D Water Framework Directive Assessment

D.1 Introduction

D.1.1 Project overview

Tarmac Marine (TM) and Hanson Aggregates Marine Ltd (HAM) wish to apply for marine licences to gain permissions to dredge aggregates from Area 531 (an extension of Area 470, also known as North Bristol Deep) in the Severn Estuary (Figure D.1). Given the cross border nature of Area 531, two marine licences are required: one from the Marine Management Organisation (MMO) (the English authority) and the other from Natural Resources Wales (NRW) (the Welsh authority). The intention is for Area 531 to extend and replace the current Area 470 when its existing marine licence expires in 2020. Area 531 measures 3.83 km² in total, with 2.15 km² located in English waters and 1.68 km² in Welsh waters.

ABPmer has been commissioned by TM and HAM to undertake a Water Framework Directive (WFD) compliance assessment to determine whether aggregate extraction from Area 531, located within the Severn Lower transitional water body (Figure D.1), complies with the objectives of the WFD. This information, together with the Environmental Statement (see main report), will support the marine licence application that will be submitted to the MMO and NRW as part of the marine licensing process.

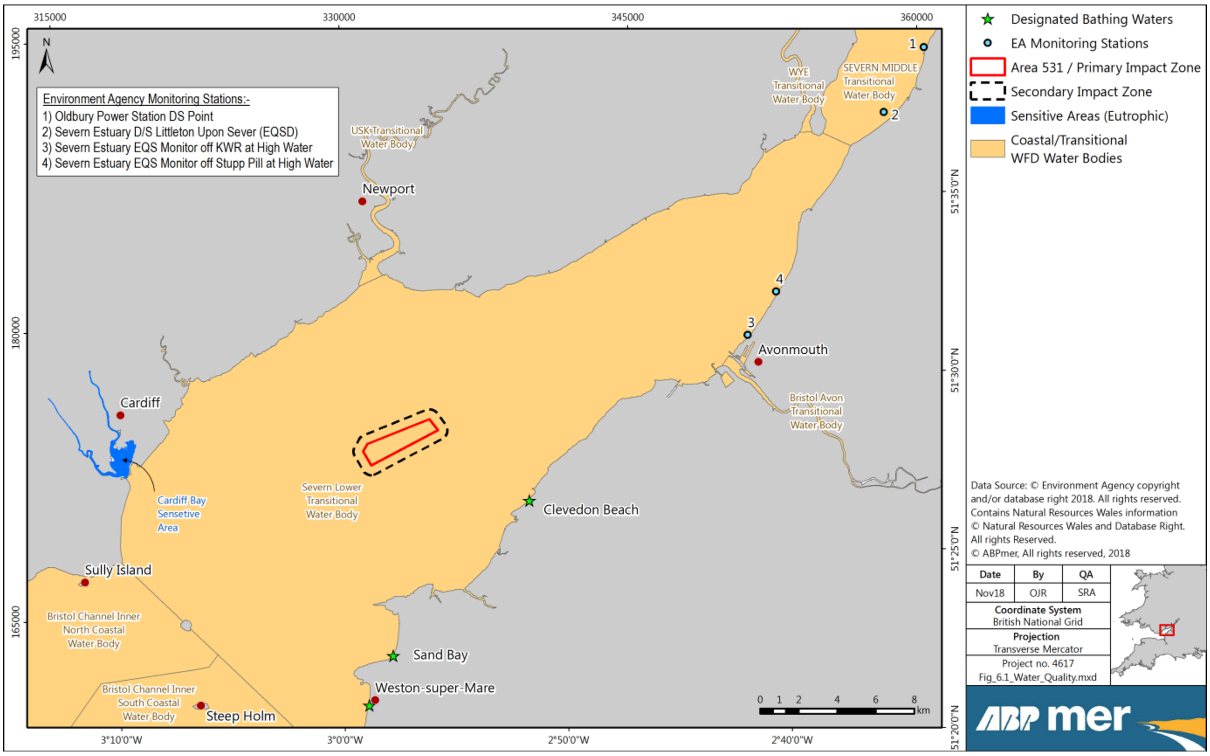


Figure D.1 **Location of Area 531 within the Severn Lower transitional water body**

D.1.2 Water Framework Directive

The WFD (2000/60/EC) came into force in 2000 and establishes a framework for the management and protection of Europe's water resources. It was implemented in England and Wales through the Water Environment (WFD) (England and Wales) Regulations 2003 (the Water Framework Regulations). These Regulations were revoked and replaced in April 2017 by the Water Environment (WFD) (England and Wales) Regulations 2017. The overall objective of the WFD is to achieve good status (GS) in all inland, transitional, coastal and ground waters by 2015, unless alternative objectives are set and there are appropriate reasons for time limited derogation (now working towards revised objectives for 2021).

The WFD divides rivers, lakes, lagoons, estuaries, coastal waters (out to one nautical mile from the low water mark), man-made docks and canals into a series of discrete surface water bodies. It sets ecological as well as chemical targets (objectives) for each surface water body. For a surface water body to be at overall GS, the water body must be achieving good ecological status (GES) and good chemical status (GCS). Ecological status is measured on a scale of high, good, moderate, poor or bad, while chemical status is measured as good or fail (i.e. failing to achieve good).

Each surface water body has a hydromorphological designation that describes how modified a water body is from its natural state. Water bodies are either undesignated (i.e. natural, unchanged), designated as a heavily modified water body (HMWB) or designated as an artificial water body (AWB). HMWBs are defined as bodies of water which, as a result of physical alteration by sustainable human use activities (such as flood protection and navigation) are substantially changed in character and cannot therefore meet GES. AWBs are artificially created through human activity. The default target for HMWBs and AWBs under the WFD is to achieve good ecological potential (GEP), a status recognising the importance of their human use while ensuring ecology is protected as far as possible.

The ecological status of surface waters is classified using information on the biological (e.g. fish, benthic invertebrates, phytoplankton, angiosperms and macroalgae), physico-chemical (e.g. dissolved oxygen and salinity) and hydromorphological (e.g. hydrological regime) quality of the body of water, as well as several specific pollutants (e.g. copper and zinc). Compliance with chemical status objectives is assessed in relation to environmental quality standards (EQS) for a specified list of 'priority' and 'priority hazardous' substances. These substances were first established by the Priority Substances Directive (PSD) (2008/105/EC) which entered into force in 2009. The PSD sets objectives, amongst other things, for the reduction of these substances through the cessation of discharges or emissions. As required by the WFD and PSD, a proposal to revise the list of priority (hazardous) substances was submitted in 2012. Subsequently, an updated PSD (2013/39/EU) was published in 2013, identifying new priority substances, setting EQSs for those newly identified substances, revising the EQS for some existing substances in line with scientific progress and setting biota EQSs for some existing and newly identified priority substances. The updated PSD is explained in the WFD (Standards and Classification) Directions (England and Wales) 2015.

In addition to surface water bodies, the WFD also incorporates groundwater water bodies. Groundwaters are assessed against different criteria compared to surface water bodies since they do not support ecological communities (i.e. it is not appropriate to consider ecological status of a groundwater). Therefore, groundwater water bodies are classified as good or poor quantitative status in terms of their quantity (groundwater levels and flow directions) and quality (pollutant concentrations and conductivity), along with chemical (groundwater) status.

River Basin Management Plans (RBMPs) are a requirement of the WFD, setting out measures for each river basin district to maintain and improve quality in surface and groundwater water bodies where necessary. In 2009, the Environment Agency published the first cycle (2009 to 2015) of RBMPs for England and Wales, reporting the status and objectives of each individual water body. The

Environment Agency and NRW subsequently published updated RBMPs for England and Wales as part of the second cycle (2015 to 2021), as well as providing water body classification results from 2015 and Cycle 2 interim classifications via the Catchment Data Explorer[15] and Water Watch Wales[16] websites, respectively. Area 531 is located within the Severn Lower transitional water body (see Figure D.1) in the Severn River Basin District which is reported in the Severn RBMP (Environment Agency and NRW, 2015).

Consideration of WFD requirements is necessary for developments which have the potential to cause deterioration in ecological (quantitative) and/or chemical status of a water body or to compromise improvements which might otherwise lead to a water body meeting its WFD objectives. Therefore, it is necessary to consider the potential for aggregate extraction from Area 531 to impact WFD water bodies, specifically referring to the following environmental objectives of the WFD:

- Prevent deterioration in status of all surface water bodies (Article 4.1 (a)(i));
- Protect, enhance and restore all surface water bodies with the aim of achieving good surface water status by 2015 or later assuming grounds for time limited derogation (Article 4.1 (a)(ii));
- Protect and enhance all HMWBs/AWBs, with the aim of achieving GEP and GCS by 2015 or later assuming grounds for time limited derogation (Article 4.1 (a)(iii));
- Reduce pollution from priority substances and cease or phase out emissions, discharges and losses of priority hazardous substances (Article 4.1 (a)(iv));
- Prevent or limit the input of pollutants into groundwater and prevent deterioration of the status of all groundwater water bodies (Article 4.1 (b)(i));
- Protect, enhance and restore all groundwater water bodies and ensure a balance between abstraction and recharge of groundwater (Article 4.1 (b)(ii));
- Ensure the achievement of objectives in other water bodies is not compromised (Article 4.8); and
- Ensure compliance with other community environmental legislation (Article 4.9).

In December 2016, the Environment Agency published online guidance ("Clearing the Waters for All") (Environment Agency, 2016) regarding how to assess the impact of activities in transitional and coastal waters for the WFD, setting out the following three discrete stages to WFD assessments (it is recognised that a similar approach to WFD assessments is being developed by NRW):

- **Screening:** excludes any activities that do not need to go through the scoping or impact assessment stages;
- **Scoping:** identifies the receptors and quality elements that are potentially at risk from an activity and need further detailed assessment; and
- **Assessment:** considers the potential impacts of an activity on bodies of surface and ground water, identifies ways to avoid or minimise impacts, and indicates if an activity may cause deterioration or jeopardise the water body achieving GS.

D.2 Screening

D.2.1 Potentially affected water bodies

To determine which water bodies would potentially be affected by the Proposed Development, all surface and groundwater water bodies located within 2 km of Area 531 were recorded (Figure D.1).

15 http://environment.data.gov.uk/catchment-planning (Accessed November 2018).
16 http://waterwatchwales.naturalresourceswales.gov.uk/en (Accessed November 2018).

Therefore, the following water bodies were screened in:

- Severn Lower transitional water body (ID: GB530905415401).

Table D.1 provides a summary of the Severn Lower transitional water body, within which Area 531 is located, including current water body status (overall, ecological and chemical) and parameters currently failing to achieve good status.

Table D.1 Severn Lower transitional water body summary

Water Body Name	Severn Lower
Water Body ID	GB530905415401
Water Body Type	Transitional
Water Body Area	465.976 km^2 (surface area)
Hydromorphological Designation (Reasons for Designation)	Heavily modified (Flood protection)
Protected Area Designations	Habitats Directive Birds Directive Bathing Water Directive
Overall Status (2016)	Moderate
Ecological Status/Potential (2016)	Moderate
Chemical Status (2016)	Good
Parameters not at Good Status (2016)	Angiosperms (moderate) Mitigation measures assessment (moderate)
Higher Sensitivity Habitats	Intertidal seagrass (2.64 km^2) Mussel beds (0.46 km^2) Polychaete reef (5.38 km^2) Saltmarsh (6.80 km^2)
Lower Sensitivity Habitats	Cobbles, gravel and shingle (0.31 km^2) Intertidal soft sediment (163.85 km^2) Subtidal soft Sediment (152.05 km^2) Rocky shore (22.93 km^2) Subtidal rocky reef (89.26 km^2)
Macroalgae Status	High
History of Harmful Algae	Not monitored

The Severn Lower transitional water body currently has an overall moderate status, based on moderate ecological potential and good chemical status. The overall ecological and chemical status/potential is determined by the "one-out, all-out" principle, whereby the poorest individual parameter classification defines the assessment level. Therefore, if any parameter is assessed as less than good (e.g. moderate), then the status for that water body is reported at that level. Moderate ecological potential of the Severn Lower transitional water body is due to the biological quality element 'angiosperms'. In addition, the 'mitigation measures assessment' identified measures which are not in place (not yet identified) thus also contributing to moderate ecological potential.

D.2.2 Protected areas

The WFD requires that activities are also in compliance with other relevant legislation, such as the Habitats Directive (92/43/EEC as amended), Birds Directive (2009/147/EC), Ramsar Convention, Bathing Water Directive (2006/7/EC), Nitrates Directive (91/676/EEC), Urban Waste Water Treatment Directive (91/271/EEC) and the provisions of the Shellfish Waters Directive (2006/113/EC). See Figure D.2 for locations of nearby protected areas to Area 531.

Nature Conservation Designations

Article 3 of the Habitats Directive (92/43/EEC as amended) requires the establishment of a European network of important high-quality conservation sites known as Special Areas of Conservation (SAC) that will contribute to conserving habitats and species identified in Annexes I and II of the Directive. The listed habitat types and species are those considered to be most in need of conservation at a European level (excluding birds). In accordance with Article 4 of the Birds Directive (2009/147/EC), Special Protection Areas (SPA) are strictly protected sites classified for rare and vulnerable birds (Annex I of the Directive), and for regularly occurring migratory species. Ramsar sites are wetlands of international importance designated under the Ramsar Convention (adopted in 1971 and came into force in 1975), providing a framework for the conservation and wise use of wetlands and their resources.

There is one international nature conservation designated site located within 2 km of Area 531, namely the Severn Estuary SAC, which directly overlaps Area 531. The Severn Estuary SPA and Ramsar sites are within 5.5 km of Area 531 (Figure D.2).

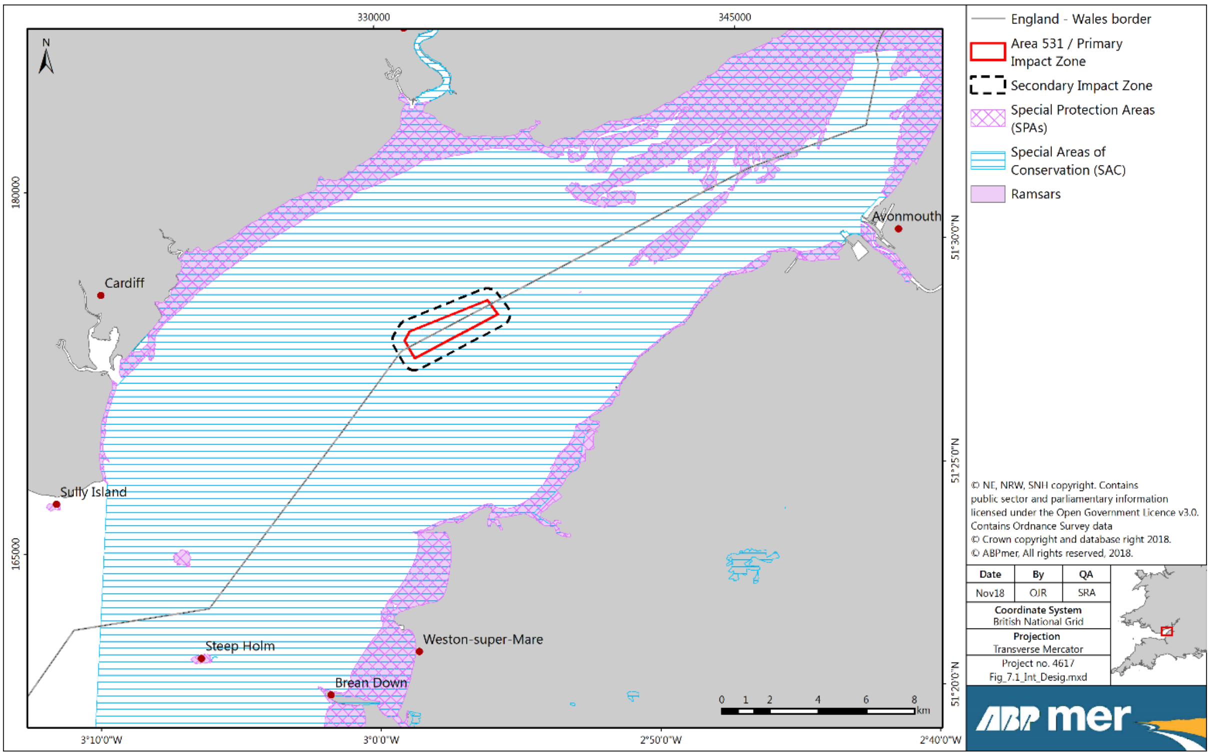


Figure D.2 International designated sites in the vicinity of Area 531

Bathing Water Directive

The revised Bathing Water Directive (rBWD) (2006/7/EC) was adopted in 2006, updating the microbiological and physico-chemical standards set by the original Bathing Water Directive (BWD) (76/160/EEC) and the process used to measure/monitor water quality at identified bathing waters. The rBWD focuses on fewer microbiological indicators, whilst setting higher standards, compared to those of the BWD. Bathing waters under the rBWD are classified as excellent, good, sufficient or poor according to the levels of certain types of bacteria (intestinal enterococci and *Escherichia coli*) in samples obtained during the bathing season (May to September).

The BWD was repealed at the end of 2014 and monitoring of bathing water quality has been reported against rBWD indicators since 2015. The new classification system considers all samples obtained during the previous four years and, therefore, data has been collected for rBWD indicators since 2012. The UK Government's target under the rBWD is to achieve 'sufficient' for all bathing waters by 2015, as described under the Bathing Water Regulations 2013 which transposes the rBWD into UK law.

There are no designated bathing waters located within 2 km of Area 531. The closest bathing water is Clevedon Beach, approximately 6 km to the southeast of Area 531 (Figure D.1).

Shellfish Waters Directive

The Shellfish Waters Directive (2006/113/EC) was repealed in December 2013 and subsumed within the WFD. However, the Shellfish Water Protected Areas (England and Wales) Directions 2016 require the Environment Agency (in England) and NRW (in Wales) to endeavour to observe a microbial standard in all 'shellfish water protected areas'. The microbial standard is 300 or fewer colony forming units of *E. coli* per 100 ml of shellfish flesh and intravalvular liquid. The Directions also requires the Environment Agency and NRW to assess compliance against this standard to monitor microbial pollution (75% of samples taken within any period of 12 months below the microbial standard and sampling/analysis in accordance with the Directions).

There are no Shellfish Water Protected Areas located within 2 km of Area 531.

Nitrates Directive

The Nitrates Directive (91/676/EEC) aims to reduce water pollution from agricultural sources and to prevent such pollution occurring in the future (nitrogen is one of the nutrients that can affect plant growth). Under the Nitrates Directive, surface waters are identified if too much nitrogen has caused a change in plant growth which affects existing plants and animals and the use of the water body.

There are no Nitrate Vulnerable Zones (NVZs) located within 2 km of Area 531.

Urban Waste Water Treatment Directive

The Urban Waste Water Treatment Directive (91/271/EEC) aims to protect the environment from the adverse effects of the collection, treatment and discharge of urban waste water. It sets treatment levels on the basis of sizes of sewage discharges and the sensitivity of waters receiving the discharges. In general, the Urban Waste Water Treatment Directive requires that collected waste water is treated to at least secondary treatment standards for significant discharges. Secondary treatment is a biological treatment process where bacteria are used to break down the biodegradable matter (already much reduced by primary treatment) in waste water. Sensitive areas under the Urban Waste Water Treatment Directive are water bodies affected by eutrophication of elevated nitrate concentrations and act as an indication that action is required to prevent further pollution caused by nutrients.

There are no "Sensitive Areas (Eutrophic)" as designated under the Urban Waste Water Treatment Directive located within 2 km of Area 531 (Department for Environment, Food and Rural Affairs (Defra), 2012).

D.2.3 Water and sediment quality

Water quality

Dissolved oxygen

Dissolved oxygen in water is essential for the survival of aquatic organisms (plants and animals) and concentrations provide an indication of the health of a particular waterbody. Therefore, a reduction in dissolved oxygen concentrations, due to an increased biological consumption (e.g. eutrophication) or other natural processes, can dramatically affect the functioning of marine ecosystems. Low dissolved oxygen concentrations have been well documented in several UK estuaries in the past, although investment in waste water treatment over a number of decades has substantially addressed the issue.

Owens (1984) reported reduced dissolved oxygen saturation in the Upper Severn Estuary (upstream of Area 531), particularly during summer conditions of low flow and high temperature. However, dissolved oxygen concentrations in the Severn Estuary are typically high. In 2004 and 2005, surface water dissolved oxygen concentrations above 8 mg/L were reported throughout the estuary in monitoring samples collected by the Environment Agency (DECC, 2010). Dissolved oxygen concentrations recorded at the Environment Agency's 'Severn Estuary EQS monitor off KWR at high water' site between 2013 and 2018 suggest a seasonal trend, with maximum concentration in the winter and minimum concentrations in the summer (Figure D.3). There was no apparent trend in oxygen saturation during this period, although values were consistently above 80%. The physico-chemical quality element 'dissolved oxygen' is currently (2016) at 'high' status for the Severn Lower transitional water body.

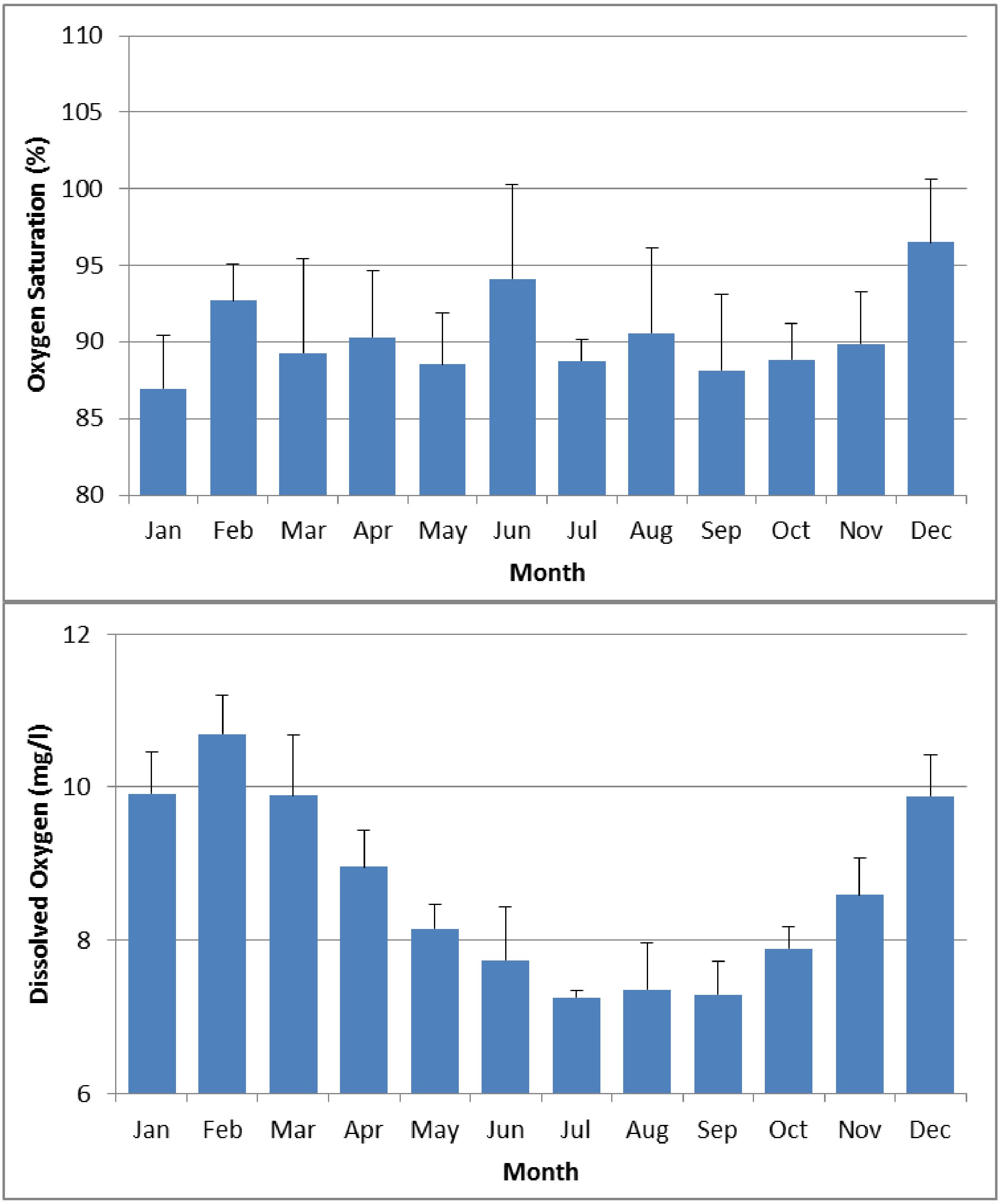
Suspended sediments

High tidal flows and muddy sediments lead to highly turbid conditions in the Severn Estuary (Langston *et al.*, 2003). In the reaches of the Severn Estuary and Bristol Channel investigated by Kirby (1986), which included Area 531, the estuary water column is reported to contain more than 30 million tonnes in fine suspended sediment on high spring tides, reducing to approximately 2 to 4 million tonnes on low neap tides (Kirby *et al.*, 2004).

Suspended sediment concentrations (SSCs) can present discrete variations in vertical, lateral and longitudinal planes within the Severn Estuary (Kirby, 2010). Typically, SSCs in the Outer Bristol Channel are <10 mg/l, around 50 mg/l in the Inner Bristol Channel and progressively increase into the Lower Severn Estuary to >500 mg/l on occasions (Kirby, 1986; 2010). It should be noted that inputs of suspended material to the water column from tidal re-suspension greatly outweigh anthropogenic inputs (DECC, 2010). In the upper reaches of the Severn Estuary, SSC can be >10 g/l (10,000 mg/l) for river flows up to 50 m^3/second, rising to over 50 g/l (50,000 mg/l) during periods of lower river flow (Manning *et al.,* 2010).

Based on Environment Agency monitoring data, median SSC values along the length of the Severn Estuary ranged from 81-336 mg/l. The highest SSCs were reported to occur in the mid-Severn Estuary region between Sharpness and Avonmouth (Langston *et al.*, 2003; Kirby *et al.*, 2004; DECC, 2010), which incorporates Area 531.

Concentrations can vary markedly in the vertical, with extremely high concentrations within near bed layers, often >20,000 mg/l (DECC, 2010). The reduction in flow rate between spring and neap tides leads to an increased settling of suspended sediment, which subsequently becomes re-suspended on the next spring tide cycle (Kirby, 1986; Kirby *et al.*, 2004; DECC, 2010).



Source: Contains Environment Agency information © Environment Agency and database right

Figure D.3 **Mean monthly oxygen saturation (%; top) and dissolved oxygen concentration (mg/l; bottom) with standard deviation bars at the Environment Agency's 'Severn Estuary EQS monitor off KWR at high water' site between 2013 and 2018**

Trace metals and organics

Significant improvements in the treatment of substances prior to their release into the marine environment have led to concentrations of metals being typically below EQS values in UK waters. Historical metal smelting in Avonmouth and south Wales led to high cadmium concentrations in the Severn Estuary; however, concentrations have declined between 1995 (0.4 µg/l) and 2001 (0.09 µg/l) to levels below the EQS (Marine Environment Monitoring Group (MEMG), 2004). Elevated concentrations of nickel, mercury, zinc and cadmium were reported at the mouth of the Severn Estuary as part of the Severn Tidal Power study (DECC, 2010), related to increased run-off with proximity to industrial areas. Concentrations of zinc have been reported above EQS values in areas of South Wales (UK Marine Monitoring and Assessment Strategy (UKMMAS), 2010). A summary of trace metal contaminant concentrations in the Severn Estuary reported by Langston and Millward (2008) is shown in Table D.2, including both fresh and saline EQS values for comparison due to the estuarine location of Area 531.

Table D.2 Dissolved metal concentrations in the Severn Estuary along with EQS for fresh and saline waters

Trace Metals	EQS (µg/l)*		Dissolved Concentration (µg/l)
	Fresh	Saline	
Arsenic	50 (AA)	25 (AA)	2.3 ± 0.68
Cadmium	0.08-0.25 (AA); 0.45-1.5 (MAC)	0.2 (AA)	<0.25
Chromium (VI)	3.4 (AA)	0.6 (AA); 32 (MAC)	1.09 ± 0.76
Copper	1 (AA)	3.76 (AA)	2.83 ± 1.65
Lead	1.2 (AA); 14 (MAC)	1.3 (AA); 14 (MAC)	5.3
Mercury	0.07 (MAC)	0.07 (MAC)	0.014 ± 0.108
Nickel	4 (AA); 34 (MAC)	8.6 (AA); 34 (MAC)	<3
Zinc	13.1 (AA)	9.0 (AA)	6.19 ± 2.9

* Based on the WFD Directions 2015
AA Annual Average
MAC Maximum Allowable Concentration

Source: Langston and Millward, 2008; DECC, 2010

Results presented by Jonas and Millward (2010) of dissolved metal concentrations in the Severn Estuary, measured between 2000 and 2005, generally match those shown in Table D.2 (Langston and Millward, 2008). Dissolved arsenic concentrations in low salinity waters peaked at 1.5 µg/l, indicating a potential anthropogenic source of the contaminant, while chromium concentrations were typically <3.5 µg/l. The concentration of dissolved copper was generally <5 µg/l, with the exception of consistent values between 5 and 10 µg/l over two consecutive days of sampling (24-25 August 2005). Zinc concentrations were typically <10 µg/l (Jonas and Millward, 2010).

Contaminant concentrations recorded at four Environment Agency monitoring sites in the vicinity of Area 531 between 2013 and 2018 are presented in Table D.3. Concentrations were typically below respective EQS values, although there remained some instances where exceedances have been observed. Chemical status for the Severn Lower transitional water body is currently (2016) good, although it is recognised that the priority hazardous substance 'brominated diphenylether (BDPE) calc' has not been reported and this parameter was previously (2015) failing to achieve good.

Table D.3 Contaminant concentrations at four Environment Agency monitoring sites in the vicinity of Area 531 between 2013 and 2018

Trace Metals	EQS (µg/l)*		Dissolved Concentration (µg/l)			
	Fresh	Saline	1	2	3	4
Cadmium	0.08-0.25 (AA); 0.45-1.5 (MAC)	0.2 (AA)	-	<0.03 – 0.192 ($\bar{x}$ = 0.088; *n* = 57)	0.054 – 0.479 ($\bar{x}$ = 0.121; *n* = 57)	0.056 (*n* = 1)
Copper	1 (AA)	3.76 (AA)	1.61 – 3.09 ($\bar{x}$ = 2.26; *n* = 21)	1.69 – 3.97 ($\bar{x}$ = 2.25; *n* = 19)	-	-
Lead	1.2 (AA); 14 (MAC)	1.3 (AA); 14 (MAC)	-	-	<0.04 – 0.188 ($\bar{x}$ = 0.058; *n* = 57)	<0.04 (*n* = 1)
Zinc	13.1 (AA)	9.0 (AA)	-	-	2.83 – 96.5 ($\bar{x}$ = 26.9; *n* = 4)	2.13 – 4.97 ($\bar{x}$ = 3.47; *n* = 24)

* Based on the WFD Directions 2015
AA Annual Average
MAC Maximum Allowable Concentration
1 Oldbury Power Station DS Point
2 Severn Estuary D/S Littleton Upon Sever (EQSD)
3 Severn Estuary EQS Monitor off KWR at High Water
4 Severn Estuary EQS Monitor off Stupp Pill at High Water

Source: Contains Environment Agency information © Environment Agency and database right

The concentration of metals in water samples appears to generally reflect the proximity to anthropogenic sources, such as wastewater discharges and industrial settings. Metals which are predominantly of riverine origin tend to decrease in concentration in more saline waters. Conversely, anthropogenic sources of dissolved metals are often observed as the salinity increases downstream (close to the source) before decreasing into the Bristol Channel (Morris, 1984). The concentration of all total metals (including dissolved metals) is highest in the middle reaches of the Severn Estuary, around the location of Area 531, which could be associated with trends in suspended solids (DECC, 2010).

Tributyltin (TBT) was used as a biocide in marine antifouling paints for yachts and large ships until the mid-1980s; however, biological effects other than the desired antifouling properties of TBT-containing products on marine organisms (e.g. reproductive ability) led to an EU-wide ban on the use of TBT. Historic concentrations of 3 ng/l have been measured in water samples from the Severn Estuary and <4 ng/l in the Bristol Channel (DECC, 2010). TBT was not assessed for the Severn Lower transitional water body as part of the Cycle 1 or Cycle 2 Severn RBMPs (Environment Agency, 2009; Environment Agency and NRW, 2016).

Little information is currently available for concentrations of polycyclic aromatic hydrocarbons (PAHs) or polychlorinated biphenyls (PCBs) in water samples. For two locations downstream of Area 531, Law *et al.* (1997) reported concentrations of total PAH in unfiltered water to range between 104 and 164 ng/l at Nash Point and up to 1,150 ng/l adjacent to Port Talbot steelworks (DECC, 2010). As part of the contaminant review of the SEA 8 region, which covers the Western Approaches, Celtic Sea and English Channel, many PAH concentrations exceeded their maximum allowable concentration (MAC) at the mouth of the River Severn (Cefas, 2007).

Measurements of PCBs in mussel tissue (*Mytilus edulis*) and fish liver (plaice, dab, whiting and flounder) were assessed against OSPAR background assessment concentrations (BACs) and environmental assessment criteria (EACs) and reported in Charting Progress 2, suggesting exceedances in EACs within the Severn Estuary. However, PAH concentrations were not considered to represent a major problem to shellfish (UKMMAS, 2010).

Radioactivity
Discharges of radioactive material are strictly controlled and concentrations observed in the UK are reported annually (Radioactivity in Food and the Environment (RIFE) report series). GE Healthcare Limited, the operator of the Cardiff radiopharmaceutical plant, ceased manufacturing a range of radiolabelled products containing tritium (^{3}H) in 2009 and products containing carbon-14 (^{14}C) in 2010. Berkeley and Oldbury nuclear power stations, both of which are currently being decommissioned, are located in the upper reaches of the Severn Estuary, while Hinkley Point B is locate downstream of Area 531. In 2017, the total dose from all pathways and sources of radiation associated with these facilities was assessed to have been <0.005 mSv (Berkeley and Oldbury) and 0.032 mSv (Hinkley Point), equating to around 3% of the dose limit, with lesser values reported for the Cardiff radiochemical production centre for the same year (<0.005 mSv) (Environment Agency, 2018).

Sediment quality

There are few formal standards for the concentration of contaminants in sediments, although the WFD has introduced optional standards for a small number of priority hazardous substances. Cefas Guideline Action Levels have been prepared to assist in the assessment of dredged material (and its suitability for disposal to sea). In general, contaminant levels in dredged material below Action Level 1 (AL1) are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above Action Level 2 (AL2) is generally considered unsuitable for disposal at sea. Dredged material with contaminant levels between AL1 and AL2 may require further consideration before a decision can be made. The Cefas Guideline Action Levels should not be viewed as pass/fail thresholds. Furthermore, it should be noted that proposed aggregate extraction from Area 531 would not involve the disposal of material at sea; however, these guidelines provide an appropriate context for consideration of contaminant levels in sediments.

Sediment samples were collected by the Environment Agency between 2001 and 2011 at the 'Severn Estuary EQS Monitor off KWR at High Water' site, approximately 15 km to the east of Area 531, and analysed for cadmium and mercury. The concentrations ranged from 0.33 to 11.6 mg/kg (n = 9) and 0.22 to 0.41 mg/kg (n = 9) for cadmium and mercury, respectively. Cadmium concentrations were typically above AL1, with one sample from 2001 above AL2, while mercury concentrations were generally below AL1 or slightly above AL1 (no exceedances of AL2).

According to Langston *et al.* (2003; 2010), trace metal concentrations in the sediments of the Bristol Channel and Severn Estuary are relatively uniform, reflecting the strong tidal mixing and fluid mud transport which disperse contaminants from their source. Duquesne *et al.* (2006) reported that sediment metal concentrations in the Bristol Channel and Severn Estuary were highest at sites close to industrial centres, but that levels have decreased significantly over the last 30 years. Metal concentrations (mg/kg dry weight) ranged from 0.1 – 1.4 for cadmium, 10 – 90 for chromium, 1 – 47 for copper, 4 – 45 for nickel, 5 – 92 for lead and 20 – 340 for zinc. The authors indicated that the highest metal concentrations in deposited sediments were typically associated with the finest particulates at locations with muddy sediments, although the report acknowledges that this was not always the case at sites with predominantly sandy sediments. Langston *et al.* (2010) reported cadmium concentrations were typically <1 mg/kg dry weight throughout the Severn Estuary in 2004, although exceptional concentrations of copper (up to 723 mg/kg), together with high values for chromium and nickel, were reported in the sediments at Berrow Flats and Sand Bay, both located to the south of Area 531. Nevertheless, the values reported by Duquesne *et al.* (2006) and Langston *et al.* (2010) are in line with those measured by the Environment Agency.

As part of a review of the contaminant status of the SEA 8 region (Cefas, 2007), sediment samples from the Bristol Channel and Severn Estuary were analysed. Once normalised to aluminium concentration to highlight anthropogenic inputs (as opposed to granulometric and mineralogical differences), elevated concentrations of nickel, cadmium, mercury and zinc were found at the mouth of the Severn Estuary and were attributed to increased run-off in proximity to industrial areas (e.g. Bristol, Cardiff, Swansea) (Cefas, 2007). In addition, the highest concentrations of PAHs in the SEA 8 region were found at two stations at the mouth of the River Severn (3,301 and 3,188 µg/kg dry weight). The highest total PCB concentration was also measured near the mouth of the River Severn (32.6 µg/kg dry weight) (Cefas, 2007). Langston *et al.* (2010) reported that PAH and PCB concentrations, like metals, are homogeneously spread throughout the Bristol Channel and Severn Estuary and measurements are typically not as high as those recorded from industrialized estuaries of northeast England.

Concentrations of contaminants such as PAHs and PCBs contained in fine sediments such as muds and silts are higher than those measured in the water column due to adsorption of contaminants to sediment particles (MEMG, 2004). This is particularly true of the less soluble substances such as metals and many organic substances which tend to attach to suspended and deposited sediments. High levels of organic contamination are generally not associated with coarse sediments (MEMG, 2004), such as the sands and gravels targeted during aggregate dredging activities. The highest concentration of TBT in the sediments sampled between 1992 and 1997 from the Bristol Channel and Severn Estuary (particularly around Swansea) was 2.37 mg/kg wet weight (Cefas, 2000), with concentrations in the higher ranges occurring in the vicinity of the ports of Newport, Cardiff and Swansea (DECC, 2010). Langston *et al.* (2010) also suggested that analyses of dredge spoils in and around the Severn Estuary SAC suggest there may be localised reservoirs of TBT near major ports and conurbations, such as Newport and Cardiff.

D.3 Scoping

The "Clearing the Waters for All" guidance (Environment Agency, 2016) provides a scoping template to record findings and consider potential risks for several key receptors, including:

- Hydromorphology;
- Biology: Habitats and Fish;
- Water quality;
- Protected areas; and
- Invasive non-native species (INNS).

Each receptor is considered in the following sections and summarised in a table. Potential risks that have been scoped into the assessment are highlighted in red and considered within the detailed assessment stage (Section D.4), while those scoped out of the assessment are highlighted in green.

D.3.1 Hydromorphology

Hydromorphology is the physical characteristics of estuaries and coasts, including the size, shape and structure of the water body and the flow and quantity of water and sediment. Table D.4 presents a summary of hydromorphological considerations and associated risk issues for aggregate extraction within Area 531. As at least one hydromorphological consideration indicates that a risk could be associated with aggregate extraction within Area 531, this receptor has been scoped into the detailed assessment (see Section D.4).

Table D.4 Hydromorphology scoping summary

Hydromorphology Considerations	Hydromorphology Risk Issue(s)
Consider if your activity could impact on the hydromorphology (for example morphology or tidal patterns) of a water body at high status?	No (hydromorphology not at high status). Impact assessment not required.
Consider if your activity could significantly impact the hydromorphology of any water body?	Yes (potential changes to hydromorphology because of activity, e.g. changes to flow rates). Requires impact assessment.
Consider if your activity is in a water body that is heavily modified for the same use as your activity?	No (hydromorphological designation related to flood protection). Impact assessment not required.

D.3.2 Biology

Habitats

It is necessary to consider the impact of the physical footprint of an activity on nearby marine and coastal habitats. This specifically refers to habitats of higher sensitivity (e.g. intertidal seagrass, maerl and saltmarsh) and lower sensitivity (e.g. cobbles, gravel and shingle, subtidal rock reef and intertidal soft sediments like sand and mud). Table D.5 presents a summary of biology (habitat) considerations and associated risk issues for the aggregate extraction within Area 531. As at least one biology (habitat) consideration indicates that a risk could be associated with aggregate extraction within Area 531, this receptor has been scoped into the detailed assessment (see Section D.4).

Table D.5 Biology (habitat) scoping summary

Biology (Habitat) Considerations	Biology (Habitat) Risk Issue(s)
Is the footprint of the activity 0.5 km^2 or larger?	Yes, footprint of activity is 3.83 km^2. Impact assessment required.
Is the footprint of the activity 1% or more of the water body's area?	No (<1%). Impact assessment not required.
Is the footprint of the activity within 500 m of any higher sensitivity habitat?	No (>500 m). Impact assessment not required.
Is the footprint of the activity 1% or more of any lower sensitivity habitat?	Yes (>1% intertidal/subtidal soft sediment). Impact assessment required.

Fish

Activities occurring within an estuary could impact on normal fish behaviour such as movement, migration or spawning. Table D.6 presents a summary of biology (fish) considerations and associated risk issues for the Proposed Development. As at least one biology (fish) consideration indicates that a risk could be associated with aggregate extraction within Area 531, this receptor has been scoped into the detailed assessment (see Section D.4).

Table D.6 Biology (fish) scoping summary

Biology (Fish) Considerations	Biology (Fish) Risk Issue(s)
Consider if your activity is in an estuary and could affect fish in the estuary, outside the estuary but could delay or prevent fish entering it or could affect fish migrating through the estuary?	Yes. "Continue with questions".
Consider if your activity could impact on normal fish behaviour like movement, migration or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow)?	Yes. Requires impact assessment.
Consider if your activity could cause entrainment or impingement of fish?	Yes. Requires impact assessment.

D.3.3 Water quality

Consideration should be made regarding whether phytoplankton status and harmful algae could be affected by the proposed works, as well as identifying the potential risks of using, releasing or disturbing chemicals. Table D.7 presents a summary of water quality considerations and associated risk issues of aggregate extraction within Area 531. As at least one water quality consideration indicates that a risk could be associated with aggregate extraction within Area 531, this receptor has been scoped into the detailed assessment (see Section D.4).

Table D.7 Water quality (physical parameters) scoping summary

Water Quality Considerations	Water Quality Risk Issue(s)
Consider if your activity could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days)?	No. Any change to water clarity and oxygen levels will occur within a spring neap tidal cycle and is expected to be insignificant. Impact assessment not required.
Consider if your activity is in a water body with a phytoplankton status of moderate, poor or bad?	No (phytoplankton status assessed as high). Impact assessment not required.
Consider if your activity is in a water body with a history of harmful algae?	No (evidence for harmful algae not monitored). Impact assessment not required.
If your activity uses or releases chemicals (for example through sediment disturbance or building works) consider if the chemicals are on the Environmental Quality Standards Directive (EQSD) list?	No (not applicable). Impact assessment not required.
If your activity uses or releases chemicals (for example through sediment disturbance or building works) consider if it disturbs sediment with contaminants above Cefas Action Level 1?	Yes (potential for sediment-bound contaminants to be disturbed). Impact assessment required.
If your activity has a mixing zone (like a discharge pipeline or outfall) consider if the chemicals released are on the EQSD list?	No (not applicable). Impact assessment not required.

D.3.4 Protected areas

Consideration should be made regarding whether WFD protected areas are at risk from your activity, including SACs and SPAs (Natura 2000 sites), as well as bathing waters, shellfish waters and nutrient sensitive areas. Table D.8 presents a summary of protected area considerations and associated risk issues of aggregate extraction within Area 531. As the protected areas consideration indicates that a risk could be associated with aggregate extraction within Area 531, this receptor has been scoped into the detailed assessment (see Section D.4).

Table D.8 Protected areas scoping summary

Protected Area Considerations	Protected Area Risk Issue(s)
Consider if your activity is within 2 km of any WFD protected area?	Yes (protected areas within 2 km). Impact assessment required.

D.3.5 Invasive non-native species (INNS)

Consideration should be made regarding whether there is a risk the activity could introduce or spread INNS. Risks of introducing or spreading INNS include materials or equipment that have come from, had use in or travelled through other water bodies, as well as activities that help spread existing INNS, either within the immediate water body or other water bodies. Table D.9 presents a summary of INNS considerations and associated risk issues of aggregate extraction within Area 531. As the INNS consideration indicates that a risk could be associated with aggregate extraction within Area 531, this receptor has been scoped into the detailed assessment (see Section D.4).

Table D.9 Invasive non-native species scoping summary

INNS Considerations	INNS Risk Issue(s)
Consider if your activity could introduce or spread INNS?	Yes (potential for introduction or spread of INNS). Requires impact assessment.

D.4 Detailed Assessment

A detailed assessment should be conducted for each receptor identified during the scoping stage as being at risk from an activity. As highlighted in Section D.3, the following receptors have been scoped into the detailed assessment:

- Hydromorphology;
- Biology: Habitats and Fish;
- Protected species; and
- Invasive non-native species (INNS).

Each of these WFD parameters have been evaluated to determine whether aggregate extraction within Area 531 might cause deterioration in the status of the relevant water body (defined as a non-temporary effect on status at water body level), or an effect that prevents the water body from meeting its WFD objectives. Where possible, the assessment has drawn on information presented in the Environmental Statement (see main report).

D.4.1 Hydromorphology

The Severn Estuary is subject to a strongly semi-diurnal and very large tide with a range of 10 to 12 m, giving the estuary the second largest tidal range in the world. This high tidal range is due to the combination of the North Atlantic tidal wave approaching through the Bristol Channel and the further amplification and convergence of this tidal wave as it moves into the funnel-shape of the Severn Estuary. The tidal prism[17] of the Severn Estuary has been calculated at approximately 96 x 10^8 m^3 (Atkins, 2009).

The tide enters the Severn Estuary from the Bristol Channel as a progressive tidal wave. As the tide moves upstream it amplifies in range, reaching a mean spring tidal range of 12.2 m at Avonmouth and a maximum of 12.3 m, on mean spring tides, at Beachley (Chepstow, Severn Bridge). Further upstream, the estuary widens out slightly and shallows rapidly, leading to increased asymmetry of the shape of the tidal curve and, therefore, steepening of the curve due to the shallow water effects. In this way, the interaction of the tidal wave with the shallowing bed causes a slowing of the trough of the tidal wave, with respect to the crest, therefore creating asymmetry.

The large and rapid rise and fall of the tide leads to very strong currents through the main body of the estuary. These strong currents maintain deep channels and high suspended sediment loads. Flows also increase in strength where they are forced through constrained narrows (e.g. The Shoots, just below the Second Severn Crossing, where the currents can exceed 6 m/s).

Where the tide becomes asymmetric, then dominance is established between ebb and flood currents; this effect also increases further up the estuary. Tidal currents appear to be the primary mechanism for sorting seabed materials, so that the channels tend to contain gravels, with rocky patches, and the intertidal margins of the estuary have muddy deposits. Within the centre of the estuary, there is also a large sand body contained within the Middle Grounds, which extends to the northeast into Welsh Grounds. The direction of the currents is strongly influenced by the morphology of the seabed, with currents generally aligned through the main channels and past shallow sandbanks. However, geological hard points extend out into the estuary and can influence the tidal flows to produce local modifications to the flow regime.

Marine sands are pushed up the estuary during the fast-flowing flood tide, where they are deposited during slack water. The slower flowing ebb tide is generally unable to remobilise all the material for a seaward return and, therefore, sand is transported up the estuary by a process called 'tidal pumping'. Muds appear to remain in suspension for most tides and tend to be introduced into the estuary primarily from fluvial sources.

As previously noted, the Severn Estuary is a relatively high suspended sediment environment. Primary sources of material in suspension are from the main tributaries to the estuary, namely the Rivers Severn, Wye, Usk, Avon and Parrett, and from intertidal erosion of mudflats, due to wave action. The most comprehensive survey of suspended sediment loads across the estuary was undertaken between 1974 and 1978, consisting of multiple cross-estuary transects, which were sampled throughout the tidal cycle. Close to 2,500 profiles were assessed in total. The main findings were of an estuary with high regional turbidity, and a cycling of suspended material over semi-diurnal (ebb and flood) and semi-lunar (spring-neap) timescales, between the water column and the seabed. Sampling indicated an estuary-wide suspended sediment load of around 30 million tonnes on high spring tides, reducing to around 2 million tonnes on low neap tides (when sediments have sufficient time to settle into fluid mud pools in the main estuary channels, e.g. Newport Deep).

17 i.e. the volume of water the enters and leaves the estuary on an average tide, calculated as the difference between the tidal volume at high water and that at low water.

Dredging activity results in a lowering of the bed over the extraction area. Where this dredge is relatively deep, or where recovery times are long, such bed lowering has the potential to affect tidal currents over the site. A coastal impact study (ABPmer, 2018) predicted small-scale changes to flood and ebb tidal currents which are principally confined to within 2 km of the Area 531 boundaries. At these extents, the predicted magnitude of change is less than ±0.02 m/s (less than 5% of baseline flows) in current speed (during flood and ebb tides) and less than a 2° shift in current direction. The effects on the peak ebb tide exhibit a very similar pattern of change, but the magnitudes and extents are slightly reduced. Changes in wave conditions as a result of the dredging are expected to be negligible locally and have no estuary-wide impact. Furthermore, the influence of the natural tidal regime on seabed height, and thus potential for wave exposure, in the Severn Estuary is far greater than the potential changes associated with the proposed dredging activity.

In conclusion, aggregate extraction within Area 531 is not expected to lead to a deterioration of the assessed hydromorphological elements within the Severn Lower transitional water body, nor prevent the water body from meeting its WFD objectives.

D.4.2 Biology

Habitats

The Severn Estuary provides a wide variety of intertidal habitats including mudflat, sandflat, gravel and rocky shore. Large-scale biotope mapping surveys have identified the spatial extent of intertidal habitats within the Severn Estuary. The Countryside Council for Wales (CCW; now NRW) surveyed the Welsh shore of Severn Estuary as part of a wider Phase 1 intertidal habitat mapping survey of the entire Welsh coast between 1996 and 2004 (Brazier *et al.,* 2007). Natural England subsequently commissioned a survey of the English side of the Severn Estuary which was undertaken between 2003 and 2004 (Emu, 2006). Most of these habitats, or sub-categories thereof, are considered Habitats of Principal Importance under the 2006 NERC Act (England), as well as the Environment (Wales) Act 2016. This includes saltmarshes and mudflats, as well as coastal sand dunes, vegetated shingle, maritime cliffs and slopes, rocky habitats and intertidal boulders.

Subtidal benthic communities of the Severn Estuary are generally impoverished due to seabed scouring and mobility of sediments that result from its large tidal range (Mettam *et al.,* 1994; Warwick and Somerfield, 2010; Ecospan Environmental Ltd. 2013). In the Severn Estuary, subtidal habitats have different sedimentary compositions, including muddy sands, clean sands, rock and gravely areas (Langston *et al.,* 2003). However, the predominant unconsolidated sediments are muds and sands, the relative composition of which varies throughout the estuary. Each of these sediment types, and the differing physical processes in operation, support a different invertebrate assemblage (Warwick and Davies, 1977; Warwick and Uncles, 1980; Mettam *et al.,* 1989).

The main impact of marine aggregate extraction relates to the direct removal of seabed sand and gravel; this removes benthic species and habitats that live on or within the sediment extracted. Previous research has suggested that this can result in a 40 to 95% reduction in the number and biomass of organisms, and a 30 to 70% reduction in the number of species present (Newell *et al.,* 1998). Seabed removal can therefore result in a change to benthic biotopes and their associated fauna and can impact prey/food items available to higher trophic organisms (Moulaert *et al.,* 2005). Removal of organisms however is restricted to areas where dredging occurs, and the higher the dredging intensity is, the more pronounced the impact (Boyd and Rees, 2003). Individuals entrained are not necessarily killed. Some may survive the entrainment process and be returned to the sea in outwash or during screening. The proportion of individuals that escape, and their subsequent survival rate, is not known (Tillin *et al.,* 2011). Additionally, some mobile epifauna may have the ability to avoid entrainment by moving away from the head.

The recoverability of benthic resources following the cessation of dredging is influenced by several environmental factors including sediment type and hydrodynamics (e.g. Foden *et al.,* 2009). Generally, recovery occurs faster in unstable dynamic environments such as shallow water mobile sands where typical recovery times range from a few months to two to four years. Conversely, for stable environments, such as deep water stable gravels, recovery can take up to 15 years due to the presence of long lived species (Tillin *et al.,* 2011). A disturbed site may not re-colonise in accordance with 'baseline' communities (e.g. Barrio Froján *et al.,* 2011; Tillin *et al.,* 2011). Rates of recolonisation and recovery of benthic communities generally conform to the well-known principles of ecological succession. Sites are initially colonised by short-lived, fast growing, opportunistic species ('r-selected') that are tolerant of high levels of disturbance; infaunal species dominate, particularly polychaetes worms. In time, these are succeeded by longer-lived, slower growing species with a lower tolerance for disturbance (Newell *et al.,* 1998; Hill *et al.,* 2011; Barrio Froján *et al.,* 2011). However, in dynamic environments, opportunistic species are often dominant in un-dredged areas (e.g. Cooper *et al.,* 2007), reflecting the prevailing regime of ongoing natural disturbance.

Regarding significance of impact on benthic habitats and species, Area 531 is mainly characterised by highly impoverished mobile clean sand with almost no benthic fauna recorded (Emu, 2001; Ecospan Environmental, 2013). The species poor, macrofaunal community present consists of species typical of tide swept sandflat habitat. These species are well adapted to living in a dynamic and disturbed tide swept environment. These disturbance-tolerant species also are considered to have high recoverability rates and are capable of rapidly recolonising disturbed habitat (Budd, 2006; Budd and Curtis 2007; Budd and Hughes, 2005). No eelgrass beds or other protected species or species/biotopes considered nationally rare or important have been recorded within Area 531.

Dredging activities result in the suspension of disturbed sediment and subsequent deposition of material (mostly by screening, overspill and hopper washing) (Newell *et al.,* 1998). This can lead to changes in sediment availability for subtidal and intertidal habitats and species. These changes may alter the composition of the biological assemblage associated with this receptor and may result in positive and negative impacts, the degree and type of which is likely to vary with distance from the extraction site. Increased siltation may lead to the gills of suspension feeders (grazing on suspended organic matter i.e. bivalves) becoming clogged and favour the development of deposit feeders (that graze on settling organic matter i.e. polychaetes). However, it should be noted that many benthic invertebrates can switch feeding modes depending on environmental conditions, reducing their sensitivity to the impact. The negative effects of increased suspended sediment may be particularly important during larval settlement in spring, with settling stages potentially being more sensitive to effects. However, this is generally thought to be of less concern where fauna are adapted to naturally high levels of suspended sediments (Boyd *et al.,* 2004).

Increases in SSC have the potential to disturb, or even kill benthic species, altering the benthic community structure of the area. The predicted increases in SSC will only occur during dredging operations and for several hours after the cessation of dredging. Even when these temporary concentration increases occur, they will be of a similar magnitude to those which occur naturally as a result of variation in tidal condition and waves. The sediment plumes will be generated mainly from overspill and screening and are expected to be localised. Thus in physical terms, the plumes resulting from proposed dredging will have a minimal effect on SSC. The biotopes and species identified in the vicinity of Area 531 are considered to be typical of the Severn Estuary and wider Bristol Channel region, being well adapted to turbid conditions as a result of natural sediment mobility in and around the study area.

Higher sensitivity habitats observed within the wider area includes polychaete reef, but these are beyond 500 m from Area 531 (noting that sidescan sonar analysis is recommended during the pre-dredge survey stage). Polychaete reefs are sensitive to direct removal and potential smothering during aggregate extraction; however, proposed dredging activity within Area 531 is not expected to remove any reefs nor increase SSCs above the already high levels recorded in the Severn Estuary. In conclusion, aggregate extraction within Area 531 are not expected to lead to a deterioration of the assessed habitats within the Severn Lower transitional water body, nor prevent this water body from meeting its WFD objectives.

Fish

The fish community of the Severn Estuary is notably species rich and exceeds 100 species in total. The use of conventional fish sampling techniques in the Severn Estuary is difficult because of the large expanses of inaccessible intertidal areas and the macro-tidal conditions. Most of the available knowledge of the Severn Estuary fish community comes from the individuals entrained on the cooling water intake screens used at power stations situated along the English and Welsh shores. Fish and crustacean abundance at Hinkley Point power station situated at the seaward margin of the estuary in Bridgewater Bay has been monitored since 1980 and is currently ongoing (Henderson and Bird, 2010). Similar records are available from Oldbury power station in the Upper Severn Estuary from 1972 to 1977 and 1996 to 1999 (Henderson and Bird, 2010; Bird, 2008). The Severn Estuary is used by a variety of migratory fish species, including twaite shad, river lamprey and sea lamprey, which are all Annex II qualifying species for the Severn Estuary SAC.

The main impact pathway in which fish may be affected by aggregate extraction within Area 531 is from elevated underwater noise levels during operation. Elevated noise and vibration levels caused by the action of the dredger could potentially disturb fish by causing physiological damage and/or inducing adverse behavioural reactions and masking (Hawkins *et al.,* 2015). Noise impacts on fish are restricted to behavioural changes through avoidance, which are limited to a localised area around the dredger for most species. As the dredger vessel is moving, fish are not physically constrained; they will be able to move away from the source of the noise and return once dredging activity has ceased.

The changes in water quality and the temporary deposition of disturbed sediment during overspilling and screening activities could also potentially impact on fish. The predicted increases in SSCs will only occur during dredging operations and for several hours after the cessation of dredging. Even when these temporary concentration increases occur, they will be of a similar magnitude to those which occur naturally as a result of variation in tidal conditions and waves, particularly given the naturally high background turbidity levels experienced in the Severn Estuary. Furthermore, the worst case footprints of the plume are localised.

Overall, aggregate extraction within Area 531 is not expected to lead to a deterioration of fish within the Severn Lower transitional water body, nor prevent this water body from meeting its WFD objectives.

D.4.3 Water quality

Several reviews of inputs of contaminants into the Severn Estuary have been undertaken over the past three decades. Rivers are the primary source of metals (copper, iron, nickel, mercury, cadmium, lead and zinc), dissolved organic carbon, silicate, suspended solids and phosphate. Urban and industrial wastewater discharges and atmospheric deposition are also sources of pollutants. Pollutants are more effectively adsorbed by fine-grained sediments (clay, mud and silt), which usually contain high concentrations of organic matter, than by coarser particles. The finer particles are also more likely to be re-suspended by currents and transported to regions far from their point of origin. For these reasons, silty muds usually contain the highest concentrations of contaminants. It should be noted that the target sediment type at Area 531 is sand/gravel material and this is likely to have low contaminant concentrations.

The Severn Lower transitional water body is currently at good chemical status. Aggregate extraction from Area 531 is unlikely to lead to a deterioration of chemical parameters within the Severn Lower transitional water body, nor prevent this water body from meeting its WFD objectives.

D.4.4 Protected areas

Area 531 overlaps with the Severn Estuary SAC (see Figure D.3), an internationally designated site for: Estuaries; Mudflats and sandflats not covered by seawater at low tide; Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*); Sandbanks which are slightly covered by sea water all the time; Reefs; Sea lamprey (*Petromyzon marinus*); River lamprey (*Lampetra fluviatilis*); and Twaite shad (*Alosa fallax*).

In considering the potential effects of the proposed dredging on the key features of this designated site, the Appropriate Assessment Signposting Document (Appendix C) suggests that dredging within Area 531 is not anticipated to affect the integrity of any of the European/Ramsar Sites, as no failure of the conservation objectives (alone or in-combination) is predicted. Therefore, aggregate extraction within Area 531 is not expected to lead to a deterioration of the assessed protected area designations, nor prevent the water body from meeting its WFD objectives.

D.4.5 Invasive non-native species

As with most activities which occur in the marine environment, there is potential risk that aggregate extraction within Area 531 could result in the introduction or spread of INNS. For example, this could include the movement of vessels from differing water bodies, the use (release) of ballast or the transfer of organisms attached to vessel hulls. The potential risk of introduction or spread of non-native species as a result of the proposed works can be managed through the production of a risk-based Biosecurity Plan.

BMAPA and its members recently contracted ABPmer to produce a Biosecurity Plan Template and Guidance Document (ABPmer, 2018b) that can be used on a regional basis by its member companies to minimise the risk of transfer of INNS during marine aggregate dredging activities within a defined region. A plan for the Bristol Channel region (ABPmer, 2018c) has been prepared, reviewed and approved by both the MMO and NRW. This plan included the potential for future dredging at Area 531.

Consequently, the probability of the introduction and spread of INNS from dredging is considered low and it is not expected to lead to a deterioration in status of the water body, nor prevent the water body from meeting its WFD objectives.

D.5 Conclusion

Based upon the information presented within this WFD compliance assessment, and considering the additional information presented in the Environmental Statement (see main report), it is concluded that aggregate extraction within Area 531 is not likely to have a permanent (i.e. non-temporary) effect on the status of WFD parameters that are significant at water body level. Therefore, deterioration to the status of the Severn Lower transitional water body is not predicted, nor a prevention of this water body achieving future WFD status objectives.

D.6 References

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D.7 Abbreviations/Acronyms

AA	Annual Average
ABP	Associated British Ports
AWB	Artificial Water Body
BWD	Bathing Waters Directive
EC	European Commission
EEC	European Economic Community
EPA	Environment Protection Agency
EQS	Environmental Quality Standards
EQSD	Environmental Quality Standards Directive
EU	European Union
GCS	Good Chemical Status
GEP	Good Ecological Potential
GES	Good Ecological Status
GI	Ground Investigation
GS	Good Status
HMWB	Heavily Modified Water Body
INNS	Invasive Non-Native Species
IQI	Infaunal Quality Index
MAC	Maximum Allowable Concentrations
NRW	Natural Resources Wales
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PSD	Priority Substances Directive
RBMP	River Basin Management Plan
SAC	Special Area of Conservation
SPA	Special Protection Area
USEPA	United States Environment Protection Agency
WFD	Water Framework Directive
WIMS	Water Information Management System

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.