HR Wallingford
Working with water

Review of aggregate dredging off the Welsh coast

Review of evidence

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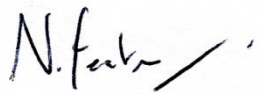		

Document history

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Summary

This review has been prepared to inform an ongoing initiative to evaluate the interim Marine Aggregate Dredging Policy for Wales (iMADP).

Monitoring reports and other data for all Welsh marine aggregate licence areas active since 2000 were examined for any evidence of effects of dredging on the coastline. A review of significant and relevant new scientific information has also been undertaken.

None of the reports reviewed for this study have indicated that there has been change to the adjacent coastline caused by the dredging activities. The review of available literature does not alter this picture.

These conclusions are based on monitoring outputs for existing active licences, and do not relate to any new applications or renewals.

Trosolwg o'r adroddiad

Mae'r adolygiad hwn wedi'i baratoi er mwyn llywio menter barhaus i werthuso Polisi Dros Dro ar Garthu Agregau Morol (iMADP).

Archwiliwyd adroddiadau monitro a data eraill ar gyfer pob un o ardaloedd trwyddedu agregau morol Cymru sydd wedi bod yn weithredol ers 2000, a hynny er mwyn gweld a oes unrhyw dystiolaeth o effeithiau carthu ar yr arfordir. Hefyd, cynhaliwyd adolygiad o dystiolaeth wyddonol newydd sylweddol a pherthnasol.

Nid oes un o'r adroddiadau a adolygwyd ar gyfer yr astudiaeth hon wedi nodi bod yr arfordir gerllaw wedi newid yn sgil gweithgareddau carthu. Nid yw'r adolygiad o'r llenyddiaeth sydd ar gael yn newid y darlun hwnnw.

Mae'r casgliadau hyn yn seiliedig ar fonitro canlyniadau'r trwyddedau sydd eisoes yn weithredol ac nid ydynt yn berthnasol i unrhyw geisiadau newydd neu geisiadau i adnewyddu trwyddedau.

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1. Introduction

Cefas, acting on behalf of the Welsh Government, commissioned HR Wallingford to carry out this review as part of an ongoing initiative to evaluate the interim Marine Aggregate Dredging Policy for Wales (iMADP). iMADP was adopted in November 2004 following a series of detailed studies and consultations to establish an evidence base of the sector's:

- current and future operations in Wales;
- governance and impacts.

As the first phase of this review, monitoring reports and other data for all Welsh marine aggregate licence areas were inspected. The review examined the reports for any evidence of a number of effects that might be distinguished from natural disturbance mechanisms:

- beach drawdown;
- changes in wave refraction;
- alteration of tidal currents;
- reduction in onshore transport of sediment;
- reduction in shelter provided by a sandbank or similar seabed feature due to lower crest levels;
- impact on natural sediment transport processes, patterns or pathways in and around the extraction areas.

In addition to the review of monitoring data, a review of significant and relevant new scientific information has been undertaken. The literature review examined the latest information on sediment transport pathways, sediment budgets, physical processes and morphological changes affecting the study area.

Based on the evidence considered above, the benefit (or not) of revisiting wave modelling was considered in relation to whether it would offer significant improvements in the quality of information leading to greater resilience of regional management decisions. This report then makes recommendations on:

- the significance of the evidence above in determining the 'resilience' of decisions;
- changes to the monitoring requirements on marine aggregate dredging licences; and
- any critical gaps in information.

The boundaries of the thirteen marine aggregate extraction licence areas considered in this study are shown in Figure 2.1. This is referred to as the study area.

2. Summary of marine dredging activity in Wales since 1998

In 2014 The Crown Estate (TCE) and the British Marine Aggregate Producers Association published a report that provided a fifteen-year overview of marine aggregate dredging in the UK between 1998 and 2012 (TCE, 2014). Key information presented in this report for the South West and North West regions is summarised in Table 2.1, Table 2.2 and Table 2.3.

Table 2.1: The area licenced 1998 to 2012

Region	Licenced area 1998 (km^2)	Licenced area 2012 (km^2)	Licensed area surrendered in period (km^2)	New licensed area in period (km^2)
South West	63	112	52	101
North West	99	69	93	64

Source: The Crown Estate, 2014

Table 2.2: The area dredged 1998 to 2012

Region	Area dredged 1998 (km^2)	Area dredged 2012 (km^2)	Minimum area dredged in period (km^2)	Maximum area dredged in period (km^2)	Cumulative area dredged in period (km^2)
South West	16	8	7.6 (2011)	17.9 (1999)	35
North West	0.8	0.9	0.3 (2010)	2.7 (2003)	8

Source: The Crown Estate, 2014

Table 2.3: Extraction rate 1998 to 2012

Region	Total extraction in period (million tonnes)	Minimum extraction in period (million tonnes)	Maximum extraction in period (million tonnes)
South West	23	0.9 (2010)	2.0 (1999)
North West	7	0.27 (1998)	0.73 (2009)

Source: The Crown Estate, 2014

Figure 2.2 and Figure 2.3 show the areas of the seabed that have been dredged within the licence boundaries for the South West and North West regions during the 15-year period between 1998 and 2012 (The Crown Estate, 2014).

To aid the interpretation of licence monitoring, a history of aggregate dredging licences issued and relinquished between 1991 and the present day is provided in Table A.1 of Appendix A.

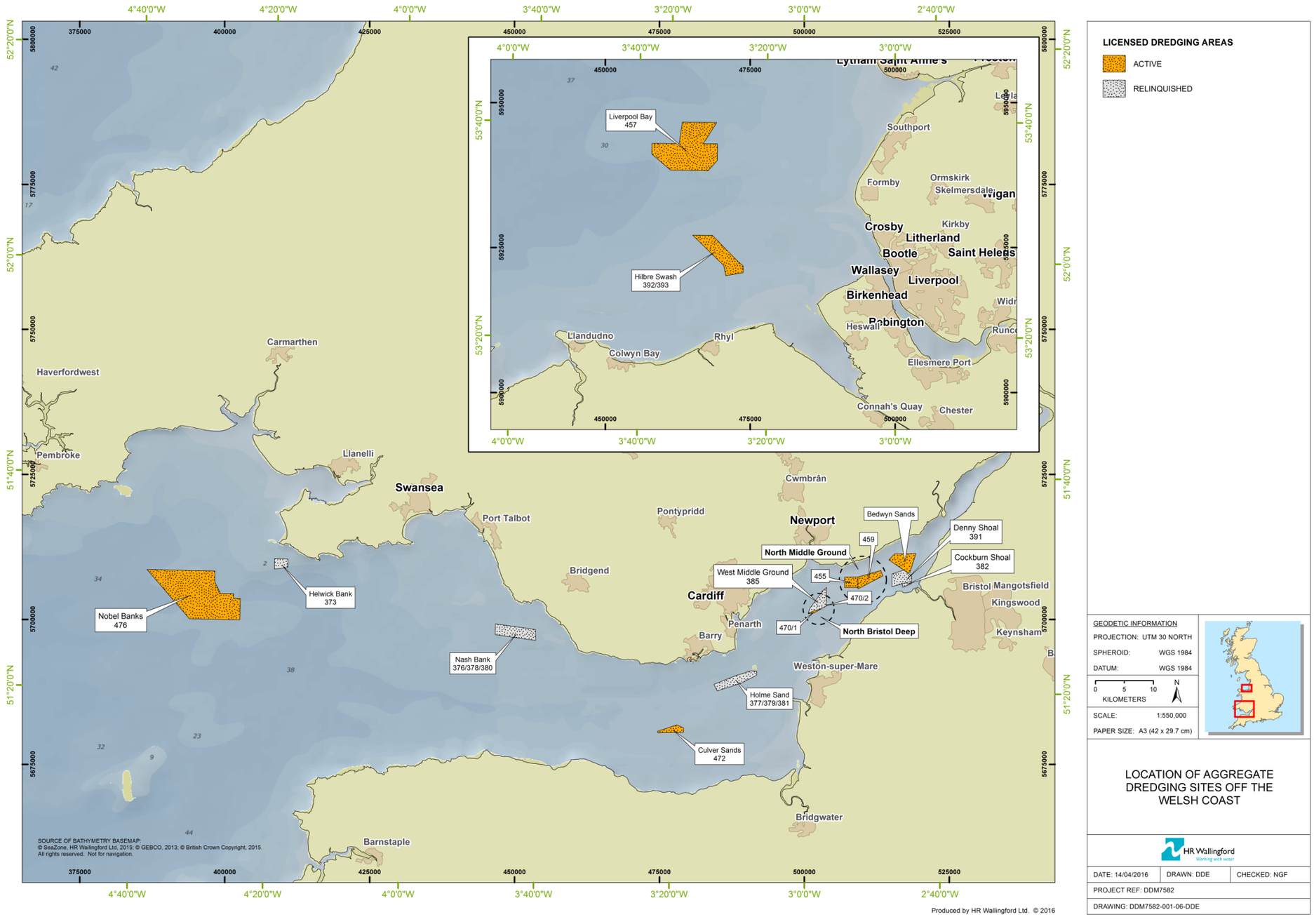

Figure 2.1: Location map for all licensed areas considered

Source: HR Wallingford

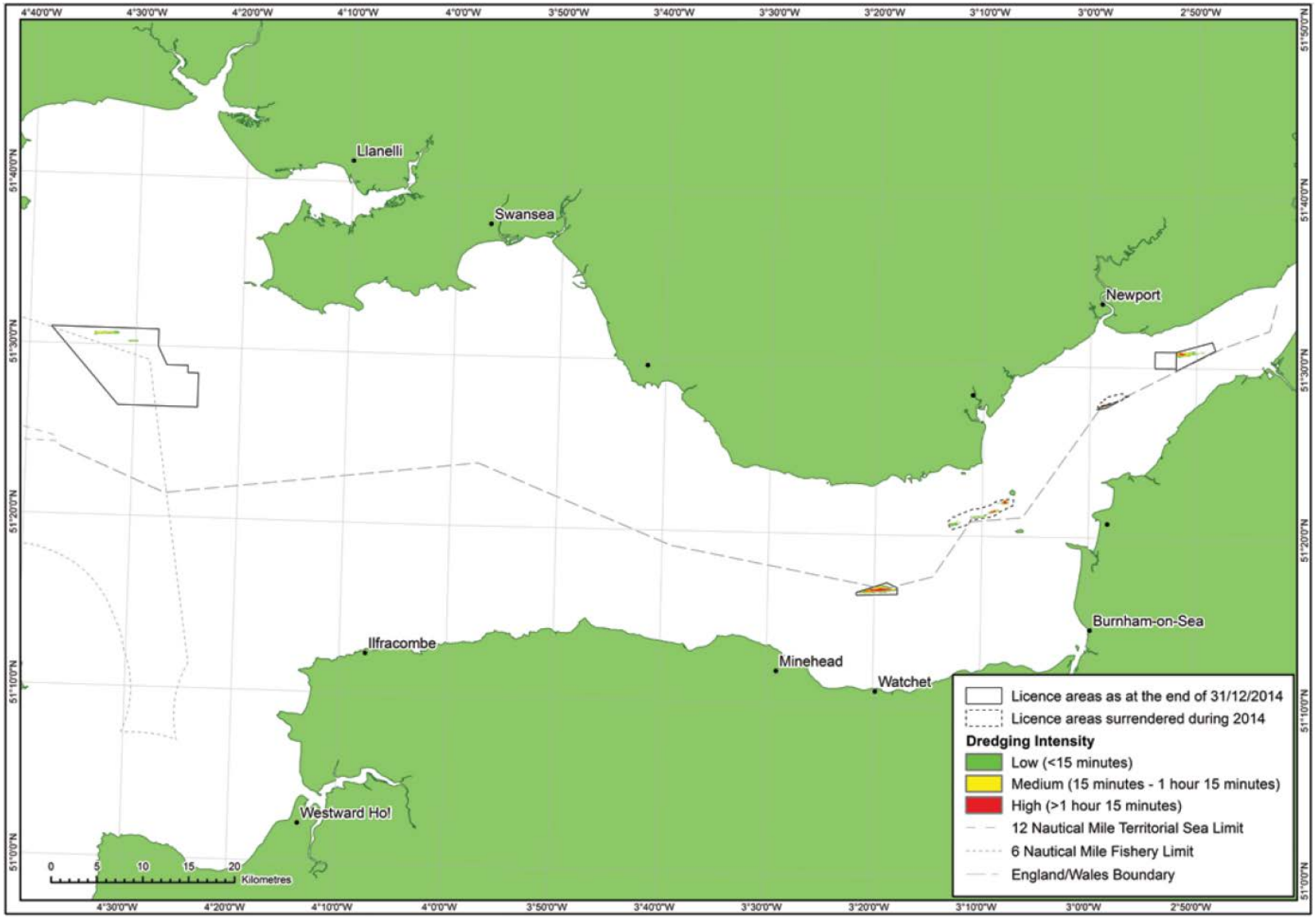

Figure 2.2: South West region - Areas involved 2014

Source: The Crown Estate, 2014

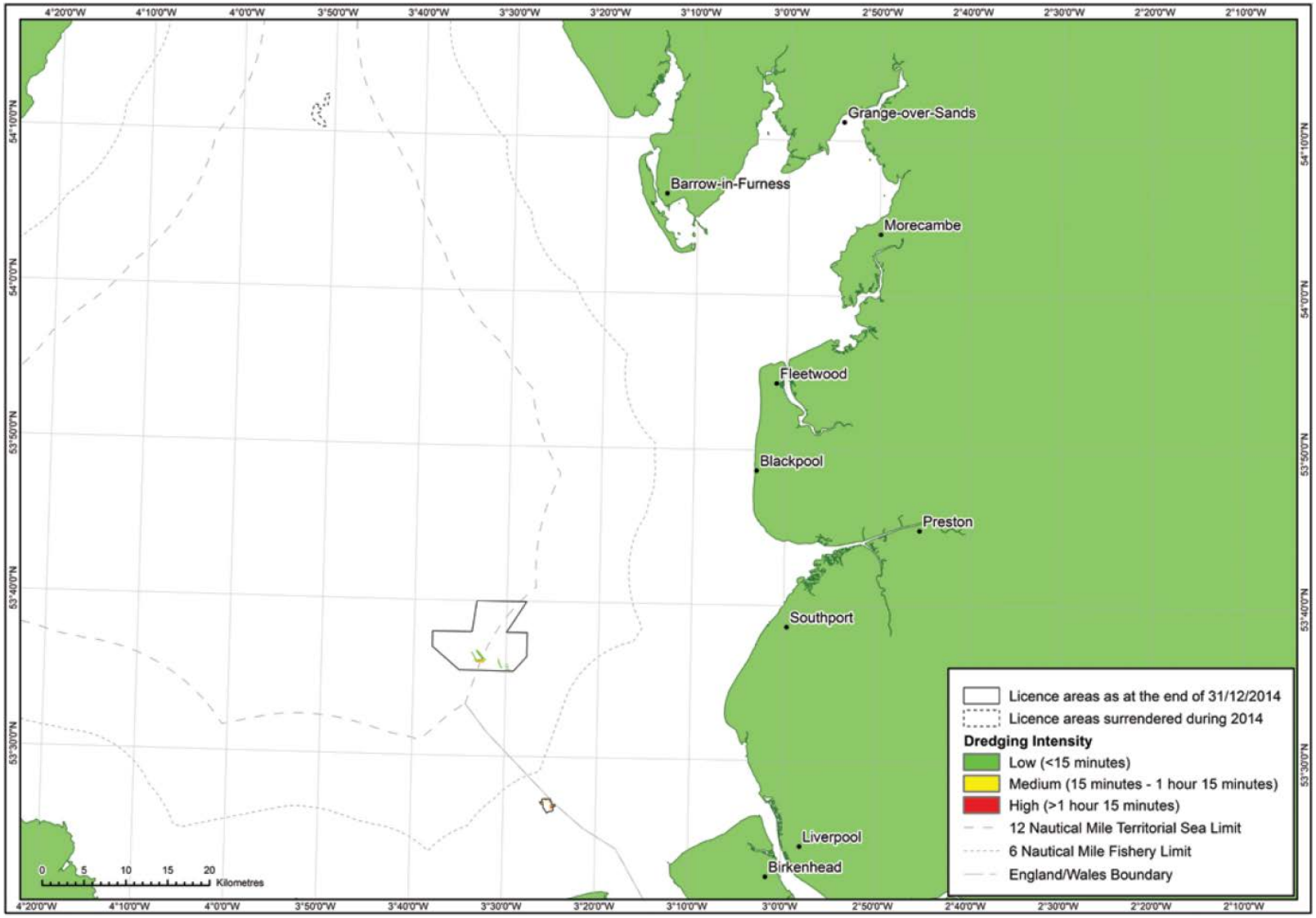

Figure 2.3: North West region - Areas involved 2014

Source: The Crown Estate, 2014

3. Review of available information for current licences

Nearly 100 reports, in both digital and hard copy, reports were received by HR Wallingford covering a total of eleven of the thirteen aggregate extraction licence areas (see Figure 2.1). Some of the areas consisted of multiple dredge zones within the licenced areas.

The number of reports received varied between areas; one site had 30 reports whilst another had no reports available. There were several different types of reports including baseline survey reports, operational survey reports, Environmental Statements, and analysis reports drawing on the results of the surveys carried out.

For the purpose of this review the areas are separated into active (Section 4) and relinquished (Section 5) areas, and within these two sections are sorted by The Crown Estate's dredging area number. It should be noted that as Bedwyn Sands lies within the Swangrove Estate, there is not a Crown Estate Area number given. This area is included at the end of Section 5.

The monitoring reports reviewed here were produced by the licence holder or their consultants. The regulator reviews these monitoring reports for compliance and in order to consider whether any actions are required. Feedback from the regulator and their advisors on these monitoring reports has not been provided as part of this review, and therefore conclusions provided within the reports reviewed have been taken at face value. Furthermore, whilst the reports and other data were inspected, no additional data analysis was undertaken as part of this review.

4. Areas with active dredging licences

4.1. Area 392/393: Hilbre Swash

Table 4.1:Hilbre Swash summary

Licence information		Comments
Site name	Hilbre Swash	The baseline survey report, a pre-licence bathymetry survey and the Environmental Statement have been made available for this site. As the licence was granted in 2014 the operational surveys and reviews of the data are not due yet. An assessment of the side scan sonar and multi-beam bathymetry data has defined the pre dredge baseline seabed sediments and features, but has not found any evidence of features of nature conservation interest. An assessment by a qualified archaeologist of the side scan sonar contacts and anomalies has been undertaken with five exclusion zones being recommended. The environmental statement stated that the impacts as a result to the dredging will be 'not significant'.
Area licence number	392/393	
Licence period	January 2014 to January 2029	
Baseline survey	2012	
Operational surveys	Required in years 2 and 4 (MBES, side scan of active dredging zone)	
Substantive review reports	Year 5 and 10 (review of monitoring results and dredging operations)	
Post dredge surveys	1 year after cessation	

Note: Information derived from reports listed in Section 4.1.1

4.1.1. Reports reviewed

The following reports were reviewed for information concerning dredging effects on the coast:

- Area 392/393 (Hilbre Swash) Bathy Survey 2012, October 2012; (Osiris Projects, 2012)
- Area 392/393 (Hilbre Swash) Environmental Statement, December 2012; (ERM, 2012)
- Area 392/393 (Hilbre Swash) Baseline Monitoring November 2014.(Fugro Emu Ltd, 2014).

4.1.2. Conclusions

As the licence was only granted in 2014, there are no surveys from which any evidence of changes to the physical environment can be drawn. No data collected during the previous licence period have been provided.

4.2. Area 455/459: North Middle Ground

Table 4.2: North Middle Ground summary

Licence information		Comments
Site name	North Middle Ground	Data from the 2011 operational survey were compared to those from the 2010 survey and with those from a lead-line survey carried out in the 1920's in a review of the monitoring data. The comparison showed that there was an increase in the bank volume, height and extent between the 2010 and 2011 surveys whilst the modern surveys were markedly different from the 1920's survey, probably due to the coarse resolution of the lead-line survey. This spatial area is encompassed by the monitoring surveys for Area 470, which did not find evidence of changes due to dredging. It is understood that there has been annual monitoring since 2011. Reports were requested, but not made available for this review.
Area licence number	455/459	
Licence period	01/05/2011 to 30/04/2016	
Baseline survey	Bathymetry, 2005 - not available	
Operational surveys	Annual bathymetry and LiDAR surveys with PSA samples – not available	
Substantive review reports	None available	
Post dredge surveys	None available	

Note: Information derived from reports listed in Section 4.2.1

4.2.1. Reports reviewed

The following reports were reviewed for information concerning dredging effects on the coast:

- North Middle Ground - Further Sampling - October/ November 2002, (Ian Walker & Associates, 2002);
- North Middle Ground - Government view consultation report November 2004, (Ian Walker & Associates, 2002);
- Area 455/459 (North Middle Ground) 2009 WAG permission, (Ian Walker & Associates, 2009);
- Area 455/459 (North Middle Ground) Pre-dredge and benthic survey, October 2009, (Pisces Conservation Ltd, 2009);
- Area 455/459 (North Middle Ground) Year 1 Bathymetric Survey, November 2011, (ABPMer, 2011);
- Area 455 and 459 (North Middle Ground) Further Data Request - Pre dredge surveys, (ABPMer, 2013);
- South West Region. A Review of Physical Impacts from Aggregate Dredging to 2013, (HR Wallingford, 2010 (a)).

4.2.2. Conclusions

The accretion on the North Middle Ground is reported as indicative of the natural variability of the sediment transport in the Bristol Channel rather than an indication of change due to the dredging. From the available analyses carried out it appears that there was a channel which cut through the southwest corner of the study site in the 1920's survey which was infilled before the 2010 survey.

It is understood that there has been annual monitoring since 2011. Reports were requested, but not made available for this review.

No definitive conclusions on the effects of dredging on the physical environment can be drawn from the information provided. The analysis of further bathymetry surveys might provide a more robust indication of any changes, these data have not been made available.

4.3. Area 457: Liverpool Bay

Table 4.3: Liverpool Bay summary

Licence information		Comments
Site name	Liverpool Bay	There are two bathymetry reports which provide some analysis of the data, from 2013 and 2014. The data from these surveys were compared to the baseline data collected in 2009. The datum used in the 2009 report was found to be offset from that used in the subsequent surveys. This made comparison with the later surveys difficult. However, an offset was calculated and applied to the baseline data so that analyses could be carried out. The conclusions in both reports are identical: Within the licence area there is a pipeline 'no-go' area. The analysis of the 2013 and 2014 MBES bathymetry data concluded that there was no evidence of any deleterious impact of the dredging operations to date upon the pipeline routes. The reports also concluded that apart from the dredging operations, there appears to be little change in the sediment budget.
Area licence number	457	
Licence period	14 July 2010 to 13 July 2025	
Baseline survey	2009	
Operational surveys	Bathymetry 2013 and 2014	
Substantive review reports	None available	
Post dredge surveys	None available	

Note: Information derived from reports listed in Section 4.3.1

4.3.1. Reports reviewed

The following reports were reviewed for information concerning dredging effects on the coast:

- Aggregate Production Licence Application, Area 457 Liverpool Bay: Environmental Statement (ERM, 2003 (b));
- Aggregate Production Licence Application, Area 457 Liverpool Bay: Vol 1 - Summary of Consultation and Supplementary ES (Appendix A), (ERM, 2003 (b));
- Area 457 (Liverpool Bay) Application Volume 1 Summary of Consultation and Supplementary ES (Appendix A) December 2003, (ERM, 2003 (c));
- Area 457 (Liverpool Bay) Application Volume 2 Supplementary ES (Appendices B, C and D) (ERM, 2003 (d));
- Area 457 Baseline Geophysical Survey August 2009 (Report), (EMU Ltd, 2009 (g);
- Area 457 Baseline Geophysical Survey August 2009 (Drawings 1), (EMU Ltd, 2009 (h));
- Area 457 Baseline Geophysical Survey August 2009 (Drawings 2), (EMU Ltd, 2009 (h));
- Area 457 (Liverpool Bay) Dredging Zone 01 Bathymetry Survey 2013, September 2013, (Davies, C. 2013 (b));
- Area 457 (Liverpool Bay) Dredging Zone 01 Bathymetry Survey 2014, July 2014, (Davies, C, 2014 (b)).

4.3.2. Conclusions

The conclusion drawn from the two bathymetry survey reports suggests that the dredging operations have had ‘little effect on the sediment budget’ and that the pipeline is unaffected. There is no discussion in the reports of any effect on the coastline, whether as a direct impact from the dredging or as a result of changes to the hydrodynamic environment.

4.4. Area 470: North Bristol Deep

Table 4.4: North Bristol Deep summary

Licence information		Comments
Site name	North Bristol Deep	An investigation into the bathymetric changes between 1993 and 2001 was carried out in 2002 to address concerns raised during consultation over the licence application for Area 470. The conclusions from the investigation were that: • The largescale natural changes outweigh the current or proposed dredging changes. • The dredging will not affect the integrity of the Middle Grounds as a sand bank SAC feature. • Against the background of natural sediment movements, no measurable accretionary or erosional impact from dredging on two locations of interest is predicted or demonstrated by evidence presented. Annual substantive reviews of the bathymetry data for this area are available from 2011 to 2015. An overview of changes was given for the five year period from 2011 to 2015 in the 2015 report. Based upon the analysis of the monitoring survey, it was concluded that there has been only minor changes in areal extents, average heights and channel widths, and hence no major change identified using the seven agreed indicators of environmental change. The study evaluated the bathymetric monitoring data with respect to the decision making process associated with the licence conditions for Area 470/1 and 470/2. Based on analysis and interpretation of bathymetric monitoring data, the overall conclusion is there is no indication of major changes having taken place with the sandbank characteristics landwards of Area 470/1 and 470/2. The changes that have been observed are attributed to the difference in the spatial extent of the monitoring data.
Area licence number	Area 470	
Licence period	16/02/2015 to 07/04/2022	
Baseline survey	Pre-dredge bathymetry survey report	
Operational surveys	2001 – 2014 bathymetry survey reports from previous licence periods	
Substantive review reports	Reviews from 2011 to 2015	
Post dredge surveys	No report available yet	

Note: Information derived from reports listed in Section 4.4.1

4.4.1. Reports reviewed

The following reports were reviewed for information concerning dredging effects on the coast:

- Area 470 (North Bristol Deep) - Dredging Licence Application - Final Scoping Report 2001, (EMU Ltd, 2001 (a));
- Application Area 470 “North Bristol Deep” Investigations of sea bed changes 1993 – 2001, (UMD Ltd & HAM Ltd 2002);
- Area 470 North Bristol Deep Regional cumulative impact assessment. Supplementary Information, (White Young Green, 2008);
- Area 470 (Bristol Deep) Pre-Dredge Bathymetric Survey, Feb 2010, (Gardline Environmental, 2010 (a));
- Area 470 (Bristol Deep) Bathymetric Survey Feb 2011, (Gardline Environmental, 2011);
- Area 470 (Bristol Deep) Bathymetric Survey Feb 2012, (Gardline Environmental, 2012);
- Area 470 (North Bristol Deep) 2012/2013 Monitoring Survey Reports and Data (2012 regional bathymetry data and 2013 bathymetric data covering Area 470), June 2013. (Marine Ecological Surveys Ltd, 2013 (c));
- Area 470 (North Bristol Deep) 2012/2013 Monitoring Survey Reports and Data Severn Estuary LiDAR Elevation Data 2012 (2 Disks) (Marine Ecological Surveys Ltd, 2013 (d));
- Area 470 (North Bristol Deep), Review of Monitoring Data (2011). HR Wallingford EX6553, (HR Wallingford, 2011);
- Area 470 (North Bristol Deep), Review of Monitoring Data (2012). HR Wallingford EX6781, HR Wallingford, 2012);
- Area 470 (North Bristol Deep), Review of monitoring data (2013). HR Wallingford DDM7022-R02, 9 HR Wallingford, 2013);
- Area 470 (North Bristol Deep), Review of monitoring data (2013/2014). HR Wallingford DDM7190-RT001-R01 (HR Wallingford, 2014);
- Area 470 (North Bristol Deep)Review of monitoring data (2014/2015). HR Wallingford DDM7417-RT001-R02-00, (HR Wallingford, 2015);
- South West Region. A Review of Physical Impacts from Aggregate Dredging to 2013, (HR Wallingford, 2010 (a)).

4.4.2. Conclusions

Based on analysis and interpretation of bathymetric monitoring data, the overall conclusion is there is no indication of major changes having taken place with the sandbank characteristics landwards of Area 470.

4.5. Area 472: Culver Sands

Table 4.5: Culver Sands summary

Licence information		Comments
Site name	Culver Sands	Dredging across the area has been variable, although largely concentrated across the central part of the licence area. Coarse sediment was returned to the seabed by the operators to prevent contamination of sand cargoes. No significant changes in seabed character have been observed over the period, above those expected following the start of dredging. According to the substantive review, a high level of sediment movement as a result of natural processes in the highly dynamic environment is apparent across the area. The distribution of major sediment types remains largely unchanged. The seabed has been lowered by as much as 2.5 m in furrows associated with dredging. However, average deepening of the licence area has been calculated at 0.37 m across the full extent of the area. Data from 2012 indicate that the resource layer is at least 0.5 m thick across the majority of the licence area. Maximum resource layer thickness across the site has decreased from 1999/2000 to 2010, although the average thickness across the entire area remained approximately 3 m. Furthermore, sediment composition in the licence area and along the sediment corridors has remained statistically similar between 2008 and 2012. There is no evidence of impacts of dredging on the sediment composition outside of the licence area. Since 2008, there have been subtle changes affecting the boundaries of some of the sediment deposits. The largest of these changes, between the 2012 to 2013 data, occurred in the centre of the main survey area where what had been a large expanse of smooth sandy gravels has developed a largely continuous sand veneer. Average sediment composition values have remained broadly similar between years. Statistical testing revealed no significant differences between years or impacts over the pre- to in-dredge periods (Substantive review, 2013). The comparisons of beach profile topographic data collected on the English and Welsh sides above and below the low water mark also show minimal changes in elevations.
Area licence number	472	
Licence period	3 October 2008 to 2 October 2013	
Baseline survey	Macrobenthic survey only	
Operational surveys	2009 - 2013 Annual bathymetry, topographic, sediment sampling 2010- 2012 Annual Seismic profiling	
Substantive review reports	2013	
Post dredge surveys	None carried out as yet	

Note: Information derived from reports listed in Section 4.5.1

4.5.1. Reports reviewed

The following reports were reviewed for information concerning dredging effects on the coast:

- Culver Sands Area 472 Dredging Licence Application - Final Scoping Report 2001, (EMU Ltd, 2001 (b));
- Area 472 Culver Sands Report of Consultation. Volume 1, 2007 (White Young Green, 2007 (a));
- Area 472 Culver Sands Report of Consultation. Volume 2 Environmental Statement Supplement, 2007 (White Young Green, 2007 (b));
- Area 472 Culver Sands Report of Consultation. Volume 3 Appendices, 2007, (White Young Green, 2007 (c));
- Area 472 (Culver Sands) Pre-Dredge Report March 2009, (EMU Ltd, 2009 (f));
- Area 472 (Culver Sands) Seabed Monitoring Survey and Analysis of 2008 and 2009 Bathymetric Data, (Gardline Environmental, 2009);
- Area 472 (Culver Sands) Analysis of Survey Data 2010, (Marine Ecological Surveys Ltd, 2011);
- Area 472 (Culver Sands) Analysis of Survey Data 2011, (Gardline Environmental, 2011 (a));
- Area 472 (Culver Sands) Seabed monitoring and bathymetry analysis 2008-2011, (Gardline Environmental, 2011 (b));
- Area 472 (Culver Sands) Five Year Substantive Review June 2013, (Marine Ecological Surveys Ltd, 2013 (b));
- Area 472 (Culver Sands) Environmental Monitoring - 2012 Updated Data, (Marine Ecological Surveys Ltd, 2013 (a));
- Area 472 (Culver Sands) 2009, 2010, 2011, 2012, 2013 Monitoring reports. Substantive Review and 2013 Archaeological Assessment data, Marine Ecological Surveys Ltd, 2014);
- Culver Sands ES CD 2007 - Application for Government View, (White Young Green, 2007(d)).

4.5.2. Conclusions

No statistically significant differences have been identified in the sediment composition. No significant changes in seabed character have been observed over the period. Furthermore, the comparisons of beach profiles topographic data collected on the English and Welsh sides above and below the low water mark show minimal changes in elevations. The evidence therefore suggests that dredging is not having an effect beyond the licence area.

4.6. Area 476: Nobel Banks

Table 4.6: Nobel Banks summary

Licence information		Comments
Site name	Nobel Banks	Macrobenthic infauna analysis showed an increase in species number, diversity and biomass across all surveyed areas between 2006 and 2008. Increases to the three indices in the reference stations suggest that the increases are a result of natural variability in the highly dynamic conditions present across the survey area and not related to dredging activity. The sediments across the survey area predominantly consisted of sands, with various fractions of fines or gravel also present. Comparative analysis of particle sizes between the 2006 and 2008 surveys showed an increase in the sand fraction and a decrease in fines across all areas, including the reference stations. These results suggest that the changes caused by the natural levels of sediment transport experienced in this dynamic environment will mask any effect of aggregate extraction on the seabed. An analysis of the similarities between year groups of sediment samples showed that there was as much variation within the yearly samples as there was between years, hence, the null hypothesis of 'no difference between years' was accepted. Therefore, there was no need to test the hypothesis that there was no change to the sediments at a radius of 250 m as there was no change over the years. The measured changes in bathymetry and calculated changes in the seabed volume within the survey area suggest that natural variations in the bathymetry due to relatively large scale sediment transport within the survey area is the cause of the observed increases and decreases in seabed levels.
Area licence number	476	
Licence period	July 2006 to July 2016	
Baseline survey	2006 (sediment sampling, bathymetry)	
Operational surveys	2006-2013 (Bathymetry)	
Substantive review reports	2009 (bathymetry, benthic monitoring)	
Post dredge surveys	None	

Note: Information derived from reports listed in Section 4.6.1

4.6.1. Reports reviewed

The following reports were reviewed for information concerning dredging effects on the coast:

- Dredging on Nobel Banks (Area 476), Bristol Channel: Coastal Impact Study August 2002, (HR Wallingford, 2002);
- Area 476 Nobel Banks Bristol Channel Benthic resource baseline Survey 2006, (ERM, 2006 (b));
- Area 476 Nobel Banks Bristol Channel Resource baseline Survey 2006, (ERM, 2006 (a));
- Aggregate Production Licence Application, Area 476 Nobel Banks: Supplementary Environmental Statement, 2002, (ERM, 2002);
- Aggregate Production Licence Application, Area 476 Nobel Banks: Supplementary Environmental Statement, Volume 1 Appendix A, 2004,(ERM, 2004 (a));
- Aggregate Production Licence Application, Area 476 Nobel Banks: Supplementary Environmental Statement, Volume 2 Appendix B and C, 2004, (ERM, 2004 (b));
- Area 476 (Nobel Banks) Application Volume 1 Summary of Consultation and Supplementary ES (Appendix A), January 2004, (ERM, 2004 (c));
- Area 476 (Nobel Banks) Application Volume 2 Supplementary ES (Appendices B and C), 2004, (ERM, 2004 (d));
- An investigation of sand bedload transport pathways on the seabed near Helwick Bank Bristol Channel, 2005, (Davies, C., 2005 (a));
- Area 476 A review of annual monitoring surveys of Helwick Bank and adjacent Gower beaches 2003-2004, (Davies, C., 2005 (b));
- Area 476. A review of Annual monitoring surveys, Helwick Bank and adjacent Gower Beaches 2003-2004, (Davies, C., 2005 (a));
- Area 476 (Outer Bristol Channel) Bathymetric Monitoring Survey, 2010, (EMU Ltd, 2010);
- Area 476 (Nobel Banks) Monitoring Surveys, Three year review, April 2009, (ERM, 2009);
- Area 476 (Nobel Banks) Benthic Baseline Monitoring Survey, 2006, (ERM, 2006 (a));
- Area 476 (Nobel Banks) Macrobenthic ecology study, Year 2 monitoring survey, 2009,(EMU Ltd, 2009 (b));
- Area 476 (Outer Bristol Channel) Seabed Monitoring Survey, 2010, (EMU Ltd, 2010);
- Area 476 (Outer Bristol Channel) Annual Bathymetry Monitoring Survey 2011, September 2011, (Davies, C., 2011 (a));
- Area 476 (Outer Bristol Channel) Annual Bathymetry Monitoring Surveys 2011, November 2011, (Davies, C., 2011 (b));
- Area 476 (Nobel Banks) Bathymetry monitoring survey, 2009, (EMU Ltd, 2009 (a));
- Area 476 (Nobel Banks) Macrobenthic ecology study and Bathymetry monitoring survey 2008, January 2009, (EMU Ltd, 2009 (c));
- Area 476 (Nobel Banks) 2010 draft bathymetry report, September 2010, (Davies, C., 2010);
- Area 476 (Outer Bristol Channel) Annual Bathymetry Monitoring Survey, 2012, (Davies, C., 2013 (a));
- Area 476 Nobel Banks Monitoring Surveys Six Year Review, 2013, (ERM, 2013);
- Area 476 (Outer Bristol Channel) Annual Bathymetry Monitoring Survey, 2013(Davies, C., 2014 (a)).

4.6.2. Conclusions

The review of the available reports suggested that the measured changes in bathymetry and calculated changes in the seabed volume within the survey area were a result of natural variations in the bathymetry. The relatively large scale sediment transport within the survey area is the cause of the observed increases and decreases in seabed levels. The evidence therefore suggests that dredging is not having an effect beyond the licence area.

5. Areas with relinquished dredging licences

5.1. Area 373: Helwick Bank

Table 5.1: Helwick Bank summary

Licence information		Comments
Site name	Helwick	The baseline survey was completed, in accordance with the Helwick Government View. All survey reports provided are for the previous licence period, the latest reports are for 2004. For clarity, Figure 5.1 shows the locations of Helwick Bank, Port Eynon and Oxwich Bay. The reports received were reviewed: • Six LiDAR datasets for the beaches analysed for the years 1998 and 2004. No detailed analysis of the data was provided. Vibrocore sampling was carried out in 2000. • Bathymetry surveys were carried out in 2001 and 2004, the 2001-2003 data showed accretion, the 2003-2004 data showed a 'steady state', i.e. no change in the overall sediment budget was discernible. • The geophysical survey (2004) undertaken as part of Helwick Links Project indicated no connectivity between the bank and Port Eynon beaches, i.e. there is a strip of clear bedrock which separates these two geographic areas. This is the only shore corridor. • The sidescan sonar mosaic produced as part of the geophysical survey indicates that there are no bedload transport pathways between Helwick Bank and Port Eynon Bay under baseline conditions, and therefore storm-driven coastal margin eastward transport is the only plausible mechanism for any ephemeral sand transport from Helwick Bank to Port Eynon Bay, depending upon the storm's direction (Davies, 2005). Dredging should not affect this transport. • The sidescan sonar mosaic shows no evidence for any omnipresent bedload transport "return" mechanism from Port Eynon Bay to Helwick Bank. The same conclusions apply to Oxwich Bay, as there are no bedload transport pathways observed immediately eastward of Helwick Bank. • Comparisons of successive bathymetry surveys of Helwick indicate that near Helwick Bank the sand wave trains in Helwick Channel migrate to the east at annual rates varying from 20 m to 200 m per year, whilst to the south of the bank the sandwaves migrate to the west.
Area licence number	373	
Licence period	Licence relinquished	
Baseline survey	Benthos and seabed sediment composition	
Operational surveys	Annual beach, bathymetry, surveys, periodic benthic surveys. Annual review of monitoring results	
Substantive review reports	Every three years	
Post dredge surveys	A single set of bathymetric, beach and benthic surveys.	

Note: Information derived from reports listed in Section 5.1.1

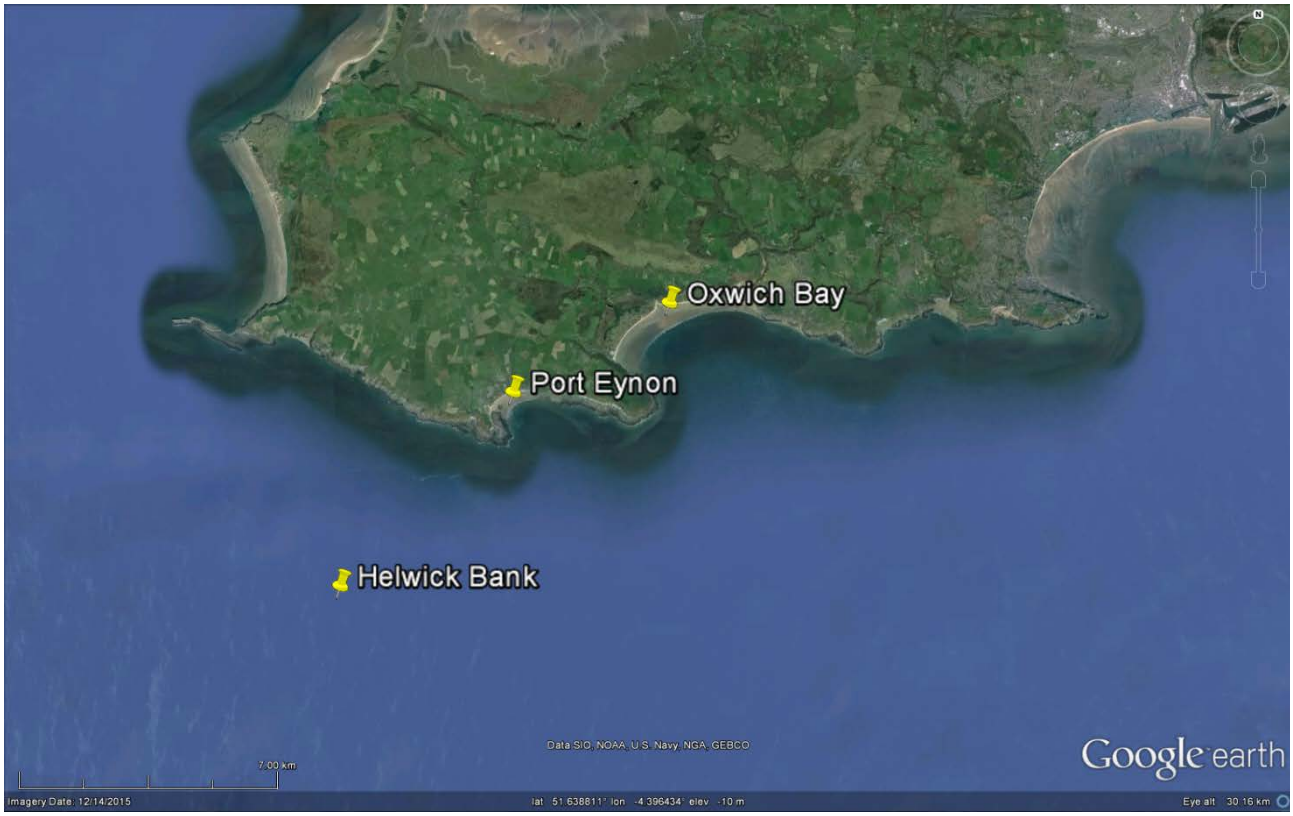

Figure 5.1: Location of Helwick Bank, Port Eynon and Oxwich Bay

5.1.1. Reports reviewed

The following reports were reviewed for information concerning dredging effects on the coast:

- Area 373 Helwick Bank Environmental Statement, January 2003, (ERM, 2003 (a));
- Area 373 Helwick Bank. Volume 1 Summary of consultations and Supplementary Environmental Statement (Appendix A), 2004, (ERM, 2004 (e));
- Area 373 Helwick Bank, Supplementary Environmental Statement Volume 2 (Appendices A, B and C), 2004, (ERM, 2004 (f));
- An investigation of sand bedload transport pathways on the seabed near Helwick Bank, Bristol Channel (2005), (Davies, C., 2005 (a));
- Helwick Government View, August 2007, (Government View, 2007).

5.1.2. Conclusions

There is no evidence of any changes arising from licenced dredging to the wider physical environment and coastline in the documents supplied.

It cannot be ruled out that analysis of the LiDAR data may provide some indication of changes, however, this is outside the scope of this study.

5.2. Area 376/378/380: Nash Bank

Table 5.2: Nash Bank summary

Licence information		Comments
Site name	Nash Bank	The results from the annual reviews of the survey data (2003-2010) revealed substantial short-term variations from year to year, especially in seabed levels. Six Indicators of potential morphological impact were proposed by HR Wallingford (2003) and which were subsequently used to monitor the response of bank and beaches to dredging activity. When one or more of the chosen indicators fell below the assigned upper or lower threshold values, then additional surveys were undertaken and further analysis carried out to assess the risk of dredging operations having an adverse effect on beach levels. In general, when this occurred, it was found that the particular indicator value or values which had triggered the additional studies had returned to a more acceptable level. There was never a requirement to recommend further measures be implemented, e.g. reducing or suspending dredging operations in subsequent years. Any surveys which indicated an apparent lowering in seabed levels on Nash Bank resulted in additional monitoring and analysis being carried out as an initial precautionary measure. The results from these additional surveys have shown a recovery in seabed levels, suggesting that the observed changes in Nash Bank were transient and a likely response to varying wave and tidal conditions rather than a result of the aggregate dredging. Consequently, using results from the monitoring programme, it was never found necessary to implement changes to the planned dredging campaign in any year of the extended licence. The beach surveys often showed rapid variations in beach cross-sectional area since 1993 but these appear to be healthy at the time of the latest survey. Long-term trends indicate a slight decline in the summed beach areas along the whole stretch of coastline between Dunraven and Kenfig. However, these trends are not statistically significant and do not help explain these fluctuating beach levels. Furthermore, the short-term trends over the last 3-years of the monitoring indicate that the summed beach areas are presently stable or increasing following a significant and sudden decline in the early part of 2007. This seems likely to have been a result of severe weather conditions, although no correlation with the corresponding hydrodynamic
Area licence number	376/378/380	
Licence period	2003 to February 2010	
Baseline survey	None available	
Operational surveys	2008-2010	
Substantive review reports	2010	
Post dredge surveys	None available	

Licence information		Comments
		conditions has been undertaken. Surveys of the sandy nearshore seabed between Nash Point and Ogmore, Figure 5.2, indicate the nearshore levels have not decreased between 1996 and 2010, and support the beach profile data in the conclusion that the dredging on Nash Bank has not caused any adverse effects along the adjacent coastline. One of the main concerns about the dredging on Nash Bank has been that its crest could become lower, thus reducing its effectiveness as a natural breakwater for the coastline west of Nash Point. The average crest height of Nash Bank to the east of the dredging area has remained high, i.e. above the Threshold Values since 1993, and does not show any downward trend. Hence, based on this analysis of the bathymetric data, the effectiveness of the bank as a natural breakwater for the coastline in its lee has not been reduced. Most importantly, the results from all the annual reviews of the monitoring data at Nash Bank between 2003 and 2010 show that, with the exception of the areas enclosed by the -5 m and -10 m CD contours, there have been no significant changes in the morphological indicator values over this period. During this time, over 4.5 million tonnes of sand have been dredged from Nash Bank, and there has been no indication from the analyses of the bathymetric and topographic data of any adverse effects either on the beaches of Swansea Bay or on the nearshore seabed levels between Nash Point and Ogmore.

Note: Information derived from reports listed in Section 5.2.1

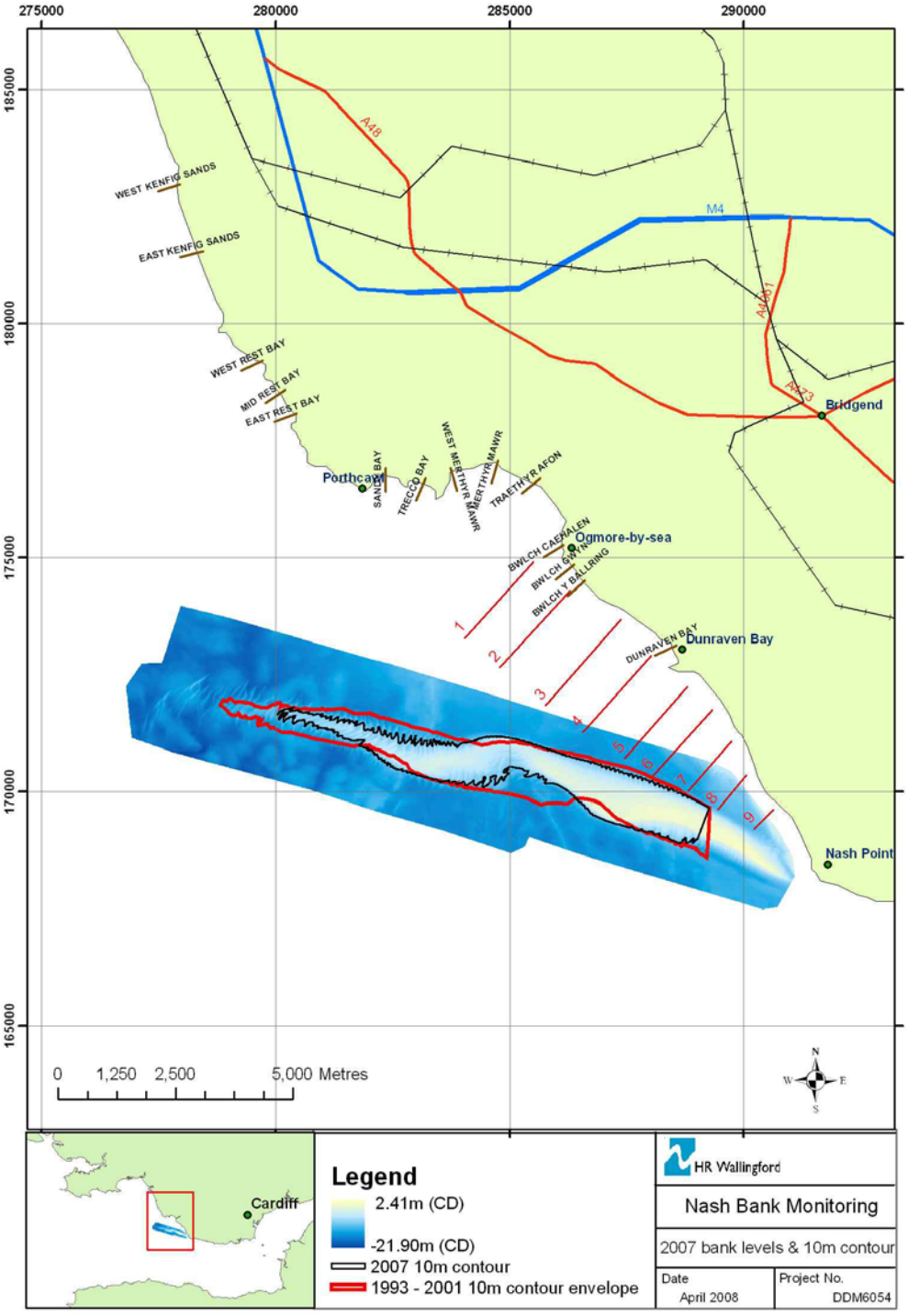

Figure 5.2: Locations of Nash Bank, Nash Point and Ogmore

Source: HR Wallingford Report EX5790

5.2.1. Reports reviewed

The following reports were reviewed for information concerning dredging effects on the coast:

- Nash Bank Coastal Monitoring Surveys 2008/09, (Gardline Environmental, 2008 (a));
- Nash Bank Coastal Monitoring Survey 2008, (Gardline Environmental, 2008 (b));
- Nash Bank Coastal Monitoring Surveys 2009, (Gardline Environmental, 2009 (a));
- Nash Bank Seabed monitoring survey, Spring 2010, (Gardline Environmental, 2010);
- Nash Bank Seabed Monitoring Survey 2009 Report, Summer 2009, (Gardline Environmental, 2009 (b));
- Nash Bank Coastal Monitoring Surveys 2009, December 2009, (Gardline Environmental, 2009 (f));
- Nash Bank Seabed Monitoring Survey Winter 2008-2009, (Gardline Environmental, 2009 (c));
- Nash Bank Environmental Assessment for aggregate extraction from Nash Bank Bristol Channel;
- Nash bank Coastal Monitoring Survey Autumn 2009, (Gardline Environmental, 2009 (d));
- Analysis of beach and seabed levels (2003-2010). HR Wallingford Report EX6333_R3, (HR Wallingford, 2010 (b));
- Nash Bank Production Licence - Review of Survey Data, 1999, (HR Wallingford, 2000);
- Dredging on Nash Bank: Application for continued extraction. Coastal Impact Study, (HR Wallingford, 1999 (b));
- Nash Bank Production Licence - Review of Survey Data, (HR Wallingford, 1999 (a));
- Nash Bank Production Licence - Review of Survey Data 1988 to 2000, (HR Wallingford, 2001 (a));
- Nash Bank Production Licence - Review of Survey Data 1988 to 2001, (HR Wallingford, 2002);
- Nash Bank Dredging Licence Extension: Analysis and reporting beach and seabed levels - Setting Thresholds, (HR Wallingford, 2005 (a));
- Nash Bank Dredging Licence Extension: Analysis of beach and seabed levels (2002-2003), (HR Wallingford, 2005(b));
- Nash Bank Dredging Licence Extension: Analysis of beach and seabed levels (2004), HR Wallingford, 2005 (c));
- Nash Bank Dredging Licence Extension: Analysis of beach and seabed levels (2005), HR Wallingford, 2006 (a));
- Nash Bank Dredging Licence Extension: Analysis of beach and seabed levels (2006), HR Wallingford, 2008 (a));
- Nash Bank Dredging Licence Extension: Analysis of beach and seabed levels (2007), HR Wallingford, 2008 (b));
- Nash Bank Dredging Licence Extension: Further analysis of monitoring data(2007/2008), (HR Wallingford, 2008 (c));
- Nash Bank Dredging Licence Extension: Analysis of beach and seabed levels (2008), (HR Wallingford, 2009);
- Nash Bank Dredging Licence Extension: Analysis of beach and seabed levels (2003-2010), (HR Wallingford, 2010 (b)).

5.2.2. Conclusions

The analysis carried out on the data collected as part of the operational and baseline monitoring has indicated that the dredging activities have not affected the local beaches. The changes observed, between the –5 m and -10 m contour reflecting a shortening of the western extent of the bank, have not had a significant impact on the morphology of the bank and are possibly due to the dynamics of the sandbank. The average bank crest height has not changed.

5.3. Area 377/379/381: Holm Sands

Table 5.3: Holm Sands summary

Licence information		Comments
Site name	Holm Sands	Four bathymetry reports are available with data from the first three years only, there are no data available for 2012. An analysis of the bathymetry data collected in 1993, 2000, 2001 and 2002 was carried out to monitor and assess the sea bed level changes in the licencing area. The years were chosen to ensure that both longer term and short term changes were discernible. It was concluded that whilst there were increases in depth in the area of most intensive dredging, there was little or no change in the areas of less intensive dredging and outside the licence area.
Area licence number	377/379/381	
Licence period	February 2013 to 30 April 2014	
Baseline survey	No information	
Operational surveys	Bathymetry surveys: 2008, 2009, 2010 and 2012	
Substantive review reports	2002	
Post dredge surveys	No information	

Note: Information derived from reports listed in Section 5.3.1

5.3.1. Reports reviewed

The following reports were reviewed for information concerning dredging effects on the coast:

- Area 377/379/381 (Holm Sands) Annual Bathymetric Monitoring Survey, 2008, (Gardline Environmental, 2008 (c));
- Holm Sands Annual Bathymetric Monitoring Survey December 2010, (Gardline Environmental, 2009);
- Area 377/379/381 (Holm Sands) Bathymetry Report 2009, (Gardline Environmental, 2009 (e));
- Area 377/379/381 (Holm Sands) Bathymetry Report 2012, (Gardline Environmental, 2012 (a));
- Analysis of 1993, 2000, 2001 & 2002 Bathymetric Data Sets 2002, (Resource Management Association, 2002);
- South West Region. A Review of Physical Impacts from Aggregate Dredging to 2013.(HR Wallingford, 2010).

5.3.2. Conclusions

The review of data carried out in 2002 concluded that whilst there were increases in depth in the area of most intensive dredging, in the areas of less intensive dredging and outside the licence area there was little or no change in the water depth.

Area 377/379/381 is in deep enough water and sufficiently far from the shore such that there is no likely interaction with the coastline. The increase in suspended solids concentration arising from dredging in the area will be negligible, except possibly within a few hundred metres of the dredging activity and, on this basis, changes to the nature of the seabed from sediment released from the aggregate dredging are also likely to be negligible.

It cannot be ruled out that analysis of the bathymetry data for 2008-10 (and 2012 if available) may provide some indication of changes, however, this is outside the scope of this study.

5.4. Area 385: West Middle Ground

Table 5.4:West Middle Ground summary

Licence information		Comments
Site name	West Middle Ground	Cemex UK Ltd – Under the terms of the expired licence the total quantity of material that could be extracted over the duration of this Licence was 312,500 tonnes at a rate not exceeding 250,000 tonnes in any calendar year.
Area licence number	385	
Licence period	15 February 2013 to 30 April 2014	
Baseline survey	Some limited data available from Velegrakis 2001	
Operational surveys	(indirectly through monitoring for Area 470) 2005	
Substantive review reports	2010 and (indirectly through monitoring for Area 470) Reviews from 2011 to 2015	
Post dredge surveys	(indirectly through monitoring for Area 470) 2011 to 2015	

Note: Information derived from reports listed in Section 5.4.1

5.4.1. Reports reviewed

The following reports were reviewed for information concerning dredging effects on the coast:

- South West Region. A Review of Physical Impacts from Aggregate Dredging to 2013.(HR Wallingford, 2010(a)).
- Area 470 (North Bristol Deep), Review of monitoring data (2014/2015). (HR Wallingford Report HR Wallingford, 2015 (a)).

5.4.2. Conclusions

The most recent licence only permitted dredging for 14 months between 15 February 2013 to 30 April 2014. However, the most recent dredging took place in 2009.

As Area 385 is situated on the flank of a sandbank which separates it from the shoreline there is no possibility of dredging at the site causing draw-down of the beaches along this coastline.

In the wider South West region it is reported that the direct impacts of dredging are limited to be within the footprint of the licenced areas with possibly some fringe effects at the site boundaries and that any changes to tidal flows and wave conditions along the coastline would be negligibly small. There is no evidence to suggest that aggregate dredging will have any impact of the naturally occurring sediment regime of the Severn Estuary nor that dredging will affect seabed levels outside of the area being dredged. This is borne out by the results of monitoring for Area 470 which includes the West Middle Ground Licence Area, and the area that would be affected by dredging at West Middle Grounds.

5.5. Bedwyn Sands

Table 5.5: Bedwyn Sands summary

Licence information		Comments
Site name	Bedwyn Sands	Only the Bedwyn Sands Environmental Statement 2015 was available for review, but the analyses in the document were based on data collected as part of the monitoring requirements for the previous licence periods (2006 and 2014). The report concluded that: • Sediment drawdown was insignificant. • The reduction in shelter by the banks was insignificant. • The changes to the tidal regime were insignificant. • The changes to the wave regime were insignificant. • The changes to sediment transport were insignificant. • The cumulative effects from multiple dredging sites was insignificant. • The direct impact of extracting sediment from Bedwyn Sands and the effect of the dredging is considered minor adverse on Bedwyn Sands.
Area licence number	Not given	
Licence period	April 2008 to June 2015	
Baseline survey	Not mentioned in Licence	
Operational surveys	None available	
Substantive review reports	None available	
Post dredge surveys	None available	

Note: Information derived from reports listed in Section 5.5.1

5.5.1. Reports reviewed

The following report was reviewed for information concerning dredging effects on the coast:

- Bedwyn Sands Environmental Statement 2015.(ABPMer, 2015).

5.5.2. Conclusions

Whilst there are no substantive reports, presenting analysed data for this location, the Environmental Statement for the new dredging licence application for Bedwyn Sands provided analysis of data from the previous licence period. The Environmental Statement concludes that the impact will be insignificant except for the direct impact on Bedwyn Sands itself which will be 'minor adverse'. However there is no monitoring evidence provided to assess whether dredging is having an effect beyond the licence area.

5.6. Area 382 Cockburn Shoal and Area 391 Denny Shoal

There are no reports available for Area 382 Cockburn Shoal or for Area 391 Denny Shoal. The Cockburn Shoal licence was granted in1991 and relinquished in 1998. The licence for Denny Shoal were granted in 1991 with no fixed term and it is understood that the site was last dredged in 2012.

6. Summary of monitoring data reviewed

None of the reports reviewed for this study have indicated that there has been any change to the surrounding areas caused by the dredging activities. For the sites where substantive reports are available, the evidence suggests that the dredging of the areas has not affected the local beaches, the hydrodynamic conditions or the overall sediment transport of the area around the dredge site. Sites that fall into this category are:

Active sites

- Area 457: Liverpool Bay;
- Area 470: North Bristol Deep;
- Area 472: Culver Sands;
- Area 476: Nobel Banks;
- Bedwyn Sands.

Inactive sites

- Area 376/378/380 Nash Bank;
- Area 373: Helwick Bank;
- Area 377/379/381: Holm Sands.

Inactive sites that have shown no sign of change, but for which there is additional monitoring data that could be analysed include:

- Area 373: Helwick Bank;
- Area 377/379/381: Holm Sands.

The Environmental Statement for Area 392/393: Hilbre Swash stated that there would be no effect from dredging operations, however the site has not been operational for a long enough period, under this licence, to have any data collected to confirm this.

It has not been possible to draw any conclusions for the sites listed below as there are insufficient data available:

- Area 382 Cockburn Shoal;
- Area 391 Denny Shoal;
- Area 455/459: North Middle Ground, although this area was covered by the monitoring surveys for Area 470. Monitoring data for this site is understood to be available but was not provided.

It is expected that any risk of significant change to a licenced area would be managed within the licencing regime. Any significant changes highlighted through the site-specific monitoring programme would have flagged more detailed consideration and potentially remedial action. This review has not detected any significant changes that would trigger such remedial action.

7. Review of latest scientific literature

7.1. Introduction

There is very little scientific literature regarding the effects of dredging in Welsh waters on suspended sediment concentrations, or substrate or habitat or biological communities. This contrasts with dredging areas in English waters where there is a considerable seam of literature considering the sedimentological or biological impacts of aggregate dredging. This lack of focus of the effects of dredging on the sedimentary and biological regimes at the dredging sites is likely to be due to the high sediment mobility of many of the sites and the general (natural) impoverishment of the fauna.

Instead, research and monitoring efforts have historically tended to concentrate on the potential effects of dredging on the shoreline – mostly driven by specific concerns regarding Nash Bank and Helwick Bank, but also by concerns that sand banks in the Severn Estuary would not be denuded and afford less protection to the coastline.

Most of the Welsh aggregate dredging areas lie within the Bristol Channel and Severn Estuary system and as such they exist within a complex sediment transport system which is continually being studied and where the knowledge base is being gradually improved. Section 7.2 presents a brief overview of the current state of literature on sediment transport processes within the wider Bristol Channel and Severn Estuary.

7.2. Summary of recent literature on sediment transport within the Bristol Channel and Severn Estuary

7.2.1. Sand transport in the Bristol Channel and Severn Estuary

The sand transport within the Bristol Channel is characterised by tidally driven westward net transport in the middle of the channel and by eastward net transport at the shallower margins, driven by a combination of wind, wave and tidal currents (Hamilton, 1973; Heathershaw and Hammond, 1980; Uncles, 1982; Collins and Ferentinos, 1984; Pye and Blott, 2009; Posford Duvivier and ABP Research Consultancy, 2000; Harris and Jones, 2005; Mackie et al, 2006).

Between Cardiff and Bridgwater there is a zone of divergence in the bedload transport. In broad terms - to the east of this zone transport is predominantly north-east into the Severn Estuary and to the east of this zone transport is predominantly westward, Figure 7.1. This concept of the zone of divergence is useful and has a geophysical and numerical modelling basis but should be seen as something of an over-simplification, as storm-driven transport also exists at the margins (Harris and Collins, 1984; Harris and Jones, 2005; Posford Duvivier and ABP Research Consultancy, 2000). Clockwise transport is driven by a combination of tidal, wind and wave processes around the sand banks of Helwick Bank, Nash Bank and Scarweather Bank (Pye and Blott, 2009; Posford Duvivier and ABP Research Consultancy, 2000; HR Wallingford, 2003; Mackie et al, 2006).

Within the Severn Estuary there is general up-estuary sand transport driven by tidal asymmetry and accompanied by a fining of the mean grainsize. However, on the English side of the estuary there is net seaward transport (see Figure 7.2, Parker and Kirby, 1982; McLaren et al, 1993; Otto, 1998; HR Wallingford, 2003).

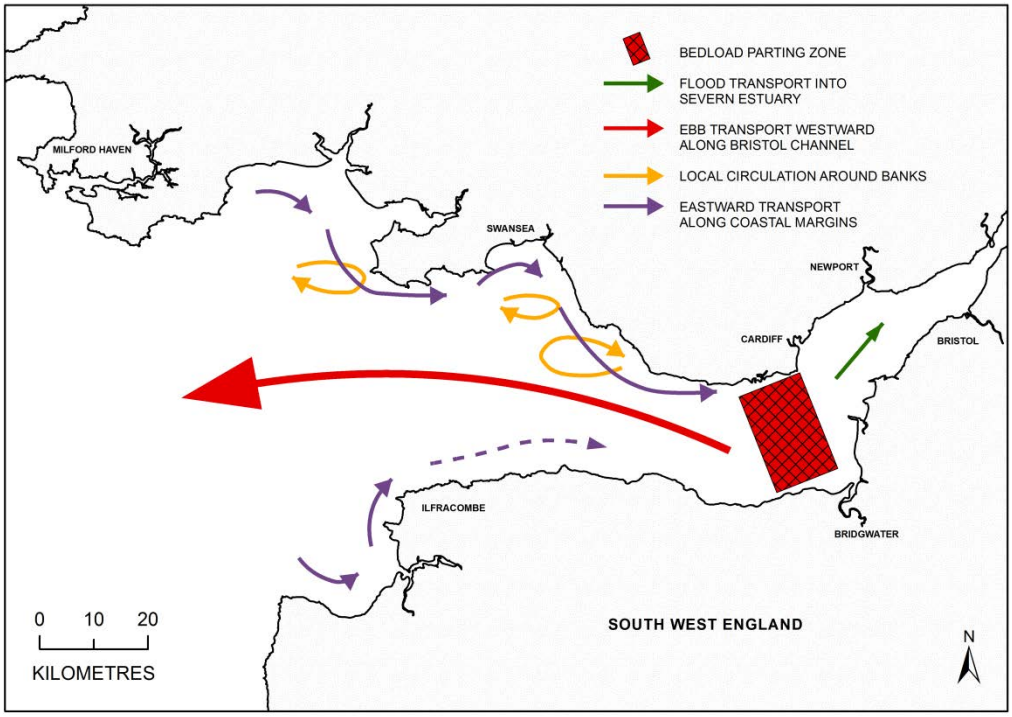

Figure 7.1: Summary of sediment transport pathways in the Bristol Channel

Source: Based on Mackie et al (2006)

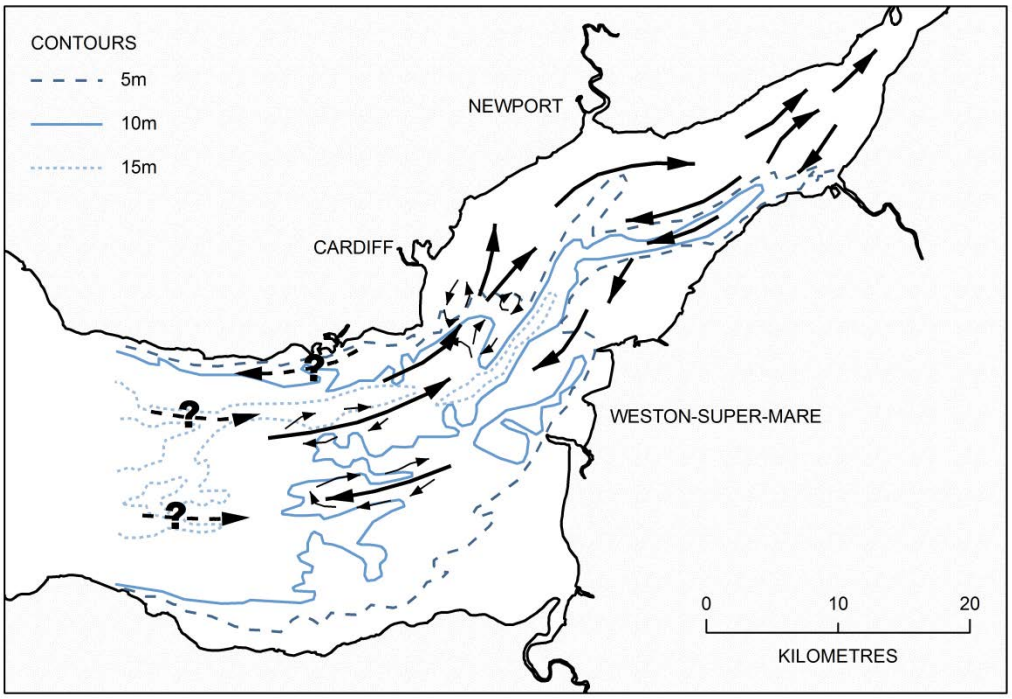

Figure 7.2: Sand transport pathways in the Inner Bristol Channel and Outer Severn Estuary

Source: Based on Otto (1998); Parker and Kirby (1982)

7.2.2. Cohesive sediment transport in the Severn Estuary

The Severn Estuary system is one of the largest estuaries in Europe and is characterised by an extreme tidal regime. This regime is partly caused by its funnel-shape which both amplifies the tidal range at the head of the estuary and enhances the tidal asymmetry (Friedrichs and Aubrey, 1994; Friedrichs et al, 1998; DECC, 2009a). The extreme tidal regime means that a very large mass of fine sediment (which may exceed 30 M tonnes, Kirby, 1986) can be mobilised on spring tides. The inputs from river sources or cliff erosion are small in comparison, and the contribution from marine sources is unknown. It is likely that this very large mass of sediment is chiefly kept in place by the landwards directed tidal asymmetry on the one hand and seawards directed diffusion (which acts in the opposite direction to the concentration gradient) on the other DECC (2009a).

The sediment contribution from marine sources is considered to be small by Kirby (1988) but, as noted by Inglis and Allen (1957) in the case of the Thames Estuary, the Bristol Channel is so large that even a 1 mg/l difference (which would be for all practical purposes immeasurable) between flood concentrations and ebb concentrations in the Inner Bristol Channel would represent a large input of sediment to the Severn Estuary.

The Severn Estuary has a positive landward concentration gradient which varies from typical spring tide peak concentrations (HR Wallingford, 1981) of around 10-20 mg/l in the Outer Bristol Channel, around 100 mg/l near Watchet, a few hundred mg/l at Flat/Steep Holm, rising to several kg/m^3 (depth-averaged) in the upper estuary (DECC, 2009a). The main turbidity maximum is at the head of the estuary but there is a second turbidity maximum in the vicinity of Bridgwater Bay (Manning et al, 2010). Suspended sediment concentrations can be several kg/m^3 at peak flood tide but near bed concentrations at slack water can be tens of kg/m^3 (Manning et al, 2010) – i.e. can form layers of fluid mud, especially in Newport Deep and Bridgwater Bay (Kirby and Parker, 1980).

7.2.3. Morphodynamic change in the Severn Estuary

HR Wallingford (2015c; 2015d) recently undertook an unpublished study to update the understanding of the baseline evolution of the intertidal morphology of the Severn Estuary through compilation and analysis of the latest information and modelling work. This study analysed recent LiDAR measurements of the intertidal evolution of the Outer Severn Estuary (several data sets between 2007 and 2014) and compared the results of this analysis against evidence from 19th and 20th century surveys, geomorphological features, archaeology, geomorphological theory and other contemporary measurements of intertidal change.

The short-term LiDAR evidence indicates overall accretion (DECC, 2009b; HR Wallingford 2015c), while the long-term evidence indicates a clear signal of continued erosion since before Roman times (Allen, 1990; Kirby, 1989; Ravensrodd Consultants, 1996; Pye and Blott, 2010; DECC, 2009b). These two, apparently contradictory, trends were reconciled by studying the trends in wave action in the Severn, and UK trends in wind climate generally, prior to and throughout the period covered by the LiDAR. The recent period of LiDAR measurement coincides with a period of relatively low wind and wave activity.

7.3. Areas with active dredging licences

7.3.1. Area 392/393: Hilbre Swash

Aggregate dredging has taken place at Hilbre Swash in this area since 1959. The current licence commenced in 2014. Other than studies to support applications there has been little or no research into the effects of dredging at Hilbre Swash or on the coastline.

7.3.2. Area 455/459 North Middle Ground

North Middle Ground and Welsh Ground consists of well sorted fine-medium grained sand currently used as building sand (WAG, 2004). Sandbanks of the Middle and Welsh Grounds are mobile but permanent features, characterised by impoverished benthic communities (Mettam et al. (1994) and Warwick et al., (2001). The banks are exposed to strong tidal currents, which sort the sediments on the Bedwyn Sands, thus producing a commercially exploitable deposit (HR Wallingford, 2003). North Middle Ground is at the up-drift end of an active sand transport pathway through the Severn Estuary, a process which is driven by the flood dominant tide and at times enhanced by prevailing south-westerly winds and waves (Parker and Kirby, 1982; McLaren et al, 1993; ABPmer, 2015). There is no apparent linkage in sediment transport to the muddier areas on the leeward side these banks (HR Wallingford, 2003). Analysis of available historic charts (Velegrakis et al, 2001) demonstrated that North Middle Ground is remarkably stable in position and level.

A survey conducted in 2005 (Henderson *et al*., 2006) found Middle Ground Sands to be highly impoverished with almost no benthic fauna recorded. Stations within the Licence Renewal Area were characterised by sand habitat with a very low number of taxa and organism abundance. This would be expected, as tideswept, sand environments have limited food availability and are typically characterised by a species poor, macrofaunal community consisting mainly of epistrate or mobile opportunistic predators. Mettam (1997) also either recorded no fauna or sand habitat characterised by a very sparse fauna in the Middle Ground area. This impoverished benthic community precludes Middle Ground from being a nursery for Sole, Sea Bass or any other commercial fish species (Cefas, 2000).

7.3.3. Area 457: Liverpool Bay

The current licence commenced in 2014. Other than studies to support applications there has been little or no research into the effects of dredging at Area 457. The potential for coastal impacts to arise from the dredging is reduced because of the distance offshore and the relict nature of the resource which has no connectivity with the beaches along the Sefton Coastline (HR Wallingford, 2007).

7.3.4. Area 470: North Bristol Deep

Area 470 (North Bristol Deep) is situated in the lower Severn Estuary, approximately 5.5 km north-west of Clevedon and 9 km to the south of Newport. It is sub-divided into two blocks, which cover an area of approximately 0.43 km² and 0.04 km², respectively.

Much recent effort has gone into the monitoring of bathymetric changes in the vicinity of North Bristol Deep to ensure that that the dredging at this location does not compromise the integrity of the Middle Grounds as a sand bank SAC feature or cause adverse impacts on the shoreline (See Section 7.3.2). These studies, which encompassed an area including that of North Bristol Deep, Welsh Grounds, West Middle Grounds,

Bedwyn Sands and the stretch of the coastline between Newport and the Severn Crossing, have indicated that there is no indication of major changes landwards of these dredging areas over the monitoring period.

Currently accretion of the seabed is found in the deep water adjacent to the dredging area due to the formation of a shoal area and the sand bank is continuously (naturally) migrating shorewards. This means a subtidal channel is growing just to the north of the dredging areas between the shoal area and the toe of the sand banks (HR Wallingford, 2015).

In common with other aggregate dredging areas (North Middle Ground and Bedwyn Sands) benthic surveys in the vicinity of North Bristol Deep indicate that this area has an extraordinarily impoverished fauna (Warwick et al, 2001).

7.3.5. Area 472: Culver Sands

Culver Sands is located mid-way between the English and Welsh coasts and is a 'wake' feature created in the lee of the island of Steep Holm (HR Wallingford, 2001b). It is an isolated sandbank (overlying rocky sea bed) of well-sorted medium grained sands. Analysis of bedforms suggests a clockwise circulation around the bank (NAW et al, 2000). The sandbank is mobile and is steadily moving westwards as shown from historic charts (Ravensrodd Consultants Ltd., 1996; HR Wallingford, 2003; EDF, 2010; Kirby, 2010). Kirby (2010) further describes Culver Sands as '*diminishing rapidly in size, hastened by aggregate removal*'. Symonds Group (2002) agreed that Culver Sands is away from any natural sources of replenishment, concluding that its isolation form nearshore sand bodies would effectively preclude any consequential impacts on the coastline. HR Wallingford (2001b) agreed with the broad thrust of the Symonds Group conclusion but noted that '*the possibility of occasional and limited sediment exchange during storms cannot be ruled out*'.

7.3.6. Area 476: Nobel Banks

Nobel Banks lies 6 miles south west from Worms Head, Gower. In this area numerous 2 km to 5 km long sandwaves occur, orientated north to south. The ridges are between 500 m and 2000 m apart, ranging in height between 8 m and 16 m. The ridges are largely immobile with the exception of a surface layer of mobile sand (ERM, 2002).

Llanelli Sand Dredging Ltd. was granted a licence to dredge Nobel Banks in 2006, following a Public Inquiry. The conclusion of the inquiry agreed with the previous report by the Symonds Group Report (2002) which suggested that dredging at the Nobel Banks would have localised effects on sediment transport but that these would be barely detectable (if at all) at the coast and would also be buffered by the very large sediment storage capacity of Carmarthen Bay.

The focus of investigation into the Nobel Banks prior to the Public Inquiry centred on the issues of the potential effects of dredging on the coastline, in common with interest in Helwick Bank and Nash Bank. Since dredging started the focus has moved more to changes in substrate and biology at the site itself - the evidence for which is summarised in Section 4.6. In addition to the dredging monitoring, a study which focused on the processes occurring within the sand wave field in the Nobel Banks, is *The Outer Bristol Channel Marine Habitat Study* (Mackie et al, 2006). The Outer Bristol Channel Marine Habitat Study was a multifaceted project involving scientific investigation, interpretation and education in an area with potential marine aggregate resources. Surveys in this project obtained data on obtained on five geophysical and biological research cruises (2003-2005). As part of the study the characteristics and geology of the Nobel Banks region was examined in detail. In particular the nature of sand waves and the mega-ripples over-lying

them, was examined. This identified that there were bedform structures moving both westwards and eastwards in the sandwave field appearing to show equilibrium. Mackie et al concluded:

> *"Although sand ripples and megaripples indicate that sediment within the top 0.5 to 1.0 m surface of the sand wave is mobile their opposing alignments suggest that the overall structure and position of the large sand wave is being maintained by the interaction of ebb and flood currents – i.e. that the large sand waves are not moving westward under the influence of the ebb tidal dominance but are in a state of in situ equilibrium. A comparison of bathymetric data collected in 1977 and 2003 indicates that the large sand waves in the Nobel (and Sobel) Sands have remained stable during this 26 year period. It would be expected that in a dynamic system, such as the Outer Bristol Channel, some indication of sand wave migration would be evident. The fact that the available evidence is that the large sand waves are stable suggests a further conclusion – that there is little or no mobile sediment being introduced into the sand wave field from the east*."

HR Wallingford (2015, unpublished) considered this evidence together with older and more recent evidence regarding the movement of the Nobel Sand waves (Harris et al., 1986; Davies, 2001; HR Wallingford, 2002; Posford Duvivier and ABP Research, 2000; Davies, 2011; ERM, 2013) including a comparison of the 2006 and 2014 surveys not available to the previous studies. HR Wallingford concluded on the weight of the evidence that:

- The bulk of the sand contained in the large sandwaves is slowly migrating west at a few metres a year, retaining their shape as they move; and
- A blanket of sand of thickness about 1 m moves actively over them in response to tidal currents, partly through migration of the mega-ripples.

The biological data collected in The Outer Bristol Channel Marine Habitat Study is considerable and is not discussed in detail here. A follow-up paper (James et al, 2012) noted that while, in general, gravel areas were found to support more species than sandy areas in the Outer Bristol Channel area surveyed, this was not found to be the case in the gravelly and sandy-gravelly substrates within the Nobel Banks area, a result thought to be caused by the sand mobility which restricts the development of rich infaunal and epifaunal assemblages usually found in more stable gravelly areas. The gravelly areas of the Nobel Banks to the south where sand is less abundant, were found to have the highest species richness and epifaunal abundance. Overall, the strongest relationships between sediment parameters and biology were obtained with the parameters of sand content, mud content and water depth.

7.4. Areas with relinquished dredging licences

7.4.1. Area 373: Helwick Bank

Helwick Bank is a headland-associated bank extending for around 15 km westwards from Port-Eynon Point. The submerged bank is divided into two shallower crest, forming East and West Helwick, separated by the slightly deeper central Helwick Swatch (HR Wallingford, 1997). The bank is around 13 km long and 750 m wide at the -10 mCD contour (NAW et al, 2000).

Dredging was undertaken at East Helwick between 1964 and 1990 and from Helwick Swatch after 1993. A further licence was granted for the extraction of 200,000 tonnes/year from Helwick Bank between 1998 and 2003. When this licence expired, Llannelli Sand Dredging Ltd. applied for a further licence for 15 years. Due to significant public concern about the potential effects of the dredging on the neighbouring Gower coastline

a Public Inquiry was held to examine the evidence regarding the potential impacts of the proposed Licence Extension. A summary of the inspector's conclusions (NAW, 2006) is presented in Halcrow (2012):

- Taking all the bathymetry evidence into account, the inspector's report concluded that the data showed a sand bank that is subject to natural variation, but that there was no evidence that dredging operations have had any harmful effect on the topography of the bank. The inspector did, however, conclude that the impact on the topography of the bank of a significantly increased rate of dredging could not be predicted with any confidence.
- It is now acknowledged that there is a link, albeit fairly weak and involving small volumes of sediment, between East Helwick area (eastern part of Helwick Bank) and the adjacent beaches, such that sediment can be transported between the bank and nearby beaches.
- In terms of impacts on the beaches of Gower, the Inspector was, however, satisfied that, with the exception of Port-Eynon beach, the beach surveys show no long-term deterioration of the beaches in terms of sand loss.
- At Port-Eynon and Horton it was considered that the long-term decline of the beaches is due to loss of sand to the dunes and the Inspector concluded that there is little evidence of harmful effects of dredging, despite the arguments of Gower Coalition that extraction offshore exacerbates the losses that occur as a result of natural forces. The report goes on to state that what evidence there is, supports the case for negligible effects.
- It was recognised that there may be a long term impact, i.e. after 50 years.
- In specific reference to the impacts upon the beaches of an increased rate of dredging, the Inspector's Report (NAW 2006) stated:

  "*I conclude that dredging at rates comparable with past operations would be unlikely to be detrimental to the retention of sand levels on the nearby beaches but that the absence of evidence on the effects of higher rates prevents me drawing any confident conclusions for that scenario. Consequently, and bearing in mind the importance of maintaining the high quality of the beaches, I consider it would be prudent to refuse dredging at significantly higher rates*".
- The proposal (appropriately limited in terms of the maximum extraction rate and subject to monitoring and control conditions) would be in accordance with the policy aims of WAG's national policy on marine aggregates dredging.

The licence for Helwick Bank was granted subject to an extensive pre-dredge biological survey. Llanelli Sand Dredging Ltd. relinquished the licence to focus on dredging at Nobel Bank.

During and since this time there have been further analysis of bathymetric surveys taken between 1991 and 2002. Schmitt (2006) examined two multi-beam surveys at Helwick Bank from 2001 and 2002. His analysis found the following:

- Steep sand dunes are found along the flanks of the bank, while in places flatter sand dunes occur near the crest. This is interpreted as the result of stronger asymmetrical tidal current carrying sand predominantly as bedload, along the flanks and the combination of tidal currents (reaching the upper flow regime over the crest) with wave-induced currents at the crest, inducing stronger erosion and enhancing suspended sand transport.
- Sand dunes laterally connect over the crest of Helwick Sands and have symmetrical profiles, even though dunes on opposite flanks migrate in opposite directions. The elongation and connection of the sand dunes across the bank is primarily explained by the orientation of the average wave propagation which is almost exactly parallel with the dunes crest.

- The residual tidal current eddy on the lee side of the headland was considered insufficient by itself to maintain the Helwick Bank system. Multiple mechanisms involving the generation of transient eddies system in the flow, bottom friction caused by the topography of the banks and across-bank wave-induced current must be considered. Morphological and sand dynamic evidence found in the data support the presence of these processes.
- Over the period studied (2001-2003), East Helwick Sands have been moderately stable features. The bank parallel components of the sand budget determined from dune tracking are roughly balanced and support the concept of dynamic equilibrium.
- Based on long term (decadal) changes in the morphology of Helwick, it has been shown that the bank has remained at stable distances from the coast. A plan view sinuosity of the bank was found to migrate. It is believed that bathymetric instabilities, originating as deposition/erosion patterns near the headland, propagate along the transport path parallel to the bank.

In further analysis of the same data Schmitt et al., (2007) considered the sediment transport mechanisms leading to the connectedness of dunes travelling in opposite directions on either side of Helwick Bank. They found evidence for three contributory processes: first, dune crests deform or bend, due to the gradient of the clockwise circular net residual current along the sandbank; second, they split or break laterally; and, third, re-join with another crest. It was speculated that the latter may be encouraged by along-dune crest sediment transport driven by surface waves. This conclusion was supported by Schmitt and Mitchell (2014).

Lewis et al (2015) examined an 11 year record (1991-2002) of bathymetric surveys at Helwick Bank (and Nash Bank). They found that the volume of Helwick Bank also decreased over an 8-year period, but at a rate six times greater than the loss due to dredging. Significant inter-annual variability of sand bank morphology was calculated and was found to correlate well to the effective wave climate, in the case of Helwick Bank there was a negative correlation with storm activity, the bank diminished in storm conditions. It was proposed that the inter-annual variability within storm wave events could be responsible for the observed natural variability of sand bank volume and morphology observed. As regards the net trend of evolution of Helwick Bank, the Lewis et al assessment (which was based on 1991-2002 data) has been superseded to some extent by the subsequent bathymetric surveys undertaken in 2003 and 2004 and the analysis of Davies (2005, see Section 5.1). These bathymetry surveys and analysis showed a ‘steady state’, i.e. no change in the overall sediment budget. Moreover the Davies analysis indicated no connectivity between the bank and Port Eynon beaches.

More recently, numerical modelling of sediment transport over the bank by Fairley et al (2016) found that under purely tidal conditions at Helwick Bank there is erosion on the southern flank and accretion on the crest and northern flank. Under storm events the change is the opposite direction to the tide-only case with accretion on the southern side of the crest and erosion on the northern side.

7.4.2. Area 376/378/380: Nash Bank

Nash Bank extends north-westward from Nash Point (south of Porthcawl) and features medium sand surrounded by sandy gravels. The bank is composed of three parts: West Nash, Middle Nash and Nash Sands (or East Nash). The bank extends for 13 km with a maximum width at the -10 mCD contour of 1.5 km. The south eastern end of Bank (East Nash) is separated from the shoreline by a 300 m wide, deep channel known as Nash Passage (Halcrow, 2012). The bank is understood to provide protection to the coast between Nash Point and Ogmore-on-Sea but studies by HR Wallingford (1992) found that any such protection is limited to periods around low water and that the protection afforded by the bank at high water levels was negligible.

Similar concerns were raised regarding the effects of dredging at Nash Bank on the coastline to those at Helwick Bank. A study (Symonds Group Limited, 2002) was undertaken to inform the development of the Welsh Governments Interim Marine Aggregates Dredging Policy (2004). The main conclusions of the 2002 study are summarised below:

- The clearest increase in sustainability would be achieved by a gradual shift of dredging operations from inshore areas (particularly Nash Bank) to other areas further offshore and/or further west.
- There is evidence of sediment transport links between offshore sandbanks within some parts of the Bristol Channel and the beaches of South Wales. The links are generally weak, however, and do not imply that dredging will inevitably have impacts on the beaches. The exception was Nash Bank where Symons report stated that "*it is clear that dredging cannot continue indefinitely without eventually giving rise to localised impacts on the adjoining coast*".
- It was suggested that it would be prudent to phase out current operations over the next 5 to 10 years, through a staged reduction with dredging ceasing by February 2010.

The licence at Nash Bank has not been renewed following its lapse in 2010.

Although the trend through 1990-2000 was for the volume of Nash Bank to deteriorate at a rate higher than the rate of dredging, which contributed to the decision to eventually cease dredging at Nash Bank, the trend through 2000-2010 (as summarised in Section 5.2) has been for the bank to remain in equilibrium, albeit a very noisy one.

The studies by Schmitt (2006), Schmitt et al (2007) and Lewis et al (2015), as well as investigating dune processes around Helwick Bank, also examined the same processes at Nash Bank. The results and conclusions were very similar, including the correlation between volume and wave action at Nash Bank. In this case, unlike at Helwick Bank, a *positive* correlation was found between storm activity and sand bank volume. Numerical modelling by Fairley et al (2016) found that deposition/erosion was similar (though different in magnitude) under tidal and storm conditions (unlike at Helwick Bank) with accretion on the southern flank and erosion on the northern flank.

7.4.3. Area 377/379/381: Holm Sands

Holm Sands is the term used to collectively describe One Fathom Bank and Mackenzie Shoal. These deposits consist of coarse sands and sand/gravel mixtures up to 8 m thick. A large sandwave field covers the Holm Sand region (Posford Duvivier and ABP Research and Consultancy, 2000). Interpretation of sandwave transport by BGS (referred to but not referenced in Halcrow, 2012) and sediment trend analysis (McLaren et al, 1993) suggests flood dominant transport to the north of the bank and ebb transport to the south of the bank. The latter investigation also concluded that Holm Sands was in a state of equilibrium.

Symonds Group Limited (2002) suggested that Holm Sands is away from any natural sources of replenishment and that therefore its isolation from nearshore sand bodies would effectively preclude any consequential impacts on the local coastline. However, this implies a limited resource - the Interim Marine Aggregate Dredging Plan (2004) noted that with continued abstraction of sand the sand resource was becoming increasingly gravelly. Whilst the Holm Sand region did go through a Coast protection Act EIA compliance process in about 2012,dredging ceased at Holm Sands in 2014.

7.4.4. Area 385: West Middle Ground

As Area 385 is situated on the flank of a sandbank which separates it from the shoreline there is no possibility of dredging at the site causing draw-down of the beaches along this coastline.

In the wider South West region it is reported that the direct impacts of dredging are limited to be within the footprint of the licenced areas with possibly some fringe effects at the site boundaries and that any changes to tidal flows and wave conditions along the coastline would be negligibly small (HR Wallingford, 2010a). There is no evidence to suggest that aggregate dredging will have any impact of the naturally occurring sediment regime of the Severn Estuary nor that dredging will affect seabed levels outside of the area being dredged.

7.4.5. Bedwyn Sands

The Bedwyn Sands sandbank lies immediately upstream of the North Middle Ground. The bank is connected to the Welsh Grounds and is part of the same geomorphologic system. These banks lie within a 'sediment sink' of Holocene deposits where sand is the dominant material. The banks are exposed to strong tidal currents, which sort the sediments on the Bedwyn Sands, thus producing a commercially exploitable deposit (HR Wallingford 2003).

Bedwyn Sands is at the up-drift end of an active sand transport pathway through the Severn Estuary, a process which is driven by the flood dominant tide and at times enhanced by prevailing south-westerly winds and waves (Parker and Kirby, 1982; McLaren et al, 1993, ABPmer, 2015). There is no apparent linkage in sediment transport to the muddier areas on the leeward side of Bedwyn Sands (ABPmer, 2015, HR Wallingford, 2003). Analysis of available historic charts (Velegrakis et al, 2001) and more recent bathymetric surveys (ABPmer, 2015), and the monitoring being currently undertaken for Area 470 (see Section 4.4 and Section 7.3.4) demonstrate that Bedwyn Sands is remarkably stable in position and level. The results from the annual grab sampling surveys reveal that the majority of the sediment across the study area is classified as 'Sand' or 'slightly gravelly Sand', and little temporal variation is observed within the Licence Renewal Area (ABPmer, 2015).

A survey conducted in 2005 (Henderson *et al*., 2006) found Bedwyn Sands to be highly impoverished with almost no benthic fauna recorded. Stations within the Licence Renewal Area (were characterised by sand habitat with a very low number of taxa and organism abundance. This would be expected, as tideswept, sand environments have limited food availability and are typically characterised by a species poor, macrofaunal community consisting mainly of epistrate or mobile opportunistic predators. The CCW biotope mapping survey also recorded impoverished mobile sand communities over much of the Licence Renewal Area along with muddy sand habitat with a higher abundance of polychaetes and bivalves in the northern part of Bedwyn Sands (Brazier et al., 2007). Mettam (1997) also either recorded no fauna or sand habitat characterised by a very sparse fauna in the Bedwyn Sands area. This impoverished benthic community precludes Bedwyn Sands from being a nursery for Sole, Sea Bass or any other commercial fish species (Cefas, 2000).

8. Conclusions and Recommendations

8.1. Introduction

This review process has considered the data reports presently available for aggregate licence areas on the Welsh coastline. None of the reports reviewed for this study have indicated that there has been change to the adjacent coastline caused by the dredging activities. A review of available literature does not alter this picture.

These conclusions are based on monitoring outputs for the existing active licences, and do not relate to any new applications or renewals as this is outside the scope of the review.

The following additional conclusions and recommendations can also be drawn.

8.2. Need for additional wave modelling

Wave modelling is routinely undertaken as part of Coastal Impact Studies for new licence applications in Wales. These studies consider the cumulative effects of other existing licence areas. This system of examination of wave modelling in each Coastal Impact Study is considered sufficient to identify whether there are potential risks to the coastline from dredging.

The review of information in this report has not identified any additional issues that warrant further investigation through wave modelling.

It is therefore recommended that no additional wave modelling is required as a consequence of this review.

8.3. Significance of the evidence for decision-making

As the review has not identified any major issues relating to the impacts of aggregate dredging on the coastline, there is no evidence to suggest that previous decision-making on licences should be revisited.

The LiDAR monitoring for Area 470 North Bristol Deep also encompasses Area 455/450 and Bedwyn Sands. It therefore provides an evidence base for future decision-making for these areas in addition to Area 470 itself.

The monitoring programme at Area 476 Nobel Banks provides an evidence base that may prove useful for future decision-making, either at Area 476 or otherwise, where the effects of dredging on sandwaves may be important.

The review also highlights the important principle that long-term, consistent data sets are invaluable for the quality of future decision-making, especially the acquisition of coastal LiDAR data. LiDAR surveys should however only be required in connection with those marine aggregate extraction licences where there could be a plausible link between marine aggregate extraction and coastal processes. This may relate to the extension of existing licence areas, or the introduction of new areas.

8.4. Changes to monitoring requirements

In general, the current licensing procedure identifies where there are concerns about coastal effects, and establishes procedures for monitoring of individual banks or features. Where the risk requires it, the

monitoring approach is usually a tiered escalation of effort, and specific indicators are used to ascertain whether changes are within acceptable limits. This approach is in our view considered proportionate (assuming it is preceded by a robust Coastal Impact Study).

Where areas lie close to the coast and require monitoring it is important to collate, QA, and archive long term LiDAR (and any other similar data) sets. These data should also be made available for wider studies. This will require discussion and agreement with the dredging industry, where they own data collected outside the consenting process.

With advances in technology, updating monitoring specifications is usually necessary on a regular basis. A good understanding of the technological advances and the advantages of using the new equipment is necessary to ensure that the data collected are not only of better accuracy but are also comparable with previous surveys.

It is acknowledged that the focus on site-specific effort on Coastal Impact Studies, and then monitoring where appropriate, could be considered a piecemeal approach. Consideration should therefore be given to regional studies of marine aggregate extraction, if sufficient applications in the same general area come forward. This is the approach adopted in Southern and South-eastern England.

8.5. Gaps in our wider understanding of coastal processes

Although there is no evidence found in this review of a direct linkage between aggregate dredging and coastal change, there are gaps in our current understanding of coastal processes more generally. In particular, two technical areas that would benefit from additional study and thereby aid the interpretation of future monitoring data for coastal change are:

- Better understanding of long-term natural variability in coastal topography. This points towards the assembly and continuation of long-term coastal LiDAR data sets; and
- Improved understanding of natural sediment transport processes over the seabed in the Irish Sea and the Bristol Channel/ Severn Estuary.

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Appendix

A. Historical dredging information

Table A.1: The history of aggregate dredging licences issued and relinquished, 1991 - Present

Area No.	Name(s)	Company	Licensed from	Licensed to	Last Active	Total Reported Historic Extraction Tonnage	Annual Tonnage (Permitted) now *	Annual Tonnage (Permitted) @ 1991 *	Annual Tonnage (Permitted) @ 2000 *
392	Hilbre Swash	United Marine Dredging	1991	ongoing	ongoing	-	400,000	400,000	400,000
393	Hilbre Swash	Norwest Sand & Ballast Co	1991	ongoing	ongoing	-	400,000	600,000	600,000
455/459	North Middle Grounds	Severn Sands Ltd	2011	ongoing	ongoing	-	150,000	-	-
457	Liverpool Bay	Westminster Gravels	2010	ongoing	ongoing	-	1,200,000	-	-
470	North Bristol Deep	Hanson Aggregates Marine Ltd	2010	ongoing	ongoing	-	125,000	-	-
470	North Bristol Deep	Tarmac Marine Dredging Ltd	2010	ongoing	ongoing	-	125,000	-	-
472	Culver Sand Extension	CEMEX UK Marine Ltd	2008	ongoing	ongoing	-	333,300	-	-
472	Culver Sand Extension	Hanson Aggregates Marine Ltd	2008	ongoing	ongoing	-	333,300		-
472	Culver Sand Extension	Tarmac Marine Ltd	2008	ongoing	ongoing	-	333,300	-	-
476	Nobel Bank	Llanelli Sand Dredging Ltd	2006	ongoing	ongoing	-	300,000	-	-
373	Helwick Bank	Llanelli Sand Dredging Ltd	1993	2010	2005	1,101,387	-	-	150,000
376	Nash Bank	Hanson Aggregates Marine Ltd	1991	2010	2010	4,415,517		330,000	300,000
378	Nash Bank	British Dredging Ltd	1991	2010	2010	4,872,943	-	745,000	300,000
380	Nash Bank	Tarmac Marine Dredging Ltd	1991	2010	2010	5,054,821		425,000	300,000
377	Holm Sand	Hanson Aggregates Marine Ltd	1991	2014	2014	4,572,343	-	1,200,000	1,200,000
379	Holm Sand	British Dredging Ltd	1991	2014	2014	6,291,344		1,200,000	1,200,000
381	Holm Sand	Tarmac Marine Dredging Ltd	1991	2014	2014	4,185,266	-	575,000	575,000
382	Cockburn Shoal	Hanson Aggregates Marine Ltd	1991	1999	1998	325,098	-	120,000	
385	West Middle Grounds	British Dredging Ltd	1991	2014	2009	2,670,408	-	250,000	250,000
389	Culver Sand	Hanson Aggregates Marine Ltd	1991	2008	2008	152,608	-	16,000	16,000
391	Denny Shoal	Hanson Aggregates Marine Ltd	1991	2012	2012	645,482	-	150,000	150,000
425	Bristol Deep	Cardiff Bay Development Corporation	1995	2000	2000	2,192,257	-	-	-
Total							3,699,900	6,011,000	5,441,000

Source: The Crown Estate

***** *Note: In any single year a higher amount may be permitted but this figure is the total permitted extraction divided by the term of the licence*

Bedwyn Sands information is not within the remit of The Crown Estate, Data are not available

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