scenario:

Figure 3.11 - Sensitivity testing – employment impact

		Final net employment (including multipliers) Total for construction period		
Option		**Low scenario**	**Medium scenario**	**High scenario**
B1	Aberthaw - Minehead Barrage	17,200	35,700	178,300
B2	Cardiff - Hinkley Point Barrage	13,900	32,300	133,000
B3	Cardiff - Weston Barrage	11,100	23,800	110,000
B4	Shoots Barrage	1,600	3,600	16,200
B5	Beachley Barrage	1,200	2,600	10,900
F1a	Cardiff to Weston Tidal fence	1,800	4,500	15,900
F1b	Aberthaw to Minehead Tidal fence	2,200	4,300	30,500
L2	Welsh Grounds Lagoon - Fleming	2,100	5,100	21,800
L3a	Russel Lagoon (English Grounds)	1,800	4,900	17,400
L3b	Russel Lagoon (Welsh Grounds)	2,500	6,500	25,100
L3c	Russel Lagoon (Peterstone Flats)	2,300	6,000	22,200
L3d	Bridgwater Bay (Land Connected Lagoon)	2,000	4,700	20,700
L3e(i)	91sq.km Offshore Lagoon	4,300	12,100	38,500
L3e(ii)	50sq.km Offshore Lagoon	2,600	7,300	23,200
R1	Aberthaw to Minehead Tidal Reef	9,600	17,600	121,400

NB: The operational requirements associated with tidal power options are explored in chapter 10 (other industries).

Figure 3.12 - Sensitivity testing – GVA impact

		Final net GVA, £ million (including multipliers) Total PV for construction period		
Option		**Low scenario**	**Medium scenario**	**High scenario**
B1	Aberthaw - Minehead Barrage	£970	£2,010	£8,840
B2	Cardiff - Hinkley Point Barrage	£810	£1,850	£6,920
B3	Cardiff - Weston Barrage	£660	£1,410	£5,770
B4	Shoots Barrage	£90	£210	£860
B5	Beachley Barrage	£70	£160	£610
F1a	Cardiff to Weston Tidal fence	£100	£250	£850
F1b	Aberthaw to Minehead Tidal fence	£100	£190	£1,340
L2	Welsh Grounds Lagoon - Fleming	£120	£290	£1,140
L3a	Russel Lagoon (English Grounds)	£100	£280	£940
L3b	Russel Lagoon (Welsh Grounds)	£140	£360	£1,320
L3c	Russel Lagoon (Peterstone Flats)	£130	£340	£1,180
L3d	Bridgwater Bay (Land Connected Lagoon)	£110	£270	£1,080
L3e(i)	91sq.km Offshore Lagoon	£240	£670	£2,060
L3e(ii)	50sq.km Offshore Lagoon	£150	£420	£1,260
R1	Aberthaw to Minehead Tidal Reef	£510	£950	£5,720

3.7 Summary of Issues[23]

Large Barrage (Option B3)

The following table summarises the main issues that have been identified in relation to the construction of a large outer barrage: Option B3. As shown below, the following areas are believed to have the largest impact on the net regional economic impact. These need to be further assessed in order to estimate what the economic impact of investing circa £18 billion on the construction of the large barrage will have on the regional economy.

Option: Large Barrage

Topic	Significance		Scenario			Assessment of Risk	Stage (S)
	Magnitude	Activity	H	M	L		
Caisson Construction	++		£2.4bn gross GVA, 50% captured locally = £1.2 Bn	£2.4bn gross GVA, 50% captured locally = £1.2 bn	£2.4bn gross GVA, 25% captured locally = £0.6bn Bn	Relatively low risk, though skills base and scale of construction suggests that assembly of caissons will be leaked from the local economy to international contractors.	C
Turbines	++		£3.02bn gross GVA, 80% captured locally = £2.4bn Bn	£3.02bn gross GVA, 10% captured locally = £0.3 Bn	£3.02bn gross GVA, 10% captured locally = £0.3 Bn	High uncertainty, depends on international market response. As with caissons, likely to be leaked to international contractors.	C
Rock armour	0		leaked	leaked	leaked	Leakage- source of supply international	C
Labour (total jobs supported over the construction period)	++		110,000 total person years of employment	24,000 total person years of employment (annual	11,000 total person years of employment (annual	Depends on nature of employment and the nature of skills in the local market – high uncertainty at present.	C

[23] See Appendix 2 for explanation of table headings.

			(annual average 15,700) (net * multiplier)	average (3,400) (net * multiplier)	average 1,600) (net * multiplier)		
Energy capacity (chapter 10)	+						O
Operation (chapter 10)	++					Uncertainty over the operational labour requirements of the barrage and related energy infrastructure	O

As shown above, the construction of caissons and turbines and the employment of general construction labour are the three greatest components that will influence the net regional impact. It is likely that of the circa £19 billion needed to invest in the construction of a large barrage, substantial leakage will take place. In particular, the Economic Impact Assessment workshop highlighted that a high proportion of materials are likely to be imported given the scale of materials required, their specific requirements and the potential supply base of these materials.

The sheer number of turbines required in a large barrage may make the construction of turbines in the region a possibility. There is great uncertainty surrounding this at present and this will need to be reviewed further. As turbines represent a substantial element of the overall project cost, this is a significant issue.

Small Barrage (Option B4)

The small barrage (Option B4) is estimated to cost approximately £2.5 billion to construct. This is significantly lower than the large barrage. As such the volumes of materials and labour required to construct a small barrage are substantially lower, and the estimated construction period is shorter. The main influencers on the regional economic impact of constructing a small barrage are summarised in the table below. As shown below, the key influencing factors are the location of caisson construction and labour supply.

Option: Small Barrage							
Topic	Significance		Scenario			Assessment of Risk	S
	Magnitude	Activity	H	M	L		
Caisson Construction	+		£274 million gross GVA, 50% captured locally = £137 million	£274 million gross GVA, 50% captured locally = £137 million	£274 million gross GVA, 25% captured locally = £69 million	Need to understand capacity of existing UK yards. Skills base and scale of construction suggests that assembly of caissons will be leaked from the local economy to international contractors.	C
Turbines	0		£441 million gross GVA, 80% captured locally = £353 million	£441 million gross GVA, 10% captured locally = £44m	£441 million gross GVA, 10% captured locally = £44m	Unlikely to be sourced from within the region. Turbine spend will leak outside	C
Rock armour	0		leaked	leaked	leaked	Leakage- source of supply international	C
Labour (total over construction period)	+		11,000 total person years of employment (annual average 3,200) (net * multiplier)	3,600 total person years of employment (annual average 700) (net * multiplier)	1,200 total person years of employment (annual average 300) (net * multiplier)	Depends on nature of employment and skills required – high uncertainty at present.	C

Energy capacity (chapter 10)	+						O
Operational (chapter 10)	++					Uncertainty over the operational labour requirements of the barrage and related energy infrastructure	O

With regards to caisson construction yard, it is unclear whether existing UK yards have sufficient capacity to meet the potential demand. If there is insufficient capacity, then it is probable that a proportion may be constructed nearer the site. Further clarification from the PB consortium is required here. If no caissons are constructed in the region, then the spend on caissons will represent a leakage out of the region.

Unlike the large barrage, it is unlikely that the demand for turbines will be sufficient to encourage a regional manufacturer to enter into this consolidated market, and the spend on turbines will be a leakage out of the region.

DTZ have estimated that approximately 3,600 people per annum will be required to construct the small barrage, though this will vary over the construction period, peaking at c. 7,000. However, the smaller volumes of labour demanded may enable a higher proportion of labour to be sourced locally, utilising labour capacity from within the Wales and South West.

Tidal Lagoon (Option L2)

Again, the source of materials and labour represent the largest potential impacts on the regional economy. In addition, unlike the construction of the barrage, an innovative wall design is being reviewed for the tidal lagoons (replacing the need for rock fill walls, which is included in the variances of lagoon options). The design of the tidal walls is unclear. However, if these are built of concrete sheets, then there may be a requirement for regional manufacturing of these panels. This means that potentially, the regional economic impact may be greater than if the walls were built of conventional rock fill (which may require a higher proportion of imported materials).

Option: Tidal Lagoon							
Topic	Significance		Scenario			Assessment of Risk	Stage
	Magnitude	Activity	H	M	L		
Caisson Construction	+		£144 million gross GVA, 50% captured locally = £72 million	£144 million gross GVA, 50% captured locally = £72million	£144 million gross GVA, 25% captured locally = £36 million	Need to understand capacity of existing UK yards	C
Wall construction / embankments	+		£341m gross GVA, 80% captured locally = £273m	£341m gross GVA, 80% captured locally = £273m	£341m gross GVA, 25% captured locally = £85m	Dependent on the type of wall construction and the source of construction.	
Turbines	0		£543 gross GVA, 80% captured locally = £434m	£543 million gross GVA, 10% captured locally = £54m	£543 million gross GVA, 10% captured locally = £54m	Unlikely to be sourced from within the region. Turbine spend will leak outside	C
Labour (total for construction period)	+		21,800 total person years of employment	5,100 total person years of employment (annual average	2,000 total person years of employment (annual average	Depends on nature of employment – high uncertainty at present.	C

			(annual average 4,400) (net * multiplier)	1,000) (net * multiplier)	400) (net * multiplier)		
Energy capacity (chapter 10)	+						O
Operational (see chapter 10)	+						

Similar to the small barrage, the capacity of local caisson construction yards needs to be understood before any assessment of regional supply can be made. If there is insufficient existing capacity, then it is probable that a proportion of the caissons may be constructed within the region.

The lower volume of turbines required means that it is unlikely that a regional manufacturer will enter into this consolidated market. This does depend on the potential of the region to develop a specialism within the market, and supply other national/international tidal power projects. However, as the international market has consolidated, it would appear (and indicated by the PB consortium) unlikely.

Tidal Fence (Option F1a)

As very little information has been received in relation to the Tidal Fence concept to date, the following table presents the main impacts that will emerge from a Tidal Fence.

Option: Tidal Fence							
Topic	Significance		Scenario			Assessment of Risk	S
	Magnitude	Activity	H	M	L		
Caisson Construction	+		£678m gross spend, 50% captured locally = £340m	£306m gross GVA, 50% captured locally = £153m	£678m gross spend, 25% captured locally = £170m	Need to understand capacity of existing UK yards	C
Turbines	0		£294m gross GVA, 80% captured locally = £235m	£294m gross GVA, 10% captured locally = £29m	£294m gross GVA, 10% captured locally = £29m	Unlikely to be sourced from within the region. Turbine spend will leak outside	C
Rock armour	0		leaked	leaked	leaked	Leakage- source of supply international	C
Labour (total over construction period)	+		15,900 total person years of employment (annual average 3,200) (net * multiplier)	4,500 total person years of employment (annual average 900) (net * multiplier)	1,800 total person years of employment (annual average 400) (net * multiplier)	Depends on nature of employment – high uncertainty at present.	C
Energy capacity (see chapter 10)	+						O
Operation (see chapter 10)							

Overall Local Area Effects

Construction impact will be regional in scale, drawing on regional resources. However, it is likely that the majority of the net direct construction benefits will be accrued in the local area, close to the points of construction and the local surrounding areas. As these include large conurbation areas such as Cardiff, Bristol and Newport; the construction benefits may impact on rural, urban and coastal areas of the region. Negative displacement effects may be felt further afield, if resources are drawn from other areas of Wales and the South West in addition to the UK as a whole.

There will be local impacts in terms of construction sites, and these will depend on the location of the schemes.

4. Transport and Logistics

4.1 Summary of Impacts

For the purposes of this assessment, this chapter has clustered the tidal power options as:

- Large barrage (B3 being illustrative - Cardiff to Weston-super-Mare)
- Small barrage (B4 being illustrative - Shoots) and Lagoons
- Other tidal power options

The main focus of the economic impact assessment in this chapter is on port operations due to the significance and concentration of negative impacts on the affected ports.

The four main ports which are likely to be subject to direct negative impacts from one or more of the tidal power options are: Bristol, Cardiff, Newport and Sharpness – all of which are upstream of at least one of the tidal power options.

Swansea, Barry and Port Talbot are excluded from the baseline, although they may secure displaced traffic, which at a regional level is captured through the intra-regional displacement adjustments. However, the assessment has not included the potential for ancillary investment to increase capacity at these ports.

Baseline	DTZ estimates 5,500 jobs and GVA of £230 million per annum (2008 prices)
	• This baseline represents the gross economic impact of Bristol, Cardiff, Newport and Sharpness ports.
	• The figures include direct and indirect impacts:
	  ○ Direct employment 3,600
	  ○ Indirect employment 1,900 (multiplier of 1.54)

Displacement	The major negative impact is displacement of port traffic to ports outside Wales and SW England. Bristol Port is the most significantly affected, especially for bulk cargoes and tanker traffic in larger vessels. Displacement ranges for operational phase are: • Larger barrage 40 – 80% • Small barrage & lagoon 0 – 10% No estimate possible for tidal fence or tidal reef option
Negative impact	Large barrage net GVA loss of £710 to £1,900m over 40 years; annual average employment loss of 1,800 during construction; annual average employment loss of 600 over 30 years of operation; peak job loss of 3,300 Small barrage & lagoon net GVA loss £0 to £220m over 40 years; annual average employment loss of 170 during construction; annual average employment loss of 40 over 35 years of operation; peak job loss of 280.

	No estimate for tidal fence or tidal reef project possible. Possible adverse impact on Deep Sea Container Terminal planned for Bristol – but uncertainty over whether it would go ahead, even in the absence of TP project.

4.2 Regional Context

Transport and logistics relates to the impact of the options on the transport and logistical networks in Wales and the South West. In particular, this sector focuses on those transport modes that are directly impacted by an option and the direct economic consequence of these. Any indirect impact that occurs to, for example, other businesses, are captured by the secondary impacts. This section therefore focuses on the impact of an option on:

- Air;
- Road;
- Rail; and
- Ports[24]

Air impacts are most likely to be related to increased air travel to the region during the construction and operational phases. Road impacts will be positive (in terms of new roads for use during construction which will be used afterwards) and negative (in terms of increased congestion mainly during construction). Transport infrastructure developed as part of an option (e.g. road links across a barrage) is being considered separately and DTZ has not reviewed these potential impacts as part of the research. Rail impacts relate to the potential use of the rail network for construction purposes which may add to rail congestion (and use of lines) during the construction process. It has not been possible to quantify the impact on road and rail due to the uncertainties about the construction process. Port impacts could be significantly negative during construction and operation, although there could be partially or fully mitigating positive impacts in Wales and the South West due to:

- Substitution of displaced port activities with new activities utilising the land, equipment and other assets of the ports. For example, new land uses within or contiguous to urban areas may have higher value economic uses and impact on the local/regional economy in the longer term.
- The additional port traffic generated for Bristol Channel ports during the construction phase. It is recognised that this traffic may be routed via a new /expanded port development as opposed to being routed via one of the existing ports.
- Further ancillary investment port capacity in the region to accommodate displaced activity (DTZ have not reviewed uncertain ancillary investments).

Air, Road and Rail

[24] In the absence of primary research or any detailed information on ship arrivals at the commercial ports and the specific navigational requirements of different vessel types, much of the assessment provided in this paper has relied upon information provided in submissions from ABP, Bristol Port Company, Sharpness Dock and Gloucester Harbour Trustees. This should therefore be considered as a preliminary assessment of the possible implications of changes imposed by a barrage.

This chapter draws upon a paper that has been prepared by MDS Transmodal and is attached as an appendix to this report.

Major air travel infrastructure is located in Bristol (Bristol International Airport & Filton) and Cardiff (Cardiff International Airport). Bristol and Cardiff have a range of domestic and international routes, as well as handling charter flights.

Both Wales and the South West have extensive road and rail networks. Both regions have dense networks in urban areas and less dense networks in the large rural areas in both regions.

Ports Markets

The historical trend in all shipping markets is that trade growth has been met by the development of ever larger ships, driven by the need for economies of scale. This is especially true of low value, high volume commodities shipped in bulk in which all of the ports in the Bristol Channel have a specialisation. However, this is now also the case for containers. While average ship sizes are increasing, it also should be pointed out that approximately 30,000 ships, equal to almost 80% of all merchant vessels, are less than 20,000 deadweight tonnes (dwt). The majority of these vessels are categorised as general cargo ships and ply a very wide range of trades and are also common to shipping in the Bristol Channel.

The increasing size of vessels has been taken into account. In our analysis it is assumed the large barrage option will be able to accommodate Panamax vessels, Capesize vessels and the larger vessels anticipated in the future. The increasing size of vessels is important but issues such as the additional time taken to navigate the Severn Estuary and reduced windows of opportunity to enter and leave ports are important for vessels of all sizes.

Bulk

The average size of ships in the world bulk carrier fleet has increased from 46,500 dwt in 1990 to 52,800 dwt at the beginning of 2007. In the past five years almost 200 vessels of more than 150,000 dwt have been added to the fleet. Orders for new buildings concentrate on bulk carriers in the Capesize segment and above, while the average size of ships on order is 80,000 dwt. These vessels are due to be delivered in the next two to three years.

While the number of Panamax[25] and Capesize vessels operating in the fleet is clearly increasing, Handysize vessels remain very much the 'workhorse' of the bulk shipping markets, operating in a wide range of trades and to some extent also reflecting constraints on ship sizes at many ports in exporting countries. Panamax vessels are more common in the big bulk trades, especially coal and grain, while Capesizes are usually deployed to deliver raw materials (i.e. coking coal, iron ore) to the steel industry and often deliver to dedicated facilities situated in close proximity to steelworks.

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Handysize: 10,000 – 39,999 dwt Handymax: 40,000 – 49,999 dwt Supramax: 50,000 – 59.999 dwt Panamax: 60,000 – 79,999 dwt Capesize: > = 80,000 dwt

Only the Port of Bristol and Port Talbot have the capacity to handle these types of vessel. Whereas the dimensions of locks at Bristol determine the absolute size of the largest bulk carriers able to dock at Avonmouth and Royal Portbury Docks, it would not be unreasonable to expect larger carriers to call with increasing frequency in the future. For example, the proposed development of a biomass power plant at Portbury will require the importation of large volumes of woodchip, mainly sourced from North America. It is most likely that Panamax and Capesize bulk carriers will be deployed in this new trade. However, it also needs to be acknowledged that the throughput of coal at Bristol will decline following the probable closure of Didcot power station in 2015.

Container ships

The maximum size of vessel in operation in 1980 was 3,000 TEU (Twenty-foot Equivalent Units – the original standard size of a box unit). In 2006 the first 12,000 TEU ship entered service. The largest vessels in operation are deployed mainly on the 'arterial' Asia-Europe and transpacific shipping routes between the Far East and North America. Across the board a 'cascade' effect or chain reaction is taking place, where larger vessels replace vessels with less capacity operating on secondary and 3rd tier routes as shipping economics are driven by the need to fill vessels and achieve a low unit cost per slot. As a consequence ports must develop to accommodate the larger ships by having the appropriate depth of water, berths of the required length and handling equipment to ensure that turnaround times in port are optimised.

At present Bristol receives two weekly scheduled 'shortsea' container services. DFDS/Lys Line operates between Greenock, Dublin, Bilbao and Bristol using a 700 TEU vessel. MSC operates a feeder service to Bristol from the deep sea port of Antwerp in Belgium using a 1,095 TEU ship. These vessels are currently handled at Avonmouth. Cardiff Container Terminal handles services to and from Ireland and the Mediterranean. The vessels involved are of less than 1,000 TEU. Feeder links with deep-sea European hub ports are being pursued to make use of the development land adjacent to the terminal for regional distribution.

The continued growth in UK trade is beginning to change the dynamics of the UK ports and both Bristol and Liverpool are gaining in competitiveness on some routes. Both ports are well-placed to serve main centres of population, industry and therefore inland distribution. This lies behind Bristol's proposals to develop a deep water container terminal at river berths outside of the dock complex, and adjacent to the main shipping channel with the intention to be able to receive vessels of at least 8,000 TEU capacity. Such vessels will require unrestricted access to port facilities with depth of water of 15.0m. Vessels of up to 12,000 TEU would require 16.0m.

Bristol Channel Vessel Calls

Figures from the Department for Transport show that there were a total of 3,615 vessel arrivals at commercial ports in 2006, creating a total of over 7,200 commercial ship movements in and out of the Channel over the course of the year. The four main ports that will be directly impacted by the large barrage proposal account for a total of 2,804 or 78% of all reported calls.

The Bristol Channel ports between them handled almost 29 million tonnes of cargo in 2006. This represents 5% of all cargo handled through all ports of Great Britain. The port region is

particularly important for imports of dry bulk commodities, particularly coal and agricultural products, oil products and both imports and exports of steel products. Bristol is also the 4th largest port in the country for the import and export of trade cars.

Bristol is shown to be the busiest port, receiving 38% of all ship calls in the Channel, handling approximately 12 million tonnes of cargo. The port also accounts for 51% of calls by bulk carriers in excess of 20,000 dwt and 98% of tankers in this size category. Newport and Cardiff receive in excess of 600 calls each per year, the combined total accounting for 35% of all ship calls. The port of Sharpness received a total of 168 calls (336 vessel movements) accounting for 5% of all ship calls.

Port of Bristol have proposed a significant development for the Bristol Channel in the Deep Sea Container Terminal (DSCT) at Avonmouth Dock. The proposed DSCT will be able to accommodate the largest container vessels currently in operation. It is designed to handle future Ultra Large Container Ships (ULCS).

The expected timescale for development of the DSCT is that construction could start in 2010 and the terminal could be operational in 3 to 4 years. The proposal has been subjected to detailed investigation in a series of Bristol Port Company studies of its economic need and benefits, environmental impacts and engineering requirements.

4.3 Areas of Impact

There is a strong possibility that the DSCT project would not proceed if the larger barrage (B3) goes ahead. However, although Bristol Port has a compelling case for securing planning consent, there is no guarantee that the container terminal will go ahead even without the barrage. There are uncertainties about how the project will fare against key competitors such as Liverpool. Nevertheless, it is a positive development opportunity for the SW region which STP may adversely impact upon. This negative effect on private sector investment is classified as displacement, assuming the project would have gone ahead in Bristol and the STP project results in it being relocated to a location outside Wales and SW England.

Container Trades – these are likely to be seriously impacted by a requirement to transit additional locks as this would add to the ships' transit and affect schedules at other ports. Car carriers will still be able to enter the port but schedules will be disrupted as for container vessels. There are limited alternative ports in Wales and the South West for trade cars, with Bristol Port enjoying approximately 230 hectares of land dedicated to car storage. If such container traffic was adversely impacted by a barrage or one of the other tidal power options, then there is a high probability that this traffic would be displaced outside Wales and the SW Region. This is loss of trade and the associated economic activity is referred to as ‘displacement’.

Bulk Cargoes - There are ship limitations at both Cardiff and Newport but big bulk trades, including coal, may be accommodated at Port Talbot depending on available space. A number of power stations are supplied by rail from Bristol, although its main customer is the Didcot power station which is earmarked for closure in 2015. This will see a significant drop in coal throughput at the port. To the extent that displaced bulk trades could be accommodated by other ports in Wales and/or the SW England, then this would have zero economic impact at

the regional level, although clearly there would be displacement at the local level and associated local economic impacts.

Smaller Vessels - our early understanding is that the smaller ship sizes will continue to be able to enter the port in any circumstance. These trades tend to use vessels on a 'single voyage' charter fixed on the 'spot' market on an end-to-end service so not the same as the liner trades where vessels are scheduled to call at several ports in Europe.

For smaller ships the need to transit two locks may have a negative impact on port competitiveness. But the materials involved are usually delivered to a more local hinterland so more possibility that these will continue at Bristol or within the region.

Tidal Access for Barrage Projects – on the positive side larger barrage options may have the effect of increasing the available docking window as high water will be held for a longer period of time upstream of the barrage although top water level will be reduced. However, the availability of this 'docking window' will depend on the length of time required to navigate through a barrage.

Bristol Port – although Cardiff, Bristol, Newport and Sharpness ports will all be affected by the construction of a large barrage option, it is clear that Bristol could be disproportionately affected. This is due to the fact that Bristol is the only port that offers deep water facilities and is able to accommodate vessels of Panamax and Capesize dimensions and because it serves a larger economic hinterland. Only Port Talbot, which is unaffected by the barrage proposals, is able to receive as large or bigger vessels.

Bristol is also one of the UK's major ports with a national "market", serving directly a significant area from the West Midlands through the Greater South East and down the South West peninsula. It is also the largest port in the South West region. The deep water facilities available at Bristol are not replicated anywhere else in the South West. Impediments to the operation of Royal Portbury which handles cargoes including coal, grain and animal feedstuffs in ships up to 130,000 tonnes deadweight potentially could be displaced to ports outside of Wales and the South West.

As discussed above, the construction of a large barrage which controls vessel traffic through a lock system could thwart Bristol Port's plans to build a deep sea container terminal.

Sharpness Port - Sharpness also stands to be seriously disadvantaged by barrage options. It is not clear from the available information on water heights whether the small barrage will cause less of an impediment to Sharpness, but it is clear that Sharpness would be disproportionately affected by a barrage development. The importance of Sharpness also lies in its being able to offer port customers an alternative to ports owned by Associated British Ports[26] which, in the absence of Bristol and Sharpness, would be in a dominant position in the Bristol Channel.

Qualification of Economic Impact Assessment – the calculation of potential impacts on port activities from a range of different tidal power options is complex. There are a large number of variables to be considered and there has been insufficient time and resources to

[26] The ABP group own Cardiff, Newport, Barry and other ports across the UK.

undertake the research and data collection exercise for a comprehensive economic impact assessment. We therefore have to qualify what are very much 'ballpark' figures presented within fairly wide impact ranges.

Going forward we recommend that more detailed navigational data is obtained directly from ports to determine ship arrival patterns, the number of larger vessels that require access on high tides, required depth at lock sill, their frequency of arrival, time in port, transit time to dock entrance, etc., in order to establish with more accuracy the degree of obstacle created by a barrage. This data combined with analysis of markets, trends and competitor ports will enable us to determine the key 'displacement' assumptions with much greater accuracy.

4.4 Calculation of Economic Impact

Our assessment of the economic impact of the tidal power options on the Bristol Channel Ports is driven by the following assessment framework:

- **Port selection process** – the first task is to identify the ports that will be impacted, potentially, by the tidal power projects

- **Economic impact baseline** – this involves the estimation of employment and Gross Value Added (GVA) for the ports that are likely to be impacted upon. This is prior to any tidal power development and represents the economic baseline as at 2008

- **Calculation of impact** – this identifies and, where possible, quantifies the economic impact attributable to the range of tidal power projects during both the construction and operational phases. The assessment includes both positive and negative impacts.

Each of these elements in the economic impact assessment framework is described in detail below. The only other key points to highlight are:

- **Geographic level for impact assessment** – our main objective is to focus on economic impact at a regional level, in terms of the Welsh and SW England economies. Hence, distributional impacts within these economies are ignored in terms of overall impact. At the sub-regional level we have estimated these to inform the nature of local impacts (positive and negative) and also to help estimate the level of trade lost to the Welsh and SW England economies.

- **Classification of tidal power options** – given that there are 10 options and a significant degree of uncertainty surrounding both the nature and specification of these options, we have simplified the economic impact assessment by focusing on four categories of project:
    - Large barrage
    - Small barrage
    - Lagoon
    - Tidal fence

There is uncertainty over the potential impact of the Tidal Fence on port operations and navigation. Therefore, it is possible that a tidal fence could be considered in the same category as a large barrage (potentially significant impact) or tidal lagoons (not significant impact).

4.4.1 Port Selection Process

The focus is on those ports which are likely to be directly impacted upon by at least one of the tidal power options. Having analysed the geography of the proposed projects we have elected to take B3 as the limit for the impact assessment – the tidal barrage from Cardiff to Weston.

This defines four main ports which are likely to be subject to direct impacts from one or more of the tidal power options: Bristol, Cardiff, Newport and Sharpness – all of which are upstream of at least one of the tidal power options. Barry, Swansea and Port Talbot are excluded from the baseline. Their ability to capture intra-regional displaced traffic has been included in the assessment. However, the assessment does not include the potential for ancillary investment to enhance capacity. They may also benefit from positive traffic generation impacts during the construction phase of the project, but there has been no attempt to quantify this separately in this study.

Barry would also be impacted upon should B1, the largest barrage from Minehead to Aberthaw, go ahead. However, given the uncertainty of the largest project and its exact location, and the relatively small scale of Barry Port this has been discounted in the port selection process, which reflects the clustering approach discussed earlier in the report. These STP specific impacts will need to be further assessed in more detailed future assessments.

4.4.2 Economic Impact Baseline

Background to calculation of economic impact baseline – the objective is to estimate the employment and GVA for the four ports likely to be impacted upon by one or more of the tidal power options. To achieve this goal DTZ has drawn upon the detailed economic impact study of Bristol Port, commissioned by SWRDA[27]. This report provides hard data upon which we can calculate the economic baseline for Bristol Port. We have then used this data to scale up the impact across the other three ports on the basis of the value of cargo handled at each port. We believe this is justified given:

- The dominance of Bristol Port, which accounts for 83% by value of port traffic handled by the four ports (based on cargo value data published by Roger Tym & Partners for SWRDA).
- The fact that the value of cargo is a good proxy for economic activity and impact at a port.

The SWRDA report states that Bristol Port supports a gross figure of 7,660 jobs in the region with a GVA contribution of over £270 million per annum. The report highlights the important role played by Bristol Port in the city of Bristol and South West economy more generally.

[27] DTZ's review of this report by Roger Tym & Partners is appended

Employment Impact at Bristol – it is important to point out that a significant proportion of the employment outlined in the report may continue, even in the absence of the port. A more tightly defined view of the economic impact of Bristol Port was taken by DTZ based on 735 port jobs and 2,246 port-related jobs, which gives a total of 2,981 'direct' jobs.

Secondary multiplier effects are likely to fall within suppliers of goods and services and transport services to and from the port. The suppliers and transport services jobs outlined above suggest secondary multiplier effects of 1,613 jobs. The direct port activities and secondary multiplier effects give overall employment of 4,594 jobs. This gives an implied employment multiplier of 1.54.

Bristol Port	Employment	Multiplier
Direct employment*: • Port operations • Port related industries • Total direct employment	 740 2,250 2,980	-
Indirect employment*: • Key transport employers • Suppliers of goods & services • Total indirect employment	 650 970 1,610	1.54
Total employment	4,590	-

Source: Economic Impact of Port of Bristol: SWRDA
* Note: Definitions appended

A multiplier of 1.54 seems plausible and appropriate for the current study and is close to employment multipliers published by the South West Regional Observatory for a range of industries across the South West.

The SWRDA report appears to focus on the wider strategic value of Bristol Port including the role of the port estate in developing businesses. The more narrowly defined level of economic impact outlined in this report is more appropriate for this impact study[28].

Gross Value Added (GVA) at Bristol – reducing the GVA by the same extent as the revised employment figures we have calculated the Gross Value Added (GVA) contribution at £161.9 million per annum. Applying the same ratio of GVA to employment, the 735 employees working directly for the port would be associated with £25.9 million of GVA. This seems reasonable given Office for National Statistics (ONS) data for all water transport activities across the South West show GVA of £28 million in 2006 (excluding transport services).

[28] The Port of Bristol and associated businesses have grown beyond pure port activity and, as well as port related multiplier effects, have a wider strategic value to the South West of England e.g. in developing and providing employment land, jobs and income on the port's estate. This assessment does not account for these valuable port estate outputs as we cannot be clear whether these may, or may not, continue in the absence of port operations. The Roger Tym & Partners work and the DTZ work about port impacts are, therefore, different rather than contradictory. In addition, however, it is important to recognise the future opportunity losses associated with a barrage-constrained Port of Bristol compared with its current investment potential. Consistent with the "here and now" baseline adopted throughout the study these calculations do not feature in this assessment.

Bristol Port	Employment	GVA (£m)
SWRDA Report – overall impact data	7,660	270
DTZ assessment - baseline data	4,590	161.9
Percentage adjustment	60%	60%

The SWRDA report bases the GVA estimate on data sources from 2002. HM Treasury inflators show the £161.9 million in 2002 prices is equal to £190.4 million in 2008 prices.

Economic Baseline for Ports – to provide a straightforward estimate of the baseline, employment and GVA were grossed up from Bristol Port based on the value of cargo at each port. These calculations are based on cargo volume data published by MDS Transmodal and cargo value data published by Roger Tym & Partners[29]. This provides overall baseline figures of 5,528 jobs and £229 million GVA for Bristol, Cardiff, Newport and Sharpness. This is set out in the table below.

	Employment	GVA (£, million)
Port		
Bristol	4,590	190.4
Cardiff	590	24.4
Newport	290	11.8
Sharpness	60	2.5
Sub-total	**5,530**	**229.0**
Swansea	140	5.6
Barry*	190	8.0
Port Talbot	440	18.4
TOTAL	**6,300**	**261.1**

* Note: Estimates for Barry are based on freight volume (relative to Bristol) only

The figures presented above do not show precise estimates, for example the difference between Cardiff and Newport could be much smaller. The aim of the above figures is to estimate the overall employment and GVA in the four ports that will be impacted most significantly by a tidal power project. The apportioned figures for the other ports would have been greater had we used the volume of cargo handled as opposed to the value of cargo. However, as this assessment is assessing the value added of activity, the value of cargo was considered more suitable than the volume of cargo

4.4.3 Calculation of Economic Impact

Positive Impacts – although the main focus of the affected ports tends to concentrate on the negative impacts arising from possible tidal power projects, there are two important upsides, which must be highlighted:

- *Substitution effects* – this relates to the displacement of port activities with new activities utilising the land, equipment and other assets of the ports. For example,

[29] See Appendix 5 for detail

new land uses within or contiguous to urban areas may have higher value economic uses and yield sustained impact on the local/regional economy in the longer term. To address substitution, the economic impact assessment below takes account of this through shortening the duration, and reducing the impact, of negative displacement effects during the operational phase.

- *Construction cargoes* – this relates to the additional port traffic generated for Bristol Channel ports during the construction phase. It is recognised that this traffic may be routed via a new or expanded port development as opposed to being routed via one of the existing ports. This is a potential upside and it would be useful to quantify this benefit once the scale and duration of cargo associated with construction is clearer.

With regard to the latter impact, ports which potentially gain from the construction of a barrage or lagoons will be those that are located in close proximity to the construction site and those which have space available to provide secure covered storage and lay-down areas for large pieces of equipment and construction materials. Deep water is less of a consideration as most construction vessels are fairly shallow-drafted.

At this stage it is difficult to comment on the economic impact of the construction phase on ports in any detail until the project developers generate a more detailed project design statement. Additional movements through the ports to construction sites from improved or adapted infrastructure are mentioned here as they may not be wholly captured within construction activity impacts. Standard multiplier analysis usually treats imports of materials and equipment as a leakage and may not be reflected in supply chain impacts.

To conclude, for construction cargoes and services, no allowance has been made in our economic impact assessment. This has the effect of overstating the overall negative impact of tidal power options on port operations and the regional economy.

Negative Impacts – the two main negative impacts to be considered are displacement and crowding out. Each is described in turn.

Displacement

As discussed above, displacement is defined as the loss of port traffic to competitor ports outside the Welsh and SW England economies. The key questions are:

- What port cargoes and services are under threat of being lost from one of the four ports due to adverse impacts from the tidal power projects?
- If traffic is lost due to slower transit times, difficulties of access, etc. what proportion of trade would be affected? Would all traffic be lost or only a proportion?
- For the traffic that is lost, how much would be picked up by other ports in Wales or SW England?

Answering these questions will determine the extent of displacement. The analysis is further complicated by having to take into consideration the following:

- Differential impacts between the construction and operational phases of the tidal power projects

- The fact that there are a range of different tidal power options and displacement will vary widely between option types
- The fact that ports are evolving and the nature and scale of their port activities are changing. (Note: no attempt has been made in the economic impact assessment to take account of such dynamic effects. We have used the impact data from the SWRDA Report and have not allowed for any projected growth/decline in port activities.)

The discussion below summarises some of the factors impacting on displacement for different cargo types.

Discussion of Displacement Factors for Bristol Channel Ports

A number of ports within Wales and the South West were identified as having potential to pick up trade lost from Bristol Port. For example, Port Talbot may receive coal or Milford Haven may receive aviation fuel. However, in many cases this capacity is marginal and further investment would be needed. There are wider economic and environment implications for redistributing freight movements across the UK and other workstreams may address these issues.

To an extent the Severn Estuary ports compete with each other in the markets they serve, although certain aspects of each port's business are unique and often have involved significant investment in specialised facilities, usually on the back of long term contract agreements with specific customers. As a result, switching of traffic to alternative ports is not easily achievable and likely to be expensive. However, the port business is extremely competitive and any disruption to shipping over a long period of time can lead to a loss of business to a competing port.

Oil products are handled at Bristol and Cardiff. The two operations are different. If there are any disruptions to these ports, oil storage facilities are available at Swansea. The nearest ports that can handle vessels of +100,000 dwt are Port Talbot or Milford Haven, although Port Talbot has no specialised berths for handling liquid bulks. The other major facilities for importing aviation fuel are located in the Thames Estuary and the Humber.

Coal is imported at Bristol and Newport. The future of coal handling at Bristol remains uncertain as two of the power stations served from Bristol, Didcot and Ironbridge, are earmarked for closure by 2015. With any disruption to either port, to an extent the facilities at Newport and Avonmouth could substitute for each other, both being able to accommodate ships of up to 40,000 dwt.

However, Newport cannot accommodate the Panamax or Capesize vessels that are handled at Royal Portbury Dock and for some tidal power options navigation at Newport may also become restricted. If Bristol could not offer access to the bigger ships other deep water ports handling imports of steam coal include Immingham, Hunterston and Liverpool. Port Talbot handles large ships delivering coking coal for the Corus steel plant and it is likely that the port could handle some third party steam coal business. Barry Port, part of Associated British Ports (ABP), also has a track record in dealing with steel, coal and aggregates.

The **trade car import/export** business is one of the most 'land hungry' in the port industry and only a few ports in the UK have sufficient space to support the scale of modern day operations. Most car manufacturers have consolidated operations to one or two key UK ports, which perform the role of distribution centres for northern and southern regions and provide facilities for a range of value added activity such as pre-delivery inspection (PDI) and associated services. Bristol is the 4th largest port in the country in the trade car market behind Grimsby/Immingham, Southampton and the Port of London.

With any disruption to Bristol, trade could be diverted to any of the competitors listed above. Most of these ports could actively compete for business handled at the port of Bristol, though none could individually accommodate the totality of Bristol's car business. There is a risk that some of this business could switch to the Continent, for example Zeebrugge and Bremerhaven, where many of the car majors have established large car transhipment operations.

Agribulks encompasses a range of agricultural commodities including grains, animal feeds and fertilisers. These commodities are handled at each of the four commercial ports in question and are particularly important at Bristol and Sharpness. The ports of Cardiff, Newport and Swansea could not economically substitute for agribulks handled at Avonmouth or Portbury and would not be economically located for product handled at the ADM Mill at Avonmouth. Nor are these ports well situated in terms of distribution to the South West. ABP's South Wales ports could provide a substitute for Sharpness, although the port's owner, the Victoria Group, importantly provides an alternative operator to port users.

Most of Sharpness's business is oriented towards the Midlands so a switch to South Wales' ports would mean that the length of road haul would increase substantially. Plymouth is the second largest port in the South West region and also handles significant volumes at Cattedown Wharves and Victoria Wharf, which is also owned and operated by the Victoria Group (in addition to Sharpness Dock). These facilities are limited to maximum vessel drafts of 8.4m and 7.0m respectively and cannot accommodate vessels of more than 10,000 dwt.

Our initial analysis has highlighted the following:

- The loss of cargo from individual Bristol Channel ports could be significant, especially for Bristol, which specialises in handling larger vessel sizes and is the dominant port in the region. The level of loss will be correlated to the project type (with the large barrage being the most detrimental) and cargo type. Smaller vessel cargo and end-to-end services are under much less threat compared to container and larger vessel services
- For the majority of this 'lost' traffic, alternative ports in Wales and SW England will be unable to capture the business and it will be displaced to competitor ports elsewhere in the UK or overseas.

A number of the Severn Estuary ports may be able to accommodate trade lost from Bristol Port. For example, Port Talbot might be suitable for coal (accounting for around 2% of the value of 'lost' activity) and there may be potential for small amount of activity to be taken up by other ports in Wales and the South West. Based on the MDS initial work 'intra-regional displacement' will be low and likely to be in the region of 2%-29% of the lost trade value (2%

being the value of coal and 29%– assuming all 'lost trade' would remain within the region apart from vehicle trade).

For the purposes of the economic impact calculations DTZ has used the following displacement percentages (*these are based on the percentage of trade lost outside Wales and the South West*):

	% Displacement Scenarios		
	High Impact	**Medium Impact**	**Low Impact**
Construction			
Large barrage	40%	30%	20%
Small barrage/ Lagoon	5%	2.5%	0%
Tidal fence/Tidal Reef	No estimate	No estimate	No estimate
Operation			
Large barrage	80%	60%	40%
Small barrage/ Lagoon	10%	5%	0%
Tidal fence/Tidal Reef	No estimate	No estimate	No estimate

Construction Displacement Assumptions:

Large barrage

- Impacts occur during an expected 10 year construction period
- Impacts increase over time in a linear fashion (one tenth in year 1, two-tenths in year 2, etc.). For 'high impact' this means displacement in year 1 is 8% and in year 10 it is 80%, with a mean displacement figure of 40% during the 10 year period.

Small barrage & Lagoon

- Impacts occur during an expected 5 year construction period
- Impacts increase over time in a linear fashion as per the large barrage. For 'high impact' this means displacement in year 1 is 2% and in year 5 is 10%, with a mean displacement figure of 5% during the 5 year period.

Tidal fence – no estimate of displacement has been possible, due to the uncertainties over the nature of the tidal fence option. At one extreme the disruption could be as significant as the large barrage option during construction, and at the other extreme there may be minimal adverse consequences on the shipping channel which could result in displacement.

Tidal Reef- no estimates of displacement has been possible as it is unclear how a tidal reef may impact on port operations during their construction and operation. The range between a large barrage (which represents a significant negative impact) and a tidal lagoon which may have a minimal impact on port operations may be used to provide potential boundaries of impact.

Operation Displacement Assumptions:

Large & small barrage options

- Impacts occur during an expected period of 40 years, which is consistent with the discount period used for the other impacts in the report

- Furthermore, they are 'depreciated' on a straight-line basis by one-tenth per annum for the low and medium impacts and one-twentieth per annum for the high impact. Hence for high impact under the large barrage option, 'net displacement' is 80% in year 11 and 4% in year 30.
- These assumptions have been applied to make allowance for the gradual absorption of port infrastructure, assets and resources back into other productive uses. This is making allowance for the 'substitution' effects described at the start of the economic calculation sub-section.

Across these scenarios, the absorption of assets are modelled over a ten year and twenty year period. However, the planning of such absorption and alternative use of such assets are assumed to begin from the point that a firm decision to progress a STP has been made (i.e. from the start of the construction process). This therefore assumes a timeframe of between 20 and 30 years, which is consistent with the usual timeframes for community and area regeneration programmes. For example, the development of Temple Quay in Bristol took approximately 20 years to bring forward, overcoming issues of land contamination, fragmented ownership, with some light industrial usage to become a 19 acre prime office hub in Bristol. This is consistent with the timeframe for the redevelopment of Bristol Harbourside, a mixed use development of office space, retail, leisure and residential developments. Other examples include the development of Kings Quarter in Gloucester, which is expected to be completed within a 15 year regeneration programme from start to finish.

In terms of labour re-absorption, we have assumed that this would take the same length of time as capital assets. However there are uncertainties with regards to this in terms of the impact of labour re-absorption on any existing unemployment pool (i.e. impact at a regional level), the focus of employment, the industry structure and the wages associated with this and the consequential impact on GVA. In light of these uncertainties, the medium and high scenarios take a prudent view of employment re-absorption. Some commentators have suggested that labour re-absorption could be achieved over a shorter time period.

Other tidal power options – no impacts are assumed to occur and this is based on there being no blocking or adverse impacts on the shipping channel which would result in displacement. However, there is uncertainty in relation to the impact of the Tidal Fence. The range between a large barrage (which represents a significant negative impact) and a tidal lagoon which may have a minimal impact on port operations may be used to provide potential boundaries of impact.

Economic Impact of Displacement

These displacement assumptions have been applied to the baseline GVA figure of £229m over the time period specified above for construction and operation and discounted to Net Present Value using the Treasury Target Discount Rate of 3.5% for years 1-30 and 3.0% for years 31-40. As illustrated in the table below, this gives a very wide range of impact outcomes. Key points are:

- The 'large barrage' options generate high impact nearly £1.9 billion GVA for the 'high impact' scenario (construction and operation) and around £0.7 billion for the 'low impact' scenario.

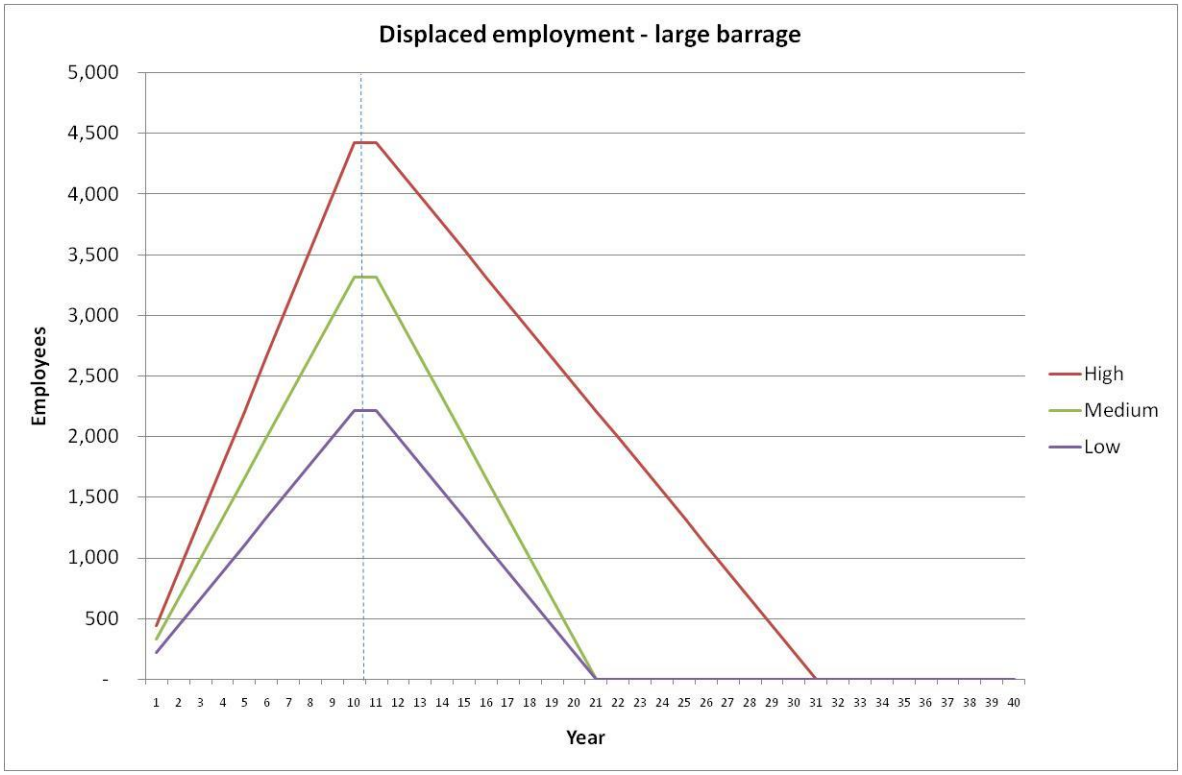
- The 'small barrage' options and other tidal power options have much more modest impact figures from no net impact to £220 million GVA.
- On the basis of the assumptions used, there are roughly similar levels of impact generated between construction and operation for the different scenarios.

Project & Impact Category	Construction (10 years large barrage, 5 years small barrage & lagoon)	Operation (30 years large barrage, 35 years small barrage & lagoon)	Total Impact
	GVA (£m)		£m
Large Barrage			
High impact	800	1,070	1,870
Medium impact	600	470	1,060
Low impact	400	310	710
Small Barrage & Lagoon			
High impact	60	160	220
Medium impact	30	50	80
Low impact	-	-	-

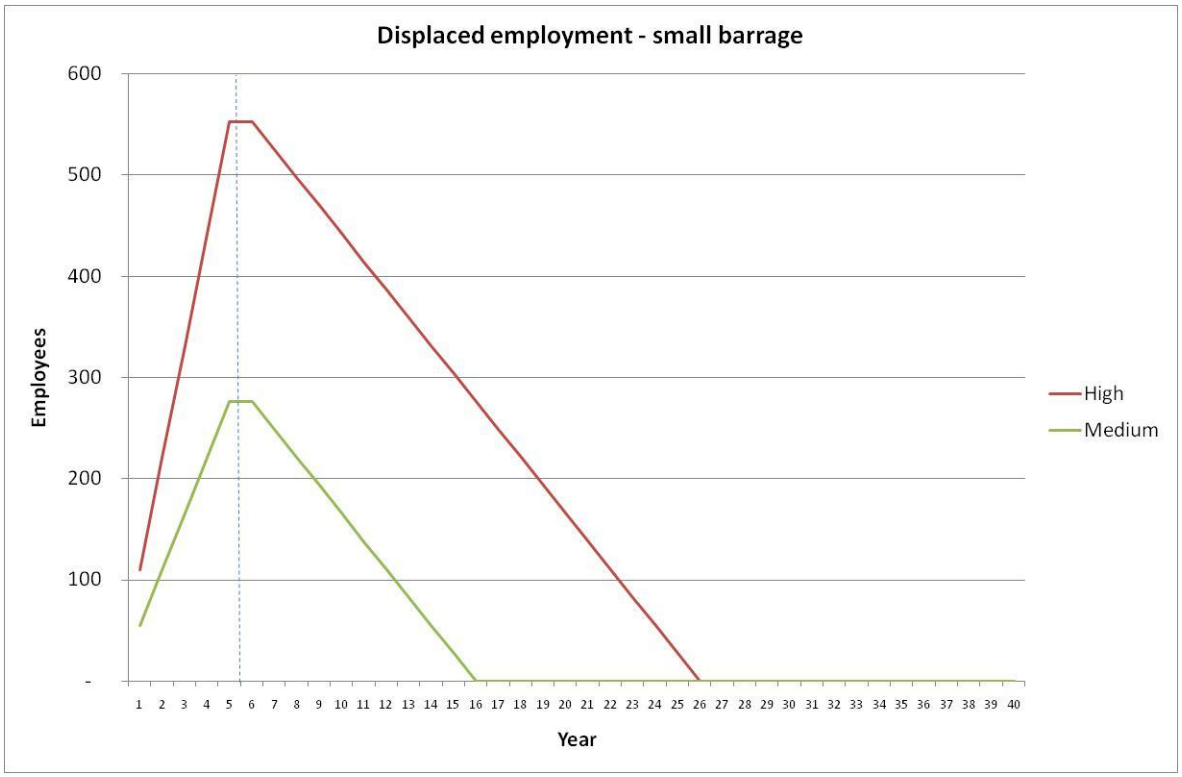
In terms of employment impact the large barrage results in the loss of a maximum of 4,400 jobs under the 'high impact' scenario in years 10 and 11 and 2,200 jobs under the 'low impact' scenario. The graph on the next page illustrates how the employment impact rises steadily during the construction phase and peaks in years 10/11 and then declines due to the absorption and substitution effects described above.

For the small barrage option the employment impacts are much more modest and lie in the range 0 – 550 jobs lost for the low and high impact scenarios – see graph on the next page.

It is important to note that no quantification of the additional port traffic relating to the construction and operational phases of the tidal power options has been included. For example, this would relate to the handling of cargo, equipment and shore support which, for logistical reasons, would most effectively be handled by existing or new port infrastructure in the Severn Estuary. This has the effect of overstating the adverse employment and GVA impacts calculated in this Section.



* Dotted line represents the movement from construction to operation



* Dotted line represents the movement from construction to operation

This assessment has not taken account of potential ancillary investment to enhance port capacity elsewhere within Wales and the South West of England.

4.4.4 Deep Sea Container Terminal

Further negative consequences are likely to arise for the DSCT project. The project is still in its early planning stages but Bristol Port has stated that investment associated with the project is likely to be around £500 million and is likely to be less viable with a larger barrage (option B3) with negative consequences also likely with options B1 and B2. The DSCT has not been incorporated into the quantitative analysis above, but proceeding with the large barrage could have an additional impact through curtailment of DSCT plans. Most, if not all, of the DSCT impacts will accrue in the South West rather than Wales, providing a potentially significant boost to sub-regional activity if it goes ahead.

However, this is an uncertain project, which may not materialise even if no tidal power projects are developed. Hence, we believe that quantifying impact is not the most appropriate course of action at this stage, especially as displacement/crowding out effects, in a generic form, are factored in elsewhere in the analysis.

Large Barrage

Topic	Significance		Scenario			Assessment of Risk	S
	Magnitude	Activity	H	M	L		
Air	0	0				Small impact in terms of increased use of air travel mainly during construction, but some impact during operation	C
Road	?	?				Significant impact during construction process as movement of workers, goods and materials could contribute to significant road congestion (especially M4-M5 interchange). Potential for some impact during operation due to increased road travel by workers and tourists	C
Rail	?	?				Potentially some impact during construction due to movement of workers, goods and materials which could lead to congestion or delays on the network	C
Ports: Construction		-				The large barrage is likely to have the largest impact on port activity. Construction taking place in the Severn estuary will impede shipping and therefore reduce the competitiveness of all ports upstream of the construction site(s)	C
Ports: Construction		+				Port facilities will be needed for the construction process – both for importing goods and materials; and for undertaking construction activity. This could generate additional business for the existing ports.	C
Overall Ports Construction			£795 million (GVA) and peak job losses of 4,400 (2,400 jobs on average)	£596 million (GVA) and peak job losses of 3,300 (1,800 jobs on average)	£397 million (GVA) and peak job losses of 2,200 (1,200 jobs on average)		
Ports: Installation of Locks		-				The installation of locks will increase the time taken to access all ports upstream of the barrage, which will reduce the competitiveness of these ports.	O
Ports:						The increased water level upstream of the barrage will reduce the tidal range,	O

Large Barrage							
Changes to Tidal Range						increasing the tidal window, improving access to the ports. However, reduction in the high water level will reduce access to some ports upstream of the barrage	
Overall Ports Operation			£1,074 million (GVA) and peak job losses of 4,400 (1,500 jobs on average)	£468 million (GVA) and peak job losses of 3,300 (600 jobs on average)	£312 million (GVA) and peak job losses of 2,200 (400 jobs on average)		

Small Barrage & Lagoon

Topic	Significance		Scenario			Assessment of Risk	S
	Magnitude	Activity	H	M	L		
Air	0	0				Small impact in terms of increased use of air travel mainly during construction, but some impact during operation.	C
Road	?	?				Significant impact during construction process as movement of workers, goods and materials could contribute to significant road congestion (especially M4-M5 interchange). Potential for some impact during operation due to increased road travel by workers and tourists.	C
Rail	?	?				Potentially some impact during construction due to movement of workers, goods and materials which could lead to congestion or delays on the network.	C
Ports: Construction		-				The small barrage is likely to impact on port activity. Construction taking place in the Severn estuary will impede shipping and therefore reduce the competitiveness of all ports upstream of the construction site(s)	C
Ports: Construction		+				Port facilities will be needed for the construction process – both for importing goods and materials; and for undertaking construction activity. This could generate additional business for the existing ports.	C
Overall Ports Construction			£61 million (GVA) and peak job losses of 550 (330 jobs on average)	£30 million (GVA) and peak job losses of 280 (170 jobs on average)	No net impact		
Ports: Installation of Locks		-				The installation of locks will increase the time taken to access all ports upstream of the barrage, which will reduce the competitiveness of these ports. In the case of the small barrage it is likely that only Sharpness will be affected.	O
Ports:		+				The increased water level upstream of the barrage will reduce the tidal range,	O

Small Barrage & Lagoon							
Changes to Tidal Range						increasing the tidal window, improving access to the ports. However, reduction in the high water level will reduce access to some ports upstream of the barrage. In the case of the small barrage it is likely that only Sharpness will be affected.	
Overall Ports Operation			£159 million (GVA) and peak job losses of 550 (170 jobs on average)	£46 million (GVA) and peak job losses of 280 (40 jobs on average)	No net impact		

Other Tidal Power Schemes (Tidal Fence and Tidal Reef) Uncertain and Un-quantified.

Topic	Significance		Scenario			Assessment of Risk	S
	Magnitude	Activity	H	M	L		
Air	-	0				Small impact in terms of increased use of air travel mainly during construction, but some impact during operation.	C
Road	- -	-				Significant impact during construction process as movement of workers, goods and materials could contribute to significant road congestion (especially M4-M5 interchange). Potential for some impact during operation due to increased road travel by workers and tourists.	C
Rail	-	0				Potentially some impact during construction due to movement of workers, goods and materials which could lead to congestion or delays on the network.	C
Ports: Construction	-	-				Construction taking place in the Severn estuary could impede shipping and therefore reduce the competitiveness of all ports upstream of the construction site(s).	C
Ports: Construction	+	+				Port facilities will be needed for the construction process – both for importing goods and materials; and for undertaking construction activity. This could generate additional business for the existing ports.	C
Port Operation			No Estimate	No Estimate	No Estimate	It is unclear how other STP options will impact upon ship movements and the competitiveness of affected ports. As such it has not been possible to estimate the impact of	
Overall			No Estimate	No Estimate	No Estimate		

In summary the impacts on ports from a large barrage ranges from a loss of £1.9 billion GVA (worst case scenario) to a loss of £710 million GVA (best case scenario). At the peak this impact equates to 3,300 jobs (with a range of 2,200 to 4,400) or an annual average ranging from 1,800 jobs (worst case scenario) to 600 jobs (best case scenario).

In summary the impacts on ports from a small barrage or lagoons range from a loss of £220 million GVA (worst case scenario) to no net loss (best case scenario). At the peak this impact equates to 550 jobs or an annual average ranging from 190 jobs (worst case scenario) to no net job losses (best case scenario).

Overall Local Area Effects

The focus of impact during the construction phase will be local – in terms of adverse impacts on the affected ports of Bristol, Cardiff, Newport and Sharpness. The assessment does not include potential benefits associated with the potential inflow of materials via the Bristol Channel and only considers the negative impacts on specific ports that may be disrupted by increased construction traffic and build programme.

As ports distribute goods nationally, these impacts may be felt more widely than Wales and the South West- although the net direct effect on employment and GVA will be very localised in impact (i.e. location specific, relating the specific port activity impacted)

5. Fishing

5.1 Summary of Impacts

The table below presents the main findings in relation to the potential impact of the STP options on the fishing industry. In this chapter, three core components of the fishing sector have been reviewed. These include recreational freshwater salmon angling, recreational marine angling and commercial eel fishing.

Baseline	The estimated expenditure value of salmon and sea trout fishing along the rivers Usk, Taff, Wye and Severn is estimated at £1.3 million. Commercial eel fisheries are estimated at £1.3 million based on export value. Recreational expenditure value marine angling is estimated at £1.6 million. In total, these three activities contribute approximately £2 million gross GVA per annum to the regional economy and account for approximately 90 gross FTE jobs.
Gross Direct Effect	Gross direct effect of barrages in the worst case scenario is a loss of £2 million GVA per annum and a loss of circa 90 FTEs (the gross direct effect of lagoons, is uncertain, and therefore assumed similar to the barrage impact because of the existence of turbines and their potential to damage fish populations). No detailed information is available in relation to either the tidal fence or tidal reef.
Leakage	Leakage of 25% has been assumed for recreational salmon fishing, given that lengths of the Severn and Wye are outside the study area. No other leakage has been assumed.
Displacement	A displacement rate of 59.5% has been applied based on another study estimating the value of recreational salmon fishing to both recreational freshwater salmon fishing and recreational marine angling. No displacement assumed for commercial eel fishery activity. The displacement rate has been varied in the sensitivity analysis.
Crowding Out	Not applicable
Multiplier Effect	1.29 to both recreational freshwater salmon fishing and recreational marine angling, but no multiplier applied to the commercial eel export value.
Local Net Additional Impact	Loss of a total £30m million net GVA over a 40 year impact period if these three activities are lost from the area as a result of the STP and the loss of circa 70 FTEs. This assessment has excluded the capital value of recreational salmon and sea trout freshwater angling to fishery owners.

Note that the capital value of recreational salmon and sea trout freshwater angling has not been included in the assessment. This is because the assessment looks at changes to the flow of employment and GVA and not capital stocks. However, it is estimated that these rights could be worth in the ballpark of circa £17 million, although there is considerable uncertainty in relation to this estimate.

5.2 Regional Context

Fishing was identified as a key sector that will be directly impacted by the development of most options. The primary source of impact being considered in this paper is on the economic agents dependent on fishing, as opposed to the value that society places on fish.

Therefore, the main sources of impact relate to the:

- Potential disruptions to fish stocks and the impact on commercial fishing activity
- Potential disruption to fish stocks and the impact on recreational fishing activity.

As detailed in SEA Topic Paper Other Sea Bed Users[30]; commercial fishing is transient and reliant on the availability of target species. The tidal power options have the potential to impact on these target species through causing a change in habitat, and consequentially factors such as prey availability. In addition, the STP may also impact on species by causing a change to spawning and nursery grounds. The existence of turbines in the tidal power options may also pose significant mortality risk for fish. The sum of these and other factors could influence:

- The species that are caught within the Severn Estuary
- The movement of fishing vessels
- The commercial viability of fishing effort
- Fishing practices that are employed.

The effects of the various tidal power schemes on commercial fishing within the study area are uncertain as it is not yet known how fish populations will be affected by the presence of the tidal power scheme in the Severn Estuary[31]. Marine commercial fishing has not been assessed, other than in reviewing ABI data on the overall estimated value of this activity, as discussions with APEM indicated that overall commercial fishing was a small and declining industry in the area[32]. Commercial salmon and commercial sea fishing have not been included in the analysis.

However, it should be noted that if strategically important nursery grounds in the estuary are heavily impacted by the STP, there may be effects further afield. Studies in the upper Forth estuary suggest that the fish populations associated with the estuary would be some 66% greater if the historic land claim over the past 200 hundred years had never occurred[33]. The special significance of the high intertidal zone - Elliott & Taylor (1989) reported that intertidal

[30] Draft 3 (230908), p46
[31] Draft 3 (230908), p46
[32] Note: S Hull 26th September 2008
[33] McLusky, Bryant & Elliott (1992) taken from (S COLCLOUGH, 2005) Fish utilisation of managed realignments; Fisheries Management and Ecology, 2005, 12, 351–360

habitats in the Forth were at least twice as productive as their sub-tidal counterparts[34]. Whilst this study has not reviewed impacts at an UK level, it is important to flag this potential economic impact for consideration in the UK national economic study.

According to the Scoping Topic Paper: Fish[35] *"the rivers entering the Severn Estuary support a diverse range of fisheries, including coarse, migratory salmonids and eel. River angling is a major recreational pastime, and contributes considerably to the regional economy. The Rivers Severn, Usk, Wye and Taff alone represent 8% of the England and Wales salmon rod catch. Sea angling in the Bristol Channel is of recreational importance although there is relatively little commercial fishing activity in the area. Net and fixed engine fisheries for salmon have been historically very significant in the Severn Estuary and its rivers. The fishery is now small as a result of buyouts however the remaining fisheries are traditional and often unique and as such are of cultural and heritage importance."*

In addition, eel have been highlighted as an important species, in particular for their value in re-stocking European rivers.

In light of these issues, this chapter focuses on the following areas:

- Recreational Freshwater River Salmon and Sea Trout Angling
- Recreational Sea Angling (to include shore based and boat based)
- Commercial Eel fishery activity

According the Fish Topic Paper, Bristol Channel sea angling is of great recreational value. The fishery is targeted at a small number of species with sport or eating value, notably: bass, grey mullet, cod, whiting, pouting, eel, sole, flounder, conger, rays (several species), lesser spotted dogfish and smooth hound. Both boat[36] and shore angling are popular and angling club records estimate the annual recreational catch at 1,000 tonnes (DOE 1989). The Severn Estuary and Bristol Channel shoreline is nationally important for shore fishing competitions.[37]

Sea angling contributes to the local economies of Somerset, Devon and South Wales, with an estimated 30 charter vessels operating from ports upstream of Ilfracombe and Swansea, and ca. 40 angling clubs having a direct interest in the Bristol Channel.

The Fish Topic Paper identifies that there are a number of factors that impact on the fish population, including factors such as changes in water temperature and oxygen levels. Some of these changes may occur in the absence of the STP options due to Climate Change effects. Therefore, establishing a baseline for all species is difficult (i.e. what would happen to species levels in the absence of STP). Furthermore, in assessing the economic impact of changes to fish, no account can be made of the regulatory changes that may come to play in the future (i.e. if a base case scenario predicted the decline of a certain species to a dangerous level then it is possible that fishing activity would be more carefully controlled

[34] SEA Fish Topic Paper; p 119
[35] Migratory and Estuarine Fish Draft G October 2008
[36] Estimated that there are approximately 30 charter boats in operation, SEA Topic Paper Other Seabed Users
[37] Source: Fish Topic Paper G; p 33

through regulation). Therefore, when reviewing the economic impact assessment, it should be noted that a 'here and now' approach has been adopted.

This chapter has examined the information produced by the SEA Scoping Report Migratory and Estuarine Fish Draft G and assessed the potential economic impacts of the STP options on recreation river salmon angling, recreational sea angling and commercial eel fishing. The most recent data available has been used to set the fixed baseline.

Areas of STP impact on the Fish Population

The STP options may impact fish populations in a number of ways. Key issues that have been highlighted include:

- Alterations to migration cues (e.g. changes to freshwater influx)
- Risk of mortality and injury through turbine passage
- Disruption to route of passage
- Habitat changes
- Water quality change

Migratory species (such as salmon) rely on freshwater discharge as a migratory cue. The large barrage will impact most of the major Severn Estuary tributary rivers and therefore most of the migratory species entering the rivers will be affected by reduced freshwater inflow[38].

The small barrage is likely to encompass fewer rivers and, as such, migratory species from rivers downstream of the structure are not likely to be affected by reduced migratory cues.

It is unclear how the tidal lagoon will impact migratory cues as it is unclear which rivers may be encompassed.

The physical object of the STP will also potentially impact fish because of factors such as noise, disrupting routes of passage, shear stress associated with moving between two water masses, increased predator attacks etc. In addition, the passage through turbines will increase the risk of injury and mortality to fish. In particular, migratory fish species are considered to have the greatest potential of receiving turbine passage related injury, in particular species such as salmon, are repeat spawners[39]. These factors apply to the large barrage, small barrage and lagoon options. No detailed assessment of the Tidal Fence or the Tidal Reef has been completed (lack of information) in the Fish Topic Paper and therefore DTZ cannot analyse this in any detail.

In addition to negative impacts, there are potentially positive impacts. Linked to the barrage options (large and small barrages), there may be a reduction in the turbidity of the water, which has been suggested could help support the development of shellfisheries in the upstream area of the barrage. However, this is dependent on the right water quality conditions being achieved (PB, 2008, p51) and, according to APEM, shellfisheries are very small, with very limited potential to grow. Therefore, this activity is not considered as significant within this economic impact assessment.

[38] SEA Fish Topic Paper, Draft G; p109
[39] i.e. likely go through turbines more than once.

There is potentially a positive impact from the large and small barrages on recreational angling of some species, as a result of longer periods of high water, reduced water turbidity and improved water quality and access[40]. There will also be an impact on angling, which is conducted from shore areas along the estuary area, which may be positively or negatively impacted, depending on the fish stocks disrupted.

5.3 Areas of Impact

Sea Angling (Recreational)

According to the Fish Topic Paper Draft G[41], the total annual catch in the Severn Estuary has been estimated in the past to be about 1,000 tonnes (DOE 1989) although it is thought to have risen considerably over the past two decades. The main species considered to be targeted by anglers are bass, cod, whiting, grey mullet, flounder, sole, lesser spotted dogfish, small eyed ray, thornback ray, conger eel and ling which are also species of interest for commercial fishermen (DOE 1989).

Shore and boat angling is popular, with rock stances giving best access to deeper waters and about 40 angling clubs fish in the Bristol Channel.

Angling opportunities seaward of the STP options are not expected to change considerably[42].

The Topic Paper identified that angling opportunities upstream of the STP may increase as a result of:

- Deposition of finer sediment attracting suspension feeders and increase the number of fish in localised areas
- Increase in the number of predatory piscivore fish being attracted by dead fish, killed during turbine passage and disorientated fish
- The potential reduction in intertidal flats, and potential improved accessibility to deep water (shore anglers)
- The operation of a STP may restrict wave passage and wave height, and could result in better sea conditions and an increase in the number of suitable fishing days for boat based angling[43].

However, it is uncertain what impact STP will have on fish population and therefore, the STP potential impact on estuarine fish species angling is considered to be of medium significance in the Fish Topic Paper (i.e. there are factors that may increase angling, but also reduce angling)[44].

Freshwater Angling (recreational)

In terms of freshwater angling, the most important rivers entering the Severn Estuary are the Rivers Usk, Wye and Severn each of which support migratory salmonids.

[40] Based on discussion in SEA workshop on the 07/08/08
[41] SEA Fish Topic Paper Graft G, p 133
[42] SEA Fish Topic Paper Draft G, p.133
[43] SEA Fish Topic Paper Draft G; p133
[44] SEA Fish Topic Paper Draft G, p 151

The SEA Scoping Topic Report: Fish[45] states

"Potential physical effects of the STP option on salmon have been discussed earlier which could lead to loss of individuals. Further modelling to assess alterations to water quality and habitat changes post-STP is required to clarify if migratory fish species, including salmonids, would potentially be adversely affected by these changes. If there was an increase in availability of prey items this could potentially be beneficial for any migratory fish species if they were feeding during passage through the estuary. Overall, however, if the STP option were to have a negative effect on migratory salmonid movement/survival within the Severn Estuary this could influence migratory salmonid numbers and hence migratory salmonid angling success within these rivers. Consequently, any loss of migratory salmonids, and other migratory species which are occasionally fished by anglers (e.g. eel) has both ecological and economic implications for the region."

Despite the uncertainty associated with the precise impact of the STP options on migratory fish (e.g. salmon), in this assessment of the potential economic impact of the tidal power option, DTZ have assumed that salmon and sea trout will be adversely impacted by the STP options. The following factors have been considered in making this assumption:

- Impact of reduced migratory cues;
- Impact on mortality rates associated with passage through turbines;
- Disruption to routes of passage; and
- Change in habitat.

The extent of impact on migratory fish population will vary by STP option. DTZ have made the following assumptions, based on information contained in the SEA Scoping Report: Topic Fish, Draft G. These assumptions are:

- Large barrage will encompass most of the important salmon fishing rivers with the Severn Estuary area (i.e. the Rivers Wye, Usk and Severn). The potential negative impacts on migratory cues, death by turbine passage, change in water quality are assumed to have a cumulative negative impact on the salmon population and therefore reduce the level of recreational freshwater migratory angling in these rivers.

- Small barrage encompasses fewer rivers within the Severn Estuary area. However, it will continue to impact important salmon fishing rivers such as the River Wye, Usk and Severn, although the Beachley barrage (B5) is located upstream of the Wye confluence. It is therefore assumed to have a similarly negative impact on recreational freshwater migratory fish angling in these rivers

- The impact of lagoons on migratory cues is dependent on their precise location and which rivers are encompassed. In addition, the impact on fish passages, water quality, temperature etc are less clear. However, given the potential scale of lagoons and the potential for multiple lagoon developments, for the purpose of this assessment, the development of lagoons are assumed to have the same negative impact on recreational freshwater migratory angling in the river Severn, Usk and Wye

[45] SEA Fish Topic Paper Draft G, p 132

as the barrage options. Whilst there is uncertainty here, the potential for increased fish mortality from turbine passage remains a significant risk, and therefore this assumption is considered appropriate.

Commercial Eel Fishing

The Severn represents a major component of the UK eel stock[46]. The eel fisheries on the River Severn exist under license for the Environment Agency. There is no monitoring of glass eel recruitment that is independent of the fisheries on the River Severn. However, glass eel trends are expected to be similar to those of for England and Wales as a whole.

According to the EA report[47], British glass eel and pigmented elver catches are almost exclusively exported, as are the majority of yellow and silver eels. Declared catches of glass eel have fallen from around 60 tonnes in the late 1970s to less than one tonne between 2002 and 2004. However, data in relation to catches may under-represent the true volume[48].

According to the Fish Topic Paper, the effect of the tidal power options will need to be carefully assessed with regards to upstream (passive and active) and downstream migration, and the area of suitable habitat available for elver maturation after any hydrological changes.

The assessment has identified that the following were all potentially significant issues:

- Changes to migration cues;
- Change in water quality;
- Change to habitat; and
- Disruption to route of passage including turbine passage

From this, DTZ have assumed that the commercial fishing of eels will be negatively affected by the large barrage, small barrage, and tidal lagoons.

5.4 Gross Direct Impact

The gross economic impact of the tidal power options on the economic value of fishing will be primarily influenced by the negative impacts on salmon angling (freshwater recreational activity), eel fishing[49] and trapping (commercial). There is uncertainty over the impact of STP on recreational sea angling, which may increase or may decrease depending on the balance of e.g. improved angling conditions against potential fewer species to catch.

Whilst there is some potential variance in the impact of the various STP options on the fish population and consequential fish related activity, for this assessment DTZ has assumed that the scale of impact will be the same for a large barrage, small barrage and tidal lagoons.

[46] Fish Topic Paper, p 70
[47] Economic Evaluation of Eel and Elver Fisheries in England and Wales EA, R& D Technical report W2-039/TR/2, 2001
[48] Fish Topic Paper, P72. Increased volume of true catches suggested because of dependency on Customs and Excise data, and the statement that many fishermen work in the black market (EA, W2-039/TR/2, p v)
[49] Based on SEA Topic Paper Other Sea Bed Users Draft 04 08 2008 claiming that Salmon and Eels are most commercially important species

In estimating the regional economic impact of the STP options on recreational salmon and sea trout angling, recreational sea angling and commercial eel sector, it is important to establish a baseline position. Each of these areas is discussed below.

Recreational Freshwater Salmon and Sea Trout Angling- Gross Value

The Environment Agency has supplied DTZ with detailed information on the fishing returns in relation to the rivers Usk, Wye, Severn and Taff. These results show that a total of 9,187 fishing days occurred on the rivers in 2007. The data on anglers and the number of days fished shows that 48 percent of all fishing days were utilised by anglers originating from Wales and the South West. The remaining angling days were utilised either by anglers assumed to be fishing relatively locally, 33% (i.e. close to the river, but not living in either Wales or the South West) or visiting from afar, 18%. The distinction between those who visit from afar and those who live in close proximity to the rivers is important as their relative spending on angling will vary (i.e. anglers who fish locally spend less than those who travel from a distant and have additional requirements such as accommodation needs).

Primary results from a study conducted by PWC[50] assessing the potential economic benefit of salmon fishing in Northern Ireland provides the basis for estimating the average expenditures associated with the activity. The results distinguished between local angler expenditure and visiting angler expenditure. Local angling expenditure was presented as an annual figure (based on the total number of local anglers) and visitor angler expenditure was presented as a 'per day' figure (and the number of days has therefore been captured). Applying these to the profile of the anglers on the rivers Usk, Wye, Taff and Severn gives the following broad estimates of gross angling expenditure[51]. The analysis is based on a 'here and now' assessment. The baseline trend in salmon catches may increase in the future (as a consequence of existing salmon angling controls)[52]; but this has not been considered.

The results are shown below[53].

	Average Expenditure	Number of Anglers/ Days Angling	Gross Expenditure Impact
Visitors (days)	£103.80 per day	1,950 days	£202,300
Locals (no. anglers)	£1,253 per annum	550 anglers	£686,400
Borders (no. anglers)[54]	£1,253 per annum	300 anglers	£380,400
Total			£1,269,100
Note: figures have been rounded and may not sum to the total			

The gross expenditure of angling on the rivers Usk, Wye, Taff and Severn are therefore estimated to result in approximately £1.3 million of expenditure to the local economy per annum. Applying the UK ratio of turnover to GVA of the fishing industry in 2006 to the expenditure estimates, and inflated to 2008 values, gives an estimated gross GVA impact of

[50] The Social and Economic Impact to Northern Ireland and areas within the Lough Agency; Recreational Fisheries, Angling and Angling Resource
[51] 2007 value
[52] EA assertion
[53] Note: total proportion of angling has been inflated by 10 percent to account for under reporting; as advised by the EA. Number of anglers and angling days sourced from EA data
[54] Borders defined as Shropshire, Herefordshire and Worcestershire

£640,000. Applying the South West GVA per FTE[55] to this estimate suggests that around 30 gross FTE jobs would be supported by recreational angling expenditure. This estimate is based on the GVA per FTE of the agriculture, fishing, and forestry sector.

However, the expenditure generated by recreational salmon angling is only a component of the total value of recreational salmon fishing. Excluding the social value associated with the activity (which falls beyond the scope of this study), there is a capital value attached to the fishing rights of these rivers.

According to the EA, the capital value to fishery owners (right owners) is in the ballpark of £9,000 per salmon caught *(i.e. in valuing the fishing rights, a ball park figure of £9,000 per salmon caught – five year mean can be applied, to estimate the value of a stretch of river*). In 2006, a total of 1,644 salmon and 252 sea trout were caught on the Rivers Usk, Wye, Severn and Taff. Applying the ball park estimate of £9,000 per fish caught would result in an estimated capital value to fishery owners of circa £17 million. However, as indicated by the EA, this is only one method of estimating capital value to owners and the market value is only truly captured during the market transaction of fisheries[56].

If the development of the STP options disrupted recreational salmon angling to the point that it would stop, approximately £1.3 million expenditure would be lost to the region (including surrounding counties) each year with an associated GVA loss of £640,000 and 30 FTE jobs. The wider impact on capital values is unclear, but could potentially be in the ball park of one-off losses of circa £17 million. Given the geographic locations of the rivers Usk, Wye and Severn, these impacts will have a greater impact on Wales than the South West of England.

Gross Value of Commercial Eel Fishery

According to the EA, there are approximately 500-600 eel licenses issued for the Severn Estuary area (including supporting rivers). In the main, glass eel fishery is the main eel related activity of the region; with yellow and sliver eel fisheries less valuable and mainly focused around Wessex.

Glass eel fishery is dependent on fishermen catching eels between February-May period and selling the catches to a holding company. The very vast majority of the eels are exported, either to Europe and the Far East. The total number of people employed in the glass eel fishery sector is unknown and whilst the number of licenses can be used as a proxy for the number of fishermen, it is unlikely that these are full time jobs (given the seasonal nature of the activity).

In 2006, the UK exported at total of 8.2 tons of glass eel, at an export value of £1.3 million[57]. According to the EA, the vast majority of these would have been sourced from the Severn Estuary area. The export value of glass eel includes the price paid to fishermen for the eels, the operational cost of handling eels for export and any margin that a holding firm would

[55] Sourced from the SW Observatory; 2005 GVA per FTE in sic 00-05 applied (£21,300) and inflated to 2008 value (£22,879) using HM Treasury GDP deflator series (0.92589).
[56] Cadora Fishery (Wye) recently sold for £550,000; with a five year mean catch of 49 salmon. It is assumed that £70,000 of this value was for grazing land. This would suggest that the angling rights were valued at £480,000/49 salmon= £9,800 per salmon.
[57] Source: telephone discussion with EA Eel Expert

make. Applying the UK ratio of turnover to GVA of the fishing industry in 2006 to the expenditure estimates, and inflated to 2008 values, gives an estimated GVA impact of £656,000 and employment estimates of approximately 30 FTEs.

It is assumed that all of the export value and related employment would be lost from the region if the commercial glass eel fishing was negatively impacted due to the changes in the overall population resulting from the development of a tidal power option. For this assessment, we have assumed that a total expenditure of £1.3 million would be lost, based on the known 2006 export value or a estimated gross GVA impact of approximately £656,000 and 30 FTE jobs.

Recreational marine angling (shore and boat) - Gross Impact

According to a report by Nautilus Consulting reviewing the inland and sea fisheries in Wales[58], the Severn Estuary[59] attracted approximately 27,000 local shore anglers, and 10,000 visiting shore anglers in 2002. In addition, a further 2,500 local and 8,500 visitors anglers utilise local charter boats. Utilising Nautilus expenditure estimates[60], this equates to:

Severn Estuary	Local	Visitor	Total
Shore angling	27,200	10,200	37,400
Spend per day	£15	£45	-
Total Shore Expenditure	£408,000	£459,000	£867,000
Charter Boat	2,550	8,500	11,050
Spend per day	£45	£70	-
Total charter boat expenditure	£114,750	£595,000	£709,750
Overall Total Expenditure	£522,750	£1,054,000	£1,576,750

This suggests that the gross expenditure associated with recreational marine fishing in the Severn Estuary equates to approximately £1.6million per annum (gross expenditure), based on 2001 prices. Applying the UK ratio of turnover to GVA of the fishing industry in 2001 to the expenditure estimates, and inflated to 2008 values, gives an estimated gross GVA impact of £726,000 and employment impact of approximately 30 FTEs

5.5 Net Additional Impact

In assessing the net additional impact of the STP options, a number of factors need to be taken into account. These are each discussed below. The summary tables present the PV of impact, discounted at 3.5%[61] and 3%[62] for a 40 year period.

[58] 2000 report
[59] This is based on data from the Nautilus report. It is unclear whether this would include sea angling activity in the Severn Estuary to include South West of England activity. The total number of anglers may be under estimated.
[60] P 51 Nautilus Report
[61] Applied to years 0-30 based on Treasury guidance
[62] Applied to years 31-40 based on Treasury guidance

5.5.1 Leakage

The extent to which the benefits or costs from fishing are leaked outside the region depends to an extent on the calculation of the reference case. In assessing the gross economic value of recreational salmon angling, benefits accruing to those outside of the region have been included; in particular benefits derived from areas of the rivers Severn and Wye that fall outside of the study area. In assessing the net economic impact on Wales and the South West, these expenditure benefits need to be removed.

In estimating the leakage effect in relation to recreational salmon angling, as 25 percent of the anglers come from counties outside of Wales and the South West; but remaining in close proximity to the specific rivers (namely Wye and Severn) a leakage rate of 25 percent has been applied to the gross impact, to account for benefits accrued outside of the region.

In assessing the commercial glass eel gross regional impact; we have assumed that all of the benefits of the sector are retained within Wales and the South West. As the EA have estimated that at least 90 percent of glass eel activity is related to the Severn Estuary area; we believe that the assumption of zero leakage is appropriate.

In assessing the gross economic value of recreational marine fishing, we have assumed zero leakage and that the benefits are retained within Wales and the South West. Given that the benefits are dependent on location of activity (i.e. recreational marine angling in and around the Severn Estuary area) it is assumed by DTZ that very little leakage of benefits is likely to occur. Therefore, the assessment applies a rate of zero leakage to the activity.

5.5.2 Displacement

The potential displacement effects of each of the options will need to be considered. Displacement effects relate to the extent by which the impact of this activity (development of an option) reduces or increases the activity of the private or public sector within the region by utilising the potential available resources. In the case of fishing, displacement effects may include a change in the viability of commercial revenues from a change in fish activity (i.e. an increase in coarse fishing, freshwater non-migratory angling; an increase in angling revenues elsewhere in the region). Again, great care must be taken in developing the reference case and gross impact to ensure that these potential displacement effects are not double counted.

According to the PWC report, a displacement of 59.5% is applicable to game fishing (which would include recreational salmon angling). This takes into account the ability of fishermen to fish in other areas within the geographic reference region (Wales and the South West of England), to fish for other species and to undertake other recreational activity. This rate of displacement was estimated from primary research undertaken with anglers and is therefore assumed to be appropriate. A similar level of displacement may be applied to the recreational marine angling, assuming that other coastal areas of Wales and the South West will be able to accommodate increased demand. This displacement assumption is subsequently varied as part of the scenarios approach.

5.5.3 Crowding Out

Crowding out is the extent to which an increase in demand occasioned by government policy is offset by a decrease in private sector demand. Crowding out differs from displacement because it relates to wider economic effects. It is a macroeconomic rather than microeconomic phenomenon. Therefore, crowding out is not relevant in the context of fishing.

5.5.4 Multiplier Effects

Multiplier effects associated with the commercial fishing activity need to be considered. In particular, the loss of supplier incomes and their impact on the economies of Wales and the South West have to be assessed. However, in relation to commercial eel fishing, as information suggests that this is a labour intensive sector, and that little processing is undertaken; together with the inherent uncertainty over the overall value of commercial eel sector it is considered prudent to omit any regional multiplier in relation to this particular activity.

In relation to recreational salmon angling, the PWC report identified a multiplier of 1.29, which has been applied to the assessment.

In relation to recreational marine angling, in the absence of sector specific information a multiplier effect of 1.29 has been applied, on the assumption that it is similar to that of game angling reported in the PWC report.

The sum of these affects are summarised in the following tables. Please note that these relate to expenditure and not GVA.

Net Recreational Salmon Angling Expenditure Estimates			Rate of Adjustment
Salmon Recreational	**Gross Direct Effects**	£ 1,269,000	
	Leakage	£ 317,000	25%
	Gross Local Direct Effects	£ 952,000	
	Displacement	£ 566,000	60%
	Net Local Direct Effects	£ 385,000	
	Multiplier Effects	£ 112,000	1.29
	Total Net Local Effects	£ 497,000	

Net Recreational Marine Angling Expenditure Estimates			Rate of Adjustment
Marine Angling	**Gross Direct Effects**	£ 1,577,000	
	Leakage	£ -	0%
	Gross Local Direct Effects	£ 1,577,000	
	Displacement	£ 938,000	60%
	Net Local Direct Effects	£ 639,000	
	Multiplier Effects	£ 185,000	1.29
	Total Net Local Effects	£ 824,000	

Net Commercial Eel Expenditure Estimates			Rate of Adjustment
Commercial Eel	**Gross Direct Effects**	£ 1,300,000	
	Leakage	£ -	0%
	Gross Local Direct Effects	£ 1,300,000	
	Displacement	£ -	0%
	Net Local Direct Effects	£ 1,300,000	
	Multiplier Effects	£ -	1.00
	Total Net Local Effects	£ 1,300,000	

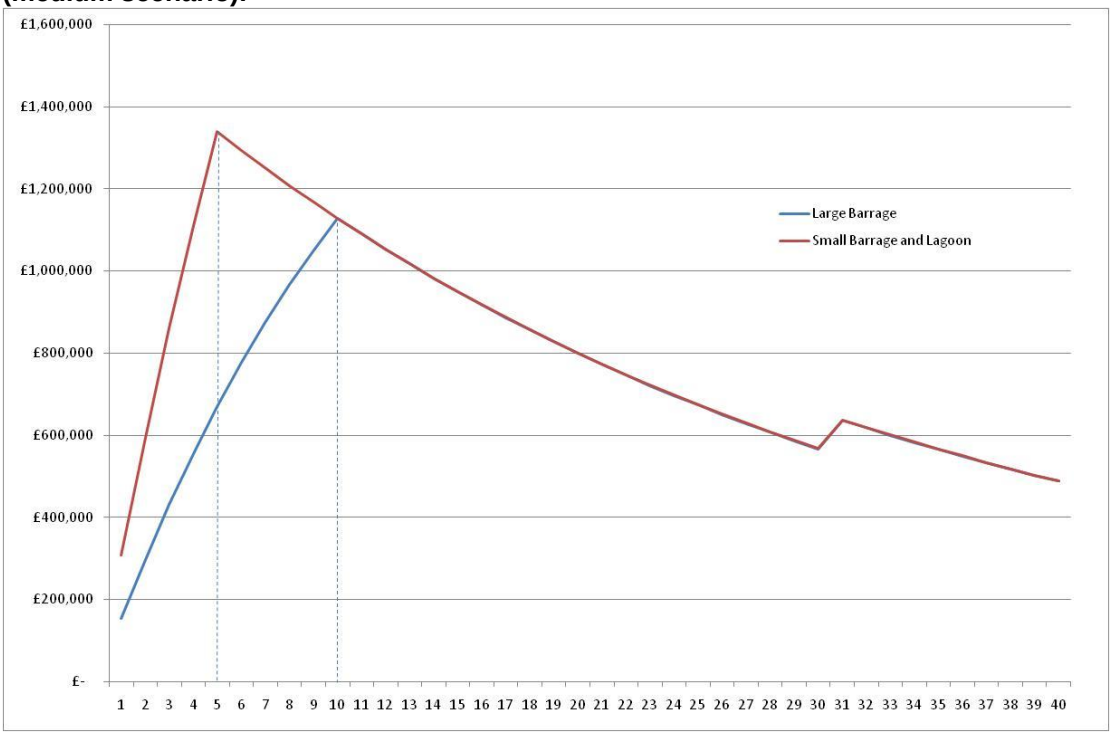
According to ABI data, the turnover to GVA ratio in the fishing industry is 0.49. Applying this figure to the estimates of net local expenditure provides the following estimates of net GVA.

Activity	Est. Net GVA[63]
Recreational Salmon	£ 251,000
Recreational Marine	£ 379,000
Commercial Eel	£ 656,000
Total	£ 1,286,000

As previously stated, given the information presented in the fish topic papers in relation to the possible detrimental impact of the STP on the fish populations (due to a number of factors including migratory cues, stress, turbine passage etc) each of the options being considered is assumed to have the same detrimental impact on the recreational salmon angling, recreational marine angling and commercial eel fisheries. As such, the key variations in impact relate to the timing of negative impacts (relating to the construction of the STP options) and the duration. This is illustrated in the following diagram.

[63] 2008 values, applying Treasury deflator

Example of GVA Impact Profile of large and small barrages over the 40 year period (medium scenario).



* Dotted line represents end of construction period.

In estimating the impact of the various options on the fishing activities discussed; the following assumptions have been made:

The 60 percent displacement rate applied to estimate the net value of recreational salmon angling and marine angling to Wales and the South West of England is considered high by the Environment Agency. Reducing this displacement rate increases the value of these activities to the regional economies. Therefore, the following changes have been made across the scenarios:

- Low Impact: 60% displacement rate applied, leading to an estimated value of £1.3m net GVA (i.e. the lowest value of activity to the economy);
- Medium Impact: Displacement rate reduced to 40% which increases the net GVA value of the activity to the regional economies to £1.6m;
- High Impact: Displacement rate reduced to 20% which increases the net GVA value of the activity to the regional economies to an estimated £1.9m.

Construction Phase Impacts:

The construction of the STP will negatively impact activity (and consequently GVA) in a linear manner over construction period, peaking at the completion of the construction process i.e. for a large barrage 10% impact in year one, increasing steadily to 100% impact by year 10. As the construction phase for small barrage and lagoons is shorter, the impact peak at the end of construction in year 5. A social time preference discount rate of 3.5% has been applied over these periods. Therefore, the small barrage has a greater impact as it disrupts fishing activities more quickly.

The loss in employment is expressed as the loss of permanent FTE jobs and therefore has not been discounted or captured in person years. They are simply, the permanent jobs lost, in perpetuity. The overall impact on employment is the same across the options (i.e. all full time jobs permanently lost).

Operational Phase Impacts:
Operational impact is assumed to have a constant negative impact on each of the three areas. I.e. we are not assuming that resources will be redeployed within the economy. A social time preference discount rate of 3.5% has been applied up to year 30, and 3% from years 31-40.

Impacts have been assessed over a total 40 year period (including both construction and operation).

The small barrage and lagoons are shown to have a greater negative impact than the large barrage because the negative impact is experienced more quickly (through shorter construction period). Therefore over the total 40 year period, the maximum negative impact (discounted to reflect social time preference) starts earlier and last longer.

It should be noted that the construction and operational jobs losses are the same and therefore not additive.

Large Barrage								
Topic	**S**	**Baseline**	**Significance of Impact**		**Scenario**			**Assessment of Risk and Level of Certainty**
		(net)	**Magnitude**	**Activity**	**H**	**M**	**L**	
Recreational Salmon Fishing	C	£0.5m GVA pa 22FTE pa	Not significant at a Wales South West of England economic level	-	-£2.1m GVA 22 FTE	-£1.6m GVA 16 FTE	-£1.1m GVA 11 FTE	10 year construction period. It is likely that unless mitigating activity is undertaken that recreational salmon fishing will diminish on the rivers Usk, Wye, Severn and Taff. The scale of impact may be lower for Wales and South West as a whole, if anglers fish in other rivers in the region (an increase in the displacement rate). This may occur during construction stage if salmon migratory patterns are disrupted. Job losses will peak in the final year of construction, estimating a loss of 10 full time equivalent jobs (medium) at this point. It should be noted that this has reviewed the economic impact of salmon angling in Wales and the South West of England; other surrounding areas will be negatively impacted by any reduction in recreational salmon angling on these rivers. In particular areas such as Herefordshire, Worcestershire and Shropshire.
Recreational Marine Angling	C	£0.7m GVA pa 33 FTE pa	As above	-	-£3.2m GVA 33 FTE	-£2.4m GVA 25 FTE	-£1.6m GVA 17 FTE	10 year construction period, with maximum negative impact peaking in the final year of construction. The peak of job losses will be 20 FTE's at this point.
Commercial Eel Fishing	C	£0.7m GVA pa 30 FTE pa	As above	-	-£2.8 m GVA 30 FTE	-£2.8m GVA 30 FTE	-£2.8 m GVA 30 FTE	10 year construction period, with maximum negative impact peaking in the final year of construction. The peak of job losses are 30FTE s at this point. No variation in impacts as displacement variable not applied to commercial eel fisheries.
Recreational	O	£0.5m	As above	-	-£6.7m	-£5.0m	-£3.4 m	PV of GVA impact is calculated over a 30 year operational period

Salmon Fishing		GVA pa 22FTE pa			GVA 22 FTE	GVA 16 FTE	GVA 11 FTE	It is likely that unless mitigating activity is undertaken that recreational salmon fishing will diminish on the rivers Usk, Wye, Severn and Taff. The scale of impact may be lower for the region, if anglers fish in other rivers in the region (an increase in the displacement rate). There is relatively high rate of leakage (i.e. the benefit from Salmon fishing is accrued to areas outside of the region such as Shropshire, Herefordshire) and therefore this regional assessment underestimates to the overall loss of wider areas around the river. The assessment omits the economic loss to fisheries, in particular the value of fishing rights, which have been estimated at circa £17m.
Recreational marine angling	O	£0.7m GVA pa 33 FTE pa	As above	-	-£10.2m GVA 33 FTE	-£7.6m GVA 25 FTE	-£5.2m GVA 17 FTE	There is substantial uncertainty over whether recreational marine angling will be negatively impact by the STP. Some factors suggest that recreational marine angling may increase. However, this assessment has assumed a detrimental impact on the fish population, and the potential negative impact on the angling as a consequence. PV of GVA impact is calculated over a 30 year operational period
Commercial eel fishing	O	£0.7m GVA pa 30 FTE pa	As above	-	-£8.9m GVA 30 FTE	-£8.9m GVA 30 FTE	-£8.9m GVA 30 FTE	Difficult to estimate the economic impact of eel fishery activity, therefore the export value has been used as a basis for estimating GVA. The export value has also been presented. PV of GVA impact is calculated over a 30 year operational period

It should be noted that job impacts associated with the construction and operational phases are NOT additive.

Small Barrage and Lagoon

Topic	S	Baseline	Significance of Impact		Scenario			Assessment of Risk and Level of Certainty
		(net)	Magnitude	Activity	H	M	L	
Recreational Salmon Fishing	C	£0.5m GVA pa 22FTE pa	Not significant at a Wales South West of England economic level	-	-£1.3m GVA 22 FTE	-£1.0m GVA 16 FTE	-£0.7m GVA 11 FTE	Five year construction period It is likely that unless mitigating activity is undertaken that recreational salmon fishing will diminish on the rivers Usk, Wye, Severn and Taff. The scale of impact may be lower for Wales and South West as a whole, if anglers fish in other rivers in the region (an increase in the displacement rate). This may occur during construction stage if salmon migratory patterns are disrupted. It should be noted that this has reviewed the economic impact of salmon angling in Wales and the South West of England; other surrounding areas will be negatively impacted by any reduction in recreational salmon angling on these rivers. In particular areas such as Herefordshire, Worcestershire and Shropshire.
Recreational Marine Angling	C	£0.7m GVA pa 33 FTE pa	As above		-£2.0m GVA 33 FTE	-£1.5m GVA 25 FTE	-£1.0m GVA 17 FTE	Five year construction period, negative impact peaking at final year of construction
Commercial Eel Fishing	C	£0.7m GVA pa 30 FTE pa	As above	-	-£1.7 m GVA 30 FTE	-£1.7m GVA 30 FTE	-£1.7 m GVA 30 FTE	Five year construction period, negative impact peaking at final year of construction
Recreational Salmon	O	£0.5m GVA pa	As above	-	-£8.6m GVA	-£6.5m GVA	-£4.4 m GVA	It is likely that unless mitigating activity is undertaken that recreational salmon fishing will diminish on the rivers Usk, Wye, Severn and Taff. The

Fishing		22FTE pa			22 FTE	16 FTE	11 FTE	scale of impact may be lower for the region, if anglers fish in other rivers in the region (an increase in the displacement rate). There is relatively high rate of leakage (i.e. the benefit from Salmon fishing is accrued to areas outside of the region such as Shropshire, Herefordshire) and therefore this assessment underestimates to the overall loss of wider areas around the river. The assessment omits the economic loss to fisheries, in particular the value of fishing rights, which have been estimated at circa £17m. PV of impact calculated over a 35 year operational period.
Recreational marine angling	O	£0.7m GVA pa 33 FTE pa	As above		-£13.0m GVA 33 FTE	-£9.7m GVA 25 FTE	-£6.6m GVA 17 FTE	There is substantial uncertainty over whether recreational marine angling will be negatively impact by the STP. Some factors suggest that recreational marine angling may increase. However, this assessment has assumed a detrimental impact on the fish population, and the potential negative impact on the angling as a consequence. PV of impact calculated over a 35 year operational period.
Commercial eel fishing	O	£0.7m GVA pa 30 FTE pa	As above	-	-£11.4m GVA 30 FTE	-£11.4m GVA 30 FTE	-£11.4m GVA 30 FTE	Difficult to estimate the economic impact of eel fishery activity, therefore the export value has been used as a basis for estimating GVA. The export value has also been presented. PV of impact calculated over a 35 year operational period.

It should be noted that job impacts associated with the construction and operational phases are NOT additive.

Other (e.g. Tidal Fence)

Topic	S	Baseline	Significance		Scenario			Assessment of Risk
			Magnitude	Activity	H	M	L	
Recreational Salmon Fishing	C	£0.5m GVA pa 22FTE pa	Not significant at a Wales and South West of England economic level	-				There is great uncertainty as to what impact a tidal fence would have on the fish population, including salmon.
Recreational Marine Angling	C	£0.7m GVA pa 33 FTE pa	As above	-				There is great uncertainty as to what impact a tidal fence would have on the fish population. The existence of turbines would suggest that there was an increased risk of mortality to fish.
Commercial Eel Fishing	C	£0.7m GVA pa 30 FTE pa	As above	-				There is great uncertainty as to what impact a tidal fence would have on the eel population
Recreational Salmon Fishing	O	£0.5m GVA pa 22FTE pa	As above	-				There is great uncertainty as to what impact a tidal fence would have on the fish population, including salmon. The existence of turbines would suggest that there was an increased risk of mortality to fish
Recreational marine angling	O	£0.7m GVA pa 33 FTE pa	As above	-				There is great uncertainty as to what impact a tidal fence would have on the fish population. The existence of turbines would suggest that there was an increased risk of mortality to fish.
Commercial eel fishing	O	£0.7m GVA pa 30 FTE pa	As above	-				There is great uncertainty as to what impact a tidal fence would have on the eel population

It should be noted that job impacts associated with the construction and operational phases are NOT additive.

Local Area Effects

The scale of impact is not substantial at a Wales and South West of England level (i.e. will not have a significant impact on the whole economy). The impacts will primarily be contained to rural and coastal areas, where angling activity takes place. Little or no impact is expected on local urban areas. This assessment is contained to recreational salmon angling on the rivers Wye, Usk, Severn and Taff. Wales will therefore be negatively impacted by the developments of the STP options as these rivers are located in Wales. The distribution of loss in relation to commercial eel fisheries and recreational marine angling will depend on the proportion of activity currently taking places in Wales and the South West of England. Not enough in known about this to comment on the distribution of losses.

The potential impacts will also affect specific areas outside of this study area; particularly relating to lengths of the rivers Severn and Wye in the Midlands.

The loss in capital value of fishing rights will be borne by the owners of these rights. Their location is unknown.

6. Land Use and Planning

6.1 Summary of Impacts

For the purpose of this chapter, the tidal schemes have been grouped into three clusters, namely:

- Large barrage
- Small barrage
- All other tidal power schemes

Baseline	Potentially £6.6 billion of assets at risk of flooding in Wales and the South West of England. 47,000 properties in flood risk areas, protected by flood defences. Sea levels are expected to rise due to climate change, so flood risk is likely to increase in the future. Future spend on flood defences are likely to be prioritised in protecting urban areas before rural areas.
Gross Direct Effect	**Large Barrage**: Could lead to a decrease in flood risk upstream; or conversely a increase in flood risk. This could lead to both positive and negative economic impacts. There may be some increase in flood risk downstream. May lose some land to dredging waste. Construction infrastructure may remain and be economically viable. There are a number of uncertainties, but net overall effect is **potentially a significant benefit** as mitigating works to overcome negative impacts are included in construction cost estimates. **Small Barrage**: Could lead to a decrease in flood risk upstream; or conversely an increase in flood risk. This could lead to both positive and negative economic impacts. May be some increase in flood risk downstream. May lose some land to dredging waste. Construction infrastructure may remain and be economically viable. There are a number of uncertainties, but whilst the net effect is likely to be a benefit, this is **not** significant. **Other Tidal Power Schemes**: Less likely to have an impact on flood risk and therefore economic viability of land. Do not offer protection against rising sea-level and storm surges. Construction infrastructure may remain and be economically viable. **No** significant benefits assumed.
Leakage	Not applicable
Displacement	Potentially some displacement of economic activity to Severn Estuary area from elsewhere in South West &

	Wales. Cannot yet be quantified
Crowding Out	Not applicable
Multiplier Effect	Not applicable
Local Net Additional Impact	**Large Barrage**: Could be significant benefit, but not yet quantifiable. **Small Barrage**: some benefit, but not assumed to be significant - not yet quantifiable. **Other Tidal Power Schemes**: limited/nil benefit, not assumed to be significant and not yet quantifiable

The extent to which the benefits from a potential reduction in flood risk are realised will depend on whether these are recognised. There is a strong view within the EA that a barrage may not be considered a formal flood defence asset unless very strict conditions were applied. In which case, any economic benefits from a reduction in flood risk may only be felt by those assets not protected by the EA in the future that indirectly benefit from a barrage (e.g. possible agriculture land). This is highly speculative and uncertain.

6.2 Regional Context and Baseline

The development of tidal power will directly impact land use and planning by changing the environment of the Severn Estuary. In this study, we focus on the potential economic value or cost of this to the Wales and South West economies, and are therefore concerned with the implications that a change in land use may have on the economy.

There are three main areas where a change in the estuary environment as a result of the development of a tidal power option will need to be considered. These are:

- A change in land use associated with the construction of options
- A change in land use as a result of a change in flood risk (upstream and downstream)
- A change in flooding frequency and associated costs to existing land users (upstream and downstream).

At present, there are a number of factors that relate to this area of work that have not been finalised and will not be finalised during this period of research by DTZ. Therefore, at present it is only possible to discuss these factors qualitatively.

The factors which have not yet been agreed are:

- The baseline flood risk of land adjacent to the Severn Estuary i.e. the amount of land at risk from flooding; the location of this land; and the flood risk on this land
- Flood defence asset management i.e. the level of future investment in flood defences
- The change in land affected and flood risk as a consequence of each of the tidal power options.

In the absence of agreement on the flood risk baseline and impacts, the map from the Environment Agency (EA) below gives an overview of the flooding issue in South Wales and the South West. The areas in blue on the map show the areas that are covered by flood defences, which without the existing defences could be affected by:

- sea flooding that has a 0.5% (1 in 200) or greater chance of happening each year
- or by a river flood that has a 1% (1 in 100) or greater chance of happening each year.

The map shows that the most heavily affected areas are likely to be from Cardiff to Newport on the South Wales side of the estuary, and from the Somerset Levels, almost continuously to Gloucester (not all shown on map) on the South West side. This indicates that in the case of a major flood event, a large number of highly significant commercial and industrial areas could be at risk of significant damage. According to a 2001 Defra Report (*National Appraisal of Assets at Risk from Flooding and Coastal Erosion*) the capital value of assets within the high risk sea and tidal flooding areas in the South West and Wales could be as much as £6.6 billion. The existing sea defences which cover 150km of the 230km of Severn Estuary coastline protect an estimated 47,000 properties, and thousands of hectares of agricultural and amenity land, including some environmental assets (PB, SEA, 2008).

The North Somerset area[64] is at particular risk, and past events have shown the impact a tidal sea surge can have on the affected area. For example, a significant tidal surge which hit the North Somerset coastline in 1981 led to flooding of 12,500 acres of land and nearly 1,100 residential and commercial properties (Environment Agency, Somerset and the Sea, 2006). Somerset has 87km of tidal rivers and 38km of sea defences and £61 million has been spent on the upgrading the North Somerset coastal defences since the 1981 storm surge. Currently there are over 37,500 properties in the zone 3 flood area in North Somerset, which represents the area that would be affected by a 1 in 200 year flood event (Environment Agency, Somerset and the Sea, 2006).

Environment Agency Flood Risk Map

[64] In this context, North Somerset is a geographical area and not local authority based area

The future level of spend on flood defences is not known, and will depend on the level of flood risk (absolute and relative) and the amount that government decides to spend on flood defences. An increase in flood risk could lead to an increased need for flood defence spending in the area; and a decrease in flood risk could lead to a reduction in the need for flood defence spending in the area.

As shown above, there are areas of the main motorway network at risk from flooding (specifically the M5 and M4) in addition to the rail network. A disruption to the main transport network may negatively impact on the Wales and South West economies (disrupting the movement of goods and services) or alternative require additional funding investment to mitigate against increased risks. These areas are highly uncertain and fall outside the scope of this study (national impact) but are flagged here as potential issues.

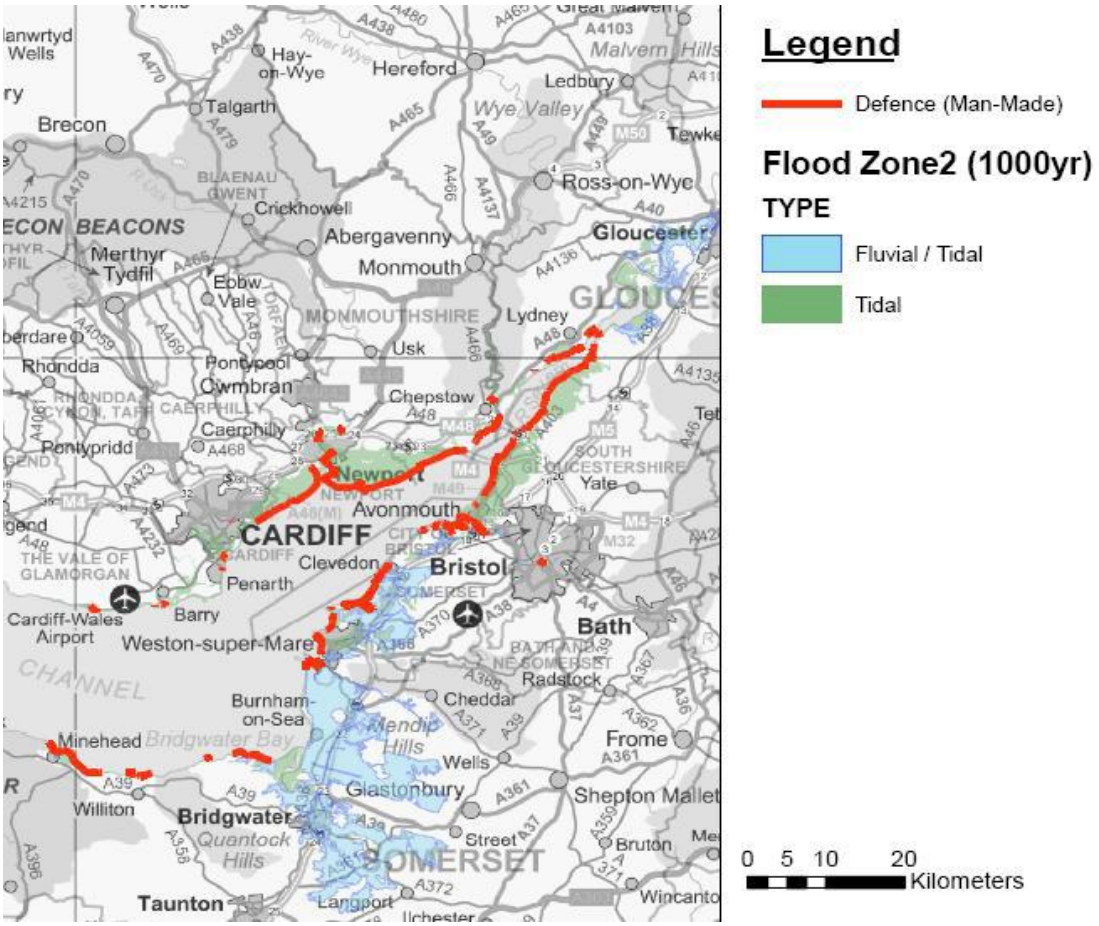
The current planning policy which guides local planning authorities on development in flood risk areas, known as Planning Policy Statement 25 (PPS25) was introduced in 2006. The Welsh equivalent of this document is Technical Advice Note 15 (July 2004). This guidance has shaped development plan policies in flood risk areas and has led to severe restrictions on allowable development in these high risk areas. The map above shows that there are large areas of South Wales and the South West which are considered high risk, and therefore affected by the PPS25 guidance.

The projected increases in sea levels, attributed to climate change are a cause for concern for all areas in the tidal floodplain including Weston-super-Mare, parts of Bristol, Avonmouth and the tidal River Severn. Current estimates claim that climate change and sea level rise will mean that severe tidal flooding events at Weston-super-Mare and Avonmouth will be six times more likely to occur by 2060. This means in 2060 a 1 in 200 year (0.5%) event will become a 1 in 33 year (3%) event according to the South West Flood Risk Assessment (EA, 2007). It is likely that the future focus of flood defence spending will be on protecting urban areas, which could lead to a greater burden of the future flood risk falling on rural areas, because they are less economical to protect[65].

The following map has been extracted from the SEA Topic Paper: Flood Risk. The map illustrates the focus of man-made flood defences in the area and the areas which may be at flood risk due to tidal influence. As shown, manmade sea defences are focused towards the eastern part of the Estuary, towards Gloucestershire, covering parts of Newport, Avonmouth and Cardiff.

[65] DTZ assessment of potential public sector response to increasing flood risks and budget constraints.

Extract from Environment Agency database showing areas which may be at flood risk due to tidal influence.[66]



The Environment Agency does not have a current formal approved strategy for the Severn Estuary, but work commenced in early 2008 with the objective of delivering a Severn Estuary Strategy. This ongoing work is addressing many of the flood risk issues which need to be fully understood before a tidal power project could be finalised. In particular these relate to the assets at risk, the condition of defences, the risk of failure and overtopping of defences, the effects of climate change and sea level rise in particular. The output of the work will be a strategic approach to flood risk issues in the Severn Estuary over a 100 year period. Until this output has been finalised, it is not possible to quantify the potential impact of the tidal power options on the cost of flood defences in the Severn Estuary area.

6.3 Areas of Impact

The IOAR (Version 2) and the accompanying Scoping Topic Paper on Flood Risk and Land Drainage set out the likely impacts of tidal power schemes on flood risk and land drainage.

[66] Extracted from the SEA Flood Risk Topic Paper :note that not all defences are shown on the map and care should be taken in distinguishing between fluvial/tidal and tidal areas given uncertainties in relation to relative tidal levels and fluvial flows

Whilst the overall impact can be summarised thus: "*the changed tidal regime and wave climate may be a benefit in some locations, but create risks in others"* (IOAR v2 p.65); there is some analysis of the potential positive and negative effects of any tidal power scheme, although this is not in any way quantified.

Positive Impacts

- Large barrage and small barrage may provide flood defence benefits in protecting communities and agricultural land upstream of barrage from effects of sea level rise (over the long term) and storm surges (short term impact).
- Outer barrage may provide flood protection to low lying areas of Somerset as well as the Wentloog Levels and Avonmouth.
- Attenuation of surge tides could reduce damages of high tides which overtop defences and avoid or delay the need for expenditure on flood defences to keep pace with sea level rise.

These positive impacts are identified as having potentially significant benefit in relation to the large barrage. Whilst the positive impacts will arise in the relation to the small barrage and land connected lagoons, they are not considered significant.

Negative Impacts

- Barrages and tidal lagoons can reduce tidal range which can adversely affect land drainage into the estuary. A reduced low tide level may impede land draining and so increase flood risk from drainage water as opposed to sea water
- A changed tidal regime may reduce the exposure of some outfalls, thus reducing the time available for maintenance work, which could in-turn lead to siltation. This is considered a potentially significant issue in relation to the large barrage and small barrage (relatively fewer outflows affected) but not significant in relation to the land connected tidal lagoon. The cost estimates that have been applied in the 'construction chapter' include mitigating work for low level outflows and therefore the standard of service should remain the same (negating this negative impact).
- If any tidal power schemes lead to greater erosion of the foreshore downstream, then this could undermine flood defences and increase flood risk. This is not considered a significant issue in the SEA Topic Paper as it is deemed a localised risk.

Either Positive or Negative

- Changes to the wave climate upstream of any structure may bring flood risk benefits or increase flood risk

6.3.1 Summary of Potential Impacts

As stated in the SEA Flood Risk Topic Paper "The expectation from previous studies will be that for barrage options, the flood risk benefits may outweigh the cost of providing mitigating measures to deal with increased risks, particularly when taking into account the predicted sea level rise and the possibility of increased storminess as a result of climate change. Further

work will be required to confirm this and to determine the effects for all options on land, property and infrastructure receptors."[67]

As the cost of mitigating works for low level outfalls is included in option cost estimates on the basis that the standard of service should remain the same; some of the negative impacts highlighted may not come to fruition.

There will be cost impacts related to resolving any issues in relation to the existing flood defences, should it be proved that the tidal power options result in detrimental effects on these. However, this is not yet known and is uncertain.

The area and potential receptors (e.g. land, infrastructure and property) impacted will vary by option due to the areas covered. For example, the large barrage will potentially protect a greater area of land upstream from storm surges and sea level rises but will also encompass a greater number of outflows (which may be negatively impacted) than a small barrage. Similarly, a land connected lagoon and the resultant impact on flood risk will impact on fewer receptors than a large barrage.

Whilst acknowledging these uncertainties; for the purpose of this qualitative assessment DTZ have assumed that:

- A large barrage will, on balance, result in a reduction in flood risk upstream (towards land), which **is potentially significant**.
- A small barrage will, on balance, result in a reduction in flood risk upstream (towards land), which is **not** potentially significant.
- A land connect lagoon will, on balance, result in a reduction in flood risk to shoreline, which is **not** potentially significant.

The two key points to consider alongside these assumptions are:

Firstly, negative impacts will be overcome through mitigating works, and these have been included in the cost estimates of STP. On this basis, it is therefore assumed that there will not be an overall negative impact from the STP. However, there remains uncertainty over the extent of negative impacts, and further work will be completed in phase two (outside the scope of this study) to assess these.

Secondly, the extent to which a flood risk reduction has an impact on the Wales and South West economies will depend on the view of the EA of changes to flood risk. There is great uncertainty with regards to this issue and it is possible that the EA will not recognise the STP as a formal sea defence. This reduces the scope for any new assets to be developed on land considered at flood risk; regardless of the STP impact. Therefore, the primary impact may be a greater level of protection afforded to existing assets (land and property).

6.4 Land Use and Planning Implications

DTZ acknowledge that there is uncertainty in relation to the impact of the tidal power options on flood risk. This will be addressed by further research suggested for phase 2 of the wider STP feasibility study. Whilst acknowledging these uncertainties; based on the information in the SEA Flood Risk Topic Paper and the fact that the construction costs have included mitigating works on low level outflows, DTZ believe that it is valuable to at least discuss,

[67] P39

qualitatively, the potential economic benefits that may emerge as a result of reduced flood risks.

Large Barrage

The land use and planning implications of a large barrage are likely to be highly significant to parts of the South West and South Wales. Clearly, from the above, there could be positive impacts on flood risk, negative impacts, or more likely a combination of the two.

If the net effect is positive, then a barrage will have the additional impact of protecting rural as well as urban areas, which are less likely to be well protected in the future[68]; whereas a negative net effect will impact on both urban and rural areas.

The implications for flood defences highlighted are potentially significant both in terms of the reduced long-term expenditure on flood defences as a result of the large barrage, and also in terms of the implications for land-use and development post-construction[69]. According to Defra (2001) there needs to be an investment of £17m per year to maintain present standards of flood defences, in light of rising sea levels, just in the South West in order to protect against sea and tidal flood risks. This investment would avoid an estimated annual damage to property in the South West of over £55m per year. If a large barrage negates the need for flood defence upgrading to respond to sea level rises, then this would potentially represent a significant benefit in terms of delaying or reducing the need for flood defence spending. However, as the Severn Estuary Flood Risk Strategy is not known- it is unclear whether this level of spending will take place in the absence of the large barrage. However, assuming a net positive impact on flood risk upstream; the large barrage would:

- Reduce or delay the need for flood defence spending; or
- Protect areas of land that would not have been protected (if flood defence spending was not planned)

As mentioned above, a barrage would also protect rural areas which may be a lower priority for future flood defence spending. However, the scenario in which a tidal power scheme leads to greater downstream erosion, which increases flood risk or undermines sea defences could lead to an increased requirement for spend on flood defences downstream of a tidal power scheme. However, this potentially negative impact would be mitigated against, and the costs for works included in construction cost estimates.

On balance, the large barrage is therefore assumed to have a net positive impact on flood risk. This is based on DTZ interpretation that: upstream the barrage will have a net positive impact and whilst there is a potential negative impact downstream; these are considered less great and will be mitigated against and included in the construction cost estimates.

The large barrage would have an impact on the availability of land for development and the amounts of rural land protected, and therefore affect the supply of land in relevant areas. If the impact is positive, areas which are currently high flood risk could become lower flood risk following construction of a barrage, as this would protect against tidal and sea surges, combined with the existing tidal defences. A large barrage would effectively protect a larger

[68] Assuming that future tidal flood defence assets will focus on urban areas
[69] DTZ – drawing on a logic link: reduced flood risk, and the high levels of expenditure on flood defences required in base case

area of land than a small barrage, whilst the impact of other tidal power schemes is likely to be negligible from a tidal surge scenario, therefore would not impact on land viability[70].

In total there is an estimated 43,000Ha of agricultural land at risk from sea and tidal flooding in Wales and the South West (Defra, 2001). This land is at significant risk from a major flood event. A tidal barrier could potentially lead to an increase in the availability of commercially viable agricultural land because of reduced tidal extremes. Some agricultural land may become considerably more valuable following barrage construction and the reduced flood risk could increase the potential of some agricultural land for other development purposes. It is also the case that a barrage will protect agricultural land, whereas any future investment in flood defences is likely to be focused on urban areas ahead of rural areas. These effects are likely to be much reduced if not negligible with other tidal power schemes, which do not offer the same level of flood protection for upstream areas. However, an increase in flood risk could lead to a reduction in value of both commercial and agricultural land.

However, areas downstream of a barrage could see an increase in flood risk, as tidal water may be deflected back down the coast. This may also have an impact on the erosion of natural flood defences, such as salt marshes, which would also have an additional potentially negative impact on salt marsh farming. Further detail is required on the potential increase of flood risk downstream and in particular whether the design of tidal power schemes will alter this. Further research will be completed as part of Phase 2 assessment (outside the scope of this study), but based on research conducted in the 1980's, this is not anticipated to be a significant issue.

Waste deposit land for dredging outputs will need to be allocated following the development of a barrage and other tidal power schemes. A large barrage will require a greater quantity of land where dredging outputs can be deposited. The barrage would increase the need for this land following an increased dredging requirement. A lagoon would have a minimal land requirement for this purpose as sediment flows would be affected to a lesser extent.

Waterside and marine developments could become more common in the Severn Estuary following increased tourism opportunities as a result of higher mean water levels and reduced turbidity. The potential for these developments could come from a change to planning policy in flood risk areas. This could increase the value of some coastal areas which are currently only worth agricultural land values[71].

Construction yards and dry docks may be set up temporarily to build various elements of a barrage or other tidal power scheme structures, e.g. caissons and turbines. These construction yards may have an industrial land value and use after the construction phase assuming a reduced flood risk or if they are constructed in areas not at flood risk. This positive effect on land use in the area would be greatest with a large barrage and would be much less with the lagoons and other tidal power schemes, because of the reduced impact on flood risk reduction of the lagoon in its operational stage compared to the barrage. In the case of the lagoons, temporary construction yards may return to agricultural or marginal land uses and values.

[70] DTZ assumption

[71] These potential developments, in theory, may only be temporary if the tidal power options are decommissioned and removed. However, DTZ have not considered the decommissioning phases of the STP

Commercial development covers industrial, residential and office development. The reduced flood risk associated with a large barrage could allow greater development of this kind within current high flood risk zones, if it is assumed that a barrage would reduce flood risk. This could lead to an increase in the population of the local area and also the stock of employment land. With the small barrage, lagoon and other tidal power schemes the impacts are likely to be considerably less because the impact on flood risk is unlikely to be so substantial.

All changes in land use in relation to changes in flood risk will depend on the planning policy response to flood risk and the extent to which changes in flood risk are recognised by authorities. There is considerable uncertainty in relation to this.

The construction process of all tidal power options is likely to require significant infrastructure development, such as access roads. This infrastructure is likely to be more significant for a large barrage because this is a larger construction project and therefore there is a larger requirement for the movement of materials. The infrastructure remaining after the construction phase could have an economic value during the operational phase of the project, which could help with physical communication in the Severn Estuary region.

6.5 Gross Direct Impact

It is not possible at this stage to quantify the impact on flood risk and land viability as a consequence of each of the tidal power schemes. However, the following tables set out a qualitative assessment of the impact. Until we have further information on the impact on flood risk, the scenarios under consideration are necessarily crude.

Large Barrage								
Topic	**S**	**Baseline**	**Significance**		**Scenario**			**Assessment of Risk**
			Magnitude	**Activity**	**H**	**M**	**L**	
Flood Defences	O	n/a	+/-	++/- -	Insufficient data available on likely impact to be able to assess scale of economic impact			A large barrage will reduce the risk from tidal flooding for a substantial area of land which could lead to a reduced need for flood defences upstream of a barrage. This will also protect rural as well as urban areas. This cannot yet be quantified and is uncertain given the potential impact on other flood defence assets (e.g. outflows) and the view of the EA of flood risk and subsequent flood defence asset plans.
Downstream flood risk	O	n/a	?/-	--	As above			There is a potentially greater risk of downstream flooding. This requires further assessment and quantification. However, this should be mitigated against, and the cost included in the construction estimates.
Upstream flood risk			+/-	+/-	As above			A large barrage could increase upstream flood risk as discharge of surface water is impeded, and this will have a negative impact. The costs of mitigating works have been included in the construction costs- but there remain some areas of uncertainties.
Land Development	O	n/a	++/- -	++/- -	As above			Due to reduced flood risk, a significant area of land could become economically viable for more productive uses. This will be dependent on the changes to the planning designations locally. This cannot yet be quantified.
Infrastructure	O	n/a	+	+	As above			Infrastructure developed for the construction phase could remain afterwards. Uncertainty as to the possible future uses of legacy

						infrastructure.

Small Barrage

Topic	S	Baseline	Significance		Scenario			Assessment of Risk
			Magnitude	Activity	H	M	L	
Flood Defences	O	n/a	+/-	++/- -	Insufficient data available on likely impact to be able to assess scale of economic impact			A small barrage will reduce the risk of tidal flooding for a smaller area of land, which is not considered significant. There may be scope to reduce spend on flood defences upstream of a barrage. This will also protect rural as well as urban areas. This cannot yet be quantified and there is some uncertainty.
Downstream flood risk	O	n/a	?/-	--	As above			There is a potentially greater risk of downstream flooding. This requires further assessment and quantification. These costs will be incorporated in the STP construction estimates.
Upstream flood risk			+/-	+/-	As above			A small barrage could increase upstream flood risk as discharge of surface water is impeded, and this will have a negative impact. The costs of mitigating works have been included in the construction costs- but there remain some areas of uncertainties
Land Development	O	n/a	+/-	+/-	As above			Due to reduced flood risk, a small area of land could become economically viable for more productive uses. This will be dependent on the changes to the planning designations locally. This cannot yet be quantified, but is not believed to be significant. An increased flood risk could lead to a reduction in economically viable land, which will have a negative economic impact, but again (*vice versa*) not considered significant
Infrastructure	O	n/a	+	+	As above			Infrastructure developed for the construction phase could remain afterwards. Uncertainty as to the possible future uses of legacy infrastructure.

Other Schemes								
Topic	**S**	**Baseline**	**Significance**		**Scenario**			**Assessment of Risk**
			Magnitude	**Activity**	**H**	**M**	**L**	
Flood Defences	O	n/a	0	0	Insufficient data available on likely impact to be able to assess scale of economic impact			A land connected lagoon may have a small positive impact in terms of the reduced need for flood defences, although other schemes are not likely to have any significant impact on flood risk. A change in sediment deposition may impact on flood risk, but further information is required. On balance, no significant impacts are assumed.
Land Development	O	n/a	0	0	As above			Some schemes may have a small positive impact in terms of the reduced flood risk and therefore land viability; or a small negative impact. However, further information is needed on this. On balance, no significant impacts are assumed.
Infrastructure	O	n/a	+	+	As above			Infrastructure developed for the construction phase could remain afterwards. Uncertainty as to the possible future uses of legacy infrastructure.

Local Area Effects

Potential scale of impact could be substantial at a Wales and South West of England level. However, there is a very high degree of uncertainty here and only a qualitative assessment has been completed. This assessment is limited by the extent of information available about the potential impact on flood risk, and policy response to this.

In terms of local area focus of impact; these in the main would be related to those areas where there is a change in flood risk (either positive or negative). Knock on impacts at a wider Wales and South West of England level may emerge from a change in development or land use focus (i.e. some areas being considered more attractive for future development at the cost of development in other areas – substitution effects).

7. Tourism

For the purpose of assessment, this chapter has clustered the tidal power option as:

- Large Barrage
- Small Barrage
- Lagoons and other

7.1 Summary of Impacts

The focus of this chapter is on additional visitors to the South West and Wales as a direct consequence of a tidal power option being developed (i.e. the scheme operating as a tourist attraction). Impacts that relate to a change in marine tourism are excluded from the quantitative assessment as these would required further ancillary investment in order to realise the benefit to any scale (e.g. windsurfing/dingy sailors could operate without any further investment, however, major tourism impact e.g. for yachting are likely to require additional investment). A qualitative discussion of the potential impacts is detailed below.

Baseline	£1.7 billion GVA and employing 78,000 in the local area per annum
Gross Direct Effect	£1.9 million GVA for large barrage, £1.2 million for small barrage and £0.2m for lagoon and tidal fence
Leakage	25% medium leakage assumed
Displacement	Relatively high displacement rates as high proportion of visitors come from the region, and would have spent money on other recreational activity, and the strong tourism pull of the regions would mean that few overnight tourists wholly influenced by the existence of the tidal power option (assumed 40% displacement). Assumed that all visits are day visits.
Crowding Out	Not relevant
Multiplier Effect	1.21 based on SW regional accounts
Wales and South West of England Net Additional Impact	£13.7m large, £10m small and £1.6m other over a 40 year discounted period (impact starting post construction). This supports annual FTE permanent jobs of 60 FTE, 40 FTE and 10 FTE respectively.

The impact on other tourism attractions have been discounted from the analysis due to the issue of displacement and the assumption that the vast majority of this impact will be retained at a Wales and South West of England level.

7.2 Regional Context

Tourism is an important sector within the South West and South Wales economies. Using ABI data (2006) the value of the tourism sector is estimated to be nearly £1.7 billion per

annum in the local area in terms of GVA, and employs over 78,000 people, including both full time and part time (seasonal) workers.

As shown in the table below, the total tourism employment within the local area is equivalent to around a quarter of total tourism employment in Wales and the South West. This is attributable to the breadth of the area covered by the local area, the inclusion of key urban areas such as Cardiff and Bristol, together with popular inland tourism areas such as the Cotswolds.

Tourism Employment and GVA, 2006[72]

Tourism Sector	SW	Wales	Local Area
Employment	192,400	98,700	78,000
Value (£)	£4,061,220,000	£2,134,241,000	£1,680,804,,000

Source: Nomis; 2008

The characteristics of the tourism offering[73] in the Severn Estuary area can be broadly categorised as follows:

- Urban Tourism – key city attractions including the cities of Bristol and Cardiff
- Nature Based Tourism – including recreational fishing and ornithological tourism
- Traditional Coastal Resort Tourism- including resorts such as Weston-super-Mare
- Inland Tourism – including areas such as the Cotswolds including Bath, Forest of Dean
- Marine Recreational Tourism – including marina activity, Severn Bore surfing
- Visitor Attractions - such as Chepstow Racecourse, Cheltenham Racecourse

In reviewing the potential economic impact of the options on the tourism sector, it is important to differentiate between these tourism and recreational markets, as the estimated impacts of the tidal power options are likely to vary in their potential impact on these markets.

Their impact on tourism markets will also vary during the construction and operational phases. Therefore, both of these will need to be reviewed separately.

7.3 Areas of Impact

Construction Overview

Regional Impacts

[72] Figures from UKTS and Stats Wales indicate that tourism-related employment in the South West and Wales is at 237,400 and 105,100 respectively. However, to maintain consistency throughout the report we will be using ABI data from NOMIS (ONS)
[73] Based on DTZ assessment

The primary economic impacts of the options on the South West of England and Wales tourism market relate to the negative impacts associated with the construction process. These negative impacts are likely to include disruption to transport networks and disruptions to the tourism offering in specific locations[74].

Depending on the nature of the construction process, tourism may be negatively impacted by disruption to the main transport routes. According to South West Tourism Intelligence Project[75], the car is the main form of transport used by visitors to the South West ranging from 83 percent for short holiday and 72 percent for business tourism. Overseas visitors are less dependent on a car, with a plane being the main transport used.

Significant disruptions to the road transport network would have a detrimental effect on the proportion of visitors coming to the South West and Wales[76]. Whilst business related visits and friends and family visits may remain resilient to transport network disturbances (i.e. visitors are less likely to substitute their visits for another area because there are strong underpinning reasons for the visit), short holiday and long holiday visits could be negatively impacted.

In order to understand the potential disruption caused to road networks over the construction period, further information is required about the construction process and the likely level and form of road usage envisaged over the build period.

In the absence of more detailed information about the potential construction process, it is very difficult to model the potential Wales and South West of England wide impact of construction on the volume of tourism visits. Information is required in order to develop an understanding as to whether construction related tourism impacts are likely to be contained to the very local level, or transcend further into the region (i.e. whether tourism visits to Cornwall, Pembrokeshire etc would be negatively affected by transport delays). If the construction process disrupts tourism more widely through the economies of Wales and South West of England, there are sectors of the tourism market less resilient to disruptions than others (i.e. those that can be substituted with other areas)[77].

Assuming that construction related disruptions to transport networks will only affect tourism at key points of construction (sites and build points), then the potential negative impact on local level tourism is likely to be displaced by an increase in tourism in other areas of the region; resulting in a neutral or minor negative impact on the economies of Wales and the South West of England[78].

Local Level Impacts

As no set locations have been determined for the construction of tidal power options or the supporting infrastructure (i.e. construction sites); local level impacts are being reviewed by four broad classification areas. These are:

[74] Based on DTZ assessment
[75] http://www.swtourism.co.uk/_assets/documents/research/state_of_tourism_south_west_intelligence_report.pdf
[76] DTZ assessment
[77] DTZ assessment
[78] DTZ assessment

- Rural areas;
- Coastal areas;
- Market Town; and
- Urban areas.

Rural Areas
Rural area tourism may be negatively affected by construction related congestion, noise and inflow of construction labour. It is likely that tourists would substitute a visit to a rural area with another rural area during the construction period if the nature of the tourism offering was detrimentally impacted during construction.

Coastal Areas
Coastal area tourism may be negatively affected by construction related congestion, noise and inflow of construction labour and change to the water quality/marine traffic during construction. It is likely that tourists would substitute a visit to a specific coastal area with another unaffected coastal area during the construction period if the nature of the tourism offering was detrimentally impacted during construction.

Market Towns
Market Town tourism may be negatively affected by construction related congestion, noise and inflow of construction labour during construction. It is likely that tourists would substitute a visit to a specific market town with another unaffected market town during the construction period if the nature of the tourism offering was detrimentally impacted during construction. This is dependent on the specific draw of the market town. For example, key events in a market town may continue to attract an inflow of visitors (e.g. Cheltenham Festival) if the draw was strong enough.

Urban Areas
Urban tourism is influenced by a number of factors, including business tourism. Business related tourism may be less sensitive to the negative impacts of the construction process, such as construction congestion, inflow of labour etc. Key events in urban areas, such as sporting events, may also remain resilient to negative construction affects. Urban areas also benefit from more diverse modes of transport. This may enable visitors to avoid the negative impacts of say construction congestion by switching transport modes (substitute car for train). However, if significant and prolonged disruptions resulted from the construction of options, then tourists may substitute urban visits with a visit to an unaffected urban location, which are likely to be outside of the region.

These potential economic impacts are assumed to be the same for all of the options, although the scale of impact may vary because of different construction periods and scale of materials and labour movement.

Operational Impacts

The following areas of potential economic impact have been identified.

Marine Recreation

It is estimated that many water based tourism activities are currently limited because of the high tidal range, strong currents and high levels of water turbidity in the estuary. However the prospects for increased water recreation are good given the high population in close proximity to the estuary. The development of a large barrage would increase the likelihood of enhanced recreational activity in the area as there would be improvements in the usability of the water and reduced turbidity[79]. The projected increases in leisure time, disposable income and housing development are also likely to lead to a rise in demand for recreational amenities (PB, SEA, 2008). For example, STPG Energy Paper 57 (STGP, 1989) projected that tourism in the region might increase by the order of 5% and 20%, with one of the assumptions underlying this prediction is a reduction the severity of the water conditions. The quality of some of the beaches within the region may improve as a result of a barrage development[80]. This is likely to have a local area impact affect.

The implications on marina development and other boating or yachting activities is also likely to be positively affected by a large barrage option, and to a smaller extent by the small barrage. Marina developments would be more commercially viable in the Severn estuary area because of the higher mean water level and reduced ferocity of tidal currents. Currently the Royal Yachting Association (RYA) has various training centres or affiliated boating clubs, in the study area with a membership of approximately 9,000 (PB, SEA, 2008). For example, there are various berths in Bristol and Chepstow as well as at the following locations:

- 400 berths in Swansea Marina
- 340 berths in Penarth Marina (inside of Cardiff Bay Barrage)
- 250 berths in Portishead
- 240 berths in Watchet

This demonstrates the existing scale of boating in the Severn Estuary area, which could potentially see a substantial increase following the construction of the large barrage.

Other water based recreational activities are also likely to be positively affected by the large barrage construction. Wind–surfing, canoeing, diving and water skiing are all activities which would be popular in the Severn Estuary and would make a positive economic contribution to the local economies[81]. The demise of the Severn Bore may have a small negative economic impact on the region, if surfers substitute Severn Bore surfing with other activity outside of the region- although the affect of this is believed to be small[82].

As marina development will, in most instances, require additional ancillary investment, the economic impact of this is excluded from the scope of this study. However, over the longer term, it is important to raise this as a potentially valuable economic impact.

Lagoons are not anticipated to have any substantial impact on the future levels of marine recreational activity as factors such as water quality and turbidity are not anticipated to be affected to the same extent as in the barrage scenario. There is reference to potential increased marine activity within the lagoons (benefiting from lower water turbidity, but this

[79] Based on SEA Topic Paper Socio-Economic Community DECC Issue 06082008
[80] Steering Group Comment
[81] Based on SEA Topic Paper Socio-community
[82] South West and Wales have a strong surfing draw (N Devon; Cornwall and the Gower) surfers may continue to come to the region.

would require further investment and has therefore not been considered). It is possible, that depending on the location of a lagoon, there may be a deterioration in the water quality in some areas, if increase sedimentation deposits occur[83]. No information is currently available with regards to this point. However, it is possible to assume that if increased sedimentation deposits occurred in a coastal resort area, that this could have a negative local area affect.

Nature Based Tourism

Both Wales and the South West have a strong 'natural environment' offering that accounts for a high proportion of total tourism into the region. For example, a study conducted by the National Trust[84] indicated that in the South West conserved landscapes attract a spend of £2,354 million annually from holiday trips and support 97,200 jobs or 43% of all tourist related jobs in the region. Other studies such as the study reviewing the economic impact of the South West coastal paths, have supported the assertion. In addition, there are five national parks in Wales and the South West, covering a total area of 2,134 square miles.

In capturing the potential economic impact on the tidal power options on nature based tourism offering of Wales and the South West is very difficult as it is unlikely that the main draw of the region will be substantially impacted (i.e. people will continue to visit The Brecons/Pembrokeshire Coast/Dartmoor) and will not be impacted by a positive or negative change in landscape around the tidal power option. Any change in landscape around the tidal power option may lead to a substitution effect, where people choose to visit the area instead of another and *vice versa*. The overall impact on Wales and South West of England tourism will likely remain unchanged. There may potentially be positive or negative local area affects depending on factors such as the change in landscape, accessibility of the area, level of development, etc. These are likely to be more substantial in relation to a large barrage, based on the large area affected and the scale of development. The completion of the All Wales Coastal Path and the existing SW coastal path may potentially increase the number of visitors in the area, and complement the STP visitor centre, although this is unknown at present.

Ornithological Tourism

Very little information has been found in relation to the economic value or scale of ornithological tourism in Wales or the South West. This makes quantifying the potential impact of a large barrage on ornithological tourism very difficult. Furthermore, it is currently unclear to what extent the large barrage would negatively impact on ornithological tourism. Whilst it is gathered (from the need to provide compensatory habitat) that areas of habitat will be lost to certain species of birds, it is unclear whether these areas support ornithological tourism. Key wetland visitor attractions, such as Slimbridge Wildfowl and Wetlands Trust, and the Newport Wetlands National Nature Reserve, attracted 188,000 visitors in 2006 and 31,000 visitors between March and December 2008[85], respectively, may not be detrimentally affected, if the broad tourism offering of Slimbridge and WWT is unaffected[86]. However, if the birds that attract visitors to Slimbridge and WWT are negatively impacted, and not replaced by other species, there may be a negative impact on the visitor attraction and a consequential economic impact associated with this.

[83] Based on SEA workshop discussion 07082008
[84] Valuing Our Environment, Tourism Associates for National Trust South West, 1998
[85] Newport Wetlands Visitor Centre Manager
[86] DTZ assessment

A study conducted on behalf of RSPB[87] estimated that, when including all economic impacts, 12 RSBP nature reserves supported an equivalent of 8 FTEs per 1,000 hectares of reserve. Using this ratio, it would be possible to estimate the potential impact of the large barrage on ornithological related employment. Slimbridge[88] and Newport Wetlands[89] cover areas of 325 and 440 hectares, respectively, hence associated employment is considered to be modest in the context of the Wales and South West of England economies.

Visitor Attraction

It is likely that a large barrage will act as a visitor attraction, drawing additional visitors into the region. La Rance tidal power scheme in Brittany was reported to have attracted approximately 200,000 visitors[90] per year before the visitor centre was closed for security reasons. Whilst it is unclear what the precise nature of the visitor centre was (i.e. whether located very close to the scheme or not) for the purpose of this exercise, we are assuming that the visitor centre will be developed in such a way that it does not cause a security risk to the STP. Using this as a benchmark, it is possible to estimate the potential level of net additional visitors to Wales and the South West from the existence of a large barrage. A small barrage would have a smaller visual impact to a large barrage and attract fewer visitors, and a lagoon and other options may attract even fewer visitors.

7.4 Gross Direct Impact

The following table presents a summary of the potential impact of the various tidal power options on visitors to the South West and Wales.

The total number of annual visitors is taken from the La Rance benchmark, and scaled in accordance to the assumed visual impact of the tidal power options. For the small barrage we have assumed a 75% impact of the large barrage. For the lagoons and tidal fence options we have assumed a much weaker visual presence, and the number of visitors has been scaled to 20 percent of the large barrage[91]. These have formed the basis of the central/ medium scenario.

	Large Barrage	Small Barrage	Lagoons and Other
Visitors *(medium scenario)*	200,000	150,000	40,000
Day trip	100%	100%	100%
Proportion originating from the SW/W	40%	50%	70%
Spend per day trip 2008 prices	£42.24	£42.24	£42.24
Gross Additional Expenditure	£5,068,000	£3,168,000	£507,000
Gross GVA	£1.9m	£1.2m	£0.2m

[87] Reserves and Local Economies, Shiel, Rayment and Burton, RSPB, Oct 2002
[88] http://www.wwt.org.uk/centre/122/slimbridge.html?gclid=CIbKlaH-tZcCFUoa3godnFw5iQ
[89] http://www.stayinginwales.com/attraction/Newport/1152/Newport-Wetlands-National-Nature-Reserve.htm
[90] http://www.stmalo-agglomeration.fr/index.jsp?id=145&key=S2L3R4R6R9R122P145&xsl=page_contenu.xsl#732

[91] DTZ assumption

	Large Barrage	Small Barrage	Lagoons and Other
Displacement[92]	40%	40%	40%
Leakage[93]	25%	25%	25%
Multiplier[94]	1.21	1.21	1.21
Net Expenditure Impact	£2.8m	£1.8m	£0.3m
Net GVA pa	£1.0m	£0.6m	£0.1m
Net FTE pa	60	40	10
Net GVA (PV discounted 40 year)[95]			
High (*visitor numbers doubled*[96]*)*	£27.4m	£19.9m	£3.2 m
Medium *(as assumed above; line one)*	£13.7m	£9.9m	£1.6m
Low *(quarter of visitor numbers)*	£3.4m	£2.5m	£0.4m
Net FTE (permanent jobs) per annum*			
High	130 FTE	80 FTE	10 FTE
Medium	60FTE	40 FTE	10 FTE
Low	20FTE	10 FTE	Less than 10 FTE
* Note FTE employment figures have been rounded to the nearest 10			

We have assumed that a relatively high proportion of the visitors will originate from Wales and the South West region; increasingly so with the tidal lagoon. Regional visitors are treated as 100% displacement- although this may over state the situation as regional visitors may chose not to leave the region and therefore contribute to the net additional visitors.

In developing the scenarios, given the range of information provided to DTZ (i.e. Dynorwig in North Wales attracting 250,000 visitors p.a; La Rance 200,000 visitors p.a and Thames Barrier 13,000 p.a) we have doubled visitors numbers to represent the 'high' impact and reduced them to a quarter for the low impact.

These impacts have been modelled over a forty year period, assuming steady state throughout. The social time preference rate of 3.5% has been applied to the first 30 years, and 3% from years 31-40. In doing so, given the potential negative impacts on wider tourism during construction (that cannot be measured); DTZ have felt it prudent to assume no positive impact during construction (i.e. no visitors to the STP). It is possible that visitors will come to the region to view construction; but as we have not captured the potential negative impacts, it is inappropriate to model this potential benefit.

Therefore, for a large barrage, benefits accrue from year 11 onwards (end of construction) and for a small barrage/lagoon and fence they accrue from year six onward (end of construction).

[92] English Partnership Guide 'recreational' at regional level suggest displacement of 65%; however as 100% day trips assumed, this is reduced by DTZ
[93] 25% based on EP- Medium leakage
[94] Based on SW Observatory UK Tourism Multiplier
[95] 3.5% discount rate yr 0-30; 3% yr 31-40.
[96] E.g. for large barrage increasing from 200,000 to 400,000 p.a

7.5 Net Additional Impact

7.5.1 Leakage

Given the location of the tidal power option, it is assumed that around a quarter of visitor spend will leak outside the region, representing a medium leakage factor. This will include spending by day trippers on route to the attraction and back.

7.5.2 Displacement

Given the strength of both the Wales and South West tourism offering, it is assumed that around between 40 percent of the visitors (excluding locals) will come to the South West and Wales regardless of the tidal power option. That is to say, that they will come to the region and substitute a day trip to the tidal power option with another attraction in Wales and the South West. This means that 60 percent of the visitors to the visitor attraction can be considered net additional.

7.5.3 Crowding Out

We have assumed no crowding out effect.

7.5.4 Multiplier Effects

A multiplier effect of 1.21 has been applied, based on the SW UK Tourism multiplier. The multiplier effects are primarily felt across hotels, restaurants and transport and indirect within the local food and drink sectors that supply the restaurants and pubs. In addition, multiplier impacts accrue in business services.

Large Barrage

Topic	S	Baseline	Significance		Scenario			Assessment of Risk
			Magnitude	Activity	H	M	L	
Construction related congestion	C		?	?				Construction related congestion could potentially be a significant regional issue if a high proportion of South West of England Wales tourism is deterred because of road network problems. Alternatively, it may only present very localised negative effects. Need to understand the construction process to assess.
Ornithological Tourism	O	8 FTE per 1,000 ha	0	0				A loss of habitat may reduce ornithological tourism, but the scale is likely to be very small. The provision of compensatory habitat and possible increase in some bird species may see net affect as neutral. Impact on attractions such as Slimbridge are unclear, but could potentially negate any benefit from a visitor attraction (below).
Marine Tourism	O		+					Potentially significant benefits from increased marine tourism through the improvements in water quality and lower turbidity. However, further ancillary investment will be required to realise these benefits. This element is excluded from the analysis
Visitor Centre	O				£27.4m GVA 130 FTE	£13.7m GVA 60 FTE	£3.4m GVA 20 FTE	Assumed that barrage would attract 200,000 visitors per annum. Assumed that 100% day visitors. An increase in visitor numbers would positively impact on net effect (after taking account of displacement); the 'high' scenario assumes a doubling of visitor numbers and low scenario assumes a quarter of visitor numbers. This may be negated is visitor attraction such as Slimbridge are negatively impacted (visitors of circa 190,000)

Small Barrage

Topic	S	Baseline	Significance		Scenario			Assessment of Risk
			Magnitude	Activity	H	M	L	
Construction related congestion	C		?	?				Construction related congestion could potentially be a significant regional issue if a high proportion of South West of England and Wales tourism is deterred because of road network problems. Alternatively, it may only present very localised negative effects. Need to understand the construction process to assess.
Ornithological Tourism	O	8 FTE per 1,000 ha	0	0				Nature reserves such as Slimbridge are unlikely to be affected. A loss of habitat may reduce ornithological tourism, but the scale is likely to be very small. The provision of compensatory habitat and possible increase in some bird species may see net affect as neutral.
Marine Tourism	O		+					Potential benefits from increased marine tourism through the improvements in water quality and lower turbidity. However, further ancillary investment will be required to realise these benefits. This element is excluded from the analysis. Benefit less than anticipated for a large barrage, due to lower area of water affected.
Visitor Centre	O				£19.9m GVA 80 FTE pa	£9.9m GVA 40 FTE pa	£2.5m GVA 10 FTE pa	Medium scenario assumed that barrage would attract 150,000 visitors per annum. Assumed that 100% day visitors. An increase in visitor numbers would positively impact on net effect (after taking account of displacement). An increase in visitor numbers would positively impact on net effect (after taking account of displacement); the 'high' scenario assumes a doubling in visitor numbers, and low scenario a quarter of visitor numbers. This may be negated is visitor attraction such as Slimbridge are negatively impacted (visitors of circa 190,000).

Lagoon and Other

Topic	S	Baseline	Significance		Scenario			Assessment of Risk
			Magnitude	Activity	H	M	L	
Construction related congestion	C		?	?				Construction related congestion could potentially be a significant regional issue if a high proportion of South West of England and Wales tourism is deterred because of road network problems. Alternatively, it may only present very localised negative effects. Need to understand the construction process to assess.
Ornithological Tourism	O	8 FTE per 1,000 ha	0	0	0	0	0	Nature reserves such as Slimbridge are unlikely to be affected. A loss of habitat may reduce ornithological tourism, but the scale is likely to be very small. Level of habitat lost unknown, but assumed lower than for the barrage options.
Marine Tourism	O				0	0	0	No benefit from increased marine tourism potential
Visitor Centre	O				£3.2m GVA 10 FTE pa	£1.6m GVA 10 FTE pa	£0.4m GVA Less than 10 FTE pa	Assumed that barrage would attract 40,000 visitors per annum. Assumed that 100% day visitors. An increase in visitor numbers would positively impact on net effect (after taking account of displacement). Scale of visual attraction relatively small and not expected to attract high visitor numbers. An increase in visitor numbers would positively impact on net effect (after taking account of displacement); the 'high' scenario assumes an uplift a doubling in visitor numbers and low scenario a reduction to a quarter. This may be negated is visitor attraction such as Slimbridge are negatively impacted (visitors of circa 190,000).

8. Accommodation

Accommodation impacts are a function of:

- Construction impacts; and
- Change in tourism offering

Value of the Accommodation Sector

The accommodation sector is assumed to comprise of the following sub sectors:

- 5510: Hotels
- 5551 : Canteens
- 5552 : Catering
- 5523 : Other provision of lodgings not elsewhere classified

Figure 8.1 Scale of the Sector

Accommodation Sector	SW	Wales	Local Area
Employment	66,100	26, 200	24,100
Value (£)	£1,040.4 million	£412.4 million	£379.6 million

The table shows that the expected GVA of the accommodation sector in the local area is approximately £334 million, based on 2006 ABI data. This supports employment of over 21,000 people.

As discussed previously, the construction of a large barrage will have an impact on labour demand and supply. In order to estimate the potential inflow of labour and their subsequent demand on the accommodation sector, the Input-Output models have been used.

Migration of construction workers

Detailed economic impact models are available for the South West through the Regional Observatory and for Wales through Cardiff University (Welsh Economy Research Unit). The impact models are useful in outlining the scale and sector distribution of economic impacts.

- Most multiplier effects lie within the service industry;
    - Business services are the main beneficiary of construction activity with one business services job created for every seven direct construction jobs (this may relate to engineering, planning, finance and other consultancy jobs).
    - For every 19 construction jobs (direct, indirect and induced) 1 job is needed in hospitality and catering.

Based on the hospitality and catering ratio outlined above the following employees may be needed to support the construction workforce (Figure 8.2). This is an upper estimate as local facilities are likely to operate more efficiently to cope with additional demand.

This is based on the employment estimate for the construction programme after leakages, but before displacement as this presents the best proxy for total demand for hospitality services.

Figure 8.1 – Estimate of hospitality & catering employment supported by construction

Option		Employment supported			
		Construction: Total person years (after leakages)	Hospitality & Catering: Total person years	Construction: Annual average during build period	Hospitality & Catering: Annual average during build period
B1	Aberthaw - Minehead Barrage	70,200	3,700	7,000	370
B2	Cardiff - Hinkley Point Barrage	63,500	3,300	7,900	420
B3	Cardiff - Weston Barrage	46,800	2,500	6,700	350
B4	Shoots Barrage	7,000	400	1,400	70
B5	Beachley Barrage	5,100	300	1,300	70
F1a	Cardiff to Weston Tidal fence	8,800	500	1,800	90
F1b	Aberthaw to Minehead Tidal fence	8,500	500	900	40
L2	Welsh Grounds Lagoon - Fleming	10,100	500	2,000	110
L3a	Russel Lagoon (English Grounds)	9,700	500	2,400	130
L3b	Russel Lagoon (Welsh Grounds)	12,800	700	2,600	130
L3c	Russel Lagoon (Peterstone Flats)	11,800	600	2,400	120
L3d	Bridgwater Bay (Land Connected Lagoon)	9,300	500	1,900	100
L3e (i)	91sq.km Offshore Lagoon	23,700	1,300	4,000	210
L3e (ii)	50sq.km Offshore Lagoon	14,400	800	2,900	150
R1	Aberthaw to Minehead Tidal Reef	34,500	1,800	3,500	180

On this basis an annual average of 370 people will be required in the hospitality and catering industry to support the needs of the construction workers under Option B1, rising to up to 420 under option B2. Guidance published by the Department for Communities and Local Government demonstrates that on average one employee in a hotel/guesthouse is required to service 2 to 4 rooms, depending on the quality of the accommodation, i.e. up to 2,000 rooms required by the construction workers under option B2.

This level of demand is likely to displace existing hotel users during months of high occupancy. However, this does not take account of a reduction in demand from other users of accommodation and catering; specifically tourism related accommodation demand. It is possible that the construction related demand would act to substitute against the reduction in tourism and recreational related demand for hospitality and catering services.

The assumed employment effect of the construction process on the hospitality sector represents a substantial increase in employment. Utilising this information, the following broad magnitudes of potential impact can be estimated.

	Annual Average Employment Support By the Construction Process	As a percentage of local employment in accommodation
Large Barrage(B3)	350	1.45%
Small Barrage (B4)	100	0.4%
Lagoon (L2)	100	0.4%
Tidal Fence (F1a)	100	0.4%
Tidal Reef (R1)	200	0.8%

Assuming that the GVA per FTE remains constant, then this would equate to between £0.7 million GVA and £6.8 million per annum over the build period to the economies of Wales and the South West of England, depending on the tidal power option constructed. However, it should be noted that these potential benefits have already been captured in the assessment of the construction related economic impact, through the multiplier impacts. The purpose of this chapter is to highlight the scale of benefits to the accommodation and hospitality sector.

Option	Annual Average Hospitality FTE (after leakages)	Estimated Annual Average GVA (£)	Estimated PV Total GVA (over the build period) £ million
B1 - Aberthaw - Minehead Barrage	370	5,998,000	52
B2 - Cardiff - Hinkley Point Barrage	420	6,808,000	48
B3 - Cardiff - Weston Barrage	350	5,674,000	36
B4 - Shoots Barrage	70	1,135,000	5
B5 - Beachley Barrage	70	1,135,000	4
F1a - Cardiff to Weston Tidal fence	90	1,459,000	7
F1b - Aberthaw to Minehead Tidal fence	40	648,000	6
L2 - Welsh Grounds Lagoon - Fleming	110	1,783,000	8
L3a - Russel Lagoon (English Grounds)	130	2,107,000	8
L3b - Russel Lagoon (Welsh Grounds)	130	2,107,000	10
L3c - Russel Lagoon (Peterstone Flats)	120	1,945,000	9
L3d - Bridgwater Bay (Land Connected Lagoon)	100	1,621,000	8
L3e(i) - 91sq.km Offshore Lagoon	210	3,404,000	19
L3e(ii) - 50sq.km Offshore Lagoon	150	2,432,000	11
R1 - Aberthaw to Minehead Tidal Reef	180	2,918,000	25

The summary tables overleaf present high, medium and low scenario outcomes in line with the sensitivity testing included in the construction section (Section 3) where leakage rates were varied, and corresponding local accommodation demand.

Large Barrage

Topic	S	Baseline	Significance		Scenario			Assessment of Risk
			Magnitude	Activity	H	M	L	
Construction related hospitality demand	C	£380m 24,000 FTE	+		£69m GVA 4,700 person years (Annual Average 670)	£36m GVA 2,500 person years (Annual average350)	£26m GVA 1,800 person years (Annual Average 250)	Duration of impact is not sustained after the construction period. These figures are based on the relationship between construction employment and supported employment in hospitality (ratio of 19:1). As the large barrages will support a high level of employment, there will be a substantial positive impact on hospitality to support this. **These impacts have already been captured in the construction chapter.**

Small Barrage

Topic	S	Baseline	Significance		Scenario			Assessment of Risk
			Magnitude	Activity	H	M	L	
Construction related hospitality demand	C	£380m 24,000 FTE	+	+	£11 m 700 person years (annual average 140)	£5.3m 370 person years (annual average 70)	£4m 260 person years (annual average 50)	Duration of impact is not sustained after the construction period. These figures are based on the relationship between construction employment and supported employment in hospitality (ratio of 19:1). As the large barrages will support a high level of employment, there will be a substantial positive impact on hospitality to support this. **These impacts have already been captured in the construction chapter.**

Lagoon

Topic	S	Baseline	Significance of Impact		Scenario			Assessment of Risk and Level of Certainty
			Magnitude	Activity	H	M	L	

Construction related hospitality demand	C	£380m 24,000 FTE	+	+	£14m 930 person years (annual average 190)	£8.3m 530 person years (annual average 110)	£5m 330 person years (annual average 70)	Duration of impact is not sustained over the construction period. These figures are based on the relationship between construction employment and supported employment in hospitality (ratio of 19:1). The variation relates to the different lagoon options being considered, as employment requirements vary **These impacts have already been captured in the construction chapter.**

Tidal Fence

Topic	S	Baseline	Significance		Scenario			Assessment of Risk
			Magnitude	Activity	H	M	L	
Construction related hospitality demand	C	£380m 24,000 FTE	+	+	£11 m 680 person years (annual average 140)	£6.8m 460 person years (annual average 90)	£6m 380 person years (annual average 80)	Duration of impact is not sustained after the construction period. These figures are based on the relationship between construction employment and supported employment in hospitality (ratio of 19:1). **These impacts have already been captured in the construction chapter.**

Tidal Reef

Topic	S	Baseline	Significance		Scenario			Assessment of Risk
			Magnitude	Activity	H	M	L	
Construction related hospitality demand	C	£380m 24,000 FTE	+	+	£73m; 5,200 person years (annual average 520)	£25m; 1,800 person years (annual average180)	£20m 1,400 person years (annual average 140)	Duration of impact is not sustained after the construction period. These figures are based on the relationship between construction employment and supported employment in hospitality (ratio of 19:1). **These impacts have already been captured in the construction chapter.**

These impacts have already been captured in the Construction chapter

9. Residential and Population

9.1 Summary of Impacts

For the purpose of this chapter, the tidal schemes have been grouped into three clusters, namely:

- Large barrage
- Small barrage
- All other tidal power schemes

Baseline	Resident population of 2.2 million in the Severn Estuary local area
Gross Direct Effect	**Large Barrage**: Potential to attract additional resident population due to construction, increased economically viable land, amenity value of waterscape and increased environmental quality; although may lead to population reduction if flood risk is increased **Small Barrage**: Lesser potential to attract additional resident population due to construction, increased economically viable land, amenity value of waterscape and increased environmental quality. Could lead to population reduction if flood risk is decreased. **Other Tidal Power Schemes**: Unlikely to be a significant impact.
Leakage	n/a
Displacement	n/a
Crowding Out	n/a
Multiplier Effect	n/a
Local Net Additional Impact	**Large Barrage**: Could be significant, but not yet quantifiable. **Small Barrage**: Less significant, but not yet quantifiable. **Other Tidal Power Schemes**: Unlikely to be significant

9.2 Regional Context and Baseline

There are an estimated 2.1 million people in South Wales and 5.1 million people in the South West of England. These two areas are also expected to grow significantly over the next 20 years. For example, the population of Wales is expected to grown by 8% between 2004 and 2024 (WAG), while the population of the South West is forecast to grow by 5.4% between 2000 and 2010 (SW Observatory). Recently, the population of the South West has increased by over 30,000 (net) people every year (SWRA).[97]

[97] Data sourced from the SEA Socio-Community Topic Paper Draft B.

The Severn Estuary local area (Bristol, Cardiff, Gloucestershire, Monmouthshire, Newport, North Somerset geographic area, South Gloucestershire, Vale of Glamorgan) has a population of just over 2 million people, which accounts for a significant part of the South West and Wales population.

The two regions have a high proportion of low density rural areas, with settlements of limited population, which contrasts to the larger urban areas, of Cardiff, Bristol, Newport and Gloucester. The major transport links and the relative proximity to London suggest that the South West and South Wales area around the estuary will see an increase in residential development in the coming years.

The major restrictions on significant population growth in the areas is the quantity of green belt land and the high flood risk which affects a large area of North Somerset, South Gloucestershire, Cardiff and Newport.

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9.3 Areas of Impact

The areas of potential economic impact in this chapter are speculative and dependent on a number of unknown factors. The purpose of this section is to highlight potential areas of impact. However, the high level of uncertainty (flood risk, marine environment and ancillary investment) should be borne in mind.

Construction Workers: Temporary and Permanent

One of the potential impacts will be the increase in the population of the local area during the construction process. Assuming a construction period of up to ten years, this will lead to a significant increase in the temporary population of the area. We have captured this potential impact on the accommodation sector. However, it is possible that the inflow of labour during the construction phase will increase demand for both rental accommodation (as well as the hospitality sector) and place pressures on local housing demand. It is also possible that the inflow of labour will add to public service demand over the construction period, placing pressures on local services.

Furthermore, some of this temporary increase may become permanent, either from continued employment in the maintenance of the barrage, or from finding other employment opportunities within the South West of England or South Wales. This operational increase in the resident population is likely to be significantly smaller than the population increase during construction. The population increase will be more significant if the large barrage is constructed, compared to the small barrage or the lagoon.

Operation and Maintenance of Tidal Power Scheme: Employment and Homes

The operation and maintenance of the tidal power scheme will create a number of direct and indirect jobs in Wales, the South West, or both. The magnitude of this will vary across the options, those with relatively higher construction costs generally generating more employment. This operating impact represents an on-going permanent impact, starting when construction is completed.

Parsons Brinkerhoff estimate the following composition of operating employees by discipline:

- 10% managers;
- 35% - 40% skilled technicians; and
- the remainder would consist variably of unskilled workers, trainees and administrators.

The annual direct FTEs required to support the operation of the STPs vary from approximately 720 FTE per annum for the large barrage, 170 FTE for a tidal fence, 120 FTE for a lagoon and 100 FTEs for a small barrage (see chapter 10).

Some of these jobs may be filled by people already resident in the two regions; whilst others may be filled by people moving into the regions. If the latter, then this will increase the demand for homes within the regions. For the large barrage projects, in particular, in-migration is likely to be a major feature.

Decreased Flood Risk: Potentially More Viable Land Available

As discussed in the chapter on land use, there are potentially positive impacts on the flood risk due to tidal power schemes; which can be summarised as:

Positive Impacts

- Large barrage and small barrage may provide flood defence benefits
- Attenuation of surge tides could reduce damages of high tides which overtop defences and avoid or delay the need for expenditure on flood defences to keep pace with sea level rise.

Negative Impacts

- Barrages and tidal lagoons can reduce tidal range which can adversely affect land drainage into the estuary.
- A changed tidal regime may reduce the exposure of some outfalls, thus reducing the time available for maintenance work, which could in-turn lead to siltation.
- If any tidal power schemes lead to greater erosion of the foreshore downstream, then this could undermine flood defences and increase flood risk

Either Positive or Negative

- Changes to the wave climate upstream of any structure may bring flood risk benefits or increase flood risk

Negative impacts are being accounted for in the STP construction costs estimates. However, there is some uncertainty and further work is being planned for phase 2 (outside the scope of this research).

The potential reduction of the flood risk could mean that greater areas of land in currently high flood risk areas become suitable for residential or employment land development, assuming that the flood risk of the area would be under greater control as the barrage performs a dual role as protection from sea or tidal flooding. This assumes that the land is made available for development through the planning process. **This is highly uncertain** and possible that the EA do not recognise a barrage as a flood defence asset, unless strict conditions are met. At which point, there may not be scope for greater development.

The greater potential for development in the area will increase employment directly through residential development or indirectly as a result of commercial development which increases employment in the area. These impacts will only be significant in the large barrage option, as the small barrage and the lagoons do not offer the same degree of flood risk mitigation or area potentially affected as the large barrage. These impacts will only be relevant post construction of the barrage. **This assessment is tentative due to the uncertainties surrounding the issue of flood risk previously discussed.**

In-Migration Due to Improved Environmental Quality

Increased migration as a consequence of improved marine environment (and an increase in the area as a tourism hub) could have a potential population increasing effect on the area. The development of marina facilities and of other water and recreational uses within the Severn estuary area could make it a more attractive location for people to move to (although this is outside of the scope of this report). These impacts are going to be greater under a large barrage option compared to the impacts which would come from the small barrage or the other tidal power schemes. It is possible that some people will choose to leave the area during the construction as a result of the disruption, although this is likely to have a negligible impact as people would replace those who may move out of the area.

Legacy of Upskilling of Population and Attraction of Suppliers

The construction of the barrage will involve the provision of specialist components (notably turbines and caissons) which cannot currently be sourced in Wales or the South West. Some of these may be imported to the region, but the sheer scale of demand for specialist components could feasibly lead to the establishment of manufacturing facilities in Wales or the South West. Once the barrage is complete, these manufacturing facilities may remain, and serve markets outside the region, thus leading to export growth. These manufacturing facilities will employ people, who may already be residents of the region, or who may move into the area for the jobs and subsequently remain. This could lead to an increase in residential population in Wales and the South West.

The barrage construction process may well lead to the up-skilling of residents of the South West and Wales, possibly including some specialist construction or engineering skills. It is difficult to estimate the level of up-skilling that will take place. The construction related impacts assume a high degree of labour inflow, to meet the skills demand, which suggest that limited local level up-skilling will take place in the absence of specific local area up-skilling programmes (e.g. intervention to reduce the level of employment leakage). If these people remain in the region, then the availability of labour with these skills could lead to the attraction

of businesses seeking to exploit these skills. This effect could mean people remaining in the region who would otherwise have gone elsewhere to work and live.

Perceptions of the area could change due to the barrage and the subsequent effects that it has on the regional economy. This could lead to in-migration of both companies that employ both current residents and in-migrants; and the in-migration of people seeking work. Both of these effects could lead to an increase in the population of Wales and the South West.

In extremis, the change in flood risk could lead to more or less land being viable for agricultural, commercial or residential uses. If the quantity of land thus affected is significant, this could in-turn lead to changes in the spatial planning structures for one or both of Wales and the South West.

9.4 Impact

Large Barrage								
Topic	**S**	**Baseline[98]**	**Significance**		**Scenario**			**Assessment of Risk**
			Magnitude	**Activity**	**H**	**M**	**L**	
Construction Workers	C	Resident local population of 2 million	Cannot be quantified at this stage		Cannot be quantified at this stage			Large number of in-migrant construction workers. Numbers in chapter on construction impact. There will be a temporary impact on resident population, but most will leave after completion of construction. A small number are likely to remain in the area.
Attraction of Supplier	C	Resident population of 2.2 million	As above		As above			The scale of development may enable facilities to be developed in the region to meet demand (e.g. turbine manufacturing). However, this is highly uncertain, especially as the international market has consolidated. Further information about the supply chain is required to assess the possibility of this.
Increase in Amount of Viable Land	O	Resident population of 2.2 million	As above		As above			Decrease in flood risk for land behind barrage could lead to increased development for residential, industrial and commercial premises, which will lead to an increase in population.
Improved Environmental Quality	O	Resident population of 2.2 million	As above		As above			Improved marine environmental quality could lead to increased in-migration as people are attracted by the quality of the environment.

[98] Census 2001 (Household residents) – local area as previously defined.

Small Barrage

Topic	S	Baseline	Significance		Scenario			Assessment of Risk
			Magnitude	Activity	H	M	L	
Construction Workers	C	Resident population of 2.2 million	Cannot be quantified at this stage		Cannot be quantified at this stage			Large (but lesser) number of in-migrant construction workers. Numbers in chapter on construction impact. There will be a temporary impact on resident population, but most will leave after completion of construction. A small number are likely to remain in the area.
Increase in Amount of Viable Land	O	Resident population of 2.2 million	As above		As above			Decrease in flood risk for land behind barrage could lead to increased development for residential, industrial and commercial premises, which will lead to an increase in population.
Improved Environmental Quality	O	Resident population of 2.2 million	As above		As above			Improved marine environmental quality could lead to increased in-migration as people are attracted by the quality of the environment.

Other Tidal Power Schemes

Topic	S	Baseline	Significance		Scenario			Assessment of Risk
			Magnitude	Activity	H	M	L	
Construction Workers	C	Resident population of 2.2 million	Cannot be quantified at this stage		Cannot be quantified at this stage			Large number of in-migrant construction workers, but probably less than for barrage options. Numbers in chapter on construction impact. There will be a temporary impact on resident population, but most will leave after completion of construction. A small number are likely to remain in the area.
Increase in Amount of Viable Land	O	Resident population of 2.2 million	As above		As above			Unlikely to have much impact on flood risk (could be positive and negative), therefore unlikely to create much more economically viable land
Improved Environmental Quality	O	Resident population of 2.2 million	As above		As above			Unlikely to have as much impact as either large or small barrage scheme on environmental quality, and therefore unlikely to have much effect on in-migration of population.

10. Other Industries

10.1 Construction related

Detailed economic impact models are available for the South West through the Regional Observatory and for Wales through Cardiff University (Welsh Economy Research Unit). The impact models are useful in outlining the scale and sector distribution of economic impacts.

More detailed information is available for the South West in highlighting sector multiplier linkages whereas only summary multipliers are published for Wales. However, an inspection of the core data for Wales suggests similar modelled results for Wales and South West hold as follows:

- For both regions there is limited impact on construction materials including aggregates;
- There are substantial knock-on benefits within the South West construction industry,
    - for example for every 14 FTE (£1 million of activity in the impact model) jobs generated directly within the construction sector another 5 FTE jobs are generated elsewhere in the construction sector(0.35);
    - this suggests that even in the case of specialised operators from outside of the regions, they may be scope for substantial sub-contracting activity;
- Most multiplier effects lie within the service industry;
    - Business services are the main beneficiary of construction activity with one business services job created for every seven direct construction jobs (this may relate to engineering, planning, finance and other consultancy jobs) (0.14).
    - For every 19 construction jobs (direct, indirect and induced) 1 job is needed in hospitality and catering (0.05).

These impacts have been captured in assessing the multiplier impacts of the construction process.

Aggregates

The following table sets out the broad magnitudes of aggregates required during the construction period.

Estimated resource requirements

	B3	B4	Land Connected Lagoon
Dredging and material for disposal	25m m^3	1.9m m^3	2.6m - 10.2m m^3
Concrete	11.9m m^3	1.2m m^3	0.16m - 1m m^3
Sand (ballast & core)	15.5m m^3	2.2m m^3	18m - 68.8m m^3
Other filling materials	10.5million m^3	2.8m m^3	21m - 80.5m m^3
Steel reinforcement	1.7m t	179,000 t	38,000 - 155,000 t
Pre-cast concrete	Inc. 'concrete' above		1m - 4 m tonnes

In addition to these aggregates, resources will be required for the construction of supporting infrastructure such as roads, footpaths, cranes and utilities connections.

The spend and supply chain impacts of the tidal power options have been captured in the Construction chapter, together with assumptions about the potential supply of aggregates; which were provided to DTZ from PB and are reflected in the leakage estimates.

Multiplier impacts have captured subsequent indirect and induced impacts on aggregates and other sectors (but they have not been double counted).

Aggregate extraction by means of dredging within the Severn Estuary is covered by license from the Marine and Fisheries Agency, under the Food and Environmental Protection Act (FEPA) 1985 Part II. The current FEPA license puts a limit on the tonnage of aggregate that can be dredged for commercial purposes at 2-2.5 million tons p/a. There is about 1.8 million tons landed currently, and the excess within the license is intended for any increase in the demands for housing. According to the Countryside Council for Wales, within the current licensing conditions there is little room for increasing capacity to supply the surge in construction demands that would result from a tidal energy project. Therefore, it is unlikely that aggregates dredged from the Severn Estuary would be used to supply all of the aggregate requirements of the tidal power options, and considerable resources would need to be imported into the local area- particularly components such as rock armour . This has been reflected by the assumptions in the construction chapter.

Post construction the aggregate extraction sector in the Severn Estuary area may be limited by the requirement to navigate through sluice gates and there may be additional restrictions placed on extraction. DTZ has not reviewed this as there is insufficient information in relation to the impact of the long list of STP options on this sector.

10.2 Port related

The impact models show that the most significant impact in Wales and the South West lies within distribution and other port related services. This is most likely hauliers, storage companies and suppliers close to Ports and is consistent with both chapter 4 of this study and the findings in the SWRDA-commissioned economic impact report for Bristol Port.

10.3 STP related Operating Impact

Local employment will be generated through the on-going management, operation and maintenance of the tidal power options. The magnitude of this will vary across the options, those with relatively higher construction costs generally generating more employment. This operating impact represents an on-going permanent impact, starting when construction is completed.

Parsons Brinkerhoff estimate the following composition of operating employees by discipline:

- 10% managers;
- 35% - 40% skilled technicians; and
- the remainder would consist variably of unskilled workers, trainees and administrators.

To derive FTE employment estimates associated with on-going operation of the tidal power infrastructure:

- The annual operating cost estimates were provided by PB[99]
- The estimated FTE employment supported was calculated by dividing the estimated annual operating cost by the turnover per employee for the electricity generating sector (source: Annual Business Inquiry 2007[100], ONS inflated to 2008 prices using the HM-Treasury deflator series); and
- The total gross impact was calculated by multiplying FTEs supported by the relevant multiplier from the input-output tables (electricity generation multiplier 2.36). The table overleaf summarises the results for each option:

Gross Employment Estimates

	Option	Annual Operation Costs (£ million)	Estimated Direct FTE	Total FTE Impact (including multiplier effects)
B1	Aberthaw - Minehead Barrage	£359	820	1,900
B2	Cardiff - Hinkley Point Barrage	£376	860	2,000
B3	Cardiff - Weston Barrage	£315	720	1,700
B4	Shoots Barrage	£44	100	200
B5	Beachley Barrage	£32	70	200
F1a	Cardiff to Weston Tidal fence	£76	170	400
F1b	Aberthaw to Minehead Tidal fence	£109	250	600
L2	Welsh Grounds Lagoon - Fleming	£55	120	300
L3a	Russel Lagoon (English Grounds)	£44	100	200
L3b	Russel Lagoon (Welsh Grounds)	£63	140	300
L3c	Russel Lagoon (Peterstone Flats)	£57	130	300

[99] Costs DCF Analysis on Options 0 artion 120 years
[100] 2007 provisional data

L3d	Bridgwater Bay (Land Connected Lagoon)	£52	120	300
L3e(i)	91sq.km Offshore Lagoon	£99	230	500
L3e(ii)	50sq.km Offshore Lagoon	£60	140	300
R1	Aberthaw to Minehead Tidal Reef	£313	710	1,700

In assessing the scenarios around the possible operational employment associated with the STP options, the following assumptions have been made:

- Low- displacement impact of 75%
- Medium- displacement impact of 50%
- High - displacement impact of 25%

These variations capture the uncertainty in relation to energy production employment. For example, if the STP option provides energy instead of other energy products in Wales and the South West, then the employment impact represents a high level of displacement (and low net additional impact). If the STP does not take the place of other energy products in Wales and the South West of England, then a low displacement factor is appropriate. DTZ does not know the answer to this, and have therefore applied a broad range to capture these uncertainties.

Sensitivity Assessment of Total net FTE employment (including multipliers)

	Option	High Scenario	Medium Scenario	Low Scenario
B1	Aberthaw - Minehead Barrage	1,450	970	480
B2	Cardiff - Hinkley Point Barrage	1,520	1,010	500
B3	Cardiff - Weston Barrage	1,270	850	420
B4	Shoots Barrage	180	120	60
B5	Beachley Barrage	130	90	40
F1a	Cardiff to Weston Tidal fence	300	200	100
F1b	Aberthaw to Minehead Tidal fence	440	290	150
L2	Welsh Grounds Lagoon - Fleming	220	150	70
L3a	Russel Lagoon (English Grounds)	180	120	60
L3b	Russel Lagoon (Welsh Grounds)	250	170	80
L3c	Russel Lagoon (Peterstone Flats)	230	150	80
L3d	Bridgwater Bay (Land Connected Lagoon)	210	140	70
L3e(i)	91sq.km Offshore Lagoon	400	270	130
L3e(ii)	50sq.km Offshore Lagoon	240	160	80
R1	Aberthaw to Minehead Tidal Reef	1,260	840	420

Whilst the more costly options will generally have a larger total impact, option B5 has a relatively higher total cost of capital: total gross impact ratio when compared to the more expensive alternatives. For example option B1 is 23 times more costly than option B5 but only yields a total gross impact seven times more than option B5.

To convert these annual impacts into PV's, the following modelling assumptions have been made:

- On-going operating impacts do not occur until the year the construction project is completed. This varies between options: those with a shorter build period start to generate operating impact sooner.
- A 40 year PV has been presented. For example, this includes the 10-year construction period, followed by a 30 year operating period for a large barrage. Discounting is applied during construction period (even though operating impacts are not yet generated) to ensure consistency with the other PV's presented in this report.
- A discount rate of 3.5% is applied per annum years 0-30 and 3% from year 31 to 40.
- The PV of operational costs have been converted to GVA based on the ratio of GVA/Turnover in the electricity generating sector; as shown in the latest ABI information.

Operating PV, £ million GVA (Net- Including Multiplier Impacts)

	Option	High Scenario	Medium Scenario	Low Scenario
B1	Aberthaw - Minehead Barrage	£4,740	£3,160	£ 1,580
B2	Cardiff - Hinkley Point Barrage	£5,490	£3,660	£ 1,830
B3	Cardiff - Weston Barrage	£ 4,830	£3,220	£1,610
B4	Shoots Barrage	£ 750	£ 500	£ 250
B5	Beachley Barrage	£ 560	£ 380	£ 190
F1a	Cardiff to Weston Tidal fence	£ 1,280	£ 850	£ 430
F1b	Aberthaw to Minehead Tidal fence	£ 1,440	£ 960	£ 480
L2	Welsh Grounds Lagoon - Fleming	£ 920	£ 610	£ 310
L3a	Russel Lagoon (English Grounds)	£ 780	£ 520	£ 260
L3b	Russel Lagoon (Welsh Grounds)	£ 1,060	£ 710	£ 350
L3c	Russel Lagoon (Peterstone Flats)	£ 960	£ 640	£ 320
L3d	Bridgwater Bay (Land Connected Lagoon)	£ 890	£ 590	£ 300
L3e(i)	91sq.km Offshore Lagoon	£ 1,600	£ 1,070	£ 530
L3e(ii)	50sq.km Offshore Lagoon	£ 1,010	£ 670	£ 340
R1	Aberthaw to Minehead Tidal Reef	£ 4,350	£ 2,900	£ 1,450

10.4 Environmental Employment

Compensatory habitat has been excluded from this initial assessment due to the uncertainty that surrounds the location of replacement habitat. However, if based in the South West and Wales region, an assessment of the potential environmental related employment would need to be undertaken to capture the economic value of this.

10.5 Energy Costs

The competitiveness of the region may be impacted by the price paid by companies for electricity supply. A national tariff system is operated by the National Grid that reflects the cost of electricity transmission. This is made up of two components; a generating tariff and a

demand tariff. Generators are charged a tariff based on their distance from a load centre (the further away the greater the tariff) and customers are charged a demand tariff. The further away from a load centre or source of power, the greater the tariff.

Developing significant generation capacity in the South West and Wales will increase the generation tariff (i.e. the charge placed on the suppliers of power for the transmission network). According to initial high level analysis by the National Grid this could result in annual generation tariff applicable to the Severn estuary increase by over £6.50/kW (£52m increase in annual costs compared with existing tariff), with generating tariffs in the South West peninsular increasing by £5/kW.

Developing significant generation capacity in the South West and Wales will decrease the demand tariff (i.e. the price paid by customers for use of the transmission network). Demand tariffs in South Wales could be reduced by over £7/kW and £5/kW in the South West. This equates to a £30m+ reduction annually in the transmission demand charges levied on consumers in South Wales and the South West.

Rough Estimates of Impact on 2008/9 GB Transmission Tariffs of additional generation in the Severn Estuary

Additional Generation		Generation Tariff Increase (£/kW)			Demand Tariff Reduction (£/kW)		
South West MW	South Wales MW	South Wales & Avonmouth	SW Peninsula	North Scotland	South Wales	South West	Scotland
4000	4000	£6.50	£5.20	-£2.70	-£7.20	-£5.10	£2.40
1500	1500	£4.00	£2.00	£1.30	-£4.40	-£2.50	£1.20
1000	0	£1.20	£0.50	-£0.40	-£1.00	-£0.70	£0.30
0	1000	£1.80	£0.30	-£0.40	-£2.30	-£0.60	£0.30

Source: National Grid

However, it should be noted that demand tariff is only a small component of the end consumer energy costs. Therefore, the scope for reduced demand tariffs to enhance the competitiveness of Wales and the South West of England may be limited and potentially only have a noticeable impact on energy intensive industries.

It should be noted that this is a very high level assessment and the National Grid is undertaking more detailed analysis of potential tariff impacts in 2009.

10.6 Other Economic Impact Modelling Issues

Both Wales and the South West of England have access to Input-Output accounts and models showing the links between different sectors in each economy. The SWRDA and the Welsh Economy Research Unit kindly provided Input-Output data for both regions to allow multipliers to be estimated. The South West Observatory publishes Regional Economic Accounts and economic impact models online (www.swo.org.uk/business/links-2/south-2/south-west-regional.shtm).

Where possible we have considered linkages in both Wales and the South West but relied more heavily on information for the South West. Therefore the multipliers used in this study are likely to be mildly conservative as they are based on the linkages within one region rather than linkages across the regions (although the latter are likely to be far smaller than the former). A full set of two-region multipliers is likely to show knock-on (indirect and induced) effects around 5-10% higher (direct impacts remain unchanged).

The most important aspect of using multipliers in this study was to ensure that activities were allocated to the most appropriate industrial sector. Much of the planned investment ranging from infrastructure in and around ports to the construction of caissons will be wholly new to the regions involving new technologies and forging new industrial structures.

The most useful benefit of using Input-Output data is the indication of the likely indirect areas of the economy that will witness costs and benefits accruing to them from direct impacts. For example, the likely accommodation impact arising from an influx of construction workers or the impact on areas like food and drink that support direct tourist activities such as hotels and restaurants. Multipliers were used to outline employment and output (GVA) impacts as some activities varied considerably in terms of labour intensity (tourism) or capital intensity (operating the tidal power projects).

In addition, the relationships within the Input-Output model can help to show what may happen to costs outside of the project, if the development leads to a rise in wages. This is undertaken by reversing the traditional Input-Output relationships showing supply linkages to show customer linkages.

However, it is the wider public sector that is more likely to feel the effects of general price rises (see modelling below). Additionally, the construction industry is currently contracting and is likely to have excess capacity in the short to medium term. Both of these factors suggest that crowding out effects in the construction sector is likely to be limited.

An initial review of this suggested the larger projects may result in a rise of up 10 per cent rise in construction wages. In terms of secondary impacts, this will feed through the economy and in particular sectors of the economy that are big purchasers of construction services, such as the public sector.

Due to the large scale of public sector projects ranging from the building of new schools to upgrading the road network, public sector works are likely to witness the largest effect of rising construction costs. Based on the South West Input-Output model a 10% increase in construction wages may potentially lead to an increased public sector cost of £27million to the South West. An increase would be felt by the housing sector and a minor impact felt by retail sector (retail development).

These impacts would potentially last through the construction period of the tidal power options, if there was an increase in construction wages as a result of high labour demand. If demand is met by an inflow of new workers, or the absorption of redundant workforce then rising wages may be curbed (indeed rising wages are likely to attract mobile workers).

The tidal power projects are unlikely to result in significant price rises outside of construction. The accommodation sector (including hospitality and catering) will witness additional demand

with any reduced capacity likely to affect local households within Wales and the South West or tourists from outside the regions.

At the macroeconomic level only construction was found to have the potential for crowding out effects. For example increased prices may make some development projects no longer viable for the private sector.

In addition to multiplier effects and demonstrating potential price rises, the Input-Output accounts provided a useful starting point for other issues such as displacement. For example, the accounts show the overall value of different activities in Wales and the South West including ports, construction and tourism spending. The accounts also show the extent to which different activities serve markets outside of the regions or compete within the regions. After providing a useful starting point for the preceding analysis much of the information was developed or supplemented using other data sources that were more up to date or detailed.

Appendices

Appendix 1: Glossary

Glossary	
Discount Rate	Money received today is worth more than the same amount of money received in one year's time because of the interest that could be earned on the capital in the interim. When putting a present value on future cashflows, these therefore need to be reduced in value to take account of this. The discount rate is the percentage of the cashflow that is taken off its value for each year that it is delayed.
Full-Time Equivalent Employment (FTE)	Full-time equivalent units are used to improve the comparability of measures of employment. Figures for the number of persons working less than the standard working time of a full-year full-time worker should be converted into full-time equivalents, with regard to the working time of a full-time full-year employee in the unit. The conversion should be carried out on the basis of the number of hours, days, weeks, or months worked.
Gross Value Added (GVA)	The total value of goods and services produced by the economy minus the value of goods and services used to produce the final products.
Net Present Value (NPV)	The present value of a series of future net cash flows that will result from an investment minus the amount of the original investment.
Optimism Bias	The demonstrated systematic tendency for appraisers to be over-optimistic about key project parameters, including capital costs, operating costs, works duration, and benefits delivery.
Person Years	Person-years is the HM-Treasury standard measure for construction related impacts. For example, 10 person-years could represent 1 FTE job for 10 years, 10 FTE jobs for a single year, or a combination in between.
Present Value (PV)	The current value of one or more payments to be received or paid in the future.
Social Time Preference Rate (STPR)	The STPR is a rate used for discounting future benefits and costs, and is based on comparisons of utility across different points in time or different generations. The Green Book recommends that the STPR be used as the standard real discount rate of 3.5% for the first 30 years, and 3% thereafter.

Appendix 2: Terminology Used in End of Chapter Tables

Heading	Meaning
Topic	Area considered
S	Stage where C=Construction and O= operation
Baseline	Value of the activity in the regional economy.
Significance of impact	The relative importance of the area being considered
Magnitude	Significance at a regional level where: 0= not regionally significant ?= uncertain significance - and --= significantly negative regional impact + and ++= significantly positive regional impact
Activity	The relative importance or uniqueness of activity impacted 0= not significant ?= uncertain significance - and --= significantly negative activity level impact + and ++= significantly positive activity level impact
Scenario	Sensitivity testing around the central case where H= High Impact (best if positive and worse if negative) M=Central Scenario which is discussed in chapter text L= Low impact (smallest if positive, smallest if negative)
Assessment of risk and level of certainty	Discusses key uncertainties such as data issues and the extent to which assessment should be assessed with caution. Also discussed key points that inform the assessment.

Appendix 3 – Key supporting policy and strategy documents;

Wales

One Wales; A progressive agenda for the government of Wales
http://new.wales.gov.uk/about/strategy/1wales/?lang=en

Renewable Energy Route Map[101]
http://newydd.cymru.gov.uk/consultations/closed/environment/renewenergymap/?lang=en

Wales: A Vibrant Economy
http://wales.gov.uk/about/cabinet/cabinetstatements/2005/231105-AD-Walesavibranteconomy?lang=en

Wales Spatial Plan
http://new.wales.gov.uk/about/strategy/spatial/?lang=en

Environment Strategy for Wales
http://new.wales.gov.uk/about/strategy/publications/935833/?lang=en

Sustainable Development Scheme: Starting to Live Differently[102]
http://new.wales.gov.uk/about/strategy/publications/startlivedifferently/?lang=en

Wales Fisheries Strategy
http://wales.gov.uk/about/strategy/publications/fisheries/?lang=en

Wales Freight Strategy
http://wales.gov.uk/topics/transport/publications/wfs/?lang=en

Wales Transport Strategy
http://new.wales.gov.uk/about/strategy/publications/transport/?lang=en

Wise About Waste; Waste Strategy
http://new.wales.gov.uk/about/strategy/publications/2096132/?lang=en

Achieving Our Potential: Tourism Strategy for Wales
http://www.industry.visitwales.co.uk/upload/pdf/AOP_ENG.pdf

Green Jobs For Wales
Public consultation launched in Winter 2008, enquiries should be directed to; business&environment@wales.gsi.gov.uk

Local Development Plans
http://new.wales.gov.uk/topics/planning/policy/developplans/LDPWales?lang=en

[101] The public consultation for a Renewable Energy Route Map for Wales concluded in May 2008. The responses will help the development of a Welsh Assembly Government energy strategy by early 2009.
[102] '*One Wales: One Planet*' a public consultation on a new sustainable development scheme for Wales was launched in Winter 2008, enquiries should be directed to sustainable.development@wales.gsi.gov.uk .

South West of England

South West Regional Economic Strategy
http://www.southwestrda.org.uk/what-we-do/policy/res-review2005/draft-res.shtm

South West Regional Spatial Strategy
http://www.southwest-ra.gov.uk/nqcontent.cfm?a_id=538&tt=swra

Our Environment Our Future: Regional Strategy for South West Environment
http://www.southwest-ra.gov.uk/nqcontent.cfm?a_id=521&tt=swra

South West Climate Change Action Plan
http://www.southwest-ra.gov.uk/nqcontent.cfm?a_id=3580

Regional Renewable Energy Strategy for the South West of England
http://www.regensw.co.uk/south-west-england/policy-context/regional-renewable-energy-strategy.php

Regional Waste Strategy: From Waste to Resource
http://www.southwest-ra.gov.uk/nqcontent.cfm?a_id=500

REvision 2010 – Empowering the region. Renewable electricity targets for the South West
http://www.oursouthwest.com/revision2010/

REvision 2020 – South West Renewable electricity, heat and onsite generation targets for 2020
http://www.oursouthwest.com/revision2020/

The Road to 2020: An analysis of Renewable Energy options in the South West of England
http://www.regensw.co.uk/road-to-2020

Appendix 4 Volume and Value of Cargo

		Cargo (tonnes)						
Port	**Total Cargo (tonnes)**	Coal	Agricultural Feed	Forest Products	Oil Products	Ores	Vehicles	Containers
Bristol	12,261,000	5,693,000	671,000	139,000	2,109,000	-	698,000	849,000
Cardiff	2,873,000	-	-	88,000	1,384,000	-	-	265,000
Newport	3,846,000	1,362,000	53,000	108,000	-	-	-	7,000
Sharpness	567,000	-	-	-	-	-	-	-
Swansea	634,000	91,000	-	104,000	-	8,000	19,000	-
Port Talbot	8,659,000	2,542,000	-	-	-	5,665,000	-	-

	Total Value of Cargo (£)	Value of Cargo (£)						
Port		Coal	Agricultural Feed	Forest Products	Oil Products	Ores	Vehicles	Containers
Bristol	£ 10,882,617,000	£ 193,562,000	£ 67,100,000	£ 30,580,000	£ 369,075,000	£ -	£ 6,980,000,000	£ 2,716,800,000
Cardiff	£ 1,393,560,000	£ -	£ -	£ 19,360,000	£ 242,200,000	£ -	£ -	£ 848,000,000
Newport	£ 676,768,000	£ 46,308,000	£ 5,300,000	£ 23,760,000	£ -	£ -	£ -	£ 22,400,000
Sharpness	£ 141,750,000	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Swansea	£ 320,174,000	£ 3,094,000	£ -	£ 22,880,000	£ -	£ 1,200,000	£ 190,000,000	£ -
Port Talbot	£ 1,049,178,000	£ 86,428,000	£ -	£ -	£ -	£ 849,750,000	£ -	£ -
TOTAL	£ 14,464,047,000							

	Value per tonne (£)
Coal	£ 34
Agricultural Feed	£ 100
Forest Products	£ 220
Oil Products	£ 175
Ores	£ 150
Vehicles	£ 10,000
Containers	£ 3,200
Others	£ 250

Sources:
Cargo Tonnes data from MDS Transmodal report (2006 cargo volumes)
Cargo Value data from Roger Tyms 2004 report (2002 cargo prices)
Other cargo assumed for everthing without category

Impact of a Severn Barrage on Commercial Ports

Briefing note

by

MDS Transmodal Limited

Date: September 2008
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CONTENTS

1. Introduction

This paper focuses mainly on the impact of proposed tidal barrage schemes in the Severn Estuary on the four main commercial seaports of Bristol, Cardiff, Newport and Sharpness. It considers the profile of ship types and sizes currently entering these ports, ship size trends in the trades served by these vessels and a high-level assessment of the extent to which port operations will be either positively or negatively affected by the principal barrage options under consideration.

2. Impact on ship navigation

2.1 General impacts

In the absence of primary research or any detailed information on ship arrivals at the commercial ports and the specific navigational requirements of different vessel types, much of the assessment provided in this paper has relied upon information provided in submissions from ABP, Bristol Port Company, Sharpness Dock and Gloucester Harbour Trustees. This should therefore be considered as a **preliminary assessment** of the possible implications of changes imposed by a barrage.

The main impacts of a tidal barrage on commercial shipping are the consequence of 1) the installation of locks to facilitate passage to ports upstream of a barrage and 2) changes to the tidal range such that high water levels will be reduced and low water levels increased within the basin upstream of a barrage.

At this stage, the immeasurable, unknown, impact is that of the impact on safety of navigation as would be created by any structure placed across a busy shipping channel. Subsidiary impacts include the effects of the barrage on currents generally and in the lock approaches and the likely queuing of vessels waiting to transit the locks and to take on tug assistance. These elements also introduce the risk of unreliability, and for example may lead to the need for vessels to find safe anchorage if a window of opportunity to proceed to dock is missed. The 'unreliability' factor has strong commercial repercussions that are considered in section 4.

Impact of locks[103]:

- The operation of the locks will add time to a ship's transit of the estuary, which together with the possibility of delay due to vessel queuing, may cause a call at ports upstream of the barrage to become unattractive to shipowners, and could lead to the diversion of ships to alternative ports. This is particularly the case for 'liner' services

[103] DTZ Note: This assessment is based on information provided by the harbour authoirities. Further modelling will be undertaken in Phase 2 of the wider feasibility study to establish the change in high tide and its effects.

(i.e. container ships, roro[104] vessels), which entail scheduled calls at other ports. All four of the major commercial ports will be affected by the need for an additional lock transit in the Middle Barrage (Cardiff-Weston) scenario. The Shoots Barrage would affect only Sharpness in this way.

- In global terms, ship sizes are generally increasing in order to maximise economies of scale in the shipment of goods. Ship size trends in the Severn Estuary are no exception to this rule. Although the largest sizes of vessel entering the major ports are constrained by the dimensions of the ports' own existing locks, the number of larger ships entering the ports is increasing[105]. The design of navigation locks presently being mooted in the Middle Barrage with a proposed length of 360m will be sufficient to accommodate the largest bulk carriers that presently are able to access Royal Portbury Docks, but insufficient for the sizes of containership (up to 12,000 TEU) for which the Deep Sea Container Terminal (DSCT) being proposed by the Port of Bristol is being designed to accommodate. A lock of 512m would be able to cater for this size of vessel.

Changes to tidal range

- In the Middle Barrage scenario, the increased low water level in the upstream basin will have the effect of increasing the available tidal window, therefore improving access for the majority of commercial vessels currently entering the four major ports. This may to some extent mitigate against the additional time taken to transit the barrage locks, but will not compensate for the more serious reduction in the top water level.

- The reduction in high tide water levels by up to 1 metre will reduce the available tidal window for larger vessels, and seriously restrict, possibly prohibit, access by the largest vessels, i.e. bulk carriers of up to 130,000 dwt (average loaded draft around 16m). As an indication of the effect, 1 metre loss of depth would equate to around 10,000 tonnes deadweight of capacity for the very large bulk carriers. The loss of depth will also seriously affect containerships of 8-12,000 TEU which will require a depth of 14.5-15.0m

- The large bulk carriers are able to make transits into the Royal Portbury Dock on high spring tides and are locked in, while containerships in the future will be received at river berths outside of the dock system and adjacent to the main shipping channel. In order to succeed commercially the DSCT will need to guarantee safe access at all states of the tide to vessels of at least 15.0m draft.

[104] Roll on-Roll off vessels such as car/passenger ferries and scheduled services such as the Grimaldi EuroMed service calling at Bristol
[105] See section 3.

- High tides are also required for relatively smaller vessels to transit as far as Sharpness. According information supplied by to Gloucester Harbour Trustees, the tidal range at Sharpness can be up to 10.8m, with Mean High Water Springs of 9.3m and Mean High Water Neaps of 5.6m. The average sizes of vessels entering Sharpness Dock have a loaded draft in the region 5.6m. Tide heights of 6.5m are required for the majority of vessels to gain access to the dock over Sharpness lock cill. The largest vessels accommodated at the port of up to 6,000 dwt and 6.5m draft will require a tide height of around 7.5m.

- A reduction of the top water level by as much as 2m at Sharpness would significantly reduce the accessibility of the port. At present the majority of vessels are able to access the port on approximately 70% of tides (493 out of a possible 708 tides in a year). The reduction of top water level will reduce the number of possible high tides to 26% (187 tides on 2008 predictions). This would mean that the port would become inaccessible for the majority of vessels over approximately 73% of tides in any year. A 2m drop in tide height implies that the port would become completely inaccessible to the largest vessels. On the basis of experience elsewhere, such a position would mean that the port's commercial position would become unsustainable.

2.2 Largest ship sizes accommodated at Bristol Channel ports

The following table provides a summary of the maximum ship dimensions for vessels accommodated at the major commercial ports.

Table 1: Maximum ship size dimensions at major ports

Port	Max draft (m)	Max length (m).	Max beam (m)	Dwt.
Swansea	9.9	200	26.5	30,000
Port Talbot	16.7	290	No limit	170,000
Cardiff	10.3	198	27.0	35,000
Cardiff – Roath Basin	8.0	158	21.3	10,000
Newport	10.5	244	30.1	40,000
Bristol – Avonmouth Docks	11.0	200	30.1	50,000
Bristol – Royal Portbury Dock	14.5	300	41.5	130,000
Sharpness	6.5	182	16.7	6,000

Source: Port directories

At Swansea, Cardiff, Newport, Bristol and Sharpness, the dimensions of the locks, width of lock gates and height of the lock cill, the latter being a prime determinant, establish the maximum vessel size that can be accommodated. Port Talbot is located in a natural deep water harbour.

The maximum draft of vessel that can enter a dock system is dependant on the height of the tide over the lock cill as a shipowner and harbour master will normally require at least 1m of underkeel clearance. This means, for example, that at Royal Portbury a tidal height of around 16m over the lock cill is required to allow safe passage of a 130,000 dwt 'capesize' bulk carrier.

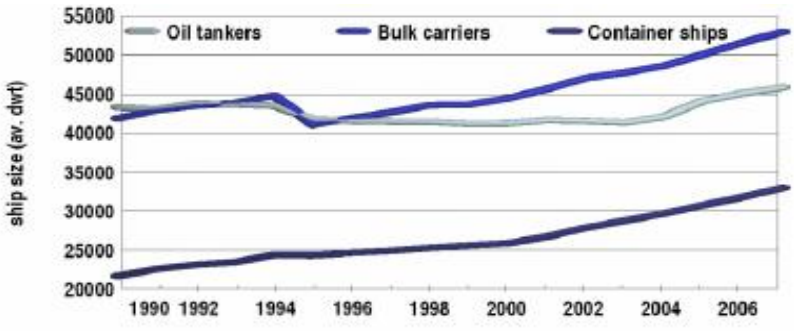
3. Ship size trends

3.1 Global trends

The historical trend in all shipping markets is that trade growth has been met by the development of ever larger ships, driven by the need for economies of scale. This is especially true of low value, high volume commodities shipped in bulk in which all of the ports in the Bristol Channel have a specialisation. However this is now also the case for containers.

Figure 1 demonstrates the general trend, illustrating the increase in the average size of vessels in the tanker, bulk carrier and container fleets, which are all important in the context of the Bristol Channel. These three ship types account for approximately 87% of the total deadweight tonnage of the world merchant fleet. While average ship sizes are increasing, it also should be pointed out that approximately 30,000 ships, equal to almost 80% of all merchant vessels, are less than 20,000 dwt. The majority of these vessels are categorised as general cargo ships and ply a very wide range of trades and are also common to shipping in the Bristol Channel.

Figure 1: World merchant fleet- ship size development of selected ship types, 1990-1 January 2007



Source: ISL

Bulk carriers

The average size of ships in the world bulk carrier fleet has increased from 46,500 dwt in 1990 to 52,800 dwt at the beginning of 2007. In the past five years almost 200 vessels of more than 150,000 dwt have been added to the fleet. Table 2, which summarises the size breakdown of the current fleet and orderbook, shows that the size increase will continue. Orders for newbuildings concentrate on bulk carriers in the capesize segment and above, while the average size of ships on order is 80,000 dwt. These vessels are due to be delivered in the next two to three years.

Table 2: World bulk carrier fleet and orderbook by size, as of 1 January 2007

	Fleet			Orderbook		
Size category	**No.**	**M dwt**	**Dwt % share of total**	**No.**	**M dwt**	**Dwt % share of total**
< 10,000	935	3.1	0.9	13	0.1	0.1
Handysize	2,409	64.9	17.9	278	8.1	9.2
Handymax	838	37.6	10.3	29	1.4	1.6
Supramax	524	27.9	7.7	320	17.7	20.0
Panamax	1,300	92.8	25.5	127	9.4	10.7
Capesize	881	137.3	37.8	341	51.6	58.5
Total	6,887	363.6	100.0	1,108	88.3	100.0

Notes
Handysize: 10,000 – 39,999 dwt
Handymax: 40,000 – 49,999 dwt
Supramax: 50,000 – 59.999 dwt
Panamax: 60,000 – 79,999 dwt
Capesize: > = 80,000 dwt
Source: ISL

While the number of Panamax and Capesize vessels operating in the fleet is clearly increasing, handysize vessels remain very much the 'workhorse' of the bulk shipping markets, operating in a wide range of trades and to some extent also reflecting constraints on ship sizes at many ports in exporting countries.

Panamax vessels are more common in the big bulk trades, especially coal and grain, while Capesizes are usually deployed to deliver raw materials (i.e. coking coal, iron ore) to the steel industry and often deliver to dedicated facilities situated in close proximity to steelworks.

Only the Port of Bristol and Port Talbot have the capacity to handle these types of vessel. Whereas the dimensions of locks at Bristol determine the absolute size of the largest bulk carriers able to dock at Avonmouth and Royal Portbury Docks, it would not be unreasonable to expect larger carriers to call with increasing frequency in the future. For example, the proposed development of a biomass power plant at Portbury will require the importation of large volumes of woodchip, mainly sourced from North America. It is most likely that Panamax and Capesize bulk carriers will be deployed in this new trade. However, it also

needs to be acknowledged that the throughput of coal at Bristol will decline following the probable closure of Didcot power station in 2015.

Container ships

The introduction of unitised cargoes carried in containers is a relatively new development in shipping terms, the first containership having been introduced in the 1960s. The size of containerships is referred to in terms of their carrying capacity measured in TEU (Twenty-foot Equivalent Units), which was the original standard size of a box unit. The number of TEU refers to the total number of box 'slots' available on a ship. In reality fewer total boxes are actually carried as forty-foot containers now make up the majority of containers now transported on the deep sea routes.

The maximum size of vessel in operation in 1980 was 3,000 TEU. In 2006 the first 12,000 TEU ship entered service. The largest vessels in operation are deployed mainly on the 'arterial' Asia-Europe and transpacific shipping routes between the Far East and North America. Across the board a 'cascade' effect or chain reaction is taking place, where larger vessels replace vessels with less capacity operating on secondary and 3rd tier routes as shipping economics are driven by the need to fill vessels and achieve a low unit cost per slot.

As a consequence ports must develop to accommodate the larger ships by having the appropriate depth of water, berths of the required length and handling equipment to ensure that turnaround times in port are optimised.

Table 3 shows the development of the containership fleet since 1990 and its projected development to 2009, based on the orderbook as at Q4 2006. The number of ships of 8,000 TEU plus capacity has increased rapidly since 2005. At one time 8,000 TEU vessels were being referred to as the main 'unit of currency' in the deep sea trades. However most of the major container shipping lines have already replaced these with 10-12,000 TEU vessels on the arterial routes and thoughts of even bigger ships being built no longer seem implausible.

Table 3: Development of the fully cellular fleet, by TEU size band (as at Q4 2006

A) Number of vessels

TEU SIZE BAND	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	% change 1990-2006	% change 2006-2012
<=1000	720	719	959	1071	1148	1228	1259	1311	1335	1342	1342	59.4	16.9
1001 - 2000	431	591	838	980	1075	1213	1297	1409	1473	1492	1496	149.4	39.2
2001 - 3000	212	299	415	591	664	718	768	804	830	849	855	213.2	28.8
3001 - 4000	67	136	211	254	273	309	325	354	393	407	407	307.5	49.1
4001 - 5000	6	77	173	305	354	400	474	573	628	673	708	5800.0	100.0
5001 - 6000	-	-	65	208	231	263	288	302	309	323	330	..	42.9
6001 - 7000	-	-	27	101	119	142	169	198	220	225	227	..	90.8
7001 - 8000	-	-	-	20	21	26	31	42	50	56	61	..	190.5
8001 - 9000	-	-	-	35	84	100	124	147	192	205	205	..	144.0
9001 - 10000	-	-	-	4	24	42	55	68	83	92	92	..	283.3
10000 - 11000	-	-	-	-	-	1	8	10	11	18	18	..	..
11000 - 12000	-	-	-	-	-	-	2	13	19	20	20	..	..
>12000	-	-	-	-	2	7	8	15	57	114	142	..	7000.0
TOTAL	**1436**	**1822**	**2688**	**3569**	**3995**	**4449**	**4808**	**5246**	**5600**	**5816**	**5903**	178.2	47.8

B) TEU (000s)

TEU SIZE BAND	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	% change 1990-2006	% change 2006-2012
<=1000	330	364	498	585	655	719	754	800	821	828	828	98.5	26.5
1001 - 2000	620	834	1178	1376	1500	1698	1822	1986	2084	2113	2120	141.9	41.3
2001 - 3000	548	760	1029	1476	1672	1816	1944	2037	2105	2154	2171	205.0	29.9
3001 - 4000	232	470	726	868	931	1051	1112	1210	1344	1391	1391	301.5	49.4
4001 - 5000	26	333	760	1335	1545	1750	2071	2502	2743	2941	3094	5843.6	100.2
5001 - 6000	-	-	357	1143	1267	1436	1577	1649	1685	1762	1801	..	42.1
6001 - 7000	-	-	175	655	773	923	1461	1649	1795	1829	1842	..	138.4
7001 - 8000	-	-	-	152	157	191	229	309	368	413	450	..	186.2
8001 - 9000	-	-	-	288	691	825	1027	1220	1600	1711	1711	..	147.6
9001 - 10000	-	-	-	37	224	390	514	640	787	875	875	..	291.1
10000 - 11000	-	-	-	-	-	10	82	104	114	187	187	..	..
11000 - 12000	-	-	-	-	-	-	23	149	220	232	232	..	..
>12000	-	-	-	-	25	88	100	192	741	1491	1852	..	7308.0
TOTAL	**1756**	**2761**	**4723**	**7914**	**9440**	**10897**	**12716**	**14447**	**16407**	**17927**	**18554**	437.6	96.6

Note : fleet forecasts are based on confirmed newbuilding orders
Source: MDS Transmodal Ltd

At present Bristol receives two weekly scheduled 'shortsea' container services. DFDS/Lys Line operates between Greenock, Dublin, Bilbao and Bristol using a 700 TEU vessel. MSC operates a feeder service to Bristol from the deep sea port of Antwerp in Belgium using a 1,095 TEU ship. These vessels are currently handled at Avonmouth.

Cardiff Container Terminal handles services to and from Ireland and the Mediterranean. The vessels involved are of less than 1,000 TEU. Feeder links with deep-sea European hub ports are being pursued to make use of the development land adjacent to the terminal for regional distribution.

Shipping economics have previously dictated that ports in the South East are better placed geographically to compete for deep sea container business as they require minimal deviation for very large container ships operating on the main shipping lane to the mega container hubs on the Continent. In this respect both Bristol and Liverpool have been at a competitive disadvantage compared to the principal UK container ports of Felixstowe, Thamesport, and Southampton, although Liverpool is the first port of call in Europe for some container vessels operating on the transatlantic trades from North America. However, the continued growth in UK trade is beginning to change dynamics and both Bristol and Liverpool are gaining in competitiveness on some routes. Both ports are well-placed to serve main centres of population, industry and therefore inland distribution. This lies behind Bristol's proposals to develop a deep water container terminal at river berths outside of the dock complex, and adjacent to the main shipping channel with the intention to be able to receive vessels of at least 8,000 TEU capacity. Such vessels will require unrestricted access to port facilities with depth of water of 15.0m. Vessels of up to 12,000 TEU would require 16.0m.

3.2. Bristol Channel vessel calls

A summary of the current profile of ships by type and size category entering ports on the Bristol Channel is shown in Table 4. Figures 2 and 3 below illustrate the progression of ship sizes in two key market sectors in this port region: dry cargo (includes general cargo ships and bulk carriers) and containers.

The figures available from the Department for Transport show that there were a total of 3,615 vessel arrivals at commercial ports in 2006 creating a total of over 7,200 commercial ship movements in and out of the Channel over the course of the year. The four main ports that will be directly impacted by the Cardiff-Weston barrage proposal account for a total of 2,804 or 78% of all reported calls.

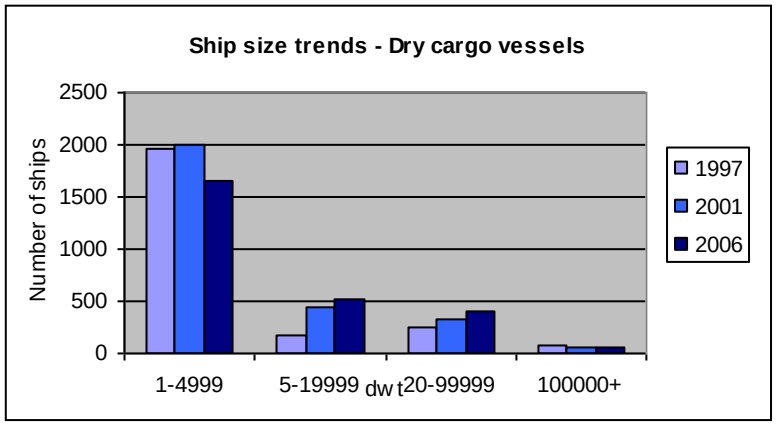


Figure 2

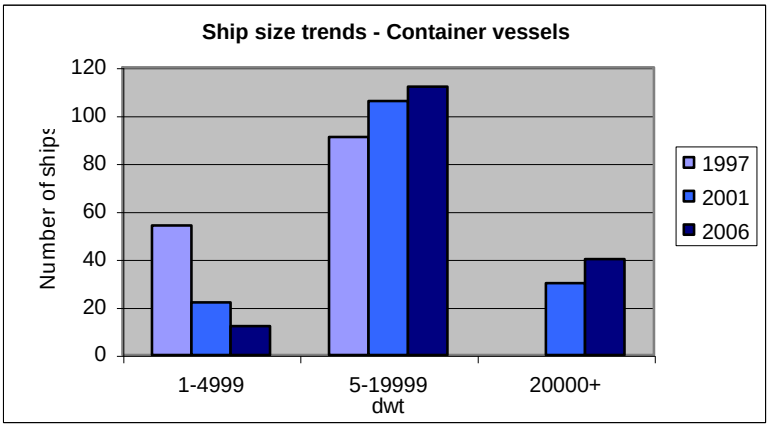


Figure 3

Source: DfT

Table 4: Bristol Channel vessel arrivals by ship type and size, 2006

	Tankers				Ro-Ro vessels			Fully cellular container vessels			Other dry cargo vessels				
Deadweight tonnes:	1-4,999	5,000-19,999	20,000-99,999	100,000+	1-4,999	5,000-19,999	20,000+	1-4,999	5,000-19,999	20,000+	1-4,999	5,000-19,999	20,000-99,999	100,000+	Total all vessels
Ports															
Bridgwater	-	-	-	-	-	-	-	-	-	-	15	-	-	-	15
Bristol	103	95	39	-	1	110	-	4	73	39	274	387	236	2	1,363
Gloucester & Sharpness	-	-	-	-	-	-	-	-	-	-	168	-	-	-	168
Newport	-	-	-	-	-	3	1	3	2	-	462	63	100	-	634
Cardiff	36	123	1	-	11	-	-	4	37	1	374	41	11	-	639
Barry	77	39	-	-	-	-	-	-	-	-	51	1	1	-	169
Port Talbot	7	7	-	-	-	-	-	-	-	-	64	24	51	55	208
Neath	-	-	-	-	-	-	-	-	-	-	69	-	-	-	69
Swansea	-	1	-	-	154	2	-	-	-	-	158	10	4	-	329
Other ports	2	-	-	-	-	-	-	1	-	-	18	-	-	-	21
All Bristol Channel	**225**	**265**	**40**	**-**	**166**	**115**	**1**	**12**	**112**	**40**	**1,653**	**526**	**403**	**57**	**3,615**

Note: 'other cargo vessels' includes bulk carriers

Source: DfT

The table below summarises total vessel calls by size category. This table excludes roro vessels as the results are affected by the cessation of the Swansea-Cork ferry service. Unfortunately the figures are not sufficiently detailed to differentiate the growth in the number of Panamax/Capesize vessels calls, however the figures highlight the 37% increase in vessels in the 20,000-99,000 dwt size range.

Table 5: Changes in ship calls by size category, 1997-2006

Dwt category	1997	2001	2006	% change 1997-2006
1,000-4,999	2,844	2,590	1,890	-34%
5,000-19,999	638	992	903	42%
20,000-99,999	352	366	483	37%
100,000+	69	55	57	-17%
Total	3,903	4,003	3,333	-15%

Source: DfT

Bristol is shown to be the busiest port, receiving 38% of all ship calls in the Channel. The port also accounts for 51% of calls by bulk carriers in excess of 20,000 dwt and 98% of tankers in this size category. Newport and Cardiff receive in excess of 600 calls each per year, the combined total accounting for 35% of all ship calls. The port of Sharpness received a total of 168 calls (336 vessel movements) accounting for 5% of all ship calls.

4. Impact on commercial port business

4.1 Commercial Port throughput

A summary of the total port throughput for major ports in the Bristol Channel is shown in Table 6. The six ports shown between them handled almost 29 million tonnes of cargo in 2006. This represents 5% of all cargo handled through all ports of Great Britain. The port region is particularly important for imports of dry bulk commodities, particularly coal and agricultural products, oil products and both imports and exports of steel products. Bristol is also the 4th largest port in the country for the import and export of trade cars.

Table 6: Bristol Channel major ports throughput, 2006

Thousand tonnes

	Bristol	Cardiff	Newport	Sharpness	Swansea	Port Talbot	Total
Liquid bulk							
Liquefied gas	-	-	-	-	-	-	0
Crude oil	-	-	-	-	-	-	0
Oil products	1,908	1,312	-	-	-	-	3,219
Other liquid bulk products	202	72	-	-	-	-	274
All liquid bulk traffic	2,109	1,384	-	0	-	-	3,493
Dry bulk							
Ores	-	-	-	-	8	5,665	5,673
Coal	5,693	-	1,362	-	91	2,542	9,688
Agricultural products	671	-	53	-	-	-	724
Other dry bulk	1,706	400	545	567	245	441	3,905
All dry bulk traffic	8,071	400	1,961	567	344	8,648	19,991
All bulks							
Bulk fuels	7,600	1,312	1,362		91	2,542	12,908
Other bulks	2,580	472	598		253	6,106	10,009
All bulk traffic	10,180	1,784	1,961	567	344	8,648	23,484
Other general cargo							
Forestry products	139	88	108	-	104	-	439
Iron and steel products	176	735	1,767	-	122	11	2,811
General cargo & containers <20'	73	-	3	-	28	-	105
All other general cargo traffic	388	823	1,878	-	254	11	3,354
Containers							
20' containers	401	124	7	-	-	-	532
40' containers	448	128	-	-	-	-	576
Containers >40'	-	13	-	-	-	-	13
All container traffic	849	265	7	-	-	-	1,121
Roll-on/roll-off (self-propelled)							
Road goods vehicles and trailers	-	-	-	-	19	-	19
Import/export motor vehicles	673	-	-	-	-	-	673
Other mobile self-propelled units	25	-	-	-	-	-	25
All ro-ro self-propelled traffic	698	0	0	-	19	-	717
Roll-on/roll-off (non self-propelled)							
Unaccompanied road goods trailers	7	-	-	-	17	-	24
Unaccompanied caravans, agricultural and industrial vehicles	2	-	-	-	-	-	2
Rail wagons, shipborne port to port trailers, and barges	137	-	-	-	-	-	137
Other mobile non self-propelled units	-	-	-	-	-	-	0
All ro-ro non self-propelled traffic	146	0	0	-	17	-	163
All traffic	**12,261**	**2,873**	**3,846**	**567**	**634**	**8,659**	**28,840**

Source: DfT

4.2 Port markets and displacement of port activity

To an extent the Bristol Channel ports compete with each other in the markets they serve, although certain aspects of each port's business are unique and often have involved significant investment in specialised facilities, usually on the back of long term contract agreements with specific customers. As a result, switching of traffic to alternative ports is not easily achievable. However, the port business is extremely competitive and any disruption to shipping over a long period of time can lead to a loss of business to a competing port.

The following paragraphs provide a brief assessment of the principal cargoes handled at the ports affected by the construction of a barrage and the alternative ports that, theoretically, could handle displaced traffic.

Oil products

Oil products are handled at Bristol and Cardiff. The two operations are different.

Cardiff offers tank storage facilities for petrol and diesel mainly for local distribution by road. Customers include Simon Storage, which operates a petrol and diesel distribution site at the port, on behalf of Chevron Texaco. Other major liquid-bulk customers include Inver Energy (UK) Ltd, which has a heavy fuel-oil import and distribution terminal, and HCB Storage, which operates a multi-purpose fuel oil, chemical and distillate-storage facility for a number of customers. Consignments of oil products are largely delivered in coastal tankers of less than 10,000 dwt.

Bristol's principal liquid bulk traffic consists of around 1.2 million tonnes per annum of aviation fuel, which is delivered direct by pipeline to Heathrow and other regional airports in the south. Aviation fuel is delivered to Berth 7 in Royal Portbury Dock, which was adapted specifically for the reception of aviation grade Kerosene in vessels of up to 120,000 dwt. The berth opened in 2003. The fuel is discharged directly from the berth into the pipeline and storage network managed by the Oil and Pipelines Agency. The remainder of Bristol's liquid bulk business is fuel (for local distribution) delivered in coastal tankers from Milford Haven.

Alternative ports:

Oil storage facilities are available at Swansea.

The nearest ports that can handle vessels of +100,000 dwt are Port Talbot or Milford Haven, although Port Talbot has no specialised berths for handling liquid bulks. The other major facilities for importing aviation fuel are located in the Thames Estuary and the Humber.

Coal

Coal is imported at Bristol and Newport. Newport handles imports of coal, petroleum coke and coke. The port's upgraded bulk terminal at South Dock can discharge two vessels, of up to 40,000 dwt, simultaneously. Coal-washing, screening and blending facilities are also provided within the port estate, in partnership with Hargreaves Industrial Services. In 2006, the port invested in a second coal-loading siding and a rail-weighing facility for coal trains.

Recently, the port has also started to handle exports of Welsh coal that is delivered to the port by rail.

Bristol supplies coal direct by rail to six power stations around the country. The two principal customers are Didcot power station, which accounted for 4 million tonnes of imports through Bristol in 2006, and Aberthaw in South Wales, which took just over 1 million tonnes. Coal is also delivered to Ironbridge (Shropshire), Fiddlers Ferry (Cheshire) and Rugeley and Ratcliffe in the Midlands. In addition to imports, a strategic stockpile of up to 600,000 tonnes of coal is maintained at Portbury.

The future of coal handling at Bristol remains uncertain as two of the power stations served from Bristol, Didcot and Ironbridge, are earmarked for closure by 2015. This is the result of environmental restrictions imposed on coal-fired power stations that have required the power companies to invest in flue gas desulphurisation (FGD) equipment. This has been done in 12 out of the 18 stations in Britain, while six are set to close between 2008 and 2016. Nevertheless, Bristol was Britain's 3rd largest port for imported coal in 2006 and, while the volume of imports may fall, forecasts developed by MDS Transmodal in 2007 have indicated that there is likely to be a continued demand for imports through Bristol.

The forecasts of electricity required from coal-fired power stations, which reflect Government energy policy ("White Paper Proposals assuming Central Carbon Saving" scenario), show that coal's share of electricity generation will decline from about 35% in 2005 to around 19% in 2020. Long term forecasts for imported coal for electricity generation indicate that coal imports would fall up to 2020, however, after 2020 it is anticipated that imports will start to rise again as the amount of coal from UK coal production starts to fall faster than the fall in total demand for steam coal.

Alternative ports:

To an extent the facilities at Newport and Avonmouth could substitute for each other, both being able to accommodate ships of up to 40,000 dwt. However Newport cannot accommodate the Panamax or Capesize vessels that are handled at Royal Portbury Dock.

If Bristol could not offer access to the bigger ships other deep water ports handling imports of steam coal include Immingham, Hunterston and Liverpool. Port Talbot handles large ships delivering coking coal for the Corus steel plant and it is likely that the port could handle some third party steam coal business.

Trade cars

The trade car import/export business is one of the most 'land hungry' in the port industry and only a few ports in the UK have sufficient space to support the scale of modern day operations. Most car manufacturers have consolidated operations to one or two key UK ports, which perform the role of distribution centres for northern and southern regions and provide facilities for a range of value added activity such as pre-delivery inspection (PDI) and associated services.

Bristol is the 4th largest port in the country in the trade car market behind Grimsby/Immingham, Southampton and the Port of London. Bristol has by far the greatest land resource available compared with other leading ports, with 185.9 hectares at Portbury

and 44.6 hectares at Avonmouth (230.5 hectares in total) devoted to car storage. This compares with167.5 hectares at Grimsby & Immingham, 75.5 hectares at Sheerness, 65 hectares at Southampton and 50 hectares at the port of Tyne.

Bristol is the dominant port for non-EU, i.e. deep sea, car carrier traffic (imports and exports). At its peak, the port's car volumes have reached 750,000, with about three-quarters of these being imports. At a national level car imports generally are expected to grow as UK demand for new cars is met increasingly from overseas markets, partly as a result of a switch in the location of manufacturing plant to Eastern Europe and other low-cost producing nations.

Major customers at the port include:

- General Motors, which has a dedicated 6.5 hectare import terminal primarily for the storage of Chevrolet vehicles. Other GM vehicles are stored on Walon land.
- The Honda Import Terminal, originally built in 1992, was extended in 1995 and now covers 11.3 hectares. All Honda imports in the UK are directed through The Bristol Port Company. Honda exports are handled BPC's export terminal.
- Mitsubishi Motors have 23 hectares of storage for the entire UK import of Mitsubishi vehicles from the Far East and Northern Europe.
- Suzuki has switched all UK imports to Bristol. The Company has 9 hectares of storage space on purpose built sites and has recently extended its commitment to Bristol.
- Toyota (GB) Ltd operates an 34 hectare vehicle reception, storage (with a capacity of up to 19,700 vehicles) and distribution facility was extended in 2007, from 21 hectares, to meet the Toyota growth forecast in the next decade.
- Walon Ltd receives a range of vehicles from Fiat, General Motors and various other manufacturers into its 57 hectares of storage.
- Exports are also handled for Jaguar and Land Rover

The Bristol Port Company also operates common user facility on 28 hectares immediately adjacent to the discharge and load berths.

As can be seen, a number of the major car manufacturing giants have made substantial commitments and investments at Bristol and are dependant upon the Port 1) remaining open and 2) continuing to provide a good level of service. It is probable that car carrying vessels will not be affected by the change in the tidal regime of the estuary in terms of having adequate depth of water, however delays at the lock gates have the potential to disrupt both deliveries and vessel schedules which, in the long term, as with other aspects of the port's business, could affect the port's commercial position and bargaining power with existing and potential new customers.

Alternative ports:

The principal trade car ports include Grimsby/Immingham, Southampton and Sheerness. The Port of London includes a number of terminals located over several locations at Tilbury, Purfleet and Dartford. Most of these ports could actively compete for business handled at the port of Bristol, though none could individually accommodate the totality of Bristol's car business.

There is a risk that some of this business could switch to the Continent, for example Zeebrugge and Bremerhaven, where many of the car majors have established large car transhipment operations.

Agribulks

Agribulks encompasses a range of agricultural commodities including grains, animal feeds and fertilisers. These commodities are handled at each of the four commercial ports in question and are particularly important at Bristol and Sharpness.

At Royal Portbury Dock animal feeds are delivered and grain exports loaded in vessels of Panamax up to Capesize dimensions. Grain importers such as Rank Hovis, Saxon Agriculture and Feed Factors use storage facilities at Avonmouth while shipments for ADM Milling are discharged and then transferred directly to ADM's Avonmouth Mill for processing. Arkady Feed, which is a market leader in the feed market, utilises Avonmouth for the discharge and storage of its European coaster traffic. Bristol handled over 670,000 tonnes of agricultural bulk products in 2006. It is the 7th largest port in the country for handling this category of commodities. It is the major point of distribution for imported agricultural products to the South West.

ABP has also recently invested in a 3,600 sq m GAFTA-/AIC-approved warehouse for Arkady Animal Feed UK Ltd, at Newport. Agribulk products are also blended and bagged at a facility operated by IAWS.

Agribulks account for a large proportion of the 600,000 tonnes per annum of commodities handled at Sharpness. The port provides extensive covered storage facilities and grain silos and goods are distributed over an area covering the South West and Midlands.

Alternative ports:

The ports of Cardiff, Newport and Swansea could not economically substitute for agribulks handled at Avonmouth or Portbury and would not be economically located for product handled at the ADM Mill at Avonmouth. Nor are these ports well situated in terms of distribution to the South West.

ABP's South Wales ports could provide a substitute for Sharpness, although the port's owner, the Victoria Group, importantly provides an alternative operator to port users. Most of Sharpness's business is oriented towards the Midlands so a switch to South Wales' ports would mean that the length of road haul would increase substantially.

Plymouth is the second largest port in the South West region and also handles significant volumes at Cattedown Wharves and Victoria Wharf, which is also owned and operated by the Victoria Group. These facilities are limited to maximum vessel drafts of 8.4m and 7.0m respectively and cannot accommodate vessels of more than 10,000 dwt.

4.3 Potential benefits

Ports potentially gaining from the construction of a Barrage will be those that are located in close proximity to the construction site and those which have space available to provide secure covered storage and lay-down areas for large pieces of equipment and construction materials. Deep water is less of a consideration as most construction vessels are fairly shallow-drafted.

It is difficult to comment on this in any detail until the project developers generate a more detailed project design statement.

6. Preliminary Conclusions

- Although all ports will be affected by the construction of a barrage, it is clear that Bristol, which is the largest port in the Severn Estuary and accounts for 38% of all vessel arrivals in the Bristol Channel, could be disproportionately affected by the construction of the Middle Barrage. This is due to the fact that Bristol is the only port that offers deep water facilities and is able to accommodate vessels of Panamax and Capesize dimensions. Only Port Talbot, which is unaffected by the barrage proposals, is able to receive as large or bigger vessels.

- Bristol is one of the UK's major ports with a national hinterland. It is also the largest port in the South West region. The deep water facilities available at Bristol are not replicated anywhere else in the South West. Impediments to the operation of Royal Portbury which handles cargoes including coal, grain and animal feedstuffs in ships up to 130,000 tonnes deadweight potentially could be displaced to ports outside of Wales and the South West.

- The proposal to control vessel traffic through a lock system could thwart Bristol Port's plans to build a deep sea container terminal.

- Sharpness and also stands to be seriously disadvantaged by the Cardiff-Weston Barrage proposal. It is not clear from the available information on water heights whether the Shoots Barrage will cause less of an impediment to Sharpness, but it is clear that Sharpness would be disproportionately affected by this proposal.

- The importance of Sharpness also lies in its being able to offer port customers an alternative to ports owned by Associated British Ports which, in the absence of Bristol and Sharpness, would be in a dominant position in the Bristol Channel.

- We recommend that more detailed navigational data is obtained directly from ports to determine ship arrival patterns, the number of larger vessels that require access on high tides, required depth at lock cill, their frequency of arrival, time in port, transit time to dock entrance, etc., in order to establish with more accuracy the degree of obstacle created by a barrage.

Appendix 6- DTZ Initial Assessment of Port Impact

Bristol Port

Overview

Bristol Port emerged early on as a potential area of significant negative economic impact. Both construction and operation of the tidal power developments are claimed to have an impact on Bristol Port operations with the Cardiff-Weston barrage cited as the most negative option.

DTZ have undertaken a review of the documents submitted by Bristol Port including "*Annex A: SEVERN BARRAGE PROJECT IN CONFLICT WITH LOCAL, REGIONAL AND NATIONAL INTERESTS*". The documents outline a considerable gross negative economic impact. The following questions are aimed at establishing whether the gross economic impact is robust and whether the net economic impact is also considerable:

- Displaced Trade
  - To what extent will trade be lost for Bristol Port?
  - Is there capacity across other Wales and South West ports to absorb displaced trade?
  - Is there capacity across other UK Ports to absorb displaced trade?
- New Investment
  - What additional investment will be needed (if any) in facilities across other ports to absorb displaced trade?
- Location Value of Bristol
  - What advantages does a Bristol location offer shipping bringing freight to the UK?
  - What advantages does a Bristol location offer customers receiving freight from Bristol Port?
  - What additional costs will be borne by shipping and customers, particularly within the region, from using ports elsewhere?

Displaced Trade

To what extent will trade be lost for Bristol Port?

Bristol Port outline three key areas of trade at risk from the tidal power developments; coal, aviation fuel and animal feed. All three areas involve relatively low cost and high volume commodities which need to be shipped in bulk.

It is reasonable to assume that tidal power development will have a significant and negative impact on trade in these areas. Vessels are large, and generally increasing in size, and are likely to be restricted in navigating the Severn Estuary.

However, it is less clear that lower volume trade or recreational use of Bristol Port would suffer to the same extent. An initial review by MDS Transmodal suggests that smaller ship sizes will continue to be able to enter the port in any circumstance. It is also unclear that lagoon development, in isolation, would impact significantly on the key trade areas.

Is there capacity across other Wales and South West ports to absorb displaced trade?

Bristol Port outlines a case that it is uniquely placed to receive or store coal, aviation fuel and animal feed for distribution. The document submitted by Bristol Port clearly demonstrates a concern that significant investments in their asset base may become redundant.

There is evidence that some trade could be absorbed by other ports in Wales and the South West. An initial review by MDS Transmodal suggests big bulk trades, including coal, may be accommodated at Port Talbot depending on available space. However, it would be reasonable to assume there is a high probability that trade would be lost to ports outside of Wales and the South West.

To prevent loss of trade outside of Wales and the South it is likely that significant investment on the scale currently outlined by Bristol Port will need to be undertaken. Even in a scenario of further significant investment in other ports, the South West is more likely to face a net loss in trade compared to Wales.

Is there capacity across other UK Ports to absorb displaced trade?

The case made by Bristol Port outlines a combination of deep water, developed assets and the location of Bristol making the port unique. It is therefore important to consider whether any other UK ports could absorb displaced trade as businesses based in Wales and the South West may suffer.

Other deep water ports exist in the UK and trade through Bristol is still likely to enter the UK. The question is whether storage and transportation would take longer or otherwise cost more to deliver from another port due to geography.

New Investment

What additional investment will be needed (if any) in facilities across other ports to absorb displaced trade?

Bristol Port states it has storage facilities for 200,000 tonnes of animal feed. But such storage facilities are likely to be relatively inexpensive to replicate and could be accommodated in other UK ports.

The asset loss for aviation fuel will be more expensive. Bristol Port is connected by pipeline to Heathrow, but this is through a national pipeline network. If the transfer of aviation fuel were moved to another port then it is reasonable to assume some use could be made of the existing network.

Most of the economic cost for aviation fuel trade relates to a significant investment in a dedicated terminal which would be costly to replicate elsewhere. In the second phase of this

study it would be worthwhile to explore further how the pipeline network could respond to impacts. Any costs from disruption and the laying of new network should be accounted for in the cost-benefit analysis.

Location Value of Bristol

What advantages does a Bristol location offer shipping bringing freight to the UK?

It is likely that transportation would take longer otherwise cost more from another port, either bringing commodities into the port or transporting commodities to end users within the UK. Further investigation is needed on the additional costs and time in bringing commodities into other ports but initial review suggests additional costs would be marginal.

What advantages does a Bristol location offer customers receiving freight from Bristol Port?

Animal feed is clearly linked to the agriculture sectors of Wales and the South West and additional time and cost are likely to be borne by these sectors. For other trade, such as coal and aviation fuel, related activities may relocate to new portside locations or other locations in the West Midlands and South East of England.

What additional costs will be borne by shipping and customers from using ports elsewhere?

For most commodities portside operations relocating to a new portside location represents a potential loss to Wales and the South West but not necessarily the final users. The exception may lie with animal feed which is clearly linked to the nearby agriculture activities (dairy sector) and may have to be transported into Wales and the South West from another port. Airports in Wales and the South West may face marginally increased costs associated with the transportation of aviation fuel.

Alternative Use of Ports

Should assets within Bristol Port become redundant then alternative uses should be considered with economic benefits therein offsetting economic costs. Ancillary investment would clearly be needed to realise alternative uses.

Economic Impact of Bristol Port

A report outlining the economic impact of Bristol Port was published by SWRDA in 2004. The report highlights potential areas of loss to the Bristol economy should port operations cease completely. The report states Bristol Port supports 7,660 jobs in the sub-regional economy through port-related industries and multiplier effects; and a further 1,765 jobs are supported by other businesses located on the port estate.

The 1,765 jobs supported by other businesses located on the port estate are "not dependent on the Port". This part of the economic impact should be treated with caution within the present study. Businesses on the port estate are worth considering in terms of inconvenience during the construction phases of the tidal power developments.

Of the 7,660 jobs only 735 jobs are classified as port operations with other areas including port-related industries (2,246 jobs), transport services (1,508 jobs), suppliers of goods and services (966 jobs) and construction employment (483 jobs). The remaining 1,722 jobs are the result of multiplier effects with jobs created through further supply chain linkages.

The multiplier effects (1,722 jobs) are based on all port and port-related jobs, transport services, suppliers and construction. The SWRDA report appears to focus on the wider strategic value of Bristol Port including the role of the port estate in developing businesses. In the current study this multiplier approach risks double counting economic activity.

The double counting risk arises because significant transactions flow between the activities outlined above. For example, suppliers of goods and services will sell to the port and export businesses will purchase services from the port. These are precisely the industry linkages measured through multiplier effects and applying these effects across all activities risks including industry linkages that have already been accounted for.

The SWRDA report is well researched and offers a solid platform compared to a desk based multiplier approach. It is therefore preferable to rearrange the components outlined in the SWRDA report so they are consistent with this study. An initial review suggests that direct port effects should be taken as the 735 port jobs and 2,246 port-related jobs, a total of 2,981 jobs.

Secondary multiplier effects are likely to fall within suppliers of goods and services (966 jobs) and "Transport Services to and from the Port". Within transport services 647 jobs are with key employers based at the port including:

- Anstee & Ware Group Ltd – Electrical and Mechanical Engineers;
- Peter Lane Transport - HGV haulage;
- DFDS Transport Ltd - Distribution and warehousing;
- R P Bedwell - Road Haulier;
- Banks Cargill Agri Ltd - Agricultural grain merchants for the domestic market; and
- EH Bennett (Shipping & Agency) Ltd - Importing Solid Fuels.

The suppliers and transport services jobs outlined above suggest secondary multiplier effects of 1,613 jobs. The direct port activities and secondary multiplier effects give overall employment of 4,594 jobs. This gives an implied employment multiplier of 1.54.

A multiplier of 1.54 seems plausible and appropriate for the current study and is close to employment multipliers published by the South West Regional Observatory for a range of industries across the South West.

Much of the employment outlined in the SWRDA report would continue in the absence of the port. Even among the worst case scenarios, the port may reasonably be expected to adapt or operate at lower capacity. This is supported by the initial MDS Transmodal review suggesting smaller ships are likely to be unaffected.

The Gross Value Added (GVA) cited in the SWRDA report is just over £270 GVA per annum. Based on the revised figures contained in this briefing note and using the same approach the GVA contribution is £161.9 million per annum. The SWRDA report bases the GVA estimate on data sources from 2002. HM Treasury inflators show the £161.9 million in 2002 prices is equal to £190.4 million in 2008 prices.

This seems reasonable given the latest Annual Business Inquiry (ABI) data for the whole water transport (including ports) sector in the South West showing GVA of £28 million (excluding port-related businesses, suppliers and transport services).

Appendix 7 Long List Economic Impact Assessment

Theme	Immediate Impact Nature
1.0 Construction / Engineering	Scale and value of build
2.0 Transport and Logistics	Impact on Ports, Road, Rail and Air Networks
3.0 Energy	Energy Outputs and Employment
4.0 Environmental	Mitigating Activity , Loss of Environmental Resource Commercial Agents (construction), Increase Environmental Resource (operational)
5.0 Industry and Sector	Winners and Losers- supply chain linkages
6.0 Land Use and Development	Availability and Suitability of Development Land and Use. Legacy impacts

Theme		Sub Theme	Theme Detail	Regional Impact Issues
1.0 Construction/Engineering				Regional impact will depend on the source of inputs
	1.1	**Materials**	**Rock armour and rock fill**	
			PC armour	
			Sand core	
	1.2	**Caissons**		Potential for caisson construction yards to be located in the region. Immediate impact and future potential will need to be considered. Potential for industrial and commercial use of some or all of the construction yards post construction, creating additional employment land in the South West and Wales and additional economic activity
			Construction yards	
			Caisson construction	
			Caisson construction value	
			Caisson installation	
			Caisson fit out	
	1.3	**Mechanical and Engineering**		Further research required to assess potential for regional production of mechanical components. Unlikely for smaller scale options. Some possibility for large scale option. Scope for sub-contracting in the UK/regions. Turbine manufacturing plant could potentially be located in the SW/Wales to meet the turbine demand, and may have a productive economic use post construction of the barrage.
			Turbine generators	
			Grid connections	
			Sluice gates	
			Lock gates	
	1.4	**Embankments**		Large rock armour unlikely to be sourced in the UK. Fill materials potentially sourced in the UK and possibly from within the region. Further clarification required
			Preparation	
			Embankment	
			Fit out	
	1.5	**Navigation Locks and Infrastructure**		only relevant for some options. Direct impact depends on the source of labour and material in construction. Indirect impact dependent on the impact on ship movements, ability of ships of different sizes to navigate locks.

Theme	Sub Theme	Theme Detail	Regional Impact Issues
		Main lock	
		Small craft lock	
		Bascule bridge	
		Main lock	
		Small craft lock	
	1.6 Ancillary Works		Future value/potential of ancillary works will need to be considered. Possible impacts include future land use development and possible port infrastructure
		Site construction area	
		Ste establishment cost	
		Embankment preparation	
		Embankment fit out	
		Navigation locks landing area	
		Main lock approach works	
		Small lock approach works	
		Surface buildings	
	1.7 Labour		Labour demand over the construction period is likely to be met both by labour from within the regions and by substantial in-migration of labour. However, the most recent claimant count data of the unemployed (June 2008) shows that between the South West and Wales there would be a total of 9,400 former skilled trades, 10,700 former process, plant & machine operatives and 26,300 former elementary profession employees which could fill the labour requirement for the construction of a STP scheme. These impacts on the local infrastructure will need to be considered. Construction periods vary by option
		Civil engineering works	
		Site investigation	
		Design and supervision	
		Contractors on cost and profit	
		Caisson construction	

Theme	Sub Theme	Theme Detail	Regional Impact Issues
		Materials labour and handling	
		Caisson installation	
		Dredging works	

Theme	Sub Theme	Theme Detail	Impact	Regional Impact Issues
2.0 Transport and Logistics				
				Impacts on ports will vary across options. Options that impede the operation of a higher number of ports will have the greatest impact
	2.1 Ports			
		2.1.1 Commercial Ports during construction	The volume and value of the Port trade, and the logistic trade hubs will be particularly affected during the 4-6 year build programme. There are limitations of the Bascule bridge (if part of scheme) to the volume and/or height of ships which can pass beneath it. Materials inflow (during construction) will boost activity to local ports during construction. Other potential factors include a negative impact on commercial confidence, an effect on investment in logistic hubs, potentially higher insurance costs and risk to the investment in a deep sea container facility.	Cumulative impact of these on the commercial viability of affected ports. Key issue to discover whether it results in a marginal impact on port activity or will result in the closure of any ports
		2.1.2 Commercial Ports during construction	Revenues gained from the handling of materials during construction phase	Potential positive impact- although aggregates generate low margins. Volume of aggregates and materials may counter this.
		2.1.3 Commercial Ports during operation	Volume and value of port trade could be impacted	Impact of shipping delays vs. higher water on commercial throughput and competitiveness. Need to assess commercial viability of ports across different shipping markets

Theme	Sub Theme	Theme Detail	Impact	Regional Impact Issues
		Operating impact	The impact on the commercial ports during operation of the barrage could be affected by the lock dimensions, changes to the high and low water levels and the timings of the lock gates. These factors affect the sizes of the vessels that can travel through the barrage, the cargo size and the level of commercial water based traffic congestion caused by the barrage. Increased dredging requirements are possible, which would increase ports operating costs and reduce commercial viability	unclear what impact non barrage STP options will have on ports and their operation
		Insurance cost	There could be an insurance liability if STPs result in greater shipping hazzards	Increased insurance premiums and greater number of hazards in the navigation channels, especially during the construction with the movement of caissons and other large objects
		Maintenance contracts	Potential for ports to secure maintenance contracts post construction	Potentially an alternative income supply for the ports
	2.2 Roads			
	2.2.1	**Existing roads**	Congestion could arise from the movement of materials, labour and plant equipment on the existing road network	Cost of congestion to sector and industry
	2.2.2	**Future roads**	The STP will cause a draw on resources (plant, labour and materials) which may effect the capacity to make future alterations to the road network during construction, as a result of displacement.	Impact on land use and development as additional road network could make additional development land feasible
	2.2.3	**Ancillary roads**	Ancillary road networks created for the construction process may present land use and economic opportunities following completion of STP construction.	Impact on land use and development post construction
	2.3 Rail			
	2.3.1	**Increased usage during construction**	Construction could lead to increased transit of materials via the rail network.	Some materials will be transported via the rail network, but will not be a significant

Theme	Sub Theme	Theme Detail	Impact	Regional Impact Issues
				factor
	2.4 Air			Economic impacts on air transport as a result of STP during construction or operation will be minimal
		2.4.1 Air transport during construction	Value of materials inflow by air and passenger transit associated with the construction could impact on the economy	
		2.4.2 Air transport during operation	Improvement to the regional air network could be displaced because of the draw on resourced caused by construction of STP, effectively limiting investment and improvements to the network (resource costs). The existence of a STP may increase global travel to the region, both as a place of work and as a major tourist attraction / place of interest.	

Theme	Sub Theme	Theme Detail	Impact	Regional Impact Issues	Additional Workshop Comment
3.0 Energy				Further information required. National Grid will be consulted	
	3.1 National Grid Capacity				
		3.1.1 During construction	There will be a requirement to upgrade the existing national grid facilities, such as transmission line and grid connections. This requires specialist labour and materials to undertake these improvements. There will be a planning requirement cost to locate the required improvements to the national grid.	Increased capacity will be required during the construction phase of a STP to accommodate the additional power generation. There will be an impact on industries and sectors related to power generation.	
		3.1.2 During operation	Potentially a lag between the completion of STP and national grid upgrades to accommodate the additional capacity. During operation the improved national grid provision will potentially lead to greater FDI investment in the regional economies as consistency of power supply will be improved.		May not impact power supply- but could reduce consumer tariff
	3.2 Renewable Energy Schemes				
		3.2.1 Crowding out	Potential crowding out of other renewable energy schemes, as a result of regional renewable targets being achieved with the completion of STP, therefore reducing the drive to exploit other forms of renewable energy.	Potentially some renewable energy schemes may become marginalised and 'crowded out' with the existence of a STP	additional grid capacity may enable other schemes to become feasible and not crowded out

Theme	Sub Theme		Theme Detail	Impact	Regional Impact Issues	Additional Workshop Comment
		3.2.2	**Additional network capacity**	Scheme could increase viability of other renewable sources if there is greater national grid network capacity which can be used		
	3.3 Energy Intensive Sectors					
		3.3.1	**Value of Energy Output**	Potential inward investment of energy intensive sectors attracted by multi-source energy. Wales/SW could become a net exporter of energy following the STP	Potentially energy intensive industries could locate to benefit from 'over the fence' arrangements. Will impact on industries and sectors	Could reduce cost of energy to consumers
		3.3.2	**Nuclear**	The resources and expertise required by the STP may 'crowd out' proposed schemes for nuclear power stations.		Cost to energy generators may increase through the transmission tariff
		3.3.3	**Siltation**	Potential siltation build up, increased pumping requirement leading to increased cost		
		3.3.3	**Energy Use**	Increased energy use in region for ground water pumping, nuclear pumping, water companies and sewage because of potential impact on water flow and water quality	Potentially increase costs to sectors (may be included in cost estimates of STP)	

Theme	Sub Theme	Impact	Impact on the Economy	Regional Impact Issues
4.0 Environmental				
	4.1 Hydraulics and geomorphology	Impact on sediment movement which may impact frequency of dredging required for navigation routes. Impact on sediment which affects the water quality of specific bathing bays. Mitigating activity will be required to overcome issues concerning hydraulics and geomorphology. There will be an impact on infrastructure erosion, post construction.	Impact on design cost	This impact is covered in the construction and engineering as the ancillary works will include costs associated with this impact
	4.2 Marine water	Impact of water quality on fish, water quality on bathing, treatment discharge and sea level and water quality on recreational and marine activity	Impact on marine tourism / activity. Cost to industries discharging in the estuary	captured in industry and sectors. Particular focus on marine tourism, including potential for marine developments and recreational use, but possible local area negative impacts on specific bays affected by reduced water quality (impact on bathing).
	4.3 Ornithology	Impact on compensatory habitats, birds and the tourist industry which is reliant on this.	Impact on Ornithological Tourism	Slimbridge is the largest Wetlands and Wildfowl tourist attraction in the Severn Estuary and this attraction receives approximately 200,000 visitors per year, which could be effected by changes to the natural environment. Possible effects on Wildfowling sector.
	4.4 Fish and Recreational Fishing	potential negative impact of STP structures on fish by changing water quality, habitat, turbines migration cues. Potential for STP to have a negative impact on commercial and recreational fishing operations. Recreational fishing includes conger eel and salmon fishing, angling and coarse fishing.	Impact on fish and fishing	The salmon movement will be severely affected by the barrage, affecting breeding patterns and the upstream Salmon fisheries dependent on this movement. Industry is vulnerable to considerable negative impact. Need to assess commercial activity (e.g. Eels). Impact of other STP less clear- however a number of factors (e.g. turbines, habitat changes, water quality etc) may indicate a similar negative impact.

Theme	Sub Theme	Impact	Impact on the Economy	Regional Impact Issues
	4.5 Marine Ecology	Changes in the movements and breeding patterns of fish and feeding patterns of wetland birds	Impact on Commercial Species	commercial value of potential species unknown - SEA to clarify, unlikely to result in substantial economic impact.
	4.6 Flood Risk and Land Drainage	Impact on the volume of water pumping requirement. Ground water levels will be raised as a result of the barrage, which could have a negative impact on the flood risk costs to residential property. The raised sea water level will impact on the on flood risk in the area although the barrage will have a sea defence operation, creating a positive impact.	Impact on Flood Risk - both positive and negative	Impact will be picked up in land use and development and more land could be made available for development. The barrage will perform a flood prevention function, reducing the need for future investment in sea defence, to protect the surrounding area from surge flooding. The estimated saving could be as a much as £1 billion. Negative impacts captured in the construction cost estimates. However, any benefit in future land developments dependent on planning response to the flood defence qualities of the structure. If not recognised, then only limited impact on future land developments.
		Uncertainty over the impact of other STP on flood risk and land drainage. Negative impacts captured in construction cost estimate.		uncertainty over the impact of other STPs on flood risk
	4.7 Landscape and seascape	Impacts investigated by Defra	Change in nature of tourism offering.	Awaiting results from Defra work
	4.8 Other seabed uses	Nuclear piping, telecoms, other piping and the marine aggregates industry will be effected but without a substantial effect on the local economy.	Impact on industrial users of estuary	May increase costs to these users. Unlikely to have great impact on the economy (marginal cost to business?).
	4.9 Resource and waste	Impact on commercial extraction of estuary materials. Impact on the commercial dredging operations (costs to ports etc).	Volume of estuary resource extracted	lower volume of future estuary resource available for extraction (aggregates industry). Potential increase in the volume of dredging required (dredging industry benefits).
	4.10 Carbon footprint	BERR national workstream are reviewing carbon footprinting	No direct impact on the local economy	Awaiting results from Defra work/ guidance from steering group

Theme	Sub Theme	Impact	Impact on the Economy	Regional Impact Issues
	4.11 Noise and vibration	Construction could cause noise and vibration impacts which may need to be mitigated.	Impact on construction costs	may impact local areas- construction phase impact on the value of property etc. Unlikely to present great regional economic impact
	4.12 Historic Environment	Impact on archaeology sites, the heritage coastal areas and statutory protected sites	Impact on Mitigating Activity	potential impact on archaeological tourism and industries related to archaeology. Unlikely to have great economic impact. Information from SEA workstream to clarify.
	4.13 Terrestrial ecology	Unknown	Unknown	Unaware of significant impact on the economy - clarification from SEA workstream required

Theme	Sub Theme	Impact	Impact on the Economy	Scale of Sector	Regional Impact Issues
5.0 Industry and Sectors					
	5.1 Agriculture and Fishing	There is potentially a gain or loss of agricultural land which will impact on agricultural production. Commercial fishing could be negatively affected by changes in the fish stocks which can thrive in the estuary following on from the construction of a barrage.	Changes to agriculture will affect the economy, as will the changes to the fish stocks.	Agriculture and fishing sector employs 26,250 people and 14,300 people in SW and Wales respectively. GVA is £620m and £340m the SW and Wales respectively. Fishing sector alone employs 720 and 550 in the SW and Wales respectively, with GVA of £40m and £30m in the SW and Wales respectively.	There may be a decrease or increase in productive agricultural land as a result of improved tidal control following a barrage. Salmon farming is likely to be significantly affected. Recreational fishing and angling also likely to be effected. Other forms of commercial fishing also likely to be effected.
	5.2 Energy and Water (incl quarrying and mining)	Impact of sediment on the cost to water and nuclear companies could cause an effect. The value and supply of aggregates used in construction could have an impact on the economy, as a result of the extensive demand for these materials during construction. Potential displacement effects caused from high demand for aggregates.	Positive effects on GVA and Employment particularly relating to the aggregates industry.	Mining of non-energy producing materials employs 4,300 and 1,100 people in SW and Wales, with a GVA of £1,600m and £400m in SW and Wales. Electricity, gas and water supply employs 12,150 and 8,450 people in SW and Wales, with GVA of £2,260m and £900m in SW and Wales.	Potentially increased demand for aggregates sourced from the region, which would have a positive economic benefit, although impact not guaranteed. Also potential for a surge in energy storage schemes which support usage across the entire grid.

Theme	Sub Theme	Impact	Impact on the Economy	Scale of Sector	Regional Impact Issues
	5.3 Manufacturing Related Industries	Potential cost implications and materials inflation for manufactured products used in the construction process. Also the issue of displacement may be relevant following significant draw on particular manufactured goods. This also includes plant and labour availability, leading to crowding out.	Material price inflation	Manufacturing related industries employ 99,000 in SW and 66,500 in Wales, with GVA of £4,800m and £3,200m in SW and Wales	Surge in demand for labour and materials could cause displacement in other industries such as related manufacturing based industries. Potentially some manufacturing operations e.g. caissons and turbines could be moved to an onsite location to reduce transportation costs. This could increase regional employment in related manufacturing industries particularly if some operations remain in the region.
	5.4 Manufacturing Unrelated Industries	Other unrelated manufacturing may be impacted by the shortage of elementary staff availability and the wage cost implications. Manufacturing that is dependent on the logistical hubs disrupted by construction/operation of schemes may face additional transport and distribution costs	Skills availability, labour costs, transport disruptions, increased transport costs	Manufacturing in unrelated industries employs 186,000 in SW and 158,000 in Wales, with GVA of £8,900m and £7,600m in SW and Wales.	Material and wage inflation could cause displacement in other manufacturing industries
	5.5 Renewable Energy	Renewable energy sector and supply chain may strengthen or weaken	Growth of a potential renewable energy hub or potentially lower investment in renewable energies as a result of crowding out of investment/ RE targets/ carbon footprint	DTZ Regen SW report shows renewable energy and energy efficiency sectors are valued at £215m and £300m respectively. In total the renewable energy sector is valued at £510m in the SW	Potential displacement of alternative renewable energy schemes. For example, wave energy schemes in the Severn are less likely to be viable given reduce ferocity following the barrage

Theme	Sub Theme			Impact	Impact on the Economy	Scale of Sector	Regional Impact Issues
	5.6	**Construction**				Construction industry employs 99,000 in SW and 63,000 in Wales. GVA is £4,800m and £3,000m in SW and Wales respectively	A considerable surge in demand in the construction sector creating employment opportunities in the region. Although there is potentially a negative impact of displacement and material and wage pull inflation
		5.6.1	**Construction phase**	Construction phase demand for labour and materials will see a rise and growth in the sector. This may crowd out/displace other construction sector jobs.	Demand for Materials and Labour		
		5.6.2	**Operational phase**	In the operational phase there is potential impact as a result in increased congestion across the distribution network. Distribution sector may see growth in demand for the transportation of materials during construction	Increased demand from a potential change to land use		
	5.7	**Distribution, Hotels and Restaurants**				Wholesale and retail sector in SW and Wales employs 390,000 and 194,000 people respectively, with GVA of £12,500m and £6,200m. Hotels and catering employ 176,000 and 82,000 in SW and Wales. GVA of sector is £1,700m and £800m	Significant boost to the sector during construction with thousands of workers coming to the region. Some offsetting of reduced tourism

Theme	Sub Theme			Impact	Impact on the Economy	Scale of Sector	Regional Impact Issues
		5.7.1	**Tourism during construction**	Potential reduction in value and volume of tourism	Impacts of the tourism sector		Tourism could be negatively affected during construction, although during operation the recreational opportunities on the estuary could increase tourism from its currently level.
		5.7.2	**Hotels and Restaurants during construction**	Hotels/restaurant and supporting businesses could see an increase in demand to accommodate in-migrant labour over the build period	This may be a local level displacement effect		
	5.8 Transport and Communications					Transport and communications employs 107,000 in SW and 57,000 in Wales, with GVA of £5,800m and £2,800m respectively	Potential short term gain for the local ports through the movement of materials during construction. Effect on the ports could be extensive as tidal ranges will be reduced, cutting the available opportunities for the largest ships to access the Port of Bristol. Approximately 1h30 is lost in passing through any navigation locks, each way, adding time and expense to ships docking in Bristol. The container terminal expansion could become commercial unviable at Bristol following the creating of the barrage. Any losses in trade the port of Bristol or Cardiff suffer could be lost from the region and gains will be felt in other reports nationally e.g. Liverpool.

Theme	Sub Theme		Impact	Impact on the Economy	Scale of Sector	Regional Impact Issues
						During operation the greater tidal window could have positive implications on smaller ships using the waterways and accessing the port.
		5.8.1 **Rail**	Transport of materials may lead to greater use of the rail network.			Materials potentially moved through the rail network, although the economic impact of this is not expected to be substantial.
		5.8.2 **Road**	Temporary road/rail infrastructure developments as part of construction phase will potentially crowd out other infrastructure projects			Potentially increased road congestion through the movement of materials for the construction process, although not expected to have a great impact on the overall economy as mitigating actions can be undertaken, such as transporting materials for peak. Local area impacts may need to be considered.
		5.8.3 **Distribution Network**	May see improvements in distribution network if temporary construction related infrastructure is retained (port access, rail access, road access)			Potentially a transport link on the barrage could have a beneficial economic effect, although not currently part of the options. Existence of transport links on the barrage will be clarified after research come back from Network Rail and the Highways Agency

Theme	Sub Theme	Impact	Impact on the Economy	Scale of Sector	Regional Impact Issues
	5.8.4 Air	Potential increase in air travel through transport of construction-related workers; and also if tourism increases.			
	5.9 Banking, Finance and Insurance (business services)	Relevant professional business services will be in high demand. During operation phase there may be positive implications for professional services in real estate if there are land use changes.	Potentially sector wage inflation depending on the volume/availability of skilled workers	Business services employs 400,000 in SW and 170,000 in Wales, with GVA of £15,500m and £6,500m.	Professional services related to construction/engineering/ environmental activity will be included in cost estimates. Further property agency/ land development activity may see positive impact, although this falls outside the scope of study due to ancillary investment requirements associated with any developments.
	5.10 Public Admin (Government Services)	Construction phase may see increased demand on local services to accommodate inflow of labour (particularly health and education).	May delay other schemes requiring planning permission, dependent on global conditions and profile of development	Public administration employs 340,000 in SW and 202,000 in Wales. Health employs 290,000 and 180,000 in SW and Wales respectively, with a GVA of £4,050m and £2,500m respectively.	Potential impact on demand for public services. Duration of demand will influence whether increase results in regional economic impacts.
	5.11 Other Services		No impact	Other services employ 109,000 and 65,000 in SW and Wales. GVA of £3,500 and £2,100 respectively	Too far removed from the development of any option to see a direct impact, may be indirectly affected by changes in labour supply, wages etc. Not considered significant

Theme	Sub Theme	Impact	Regional Impact Issues
6.0 Land Use and Development			
	6.1 Availability and Suitability of Development Land and Use	Increased land development	Greater control of the tidal range could reduced the flooding risk and could increase the availability of land suitable for residential, industrial and commercial development. This will potentially increase the level of employment land and therefore employment in the region generating positive economic gains. However, there could also be an increase in flood risk in some areas as a consequence of the scheme, so a consequent reduction in the availability of development land. Any significant effect is only likely to be realised by a large barrage.
	6.2 Demand for Land Could Increase	Value of land and development	Greater manipulation of the tidal range could increase the value of development sites which previously were too high risk from a flooding perspective therefore there could be an increase in the value of these marginal sites.
	6.3 Agriculture land availability	Volume of agricultural land availability	More agricultural land could become commercially viable for farming following a lower tidal range and better control of the tidal range. Some agriculture land may be lost to accommodate construction infrastructure. Value of agriculture land for development may encourage release of land for alternative use.
	6.4 Waste deposit land (dredging outputs)	Volume of waste land required	Dredging will have to be increased because a lesser tidal range could lead to increased build up of outputs. The burden of this dredging will have to fall on one party, but the overall economic impact is minimal and any indirect negative effects can be mitigated against.
	6.5 Temporary worker units during construction	Quantity of temporary units	Land will have to be allocated for temporary accommodation during the construction phase, and this land may have a commercial or industrial application following completion of the construction phase which could add value to the regional economy.

6.6	**Waterside developments (harbour for materials movement)**	Future value of marine ancillary investment	Significant opportunity for waterside developments particularly to accommodate the movement and storage of materials during construction. These sites may have a commercial use in the operational phase of the barrage. Unlikely to be realised by other schemes.
6.7	**Construction yards**	Quantity of construction yards	Significant demand will be required for construction yards particularly relating to the construction of certain parts of the barrage e.g. caissons. These sites may have a commercial use in the operational phase of the barrage.
6.8	**Marina development**	Value of marina development	Potentially marina developments could become viable following the operational phase as a result of higher minimum water levels, a larger tidal window, improved water quality (clearer water) and lesser tidal forces which lend itself to sailing and recreational fishing.
6.9	**Energy intensive industry inward investment**	Value of inward investment	Energy intensive industries could potentially be attracted to the estuary area because of favourable 'over the fence' energy arrangements and through improved supply, following investment in the grid capacity by the national grid.
6.10	**Housing/residential development**	Change in residential land use	Potentially increased housing and residential opportunities as a result of reduced flooding risk.
6.11	**Industrial development**	Change in industrial land use	Potentially increased industrial opportunities as a result of reduced flooding risk.
6.12	**Office developments**	Change in office land use	Potentially increased office opportunities as a result of reduced flooding risk.