Department for Business, Energy & Industrial Strategy

OFFSHORE OIL & GAS LICENSING 30TH SEAWARD ROUND

Habitats Regulations Assessment

Appropriate Assessment: Irish Sea

May 2018

Any enquiries regarding this publication should be sent to us at oep@beis.gov.uk.

Contents

1 Introduction

1.1 Background and purpose

The plan/programme covering this and potential future seaward licensing rounds has been subject to a Strategic Environmental Assessment (OESEA3), completed in July 2016. The SEA Environmental Report includes detailed consideration of the status of the natural environment and potential effects of the range of activities which could follow licensing, including potential effects on conservation sites. The SEA Environmental Report was subject to an 8 week public consultation period, and a post-consultation report summarising comments and factual responses was produced as an input to the decision to adopt the plan/programme. This decision has allowed the Oil & Gas Authority (OGA) to progress with further seaward oil and gas licensing rounds. As a result on 25th July 2017, the OGA invited applications for licences regarding 821 Blocks in a 30th Seaward Licensing Round covering mature areas of the UKCS, and applications were received for licences covering 239 Blocks/part Blocks.

The *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended) implement the requirements of Articles 6(3) and 6(4) of the Habitats Directive with respect to oil and gas activities in UK territorial waters and on the UK Continental Shelf. The *Conservation of Offshore Marine Habitats and Species Regulations 2017* cover other relevant activities in offshore waters (i.e. excluding territorial waters). Within territorial waters, the Habitats Directive is transposed into UK law via the *Conservation of Habitats and Species Regulations 2017* in England and Wales, the *Conservation (Natural Habitats, &c.) Regulations 1994* in Scotland (for non-reserved matters), and the *Conservation (Natural Habitats, &c) Regulations (Northern Ireland) 1995* (as amended) in Northern Ireland.

As the petroleum licensing aspects of the plan/programme are not directly connected with or necessary for nature conservation management of European (Natura 2000[1]) sites, to comply with its obligations under the relevant regulations, the Department for Business, Energy and Industrial Strategy[2] (BEIS, formerly the Department of Energy and Climate Change) is undertaking a Habitats Regulations Assessment (HRA). To comply with obligations under the *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended), in winter 2017, the Secretary of State undertook a screening assessment to determine whether the award of any of the Blocks offered would be likely to have a significant effect on a relevant

[1] This includes Special Areas of Conservation (SAC) and Special Protection Areas (SPA), and potential sites for which there is adequate information on which to base an assessment.
[2] Note that while certain licensing and regulatory functions were passed to the OGA (a government company wholly owned by the Secretary of State for BEIS) on 1 October 2016, environmental regulatory functions are retained by BEIS, and are administered by the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED).

site, either individually or in combination[3] with other plans or projects (BEIS 2018). In doing so, the Department has applied the Habitats Directive test[4] (elucidated by the European Court of Justice in the case of Waddenzee (Case C-127/02)[5]) which is:

> *…any plan or project not directly connected with or necessary to the management of the site is to be subject to an appropriate assessment of its implications for the site in view of the site's conservation objectives if it cannot be excluded, on the basis of objective information, that it will have a significant effect on that site, either individually or in combination with other plans or projects.*
>
> *…where a plan or project not directly connected with or necessary to the management of a site is likely to undermine the site's conservation objectives, it must be considered likely to have a significant effect on that site. The assessment of that risk must be made in the light inter alia of the characteristics and specific environmental conditions of the site concerned by such a plan or project.*

1.2 Relevant Blocks

The screening assessment (including consultation with the statutory conservation agencies/bodies) formed the first stage of the HRA process. The assessment was undertaken in the period within which applications for Blocks were being accepted, and therefore considered all 821 Blocks offered. The screening identified 304 whole or part Blocks as requiring further assessment prior to decisions on whether to grant licences (BEIS 2018). Following the closing date for 30th Seaward Round applications, and the publication of the screening document, those Blocks identified as requiring further assessment were reconsidered against the list of actual applications. It was concluded that further assessment (Appropriate Assessment (AA)) was required for 61of the Blocks applied for. Because of the wide distribution of these Blocks around the UKCS, the Appropriate Assessments (AA) in respect of each potential licence award, are contained in four regional reports as follows:

- Southern North Sea
- Central North Sea
- West of Shetland
- Irish Sea

[3] Note that "in-combination" and "cumulative" effects have similar meanings, but for the purposes of HRA, and in keeping with the wording of Article 6(3) of the Habitats Directive, "in-combination" is used to describe the potential for such effects throughout. More information on the definitions of "cumulative" and "in-combination" effects are available in MMO (2014) and Judd *et al.* (2015).

[4] See Article 6(3) of the Habitats Directive.

[5] Also see the Advocate General's Opinion in the recent 'Sweetman' case (Case C-258/11), which confirms those principles set out in the Waddenzee judgement.

1.2.1 Irish Sea Blocks

The Irish Blocks applied for in the 30th Round and considered in this assessment are listed below in Table 1.1, and are shown in Figure 1.1.`

Table 1.1: Blocks requiring further assessment

110/3b	110/5	113/27e	113/28	113/29

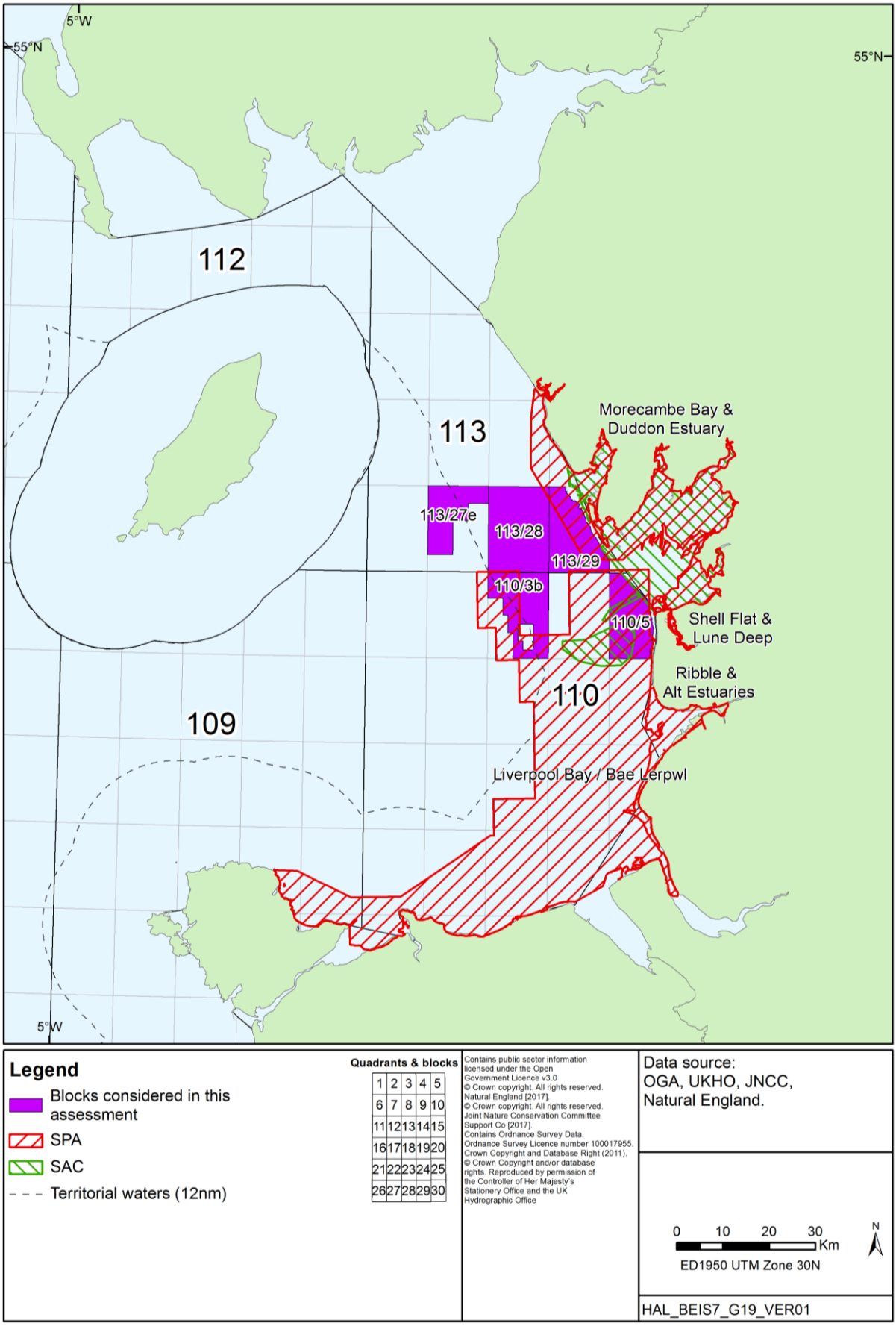
1.3 Relevant Natura 2000 sites

The screening identified the relevant Natura 2000 sites and related Blocks requiring further assessment in the Irish Sea (refer to Appendix B of BEIS 2018). Following a reconsideration of those Blocks and sites screened in against those Blocks applied for, five Natura 2000 sites in parts of the Irish Sea were identified as requiring further assessment in relation to the 5 Blocks (Table 1.2 and Figure 1.1).

Table 1.2: Relevant sites requiring further assessment

Relevant site Features	**Relevant Blocks applied for**	**Sources of potential effects**
SPAs		
Morecambe Bay & Duddon Estuary SPA Breeding terns, gulls and seabirds, on passage and overwintering waterfowl and waders. Waterfowl and seabird assemblages (any season)	110/3b, 110/5, 113/27e, 113/28, 113/29	Physical disturbance and drilling: rig siting, drilling discharges, vessel presence and movement
		Underwater noise: site survey and well evaluation, conductor piling.
Ribble & Alt Estuaries SPA Breeding tern, gulls, waders and seabirds, on passage and overwintering waterfowl and waders. Breeding seabird and overwintering waterfowl assemblages.	110/5	Physical disturbance and drilling: rig siting, drilling discharges, vessel presence and movement
		Underwater noise: site survey and well evaluation, conductor piling.
Liverpool Bay / Bae Lerpwl SPA Breeding terns, overwintering diver, gulls and waterfowl. Waterfowl assemblage	110/3b, 110/5, 113/28, 113/29	Physical disturbance and drilling: rig siting, drilling discharges, vessel presence and movement
	110/3b, 110/5, 113/27e, 113/28, 113/29	Underwater noise: site survey and well evaluation, conductor piling.
SACs		
Morecambe Bay SAC Annex I habitats (primary): estuaries, mudflats and sandflats, inlets and bays, vegetation of stony banks, saltmarsh and salt meadows and coastal dunes Annex I habitats (qualifying): sandbanks, coastal lagoons, reefs and coastal dunes Annex II species: Great-crested newt	110/5, 113/28, 113/29	Physical disturbance and drilling: rig siting, drilling discharges
Shell Flat & Lune Deep SAC Annex I habitats: sandbanks and reefs	110/3b, 110/5, 113/29	Physical disturbance and drilling: rig siting, drilling discharges

Figure 1.1: Blocks and sites relevant to this Appropriate Assessment



1.4 Assessment overview

This document sets out the key assumptions and approach to the AA, the evidence base underpinning the assessment and the assessment of relevant Blocks and sites. The document is organised as follows:

- Overview of the licensing process and nature of the activities that could follow including assumptions used to underpin the AA process (Section 2)
- Description of the approach to ascertaining the absence or otherwise of adverse effects on the integrity of relevant European sites (Section 3)
- Evidence base on the environmental effects of offshore oil and gas activities to inform the assessment (Section 4)
- The assessment of effects on the integrity of relevant sites, including in-combination with other plans or projects (Section 5)
- Overall conclusion (Section 6)

As part of this HRA process, the draft AA document was subject to statutory consultation and has been amended as appropriate in light of comments received. Both the draft and final AA documents are available via the 30th Round Appropriate Assessment webpage of the gov.uk website.

2 Licensing and potential activities

2.1 Licensing

The exclusive rights to search and bore for petroleum in Great Britain, the territorial sea adjacent to the United Kingdom and on the UK continental shelf (UKCS) are vested in the Crown and the *Petroleum Act 1998* (as amended) gives the OGA the power to grant licences to explore for and exploit these resources. Offshore licensing for oil and gas exploration and production commenced in 1964 and progressed through a series of Seaward Licensing Rounds. A Seaward Production Licence grants exclusive rights to the holders "to search and bore for, and get, petroleum" in the area covered by the Licence but does not constitute any form of approval for activities to take place in the Blocks, nor does it confer any exemption from other legal or regulatory requirements. Offshore activities are subject to a range of statutory permitting and consenting requirements, including, where relevant, activity specific AA under Article 6(3) of the Habitats Directive (Directive 92/43/EC).

Several sub-types of Seaward Production Licence were available in previous rounds (Traditional, Frontier and Promote) which have been replaced by the single "Innovate" licence[6]. As per previous licensing structures, the Innovate licence is made up of three terms covering exploration (Initial Term), appraisal and field development planning (Second Term), and development and production (Third Term). The lengths of the first two terms are flexible, but have a maximum duration of 9 and 6 years respectively. The Third Term is granted for 18 years but may be extended if production continues beyond this period. The Innovate licence introduces three Phases to the Initial Term, covering:

- Phase A: geotechnical studies and geophysical data reprocessing (note that the acquisition of new seismic could take place in this phase for the purpose of defining a 3D survey as part of Phase B, but normally this phase will not involve activities in the field)
- Phase B: shooting of new seismic and other geophysical data
- Phase C: exploration and appraisal drilling

Applicants may propose the Phase combination in their submission to the OGA. Phase A and Phase B are optional and may not be appropriate in certain circumstances, but every application must propose a Phase C, except where the applicant does not think any exploration is needed (e.g. in the development of an existing discovery or field re-development) and proposes to go straight to development (i.e. 'straight to Second Term'). The duration of

[6] *The Petroleum and Offshore Gas Storage and Unloading Licensing (Amendment) Regulations 2017* amend the Model Clauses to be incorporated in Seaward Production Licences so as to implement the Innovate licences to be issued in the 30th Round.

the Initial Term and the Phases within it are agreed between the OGA and the applicant. Applicants may choose to spend up to 4 years on a single Phase in the Initial Term, but cannot take more than 9 years to progress to the Second Term. Failure to complete the work agreed in a Phase, or to commit to the next Phase means the licence ceases, unless the term has been extended by the OGA.

Financial viability is considered prior to licence award for applicants proposing to start at Phase A or B, but further technical and financial capacity for Phase C activities would need to be demonstrated before the licence could enter Phase C and drilling could commence. If the applicant proposes to start the licence at Phase C or go straight to the Second Term, the applicant must demonstrate that it has the technical competence to carry out the activities that would be permitted under the licence during that term, and the financial capacity to complete the Work Programme, before the licence is granted. It is noted that the safety and environmental capability and track record of all applicants are considered by the OGA (in consultation with the Offshore Safety Directive Regulator)[7] through written submissions before licences are awarded[8]. Where full details cannot be provided via the written submissions at the application stage, licensees must provide supplementary submissions that address any outstanding environmental and safety requirements before approvals for specific offshore activities such as drilling can be issued.

2.2 Activities that could follow licensing

As part of the licence application process, applicants provide the OGA with details of work programmes they propose in the Initial Term. These work programmes are considered along with a range of other factors by the OGA before arriving at a decision on whether to license the Blocks and to whom. Activities detailed in work programmes may include the purchase, reprocessing or shooting of 2D or 3D seismic data (Phases A and B) and the drilling of wells (Phase C). There are three levels of drilling commitment:

- A Firm Drilling Commitment is a commitment to the OGA to drill a well. Firm drilling commitments are preferred on the basis that, if there were no such commitment, the OGA could not be certain that potential licensees would make full use of their licences. However, the fact that a licensee has been awarded a licence on the basis of a “firm commitment” to undertake a specific activity should not be taken as meaning that the licensee will actually be able to carry out that activity. This will depend upon the outcome of relevant activity specific environmental assessments.

[7] The Offshore Safety Directive Regulator is the Competent Authority for the purposes of the Offshore Safety Directive comprising of the Department for Business, Energy and Industrial Strategy (BEIS) Offshore Petroleum Regulator for Gas Environment and Decommissioning (OPRED) and the Health and Safety Executive (HSE) working in partnership.
[8] Refer to OGA technical guidance and safety and environmental guidance on applications for the 30th Round at: https://www.ogauthority.co.uk/licensing-consents/licensing-rounds/

- A Contingent Drilling Commitment is also a commitment to the OGA to drill a well, but it includes specific provision for the OGA to waive the commitment in light of further technical information.
- A Drill or Drop (D/D) Drilling Commitment is a conditional commitment with the proviso that the licence is relinquished if a well is not drilled.

Note that Drill or Drop and Contingent work programmes (subject to further studies by the licensees) will probably result in a well being drilled in less than 50% of the cases.

The OGA general guidance[9] makes it clear that an award of a Production Licence does not automatically allow a licensee to carry out any offshore petroleum-related activities from then on (this includes those activities outlined in initial work programmes, particularly Phases B and C). Figure 2.2 provides an overview of the plan process associated with the 30th Seaward Licensing Round and the various environmental assessments including HRA. Offshore activities such as seismic survey or drilling are subject to relevant activity specific environmental assessments by BEIS (see Figures 2.3 and 2.4), and there are other regulatory provisions exercised by the Offshore Safety Directive Regulator and bodies such as the Health and Safety Executive. It is the licensee's responsibility to be aware of, and comply with, all regulatory controls and legal requirements.

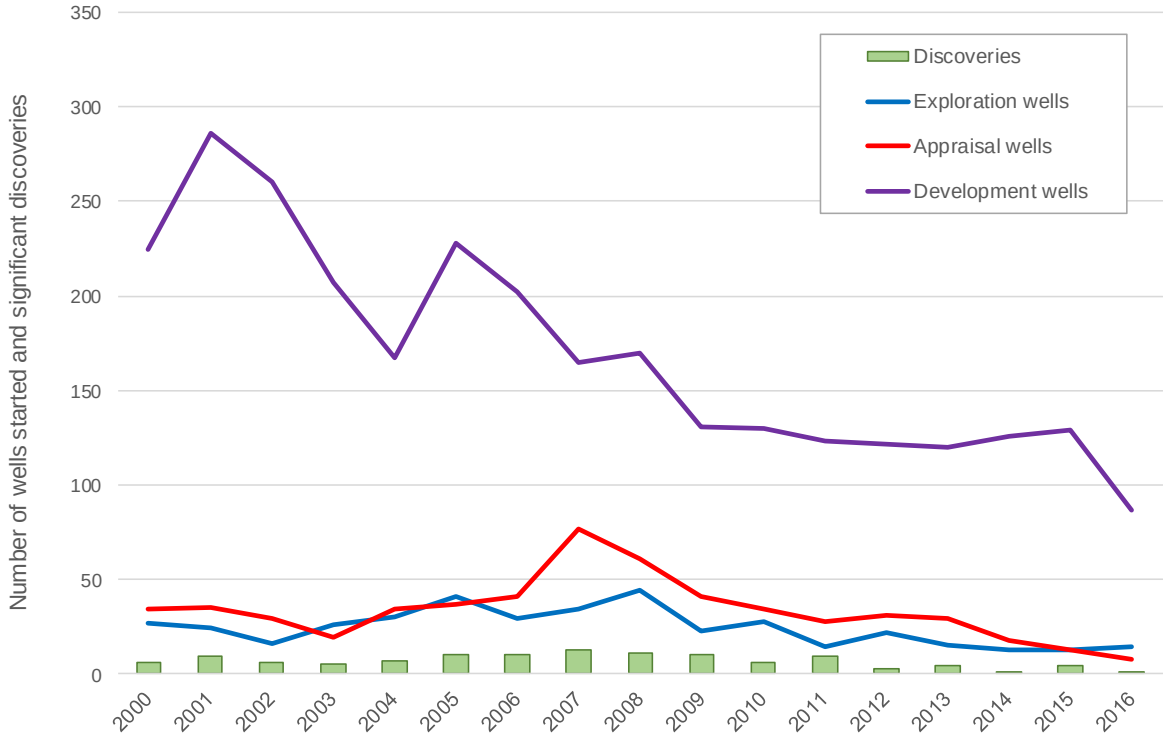
The proposed work programmes for the Initial Term are detailed in the licence applications. For some activities, such as seismic survey, the potential impacts associated with noise could occur some distance from the licensed Blocks and the degree of activity is not necessarily proportional to the size or number of Blocks in an area. In the case of direct physical disturbance, the licence Blocks being applied for are relevant.

2.2.1 Likely scale of activity

On past experience the activity that actually takes place is less than what is included in the work programme at the licence application stage. A proportion of Blocks awarded may be relinquished without any offshore activities occurring. Activity after the Initial Term is much harder to predict, as this depends on the results of the initial phase, which is, by definition, exploratory. Typically less than half the wells drilled reveal hydrocarbons, and of that, less than half will have a potential to progress to development. For example, the OGA analysis of exploration well outcomes from the Moray Firth & Central North Sea between 2003 and 2013 indicated an overall technical success rate of 40% with respect to 150 exploration wells and side-tracks (Mathieu 2015). Depending on the expected size of finds, there may be further drilling to appraise the hydrocarbons (appraisal wells). For context, Figure 2.1 highlights the total number of exploration and appraisal wells started on the UKCS each year since 2000 as well as the number of significant discoveries made (associated with exploration activities).

[9] https://www.ogauthority.co.uk/media/3951/general-guidance.pdf

Figure 2.1: UKCS Exploration, appraisal & development wells, and significant discoveries since 2000



Note: "significant" generally refers to the flow rates that were achieved (or would have been reached) in well tests (15 mmcfgd or 1000 BOPD) and does not indicate commercial potential of the discovery. Source: OGA Drilling Activity (October 2017), Significant Offshore Discoveries (April 2017)

Discoveries that progress to development may require further drilling, installation of infrastructure such as wellheads, pipelines and possibly fixed platform production facilities, although recent developments are mostly tiebacks to existing production facilities rather than stand alone developments. For example, of the 48 current projects identified by the OGA's Project Pathfinder (as of 4th August 2017)[10], 18 are planned as subsea tie-backs to existing infrastructure, 4 involve new stand-alone production platforms and 10 are likely to be developed via Floating Production, Storage and Offloading facilities (FPSO). The final form of development for many of the remaining projects is not decided, with some undergoing re-evaluation of development options but some are likely to be subsea tie-backs. Figure 2.1 indicates that the number of development wells has declined over time and this pattern is likely to continue. The nature and scale of potential environmental impacts from the drilling of development wells are similar to those of exploration and appraisal wells and thus the screening criteria described in Section 4 are applicable to the potential effects of development well drilling within any of the 30th Round Blocks.

[10] https://itportal.ogauthority.co.uk/eng/fox/path/PATH_REPORTS/pdf

2.2.2 30th Round activities considered by the HRA

The nature, extent and timescale of development, if any, which may ultimately result from the licensing of 30th Round Blocks is uncertain, and therefore it is regarded that at this stage a meaningful assessment of development level activity (e.g. pipelay, placement of jackets, subsea templates or floating installations etc) cannot be made. A small number of 30th Round applications proposed to go straight to the Second Term (i.e. appraisal and field development planning, see above), one of which is relevant to this Appropriate Assessment (covering Blocks 113/28 and 113/29). Whilst such an application makes a firm commitment to undertake development level activities, at this stage the nature of any development is not known. These Blocks are still considered in this assessment, in view of the similarity in the nature and scale of development drilling to that for exploration (see above) and that to progress to this stage, no further exploration (i.e. deep geological seismic survey) is required. Once project plans are in place, subsequent permitting processes relating to exploration, development and decommissioning, would require assessment (including HRA) as appropriate, allowing the opportunity for further mitigation measures to be identified as necessary, and for permits to be refused if necessary. In this way the opinion of the Advocate General in ECJ (European Court of Justice) case C-6/04, on the effects on Natura sites, "*must be assessed at every relevant stage of the procedure to the extent possible on the basis of the precision of the plan. This assessment is to be updated with increasing specificity in subsequent stages of the procedure*" is addressed. Therefore only activities as part of the work programmes associated with the Initial Term and its associated Phases A-C will be considered in this AA (see Table 2.2).

Potential accidental events, including spills, are not considered in the AA as they are not part of the work plan. Measures to prevent accidental events, response plans and potential impacts in the receiving environment would be considered as part of the environmental impact assessment (EIA) process for specific projects that could follow licensing when the location, nature and timing of the proposed activities are available to inform a meaningful assessment of such risks.

The approach used in this assessment has been to take the proposed activity for the Block as being the maximum of any application for that Block, and to assume that all activity takes place. The estimates of work commitments for the relevant Blocks derived from the applications received by the OGA are shown in Table 2.1.

Table 2.1: Indicative work programmes relevant to Blocks considered in this assessment

Relevant Blocks	Obtain[11] and/or reprocess 2D or 3D seismic data	Shoot 3D seismic	Drill or drop well/contingent well	Second Term
110/3b	-	-	✓	-
110/5	-	-	✓	-

[11] To obtain seismic data means purchasing or otherwise getting the use of existing data and does not involve shooting new seismic.

Relevant Blocks	Obtain[11] and/or reprocess 2D or 3D seismic data	Shoot 3D seismic	Drill or drop well/contingent well	Second Term
113/27e	-	-	✓	-
113/28	-	-	-	✓
113/29	-	-	-	✓

Completion of the work programmes is likely to involve one or more of the activities summarised in Table 2.2. A series of assumptions has been developed on the nature and scale of activities to be assessed based on the evidence base for potential effects presented in Section 4 as well as reviews of exemplar Environmental Statements of relevant activities. Subsequent development activity is contingent on successful exploration and appraisal and may or may not result in the eventual installation of infrastructure. Where relevant, such future activities will themselves be subject to activity specific screening procedures and tests under the Habitats Directive.

Table 2.2: Potential activities and assessment assumptions

Potential activity	Description	Assumptions used for assessment
Initial Term Phase C: Drilling and well evaluation		
Rig tow out & de-mobilisation	Mobile rigs are towed to and from the well site typically by 2-3 anchor handling vessels.	The physical presence of a rig and related tugs during tow in/out is both short (a number of days depending on initial location of rig) and transient.
Rig placement/ anchoring	Jack-up rigs are used in shallower waters (normally <120m) and jacking the rig legs to the seabed supports the drilling deck. Each of the rig legs terminates in a spud-can (base plate) to prevent excessive sinking into the seabed.	It is assumed that jack-up rigs will be three or four-legged rigs with 20m diameter spudcans with an approximate seabed footprint of 0.001km^2 within a radius of *ca*. 50m of the rig centre. For the assessment it is assumed that effects may occur within 500m of a jack-up rig which would take account of any additional rig stabilisation (rock placement) footprint. A short review of 18 Environmental Statements, 6 of which included drilling operations in the Irish Sea since 2009 (specifically in quadrants 110 and 113) indicated that rig stabilisation was either not considered necessary and/or assessed as a worst case contingency option. Where figures were presented, the spatial scale of potential rock placement operations was estimated at between 0.001-0.004km^2 per rig siting. A BEIS study due to report later this year will compare the rock volumes estimated in operator applications (e.g. drilling application) with those actually used (from close-out returns).
Marine discharges	Typically around 1,000 tonnes of cuttings (primarily rock chippings) result from drilling an exploration well. Water-based mud cuttings are typically discharged at, or relatively close to sea surface during “closed drilling” (i.e. when steel casing in the well	The footprint of cuttings and other marine discharges, or the distance from source within which smothering or other effects may be considered is generally a few hundred metres. For the assessment it is assumed that effects may occur within 500m of the well

Potential activity	Description	Assumptions used for assessment
	bore and a riser to the rig are in place), whereas surface hole cuttings are normally discharged at seabed during "open-hole" drilling. Use of oil based mud systems, for example in highly deviated sections or in drilling water reactive shales, would require onshore disposal or treatment offshore to the required standards prior to discharge.	location covering an area in the order of 0.8km^2.
Conductor piling	Well surface holes are usually drilled "open-hole" with the conductor subsequently inserted and cemented in place to provide a stable hole through which the lower well sections are drilled. Where the nature of the seabed sediment and shallow geological formations are such that they would not be stable open-hole (i.e. risking collapse), the conductor may be driven into the sediments. In North Sea exploration wells, the diameter of the conductor pipe is usually 26" or 30" (<1m), which is considerably smaller than the monopiles used for offshore wind farm foundations (>3.5m diameter), and therefore require less hammer energy and generate noise of a considerably lower amplitude. For example, hammer energies to set conductor pipes are in the order of 90-270kJ (see: Matthews 2014, Intermoor website), compared to energies of up to 3,000kJ in the installation of piles at some southern North Sea offshore wind farm sites. Direct measurements of underwater sound generated during conductor piling are limited. Jiang *et al.* (2015) monitored conductor piling operations at a jack-up rig in the central North Sea in 48m water depth and found peak sound pressure levels (L_{pk}) not to exceed 156dB re 1 µPa at 750m (the closest measurement to source) and declining with distance. Peak frequency was around 200Hz, dropping off rapidly above 1kHz; hammering was undertaken at a stable power level of 85 ±5 kJ but the pile diameter was not specified (Jiang *et al.* 2015).	The need to pile conductors is well-specific and is not routine. It is anticipated that a conductor piling event would last between 4-6 hours.
Rig/vessel presence and movement	On site, the rig is supported by supply and standby vessels, and helicopters are used for personnel transfer.	Supply vessels typically make 2-3 supply trips per week between rig and shore. Helicopter trips to transfer personnel to and from the rig are typically made several times a week. A review of Environmental Statements for exploratory drilling suggests that the rig could be on location for up to 10 weeks.
Rig site survey	Rig site surveys are undertaken to identify seabed and subsurface hazards to drilling, such as wrecks and the presence of shallow gas. The surveys use a range of techniques, including multibeam and side scan sonar, sub-bottom profiler, magnetometer and high-resolution seismic involving a much smaller source (mini-gun or four airgun cluster of	Rig site survey typically covers 2-3km^2. Survey durations are usually of the order of four or five days.

Potential activity	Description	Assumptions used for assessment
	160in^3) and a much shorter hydrophone streamer. Arrays used on site surveys and some VSP operations (see below) typically produce frequencies predominantly up to around 250Hz, with a peak source level of around 235dB re 1µPa @ 1m (Stone 2015). The rig site survey vessel may also be used to characterise seabed habitats, biota and background contamination.	
Well evaluation (e.g. Vertical Seismic Profiling)	Sometimes conducted to assist with well evaluation by linking rock strata encountered in drilling to seismic survey data. A seismic source (airgun array, typically with a source size of ~500 in^3 and a maximum of 1,200 in^3, Stone 2015) is deployed from the rig, and measurements are made using a series of geophones deployed inside the wellbore.	Vertical Seismic Profiling (VSP) surveys are static and of short duration (one or two days at most).

2.3 Existing regulatory requirements and controls

The AA assumes that the high level controls described below are applied as standard to activities since they are legislative requirements. These are distinct from further mitigation measures which may be identified and employed to avoid likely significant effects on relevant sites (see Section 5.1.3).

2.3.1 Physical disturbance and drilling

There is a mandatory requirement to have sufficient recent and relevant data to characterise the seabed in areas where activities are due to take place (e.g. rig placement)[12]. If required, survey reports must be made available to the relevant statutory bodies on submission of a relevant permit application or Environmental Statement, and the identification of any potential sensitive habitats by such survey (including those under Annex I of the Habitats Directive) may influence BEIS's decision on a project level consent.

Discharges from offshore oil and gas facilities have been subject to increasingly stringent regulatory controls over recent decades (see review in DECC 2016, and related Appendices 2 and 3). As a result, oil and other contaminant concentrations in the major streams (drilling wastes and produced water) have been substantially reduced or eliminated (e.g. the discharge of oil based muds and contaminated cuttings is effectively banned), with discharges of chemicals and oil exceeding permit conditions or any unplanned release, potentially constituting a breach of the permit conditions and an offence. Drilling chemical use and discharge is subject to strict regulatory control through permitting, monitoring and reporting (e.g. the mandatory Environmental Emissions Monitoring System (EEMS) and annual environmental performance reports). The use and discharge of chemicals must be risk

[12] See BEIS (2017). Guidance notes on the *Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999* (as amended).

assessed as part of the permitting process (e.g. Drilling Operations Application) under the *Offshore Chemicals Regulations 2002* (as amended), and the discharge of chemicals which would be expected to have a significant negative impact would not be permitted.

At the project level, discharges would be considered in detail in project-specific environmental impact assessments, (where necessary through HRAs) and chemical risk assessments under existing permitting procedures.

2.3.2 Underwater noise

Controls are in place to cover all significant noise-generating activities on the UKCS, including geophysical surveying. Seismic surveys (including VSP and high-resolution site surveys), sub-bottom profile surveys and shallow drilling activities require an application for consent under the *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended) and cannot proceed without consent. These applications are supported by an EIA, which includes a noise assessment. Applications are made through BEIS's Portal Environmental Tracking System using a standalone Master Application Template (MAT) and Geological Survey Subsidiary Application Template (SAT). Regarding noise thresholds to be used as part of any assessment, applicants are encouraged to seek the advice of relevant SNCB(s) (JNCC 2017b) in addition to referring to European Protected Species (EPS) guidance (JNCC 2010). Applicants should be aware of recent research development in the field of marine mammal acoustics and the publication in the US of a new set of criteria for injury (NMFS 2016, referred to as NOAA thresholds).

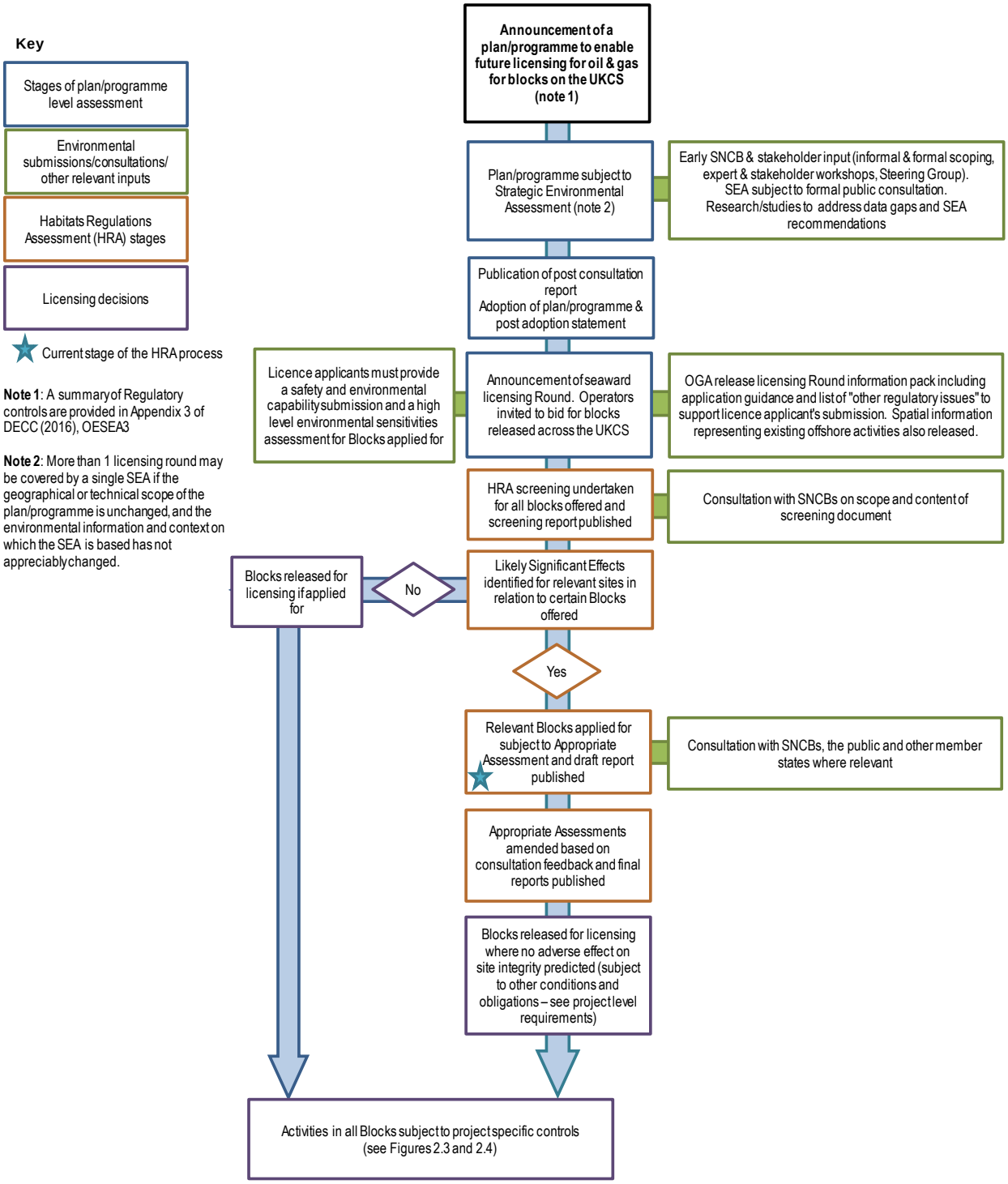
BEIS consults the relevant statutory consultees on the application for advice and a decision on whether to grant consent is only made after careful consideration of their comments. Statutory consultees may request additional information or risk assessment, specific additional conditions to be attached to consent (such as specify timing or other specific mitigation measures), or advise against consent.

It is a condition of consents issued under Regulation 4 of the *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended) for oil and gas related seismic and sub-bottom profile surveys that the JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (JNCC 2017b) are followed. Where appropriate, EPS disturbance licences may also be required under the *Conservation of Offshore Marine Habitats and Species Regulations 2017*[13]. JNCC (2017b) reaffirms that adherence to the guidelines constitutes best practice and will, in most cases, reduce the risk of deliberate injury to marine mammals to negligible levels. Applicants are expected to make every effort to design a survey that minimises sound generated and consequent likely impacts, and to implement best practice measures described in the guidelines.

[13] Disturbance of European Protected Species (EPS) (i.e. those listed in Annex IV) is a separate consideration under Article 12 of the Habitats Directive, and is not considered in this assessment.

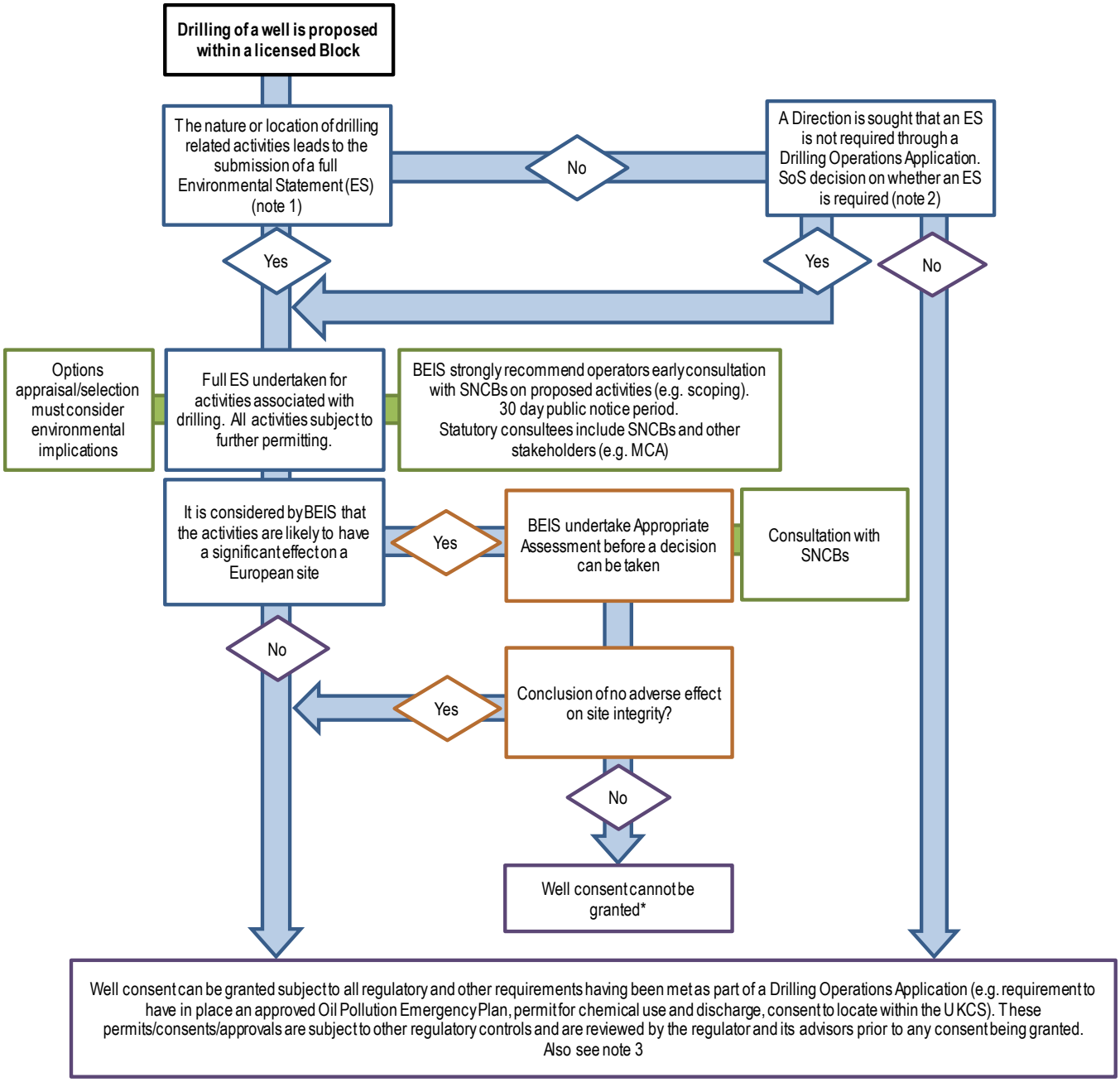
In addition, potential disturbance of certain species may be avoided by the seasonal timing of offshore activities. Periods of seasonal concern for individual Blocks on offer have been highlighted (see Section 2 of OGA's Other Regulatory Issues[14] which accompanied the 30th Round offer) which licensees should take account of. Licensees should also be aware that it may influence BEIS's decision whether or not to approve particular activities.

Figure 2.2: Stages of plan level environmental assessment



[14] https://www.ogauthority.co.uk/media/4004/other_regulatory_issues.docx

Figure 2.3: High level overview of exploration drilling environmental requirements



Key

- Stages of project permitting
- Environmental submissions/consultations/ other relevant inputs
- Habitats Regulations Assessment (HRA) stages
- Permitting/Consenting decisions

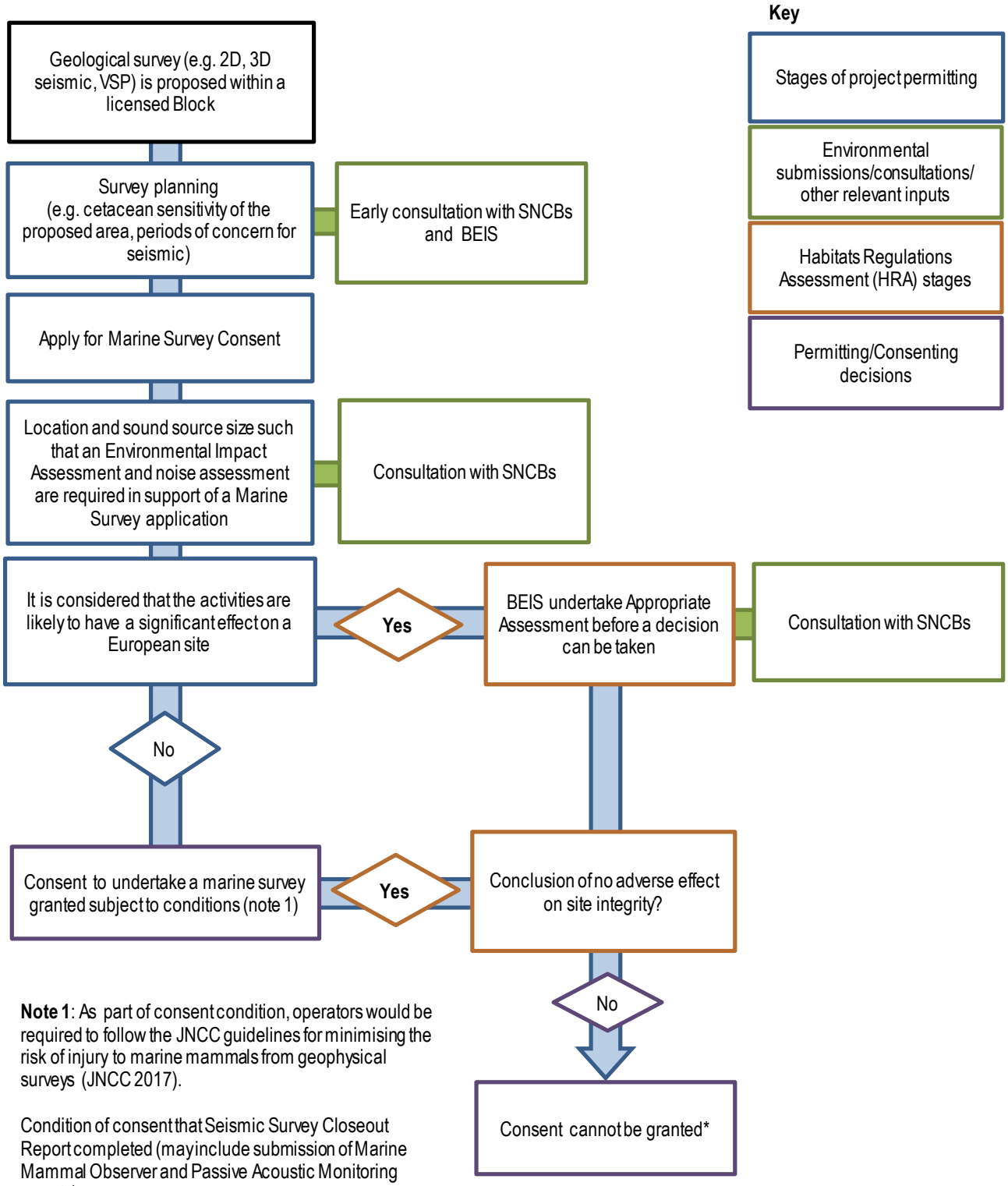
Note 1: See BEIS (2017). The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended) – A Guide. The Offshore Petroleum Regulator for Environment and Decommissioning, 80pp.

Note 2: Early consultation between BEIS and operators is typical to mitigate against Environmental Statement (ES) requirements being identified following the request for a direction

Note 3: In cases where an ES was initially identified as not required, or where an ES has been approved, the requirement to undertake AA may still apply (e.g. due to changes in the nature of the project or the designation of additional European sites)

* Article 6(4) of the Habitats Directive provides a derogation which would allow a plan or project to be approved in limited circumstances even though it would or may have an adverse effect on the integrity of a European site (see: Defra 2012).

Figure 2.4: High level overview of seismic survey environmental requirements



Note 1: As part of consent condition, operators would be required to follow the JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (JNCC 2017).

Condition of consent that Seismic Survey Closeout Report completed (may include submission of Marine Mammal Observer and Passive Acoustic Monitoring reports)

* Article 6(4) of the Habitats Directive provides a derogation which would allow a plan or project to be approved in limited circumstances even though it would or may have an adverse effect on the integrity of a European site (see: Defra 2012).

3 Appropriate assessment process

3.1 Process

In carrying out this AA so as to determine whether it is possible to agree to the grant of licences in accordance with Regulation 5(1) of *The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended), BEIS has:

- Considered, on the basis of the precautionary principle, whether it could be concluded that the integrity of relevant European Sites would not be affected. This impact prediction involved a consideration of the in-combination effects.
- Examined, in relation to elements of the plan where it was not possible to conclude that the integrity of relevant sites would not be affected, whether appropriate mitigation measures could be designed which negated or minimised any potential adverse effects identified.
- Subject to consultation on this document, drawn conclusions on whether or not it can agree to the grant of relevant licences.

In considering the above, BEIS used the clarification of the tests set out in the Habitats Directive in line with the ruling of the ECJ in the *Waddenzee* case (Case C-127/02), so that:

- Prior to the grant of any licence all activities which may be carried out following the grant of such a licence, and which by themselves or in combination with other activities can affect the site's conservation objectives, are identified in the light of the best scientific knowledge in the field.
- A licence can only be granted if BEIS has made certain that the activities to be carried out under such a licence will not adversely affect the integrity of that site (i.e. cause deterioration to a qualifying habitat or habitat of qualifying species, and/or undermine the conservation objectives of any given site). That is the case where no reasonable scientific doubt remains as to the absence of such effects.

3.2 Site integrity

The integrity of a site is defined by government policy, in the Commission's guidance and clarified by the courts (Cairngorms judicial review case[15]) as being: *'…the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat,*

[15] World Wild Life Fund & Others, Re application for judicial review of decisions relating to the protection of European Sites at Cairngorm Mountain, by Aviemore and proposals for construction of a funicular railway thereon.

complex of habitats and/or the levels of populations of the species for which it was classified[/designated].' This is consistent with the definitions of favourable conservation status in Article 1 of the Directive (JNCC 2002). As clarified by the European Commission (2000), the integrity of a site relates to the site's conservation objectives. These objectives are assigned at the time of designation to ensure that the site continues, in the long-term, to make an appropriate contribution to achieving favourable conservation status for the qualifying interest features. An adverse effect would be something that impacts the site features, either directly or indirectly, and results in disruption or harm to the ecological structure and functioning of the site and/or affects the ability of the site to meet its conservation objectives. For example, it is possible that a plan or project will adversely affect the integrity of a site only in a visual sense or only with respect to habitat types or species other than those listed in Annex I or Annex II. In such cases, the effects do not amount to an adverse effect for purposes of Article 6(3) of the Habitats Directive, provided that the coherence of the network is not affected. The AA must therefore conclude whether the proposed activity adversely affects the integrity of the site, in the light of its conservation objectives.

3.3 Assessment of effects on site integrity

The assessment has been undertaken in accordance with the European Commission Guidance (EC 2000) and with reference to other guidance, reports and policy, including the Habitats Regulations Guidance Notes (English Nature 1997, Defra 2012, SEERAD 2000), SNH (2015), the National Planning Policy Framework (DCLG 2012), the Marine Policy Statement (HM Government 2011), English Nature report, No. 704 (Hoskin & Tyldesley 2006) and Natural England report NECR205 (Chapman & Tyldesley 2016).

The assessment of effects on site integrity is documented in Section 5. It has been informed by an evidence base on the environmental effects of oil and gas activities on the UKCS and elsewhere (Section 4), and has utilised a number of assumptions on the nature and scale of potential activities that could follow licensing (Table 2.2), along with the characteristics and specific environmental conditions of the relevant sites (see Section 5). Activities which may be carried out following the grant of a licence, and which by themselves or in combination with other activities can affect the conservation objectives of relevant sites are discussed under the following broad headings:

- Physical disturbance and drilling effects (Section 5.1)
- Underwater noise effects (Section 5.2)
- In-combination effects (Section 5.3)

4 Evidence base for assessment

4.1 Introduction

The AAs are informed by an evidence base on the environmental effects of oil and gas activities derived from the scientific literature, relevant Strategic Environmental Assessments (e.g. DECC 2009, 2011 and 2016) and other literature. Recent operator Environmental Statements for offshore exploration and appraisal activities on the UKCS have also been reviewed, providing for example a more specific indication of the range of spatial footprints associated with relevant drilling activities to inform the further consideration of those sites where physical disturbance and drilling effects may be considered likely.

In recent years, significant work has been undertaken in the area of sensitivity assessments and activity/pressure matrices (e.g. Tillin *et al*. 2010, Tillin & Tyler-Walters 2014). Defra (2015) includes an evidence base for the latest pressures-activity matrix produced by JNCC (2013). These are intended to be representative of the types of pressures that act on marine species and habitats from a defined set of activities, based on benchmarks of these pressures where the magnitude, extent or duration is qualified or quantified in some way. This approach underpins advice on operations for a number of the sites included in this assessment (Morecambe Bay SAC, Ribble and Alt Estuaries SPA, Shell Flat and Lune Deep SAC). The advice identifies a range of pressures for the sites in relation to oil and gas exploration activity for which the site features are regarded to be sensitive, not sensitive; or where a sensitivity assessment has not been made, or it is concluded there is insufficient evidence for a sensitivity assessment to be made at the pressure benchmark[16]. Whilst these matrices provided as part of the advice are informative and note relevant pressures associated with hydrocarbon exploration, resultant effects are not inevitable consequences of oil and gas activity since often they can be mitigated through timing, siting or technology (or a combination of these). The Department expects that these options would be evaluated by the licensees and documented in the environmental assessments required as part of the activity specific consenting regime.

On review of the identified pressures for the relevant sites (e.g. relating to abrasion/disturbance of surface/subsurface substrate, habitat structure and siltation rate changes, introduction of contaminants, underwater noise) and their justifications, it is regarded that the evidence base on the potential effects of oil and gas exploration (e.g. as considered in successive SEAs, and summarised in Sections 4.2 and 4.3), comprehensively covers the range of pressures identified in the advice, and is used to underpin the assessment against site specific information.

[16] Note that the advice does not take into account the intensity, frequency or cumulative impacts from activities, and pressure benchmarks are used as reference points to assess sensitivity and are not thresholds that identify a likely significant effect within the meaning of Habitats Regulations (JNCC 2017a)

The following sections provide a summary of the evidence informing the site-specific assessment of effects provided in Section 5. To focus the presentation of relevant information, the sections take account of the environments in which those Blocks to be subject to further assessment and relevant Natura 2000 sites are located (Table 1.2, Figure 1.1).

4.2 Physical disturbance and drilling effects

The pathways by which exploration activities may have physical disturbance and drilling effects on Natura 2000 sites include:

- Physical damage to benthic habitats caused by the placement of jack-up drilling rig spud cans (see Section 4.2.1)
- Physical loss and change of benthic habitats through rock placement around jack-up legs for rig stabilisation (see Section 4.2.2)
- Physical loss of benthic habitats through the discharge of surface hole cuttings around the well and placement of wellhead assembly (see Section 4.2.2)
- Smothering by settlement of drill cuttings on seabed following discharge near sea surface (see Section 4.2.2)
- Displacement of sensitive receptors by visual/acoustic disturbance from the presence and movement of vessels and aircraft (see Section 4.2.3)

4.2.1 Physical damage to benthic habitats

Jack-up rigs, normally used in shallower water (<120m), leave three or four seabed depressions from the feet of the rig (the spud cans) around 15-20m in diameter. The form of the footprint depends on factors such as the spudcan shape, the soil conditions, the footing penetration and methods of extraction, with the local sedimentary regime affecting the longevity of the footprint (HSE 2004). For example, swathe bathymetry data collected as part of FEPA monitoring of the Barrow offshore wind farm off the Cumbria coast (partly within Block 113/29, see Figure 5.3) indicated that faint jack-up leg depressions were present close to a number of the turbine locations approximately four months after construction. However, most of the depressions were almost completely infilled by mobile sediments (BOWind 2008). As part of the Walney Extension wind farm geophysical survey in April-July 2011, sidescan sonar identified spud can depressions associated with two well locations (113/26b-3 and 113/27b-6), drilled in April 2010 and November 2009 respectively. No information on the depths of the depressions was provided but they were identifiable at least one year post-drilling (Gardline Geosurvey 2013). In locations with an uneven or soft seabed, material such as grout bags or rocks may be placed on the seabed to stabilise the rig feet, and recoverable mud mats may be used in soft sediment.

Habitat recovery from temporary disturbance will depend primarily on re-mobilisation of sediments by current shear (as reviewed by Newell *et al*. 1998, Foden *et al.* 2009). Subsequent benthic population recovery takes place through a combination of migration, re-

distribution (particularly of microfaunal and meiofaunal size classes) and larval settlement. On the basis that seabed disturbance is qualitatively similar to the effects of wave action from severe storms, it is likely that in most of the shallower parts of the UKCS, sand and gravel habitat recovery is likely to be relatively rapid (1-5 years) (van Dalfsen *et al.* 2000, Newell & Woodcock 2013).

4.2.2 Physical loss of benthic habitats and smothering

The surface hole sections of exploration wells are typically drilled riserless, producing a localised (and transient) pile of surface-hole cuttings around the surface conductor. These cuttings are derived from shallow geological formations and a proportion will therefore be similar to surficial sediments in composition and characteristics. The persistence of cuttings discharged at the seabed is largely determined by the potential for it to be redistributed by tidal and other currents.

After installation of the surface casing (which will result in a small quantity of excess cement returns being deposited on the seabed), the blowout preventer (BOP) is positioned on the wellhead housing. These operations (and associated activities such as ROV operations) may result in physical disturbance of the immediate vicinity (a few metres) of the wellhead. When an exploration well is abandoned, the conductor and casing are plugged with cement and cut below the mudline (seabed sediment surface) using a mechanical cutting tool deployed from the rig and the wellhead assembly is removed. The seabed "footprint" of the well is therefore removed although post-well sediments may vary in the immediate vicinity of the well compared to the surrounding seabed (see for example, Jones *et al*. (2012), although this is only likely to be temporary in the Irish Sea).

In contrast to historic oil based mud discharges[17], effects on seabed fauna of the discharge of cuttings drilled with water based muds (WBM) and of the excess and spent mud itself are usually subtle or undetectable (e.g. Cranmer 1988, Neff *et al.* 1989, Hyland *et al.* 1994, Daan & Mulder 1996, Currie & Isaacs 2005, OSPAR 2009, Bakke *et al*. 2013, DeBlois *et al*. 2014). Modelling of WBM cuttings discharges in the eastern Irish Sea for an exploration well in Block 113/27b in *ca*. 28m water depth (Centrica Energy 2009), indicated that most (84%) of the cuttings material would be deposited within *ca*. 47m of the well, with a maximum depth of deposited cuttings of 11mm within 22m of the well. The remaining cuttings, comprising finer particles were estimated to travel up to 500m from the well and were not considered likely to be detectable. The cuttings "footprint" of the well is temporary in nature due to the mobile nature of the seabed sediments within the eastern Irish Sea (see Holmes & Tappin 2005) and the impacted area can be expected to recover quickly.

OSPAR (2009) concluded that the discharge of drill cuttings and water-based fluids may cause some smothering in the near vicinity of the well location. The impacts from such discharges are localised and transient, but may be of concern in areas with sensitive benthic fauna. Field

[17] OSPAR Decision 2000/3 on the Use of Organic-Phase Drilling Fluids (OPF) and the Discharge of OPF-Contaminated Cuttings came into effect in January 2001 and effectively eliminated the discharge of cuttings contaminated with oil based fluids (OBF) greater than 1% by weight on dry cuttings.

experiments on the effects of water-based drill cuttings on benthos by Trannum *et al.* (2011) found after 6 months only minor differences in faunal composition between the controls and those treated with drill cuttings. This corresponds with the results of field studies where complete recovery was recorded within 1-2 years after deposition of water-based drill cuttings (Daan & Mulder 1996, Currie & Isaacs 2005).

Finer particles may be dispersed over greater distances than coarser particles although exposure to WBM cuttings in suspension will in most cases be short-term (Bakke *et al.* 2013). Chemically inert, suspended barite has been shown under laboratory conditions to potentially have a detrimental effect on suspension feeding bivalves. Standard grade barite, the most commonly used weighting agent in WBMs, was found to alter the filtration rates of four bivalve species (*Modiolus modiolus, Dosinia exoleta, Venerupis senegalensis* and *Chlamys varia*) and to damage the gill structure when exposed to 0.5mm, 1.0mm and 2.0mm daily depth equivalent doses (Strachan 2010, Strachan & Kingston 2012). All three barite treatments altered the filtration rates leading to 100% mortality. The horse mussel (*M. modiolus*) was the most tolerant to standard barite with the scallop (*C. varia*) the least tolerant. Fine barite, at a 2mm daily depth equivalent, also altered the filtration rates of all species, but only affected the mortality of *V. senegalensis*, with 60% survival at 28 days. The bulk of WBM constituents (by weight and volume) are on the OSPAR list of substances used and discharged offshore which are considered to Pose Little or No Risk to the Environment (PLONOR). Barite and bentonite are the materials typically used in the greatest quantities in WBMs and are of negligible toxicity. Field studies undertaken by Strachan (2010) showed that the presence of standard grade barite was not acutely toxic to seabed fauna but did alter benthic community structure. When the suspended barite levels used in laboratory studies are translated to field conditions (i.e. distances from the point of discharge) it is clear that any effects will be very local to a particular installation (in the case of oil and gas facilities, well within 500m).

Relevant information on the recovery of benthic habitats to smothering mainly comes from studies of dredge disposal areas (see Newell *at al*. 1998). Recovery following disposal occurs through a mixture of vertical migration of buried fauna, together with sideways migration into the area from the edges, and settlement of new larvae from the plankton. The community recolonising a disturbed area is likely to differ from that which existed prior to construction. Opportunistic species will tend to dominate initially and on occasion, introduced and invasive species may then exploit the disturbed site (Bulleri & Chapman 2010). Harvey *et al.* (1998) suggest that it may take more than two years for a community to return to a closer resemblance of its original state (although if long lived species were present this could be much longer). Shallow water (<20m) habitats in wave or current exposed regimes, with unconsolidated fine grained sediments have a high rate of natural disturbance and the characteristic benthic species are adapted to this. Species tend to be short lived and rapid reproducers and it is generally accepted that they recover from disturbance within months. By contrast a stable sand and gravel habitat in deeper water is believed to take years to recover (see Newell *et al.* 1998, Foden *et al*. 2009).

As noted, there may be a requirement for jack-up rig stabilisation (e.g. rock placement or use of mud mats) depending on local seabed conditions. In soft sediments, rock deposits may

cover existing sediments resulting in a physical change of seabed type. The introduction of rock into an area with a seabed of sand and/or gravel can hypothetically provide "stepping stones" which might facilitate biological colonisation including by non-indigenous species by allowing species with short lived larvae to spread to areas where previously they were effectively excluded. On the UK continental shelf such "stepping stones" are already widespread and numerous for example in the form of rock outcrops, glacial dropstones and moraines, relicts of periglacial water flows, accumulations of large mollusc shells, carbonate cemented rock etc., and these are often revealed in UK rig site and other (e.g. pipeline route) surveys.

4.2.3 Presence and movement of vessels

Blocks may support important numbers of seabirds at certain times of the year including overwintering birds and those foraging from coastal SPAs. Therefore, the presence and/or movement of vessels and aircraft from and within Blocks during exploration and appraisal activities could temporarily disturb foraging seabirds from relevant SPA sites. The anticipated level of airborne noise from helicopter traffic associated with Block activity is likely to be insignificant in the context of existing helicopter, military and civilian aircraft activity levels. Given the mature nature of the regions within which 30th Round Blocks are being offered, helicopter traffic is also likely to use established routes. In view of the seasonal nature of the sensitivity, where relevant it is more appropriate to consider this in project level assessment (e.g. EIA and HRA where necessary), when the location and timing of activities are known.

Physical disturbance of seaduck and other waterbird flocks by vessel and aircraft traffic associated with hydrocarbon exploration and appraisal is possible, particularly in SPAs established for shy species (e.g. common scoter). Such disturbance can result in repeated disruption of bird feeding, loafing and roosting. For example, large flocks of common scoter were observed being put to flight at a distance of 2km from a 35m vessel, though smaller flocks were less sensitive and put to flight at a distance of 1km (Kaiser 2002, also see Schwemmer *et al.* 2011). Larger vessels would be expected to have an even greater disturbance distance (Kaiser *et al.* 2006). With respect to the disturbance and subsequent displacement of seabirds in relation to offshore wind farm (OWF) developments, the Joint SNCB interim displacement advice[18] recommends for most species a standard displacement buffer of 2km with the exception of the species groups of more sensitive divers and sea ducks for which a 4km displacement buffer has been recommended. Whilst displacement effects for divers have been detected at greater distances (e.g. 5-7km, Webb 2016), this relates to the construction and operation of offshore wind farms which have a much larger spatial and temporal footprint than oil and gas exploration activities.

[18] http://jncc.defra.gov.uk/pdf/Joint_SNCB_Interim_Displacement_AdviceNote_2017.pdf

4.3 Underwater noise

The sources, measurement, propagation, ecological effects and potential mitigation of noise associated with hydrocarbon exploration and production have been extensively reviewed, assessed and updated in each of the successive offshore energy SEAs (see DECC 2009, 2011, 2016).

4.3.1 Noise sources and propagation

Of those oil and gas activities that generate underwater sound, deep geological seismic surveys (2D and 3D) are of primary concern due to the high amplitude, low frequency and impulsive nature of the sound generated over a relatively wide area. As detailed in Section 2.2.2, no new 2D or 3D seismic surveys are proposed within the work programmes of the relevant Irish Sea Blocks applied for in the 30th Round. Consequently, sources of impulsive sound are restricted to the smaller volume air-guns and sub-bottom profilers used in site surveys and well evaluation (i.e. Vertical Seismic Profiling, VSP), and also from occasional conductor-piling during drilling (see Table 2.2). Compared to deep geological survey, these sources tend to generate sound of lower amplitude, are typically complete within several hours on a single day, are conducted from either a fixed point (VSP) or cover a small area (site surveys) and, in the case of some sub-bottom profilers, operate at a higher frequency than air-guns[19]. Consequently, the overall magnitude and area of risk from sound effects is considerably smaller than in the case of deep geological seismic surveys.

Drilling operations and support vessel traffic are sources of continuous noise (non-impulsive) of comparable amplitude and dominated by low frequencies and of a lower amplitude than deep geological seismic survey. Sound pressure levels of between 120dB re 1µPa in the frequency range 2-1,400Hz (Todd & White 2012) are probably typical of drilling from a jack-up rig, with slightly higher source levels likely from semi-submersible rigs due to greater rig surface area contact with the water column. In general, support and supply vessels (50-100m) are expected to have broadband source levels in the range 165-180dB re 1µPa@1m, with the majority of energy below 1kHz (OSPAR 2009). Additionally, the use of thrusters for dynamic positioning has been reported to result in increased sound generation (>10dB) when compared to the same vessel in transit (Rutenko & Ushchipovskii 2015).

For all sources, there is now a reasonable body of evidence to quantify sound levels associated with these activities and to understand the likely propagation of these sounds within the marine environment, even in more complex coastal locations (DECC 2016).

4.3.2 Potential ecological effects

Potential effects of anthropogenic noise on receptor organisms range widely, from masking of biological communication and small behavioural reactions, to chronic disturbance,

[19] It should be noted that airgun (including VSP) and sub-bottom profiling site surveys undertaken in relation to licences issued under the *Petroleum Act 1998* require consent under the *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended), but side-scan sonar and multibeam echosounder surveys only require to be notified to the Regulator (JNCC 2017b).

physiological injury and mortality. While generally the severity of effects tends to increase with increasing exposure to noise, it is important to draw a distinction between effects associated with physical (including auditory) injury and effects associated with behavioural disturbance. In addition to direct effects, indirect effects may also occur, for example via effects on prey species, complicating the overall assessment of significant effects. Marine mammals, and in particular the harbour porpoise, are regarded as the most sensitive to acoustic disturbance and are typically the focus of impact assessments; however, high amplitude impulsive noise also potentially presents a risk to fish and diving birds.

There are no sites with marine mammal or fish qualifying features which were screened in for underwater noise effects for the Blocks applied for in the Irish Sea region. The Blocks applied for are all distant (i.e. ≥90km) to areas of high use by grey and harbour seals associated with sites on the Irish coast, west coast of Scotland, and of grey seals associated with sites on the Welsh west coast (Jones *et al*. 2015); the relevant Blocks lie ≥50km from areas off the north Wales coast shown to be of importance to bottlenose dolphins associated with sites on the west coast of Wales (e.g. Evans *et al*. 2015), and also lie ≥50km from the boundary of the nearest site designated for harbour porpoise, the North Anglesey Marine cSAC.

While the Blocks applied for are distant to sites designated for harbour porpoise and bottlenose dolphin and do not overlap areas identified as of high importance to these species, it is acknowledged that these highly mobile animals do travel widely throughout the Irish Sea region, their management units[20] and beyond. As such, there is the potential for individuals affiliated with one or more sites elsewhere within their management units to be within sufficient range of the relevant Blocks to be exposed to underwater noise. Whilst a conclusion of no likely significant effect has been reached with regards to marine mammal sites of relevance to the Irish Sea area (see BEIS 2018), further protection is afforded to Annex IV species (which includes all cetaceans) throughout their range, whereby it is an offence to deliberately kill, injure, capture or disturb these animals. It is considered that the potential for disturbance offences to occur as a result of licensing cannot be validly assessed at this stage, though the consenting process for noise generating activities (i.e. VSP and rig site survey) will require operators to seek advice from regulators and SNCBs and undertake an impact assessment of potential impacts to cetaceans (and seals), including an assessment of potential impacts to protected sites and species where relevant. Current mitigation measures as described in JNCC guidelines are considered to be sufficient in minimising the risk of injury to negligible levels for the marine mammal species of relevance in this AA. Should disturbance of EPS be likely, further assessment will be required giving consideration to guidance provided by SNCBs[21] and the operator may be required to apply for an EPS disturbance licence.

[20] For harbour porpoise, the relevant identified management unit is the Celtic and Irish Seas - a large area including much of the Irish west coast and the western half of the English Channel; for bottlenose dolphins the relevant identified management unit is the Irish Sea - a smaller area bounded to the north by St George's channel and to the south by the southern extent of Cardigan Bay (IAMMWG 2015).
[21] For inshore waters of England, Wales and the UK offshore marine area - JNCC *et al*. (2010); for Scottish inshore waters - Marine Scotland (2014);

The following discussion focuses on potential effects of underwater noise on diving birds and their prey species, fish.

Diving birds

Direct effects from seismic exploration noise on diving birds could occur through physical damage, or through disturbance of normal behaviour, although evidence for such effects is very limited. Deeper-diving species which spend longer periods of time underwater (e.g. auks) may be most at risk of exposure to high-intensity noise from seismic survey and consequent injury or disturbance, but all species which routinely submerge in pursuit of prey and benthic feeding opportunities (i.e. excluding shallow plunge feeders) may be exposed to anthropogenic noise. A full list of relevant species occurring in the UK is provided in Box 4.1; of these, six species are qualifying features of sites in the Irish Sea region which this AA addresses: red-throated diver, common scoter, cormorant, red-breasted merganser, eider and goldeneye.

Very high amplitude low frequency underwater noise may result in acute trauma to diving seabirds, with several studies reporting mortality of diving birds in close proximity (i.e. tens of metres) to underwater explosions (Yelverton *et al*. 1973, Cooper 1982, Stemp 1985, Danil & St Leger 2011). However, mortality of seabirds has not been observed during extensive seismic operations in the North Sea and elsewhere. While seabird responses to approaching vessels are highly variable, flushing disturbance would be expected to displace most diving seabirds from close proximity to seismic airgun arrays, particularly among species more sensitive to visual disturbance such as scoter, divers and cormorant (Garthe & Hüppop 2004 and see Section 4.2.3). Therefore, the potential for acute trauma to diving birds from seismic survey is considered to be very low.

Data relating to the potential behavioural disturbance of diving birds due to underwater noise are very limited. The reported in-air hearing sensitivity for a range of diving duck species, red-throated diver and gannet have been tested for tone bursts between frequencies of 0.5-5.7kHz; results revealed a common region of greatest sensitivity from 1-3kHz, with a sharp reduction in sensitivity >4kHz (Crowell e*t al.* 2015). Similar results were observed for African penguin; tests of in-air hearing showed a region of best sensitivity of 0.6-4kHz, consistent with the vocalisations of this species (Wever *et al*. 1969). Testing on the long-tailed duck underwater showed reliable responses to high intensity stimuli (> 117 dB re 1µPa) from 0.5-2.9kHz (Crowell 2014). One recent study of underwater hearing in the cormorant suggested a hearing threshold of 70-75 dB re 1µPa rms for tones at tested frequencies of 1-4kHz (Hansen *et al*. 2017). The authors argue that this underwater hearing sensitivity, which is broadly comparable to that of seals and small odontocetes at 1-4kHz, is suggestive of the use of auditory cues for foraging and/or orientation and that cormorant, and possibly other species which perform long dives, are sensitive to underwater sound. A study showed that the use of acoustic pingers mounted on the corkline of a gillnet in a salmon fishery, emitting regular impulses of sound at *ca.* 2kHz, was associated with a significant reduction in entanglements of one species of interest, the guillemot, but not rhinoceros auklet (Melvin *et al*. 1999). In a playback experiment on wild African penguins, birds showed strong avoidance behaviour (interpreted as an antipredator response) when exposed to killer whale vocalisations and sweep frequency pulses, both of which were focussed between 0.5-3kHz (Frost *et al*. 1975).

McCauley (1994) inferred from vocalisation ranges that the threshold of perception for low frequency seismic noise in some species (e.g. penguins, considered as a possible proxy for auk species) would be high, hence individuals might be adversely affected only in close proximity to the source. A study investigated seabird abundance in Hudson Strait (Atlantic seaboard of Canada) during seismic surveys over three years (Stemp 1985). Comparing periods of shooting and non-shooting, no significant difference was observed in abundance of fulmar, kittiwake and thick-billed murre (Brünnich's guillemot). More recently, Pichegru *et al*. (2017) used telemetry data from breeding African penguins to document a shift in foraging distribution concurrent with a 2D seismic survey off South Africa. Pre/post shooting, areas of highest use (indicated by the 50% kernel density distribution) bordered the closest boundary of the seismic survey; during shooting, their distribution shifted away from the survey area, with areas of higher use at least 15km distant to the closest survey line. However, insufficient information was provided on the spatio-temporal distribution of seismic shooting or penguin distribution to determine an accurate displacement distance. It was reported that penguins quickly reverted to normal foraging behaviour after cessation of seismic activities, suggesting a relatively short-term influence of seismic activity on these birds' behaviour and/or that of their prey (Pichegru *et al*. 2017).

These data are limited, and further studies across a variety of diving species are required. However, the observed regions of greatest hearing sensitivity for cormorants in water and other diving birds in air are above those low frequencies (i.e. <500Hz) which dominate and propagate most widely from geological survey. While there is some evidence of noise-induced changes in the distribution and behaviour of diving birds in response to impulsive underwater noise, these have been temporary and may be a direct disturbance or reflect a change in fish distribution during that period (possibly as a result of seismic activities).

Box 4.1: Migratory and/or Annex I diving bird species occurring in the UK considered potentially vulnerable to underwater noise effects

Divers and grebes	**Diving ducks**
Great northern diver *Gavia immer* **Red-throated diver *Gavia stellata*** Black-throated diver *Gavia arctica* Little grebe *Tachybaptus ruficollis* Great crested grebe *Podiceps cristatus* Slavonian grebe *Podiceps auritus* **Seabirds** Manx shearwater *Puffinus puffinus* **Gannet *Morus bassanus*** Cormorant *Phalacrocorax carbo carbo* **Shag *Phalacrocorax aristotelis*** **Guillemot *Uria aalge*** Razorbill *Alca torda* Puffin *Fratercula arctica*	Pochard *Aythya ferina* Tufted duck *Aythya fuligula* Scaup *Aythya marila* **Eider *Somateria mollissima*** Long-tailed duck *Clangula hyemalis* **Common scoter *Melanitta nigra*** Velvet scoter *Melanitta fusca* **Goldeneye *Bucephala clangula*** **Red-breasted merganser *Mergus serrator*** Goosander *Mergus merganser*

*Note: Includes species which are known to engage in pursuit diving or benthic feeding in marine, coastal and estuarine waters at least during part of the year. Species in **bold** are those of relevance to the sites and Blocks considered within this AA.*

Fish

While there are no sites with fish qualifying features relevant to the Blocks considered in this assessment, it is important to consider fish as important prey items of seabird qualifying features. Example fish species of known importance to both diving seabirds and marine mammals in the Irish Sea include sandeels, herring and sprat. Many species of fish are highly sensitive to sound and vibration and broadly applicable sound exposure criteria have recently been published (Popper *et al.* 2014). Studies investigating fish mortality and organ damage from noise generated during seismic surveys are very limited and results are highly variable, from no effect to long-term auditory damage (reviewed in Popper *et al.* 2014). Behavioural responses to high amplitude noise (such as increased swimming speed and startle responses) have been widely reported (see DECC 2009), but are highly variable in nature and their biological significance is difficult to determine. Behavioural responses and effects on fishing success (i.e. increases or decreases in "catchability" depending on gear type) have been reported following seismic surveys for several species (Pearson *et al.* 1992, Skalski *et al.* 1992, Engås *et al.* 1996, Wardle *et al*. 2001).

Sandeels lack a swim bladder, which is considered to be responsible for their observed low sensitivity to underwater noise (Suga *et al*. 2005) and minor, short-term responses to exposure to seismic survey noise (Hassel *et al*. 2004), although data are currently limited. By contrast, herring are considered hearing specialists, detecting a broader frequency range than many species. Sprat are assumed to have similar sensitivities to herring due to their comparable morphology, although studies on this species are lacking. Observed responses of herring to underwater noise vary; for example, Peña *et al*. (2013) did not observe any changes in swimming speed, direction, or school size as a 3D seismic vessel slowly approached from a distance 27-2km to schools of feeding herring; conversely, Slotte *et al*. (2004) observed herring and other mesopelagic fish to be distributed at greater depth during periods of seismic shooting than non-shooting, and a reduced density within the survey area. Evidence for and against avoidance of approaching vessels by herring has been reported (e.g. Skaret *et al*. 2005, Vabø *et al*. 2002), with the nature of responses believed to be related to the activity of the school at the time.

Following a review of relevant studies, MMS (2004) consider that the "consensus is that seismic airgun shooting can result in reduced trawl and longline catch of several species when the animals receive levels as low as 160dB". These reduced catches are temporary in nature and likely reflect temporary displacement and/or altered feeding behaviour. No associations of lower-intensity, continuous drilling noise and fishing success have been demonstrated, and large numbers of fish are typically observed around North Sea (e.g. Løkkeborg *et al*. 2002, Fuji *et al*. 2015) and other production platforms (e.g. Stanley & Wilson 1991).

5 Assessment

The screening process (BEIS 2018) identified a number of sites where there was the potential for likely significant underwater noise, physical disturbance and/or drilling effects associated with proposed activities that could follow licensing of Blocks offered in the 30th Round. A number of these Blocks have been applied for (see Section 1.2) and the further assessment of licensing of these Blocks on relevant Natura 2000 sites (those shown in Figure 1.1) is given below. This assessment has been informed by the evidence base on the environmental effects of oil and gas activities (Section 4), and the assumed nature and scale of potential activities (Table 2.2).

5.1 Assessment of physical disturbance and drilling effects

5.1.1 Blocks and sites to be assessed

The nature and extent of potential physical disturbance and drilling effects are summarised in Section 4.2. On the basis of this information, in conjunction with the location of Blocks applied for in the 30th Round and the location of sites with relevant qualifying features, potential likely significant effects are considered to remain for five Blocks (or part Blocks), in respect of five sites (Figure 5.1) which are described below.

The Liverpool Bay/Bae Lerpwl SPA is in the east of the Irish Sea, bordering northern England and north Wales, and running as a broad arc from Morecambe Bay to the east coast of Anglesey. The seabed and waters of the site provide an important habitat in the non-breeding season for major concentrations of red-throated divers and sea ducks, notably common scoter, which visit the area to feed on the fish, mollusc and crustacean populations. Annual aerial surveys over winter from 2004-2011 revealed the distribution and abundance of red-throated diver, common scoter and other bird species within the site and adjacent waters (Lawson *et al*. 2016). Red-throated diver were widely distributed throughout the site, with the highest density areas off the north Wales coast, the Wirral, Formby and the mouth of the Ribble Estuary; areas of higher density were also recorded off the Duddon Estuary and south into outer Morecambe Bay. Common scoter were less widely distributed, with two areas of notably high density: off the north Wales coast from Rhos on Sea to the mouth of the Dee estuary, and off Blackpool from Fleetwood south to the mouth of the Ribble Estuary. Peak winter abundance shows large fluctuations between years; mean peak winter abundance estimates across the five years of survey were 1,409 red-throated diver and 57,995 common scoter, in addition to 826 for cormorant and 160 for red-breasted merganser (both also qualifying species). The recent extension to the site includes an area to the north and west of the existing SPA, identified to support non-breeding little gulls. The highest densities of little gull were consistently located offshore of Blackpool and the Ribble Estuary, close to the 12 nautical mile line (Lawson *et al.* 2016). The site also includes a marine foraging area for terns identified and defined by little terns breeding within The Dee Estuary SPA and the predicted foraging area for common terns breeding within Mersey Narrows & North Wirral Foreshore SPA. These areas add marine

habitat extending into the Mersey Estuary, and a small intertidal area abutting the western boundary of The Dee Estuary SPA. The seabed of the SPA consists of a wide range of mobile sediments. Large areas of muddy sand stretch from Rossall Point to the Ribble Estuary, and sand predominates in the remaining areas, with a concentrated area of gravelly sand off the Mersey Estuary[22]. Tidal currents throughout the Bay are generally weak and this combined with a relatively extended tidal range of 6 to 8m along the Lancashire coastline facilities the deposition of sediments, encouraging mud and sand belts to accumulate[23].

The boundary of the Morecambe Bay and Duddon Estuary SPA is formed by the recent amalgamation of two existing SPAs (Morecambe Bay SPA and Duddon Estuary SPA); and the addition of a marine foraging area for terns identified and defined by the modelled foraging area for sandwich terns breeding at Hodbarrow Lagoon. In total, 25 species of waterbirds and seabirds (gulls and terns) are present in qualifying numbers (≥1% of GB/biogeographic population); qualifying assemblages (in any season) of seabirds and waterbirds are present, with the latter including the diving species of eider, goldeneye, red-breasted merganser and cormorant[24]. While red-throated diver are not listed as qualifying features, aerial surveys indicate their presence within the site, particularly off the mouth of the Duddon Estuary. Morecambe Bay is a large, very shallow, predominantly sandy bay at the confluence of four principal estuaries, the Leven, Kent, Lune and Wyre. The Duddon Estuary is to the north of Morecambe Bay, although directly connected to it by Walney Channel. At low tide vast areas of intertidal sandflats are exposed, with small areas of mudflat, particularly in the upper reaches of the associated estuaries. The sediments of the bay are mobile and support a range of community types, from those typical of open coasts (mobile, well-sorted fine sands), grading through sheltered sandy sediments to low-salinity sands and muds in the upper reaches. Apart from the areas of intertidal flats and subtidal sandbanks, Morecambe Bay supports exceptionally large beds of mussels *Mytilus edulis* on exposed “scars" of boulder and cobble, and small areas of reefs with fucoid algal communities. Of particular note is the rich community of sponges and other associated fauna on tide-swept pebbles and cobbles at the southern end of Walney Channel[25]. Extensive intertidal eelgrass beds are present around Foulney Island and in the south Walney Channel. The Duddon and Ravenglass Estuaries support saltmarsh, intertidal mud and sand communities and sand dune systems with small areas of stony reef[26]. The Morecambe Bay SAC is a highly dynamic coastal and estuarine system which creates continually shifting channels and phases of erosion and accretion. The

[22] http://publications.naturalengland.org.uk/file/5301807986769920
[23] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/566835/liverpool-bay-bae-lerpwl-spa-departmental-brief.pdf
[24] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/641980/morecambe-duddon-citation.pdf
[25] http://publications.naturalengland.org.uk/file/4531557855395840
[26] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492891/morecambe-duddon-departmental-brief.pdf

total extent, distribution and character of most subtidal and intertidal habitats are therefore subject to high levels of change over both short and long periods of time[27].

The Ribble and Alt Estuaries SPA comprises two estuaries, of which the Ribble Estuary is the larger, together with an extensive area of sandy foreshore along the Sefton Coast. The site consists of extensive sand- and mud-flats and, particularly in the Ribble Estuary, large areas of saltmarsh. There are also areas of coastal grazing marsh located behind the sea embankments. The highest densities of feeding birds are on the muddier substrates of the Ribble, though sandy shores throughout are also used. The saltmarshes and coastal grazing marshes support high densities of grazing and seed-eating wildfowl and these, together with the intertidal sand- and mud-flats, are used as high-tide roosts. Important populations of waterbirds occur in winter, including swans, geese, ducks and waders. The SPA is also of major importance during the spring and autumn migration periods, especially for wader populations moving along the west coast of Britain. The larger expanses of saltmarsh and areas of coastal grazing marsh support breeding birds during the summer, including large concentrations of gulls and terns. These seabirds feed both offshore and inland, outside the SPA. In total, 21 species of waterbirds and seabirds (gulls and terns) are seasonally present in qualifying numbers (≥1% of GB/biogeographic population); qualifying assemblages of seabirds (breeding) and waterbirds (over-winter) are present, with the latter including the diving species of common scoter and cormorant[28].

The Shell Flat and Lune Deep SAC is characterised by a deep water channel (Lune Deep) and a large sandbank feature (Shell Flat) at the mouth of Morecambe Bay surrounded by shallower areas to the north and south. The reef habitat present in the Lune Deep represents a good example of boulder and bedrock reef with the northern edges of the channel characterised by heavily silted cobble and boulder slopes, subject to strong tidal currents with a dense hydroid and bryozoan turf (Emblow 1992). This unique enclosed deep hole provides a contrasting habitat to the surrounding muddy communities of the Eastern Irish Mudbelt. Data from a 2004 survey show that the northern flanks of Lune Deep are composed of exposed bedrock with a rugged seabed physiography. In contrast, the southern flank consists of a smooth seabed which is a sink for muddy sands[29]. Habitat distribution maps show the northern flank supporting moderate and exposed circalittoral rock habitats and the southern flank having mixed substrate biotopes with occasional sand influenced habitats (Envision 2015). The Shell Flat sandbank forms a continuous structure approximately 15km long from east to west. The bank is an example of a banner bank, which are generally only a few kilometres in length with an elongated pear/sickle-shaped form, located in water depths less than 20m. The predicted distribution of sediment types show the Shell Flat to be dominated by slightly gravelly sand on the top of the bank with slightly gravelly muddy sands in the deeper areas. The fine shallower sediments of the bank are occupied by the *Fabulina fabula* and *Magelona mirabilis* biotope

[27] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK0013027&SiteName=morecambe&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=#suppadvice
[28] http://jncc.defra.gov.uk/pdf/SPA/UK9005103.pdf
[29] http://publications.naturalengland.org.uk/file/3275848

with *Abra alba* and *Nucula nitidosa* biotope occurring in the deeper and slightly muddier sediments found on the slopes and in deeper areas of the bank (Envision 2015). Shell Flat is known to provide important habitats for commercial fish species and bird populations and overlaps with the Liverpool Bay SPA. Density estimates of the distribution of qualifying features within the SPA, indicate that the Shell Flat area coincides with high densities of overwintering common scoter in particular (Lawson *et al*. 2016).

5.1.2 Implications for site integrity of relevant sites

The conservation objectives of relevant sites and other relevant information relating to site selection and advice on operations has been considered against indicative Block work programmes for the Blocks applied for (see Section 2.2.1) to determine whether they could adversely affect site integrity. The results are given in Table 5.1 below. In terms of mitigation, all mandatory requirements (as given in Section 2.3.1), are assumed to be in place as a standard for all activities assessed here.

Figure 5.1: Sites and Blocks to be subject to further assessment for physical disturbance and drilling effects

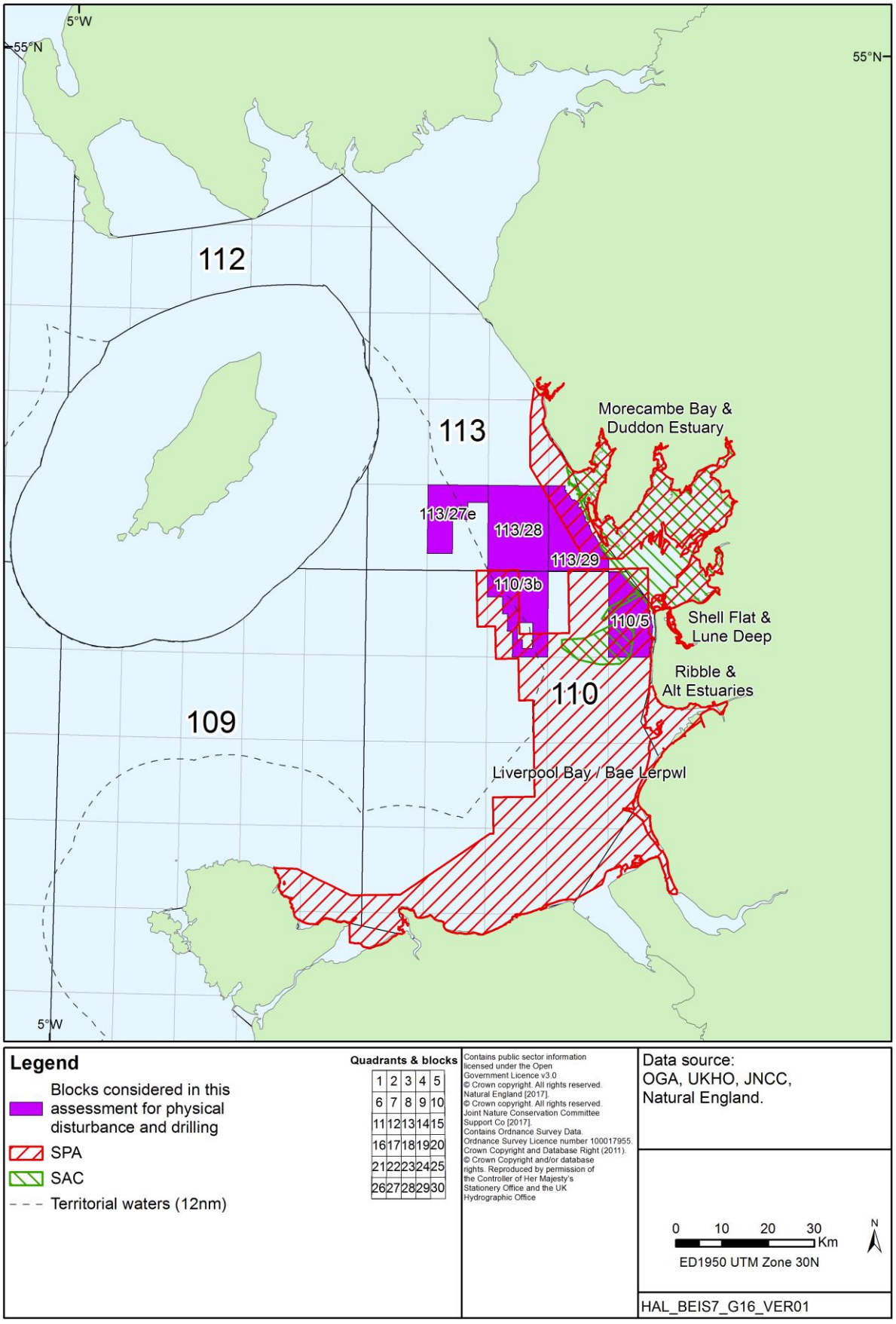


Table 5.1: Consideration of potential physical disturbance and drilling effects and relevant site conservation objectives

Liverpool Bay / Bae Lerpwl SPA

Site information

Area (ha): 252,757.73
Relevant qualifying features: Overwintering waterfowl, diver and gulls, breeding terns. Overwintering waterbird assemblage. See Natura 2000 standard data form for details of qualifying features[30]

Conservation objectives:
With regard to the SPA and the individual species and/or assemblage of species for which the site has been classified, and subject to natural change;
Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

- The extent and distribution of the habitats of the qualifying features
- The structure and function of the habitats of the qualifying features
- The supporting processes on which the habitats of the qualifying features rely
- The population of each of the qualifying features, and,
- The distribution of the qualifying features within the site.

Relevant Blocks for physical disturbance and drilling effects

110/3b, 110/5, 113/27e, 113/28, 113/29

Assessment of effects on site integrity

Rig siting
Block 113/27e is 6.5km from the site boundary and given the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2), rig installation will not significantly impact the extent and distribution of the habitats of the qualifying features. Blocks 113/28, 113/29 and 110/3b have significant areas outside the site boundaries in which rig siting would be possible, and therefore interaction with the habitats of the qualifying features could be avoided. With respect to Block 110/5 which is within the site, the maximum spatial footprint of physical damage associated with jack-up rig siting is small (0.8km^2) compared to the large site (covering <0.03%). The southern half of Block 110/5 partly coincides with an area of high common scoter density over winter (Lawson *et al.* 2016), the distribution of which is strongly associated with the distribution of its benthic prey species (Kaiser *et al*. 2006). Benthic communities of sandy sediments are in general relatively resilient to physical damage. However, repeated damage to the habitats (through changes in suspended sediment or physical disturbance such as anchoring) could adversely affect the ability of the habitats to recover, leading to permanent damage and ultimately lead to loss of prey species. This may result in a reduction in the value of habitats as foraging sites for the overwintering population of common scoter. Therefore, the overall sensitivity of common scoter to damage to their habitat is considered to be moderate in the case of siltation and abrasion impacts[31]. The work programme for Block 110/5 proposes a single well thus limiting the potential for repeated damage to supporting habitats, such that site conservation objectives will not be undermined.

The requirement for rig stabilisation measures would be determined by site survey of local conditions. In soft sediments, rock placement may cause smothering of existing sediments and a physical change of seabed type. Seabed sediments in Block 110/5 are likely to consist of muddy sands and sands which are widespread. It is assumed that if rock placement is required it would be within 500m of a rig and based on a review of submitted ESs could cover an area of 0.001-0.004km^2 (Table 2.2). Hence, the potential loss of extent of sediment is small compared to the widespread nature of these sediment types across the large site. Further mitigation measures are available (Section 5.1.3) and will be required, where appropriate to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

Drilling discharges
It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). Therefore with respect to Block 113/27e, drilling discharges will not significantly impact the extent and distribution or the structure and function of the habitats of the qualifying features. With respect to Blocks 113/28, 113/29 and 110/3b, as mentioned above there are significant areas outside the site in which drilling discharges would not

[30] http://jncc.defra.gov.uk/pdf/SPA/UK9020294.pdf
[31] http://publications.naturalengland.org.uk/file/5733149452009472

impact the site. However, if located within the site (as in the case of Block 110/5), the maximum spatial footprint within which smothering by drilling discharges may occur (0.8km^2) is small (representing 0.03% of the total site area). Physical loss by smothering of any of the habitats on which common scoter depend may result in the loss of foraging sites and therefore the reduction of the food resource for the overwintering population. This would consequently be detrimental to the favourable condition of the interest feature. Thus the overwintering population is considered to be highly sensitive to physical loss of habitat through its removal or smothering. However, the small scale (as compared to the extent of supporting habitat) and temporary nature of potential smothering, and mandatory mitigation requirements with respect to drilling chemical use and discharge (Section 2.3.1), will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

Rig/vessel presence and movement

Red-throated diver and common scoter are highly sensitive to disturbance from ship and helicopter traffic (Garthe & Hüppop 2004) and by extension, are likely to be equally sensitive to other sources of non-physical disturbance, especially those creating noise and/or movement. Disturbance can cause birds to reduce or cease feeding in a given area or to fly away from an area (i.e. be displaced[32]). Given that most of the Blocks have significant areas outside of the site boundaries, the potential for disturbance to impact the distribution of qualifying features within the site is primarily associated with the movement of supply vessels and helicopters to drilling rigs (that may be located outside of the site, with the exception of Block 110/5 which is wholly within the site). The Blocks are already exposed to high shipping densities[33] and the temporary and localised nature of drilling activities and limited number of associated supply vessel and helicopter trips (see Table 2.2) is unlikely to represent a significant increase in the level of disturbance of sensitive qualifying features. Further mitigation measures are available (Section 5.1.3) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

In-combination effects

Intra-plan in-combination effects are possible although spatial footprints associated with rig installation and drilling discharges in the Blocks are localised and temporary, and given that only Block 110/5 is wholly within the site, are unlikely to overlap either spatially or temporally between Blocks or with the site. There is also the potential for in-combination effects associated with the presence and movement of supply vessels and rigs within each of the Blocks. However, drilling operations for the 3 proposed wells and any appraisal or development wells proposed as part of the Second Term licence application for Blocks 113/28 and 113/29 are unlikely to coincide either spatially or temporally to such an extent that the level of disturbance would lead to significant adverse impacts on the population or distribution of sensitive qualifying features. Section 5.3 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

Morecambe Bay & Duddon Estuary SPA

Site information

Area (ha): 66,899

Relevant qualifying features: Overwintering and on passage waders, waterfowl and gulls, breeding terns and gulls. Seabird and waterbird assemblages in any season. See Natura 2000 standard data form for details of qualifying features[34].

Conservation objectives:

With regard to the potential SPA and the individual species and/or assemblage of species for which the site has been classified, and subject to natural change;

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

- The extent and distribution of the habitats of the qualifying features
- The structure and function of the habitats of the qualifying features
- The supporting processes on which the habitats of the qualifying features rely
- The population of each of the qualifying features, and,
- The distribution of the qualifying features within the site.

[32] http://publications.naturalengland.org.uk/file/5733149452009472

[33] https://www.ogauthority.co.uk/media/1419/29r_shipping_density_table.pdf, https://data.gov.uk/dataset/vessel-density-grid-2015

[34] http://jncc.defra.gov.uk/pdf/SPA/UK9020326.pdf

Relevant Blocks for physical disturbance and drilling effects
110/3b, 110/5, 113/27e, 113/28, 113/29
Assessment of effects on site integrity

Rig siting

Blocks 110/5, 110/3b and 113/27e are 3, 9 and 10km respectively from the site boundary and given the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2), rig installation will not significantly impact the extent and distribution of the habitats of the qualifying features. Blocks 113/28 and 113/29 have significant areas outside the site boundaries in which rig siting would be possible, and therefore interaction with the habitats of the qualifying features could be avoided. However, if located within the site, the maximum spatial footprint of physical damage associated with jack-up rig siting is small (0.8km^2) compared to the large site (covering 0.1%). The areas of overlap with the Block are primarily associated with the marine foraging area for terns identified and defined by the modelled foraging area for sandwich terns breeding at Hodbarrow Lagoon. Predicted usage is greatest in the vicinity of the colony[35], and given the limited spatial and temporary extent of physical damage associated with jack-up rig siting, activities are unlikely to significantly impact the extent and distribution of their habitats and undermine site conservation objectives.

The requirement for rig stabilisation measures would be determined by site survey of local conditions. In soft sediments, rock placement may cause smothering of existing sediments and a physical change of seabed type. With respect to Blocks 113/28 and 113/29, seabed sediments are likely to consist of muddy sands and sands which are widespread. It is assumed that if rock placement is required it would be within 500m of a rig and based on a review of submitted ESs could cover an area of 0.001-0.004km^2 (Table 2.2). Hence, the potential loss of extent of sediment is small compared to the widespread nature of these sediment types across the large site. Further mitigation measures are available (Section 5.1.3) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

Drilling discharges

It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). Therefore with respect to Blocks 110/5, 110/3b and 113/27e, drilling discharges will not significantly impact the extent and distribution or the structure and function of the habitats of the qualifying features. Blocks 113/28 and 113/29 have significant areas outside the site in which drilling discharges would not impact the site. However, if located within the site, the maximum spatial footprint within which smothering by drilling discharges may occur (0.8km^2) is small (representing 0.1% of the total site area) and given the mobile nature of the sediments within the area of overlap, redistribution of drilling discharges and recovery from smothering would be rapid. The small scale and temporary nature of potential smothering, and mandatory mitigation requirements with respect to drilling chemical use and discharge (Section 2.3.1), will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

Rig/vessel presence and movement

Blocks 113/28 and 113/29 are the only Blocks where there is the potential for a rig to be present within the site and for both Blocks there are significant areas outside the site boundaries in which rig siting would be possible. Therefore, the potential for disturbance to impact the distribution of qualifying features is primarily associated with the movement of supply vessels and helicopters to drilling rigs. Of the qualifying features likely to be present within relevant parts of the site, breeding common tern, sandwich tern, lesser black-backed gull and herring gull are all moderately sensitive to disturbance by ship and helicopter traffic (Garthe & Hüppop 2004). Both Blocks 113/28 and 113/29 are currently exposed to high shipping densities[36], and the temporary nature of drilling activities and limited number of associated supply vessel and helicopter trips (Table 2.2), is unlikely to represent a significant increase in the level of disturbance of moderately sensitive qualifying features. Further mitigation measures are also available (Section 5.1.3) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

In-combination effects

No intra-plan in-combination effects are likely with respect to the spatial footprints associated with rig siting and drilling discharges given that although Blocks 113/28 and 113/29 transect the site, this includes only a very small

[35] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492891/morecambe-duddon-departmental-brief.pdf

[36] https://www.ogauthority.co.uk/media/1419/29r_shipping_density_table.pdf, https://data.gov.uk/dataset/vessel-density-grid-2015

area of 113/28. Therefore the likelihood of in-combination footprint effects is low. There is the potential for in-combination effects associated with the presence and movement of supply vessels to rigs within each of the Blocks. However, given the existing high shipping densities and the limited and temporary supply vessel traffic (see Table 2.2) intra-plan effects are not considered likely for the five Blocks. Further mitigation measures are also available (Section 5.1.3) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity. Section 5.3 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

Ribble and Alt Estuaries SPA

Site information

Area (ha): 12,449.92
Relevant qualifying features: Breeding terns, gulls and waders; on passage waders; overwintering waders, waterfowl and gulls. Breeding seabird and overwintering waterfowl assemblages. See Natura 2000 standard data form for details of qualifying features[37].

Conservation objectives:
With regard to the SPA and the individual species and/or assemblage of species for which the site has been classified, and subject to natural change;
Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

- The extent and distribution of the habitats of the qualifying features
- The structure and function of the habitats of the qualifying features
- The supporting processes on which the habitats of the qualifying features rely
- The population of each of the qualifying features, and,
- The distribution of the qualifying features within the site.

Relevant Blocks for physical disturbance and drilling effects

110/5

Assessment of effects on site integrity

Rig siting
Block 110/5 is a minimum of 6km from the site boundary and given the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2), rig installation and associated stabilisation (if required) will not significantly impact the extent and distribution of the habitats of the qualifying features. No adverse effect on site integrity.

Drilling discharges
It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). Therefore with respect to Block 110/5, drilling discharges will not significantly impact the extent and distribution or the structure and function of the habitats of the qualifying features. No adverse effect on site integrity.

Rig/vessel presence and movement
Given that the Block is outside of the site boundary, the potential for disturbance to impact the distribution of qualifying features within the site is primarily associated with the movement of supply vessels and helicopters to drilling rigs. The qualifying features are sensitive to visual disturbance and airborne noise although these are low risk pressures[38]. Part of Block 110/5 is exposed to very high shipping densities as part of a traffic separation scheme[39]. The temporary nature of drilling activities and limited number of associated supply vessel and helicopter trips (Table 2.2), is unlikely to represent a significant increase in the level of disturbance of these qualifying features. However, further mitigation measures are available (Section 5.1.3) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

In-combination effects
No intra-plan in-combination effects are likely with respect to the spatial footprints associated with rig siting and

[37] http://jncc.defra.gov.uk/pdf/SPA/UK9005103.pdf
[38] https://designatedsites.naturalengland.org.uk/Marine/FAPMatrix.aspx?SiteCode=UK9005103&SiteName=ribble&SiteNameDisplay=Ribble+and+Alt+Estuaries+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=
[39] https://www.ogauthority.co.uk/media/1419/29r_shipping_density_table.pdf

drilling discharges given that the Block is outside of the site boundary. There is the potential for in-combination effects associated with the presence and movement of supply vessels to rigs within the Block. However, given the existing high shipping densities and the limited and temporary supply vessel traffic (see Table 2.2) intra-plan effects are not considered likely for the Block. Section 5.3 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

Morecambe Bay SAC

Site information

Area (ha): 61,538.23
Relevant qualifying features: Estuaries, mudflats and sandflats, inlets and bays, vegetation of stony banks, saltmarsh and salt meadows, coastal dunes, sandbanks, coastal lagoons, reefs, great crested newt.

Conservation objectives:
With regard to the natural habitats and/or species for which the site has been designated, and subject to natural change;
Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring;

- The extent and distribution of qualifying natural habitats and habitats of qualifying species
- The structure and function (including typical species) of qualifying natural habitats
- The structure and function of the habitats of qualifying species
- The supporting processes on which qualifying natural habitats and habitats of qualifying species rely
- The populations of qualifying species, and,
- The distribution of qualifying species within the site.

Relevant Blocks for physical disturbance and drilling effects

110/5, 113/28, 113/29

Assessment of effects on site integrity

Rig siting
Block 113/28 is a minimum of 4km from the site boundary and given the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2), rig installation will not significantly impact the extent and distribution of the qualifying habitats. Blocks 110/5 and 113/29 are on the site boundary and have significant areas outside the site boundaries in which rig siting would be possible, and therefore interaction with the habitats of the qualifying features could be avoided. If located within the site (only possible for Block 110/5), the maximum spatial footprint of physical damage associated with jack-up rig siting is small (0.8km^2) but the qualifying habitats are sensitive to abrasion pressure[40]. However, given the dynamic nature of the site, recovery from physical damage of the scale associated with rig placement would be rapid. The small scale and temporary nature of the potential physical damage will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

The requirement for rig stabilisation measures would be determined by site survey of local conditions. In soft sediments, rock placement may cause smothering of existing sediments and a physical change of seabed type. With respect to Blocks 110/5 and 113/29, seabed sediments are likely to consist of muddy sands and sands which are widespread. It is assumed that if rock placement is required it would be within 500m of a rig and based on a review of submitted ESs could cover an area of 0.001-0.004km^2 (Table 2.2). Hence, the potential loss of extent of sediment is small compared to the widespread nature of these sediment types across the region. Further mitigation measures are available (Section 5.1.3) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

Drilling discharges
It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). Therefore drilling discharges relating to Block 113/28 will not significantly impact the extent and distribution or the structure and function of the qualifying habitats. With respect to Blocks 110/5 and 113/29, as mentioned above there are significant areas outside the site in which drilling discharges would not impact the site. However, if located within the site, the maximum spatial footprint within which smothering by drilling discharges may occur (0.8km^2) is small (representing 0.1% of the total site area) but the qualifying features are sensitive to smothering

40 https://designatedsites.naturalengland.org.uk/Marine/FAPMatrix.aspx?SiteCode=UK0013027&SiteName=morecambe&SiteNameDisplay=Morecambe+Bay+SAC&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

and siltation rate changes. However, given the dynamic nature of the site, redistribution of drilling discharges and recovery from smothering would be rapid. The small scale and temporary nature of potential smothering, and mandatory mitigation requirements with respect to drilling chemical use and discharge (Section 2.3.1), will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

In-combination effects
Intra-plan in-combination effects are possible although spatial footprints associated with rig installation and drilling discharges in Blocks 110/5 and 113/29 (i.e. those Blocks partly within the site) are localised and temporary, and unlikely to overlap between Blocks either spatially or temporally. The small scale and temporary nature of the disturbance, the dynamic nature of the site and available mitigation (Sections 2.3.1 and 5.1.3), will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity. Section 5.3 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

Shell Flat and Lune Deep SAC

Site information

Area (ha): 10,567.49
Relevant qualifying features: Sandbanks, reefs

Conservation objectives:
The objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the Favourable Conservation Status of its qualifying features, by maintaining or restoring:

- the extent and distribution of qualifying natural habitats and habitats of the qualifying species
- the structure and function (including typical species) of qualifying natural habitats
- the structure and function of the habitats of the qualifying species
- the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely
- the populations of qualifying species
- the distribution of qualifying species within the site

Relevant Blocks for physical disturbance and drilling effects

110/3b, 110/5, 113/29

Assessment of effects on site integrity

Rig siting
Blocks 110/3b and 113/29 are a minimum of 3 and 6km respectively from the site boundary and given the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2), rig installation will not significantly impact the extent and distribution of the qualifying features. Block 110/5 has significant areas outside the site boundaries in which rig siting would be possible, and therefore interaction with the qualifying features could be avoided. If located within the site, the maximum spatial footprint of physical damage associated with jack-up rig siting is small (0.8km^2) but the qualifying features are sensitive to abrasion pressure[41]. Recovery from physical damage of the scale associated with rig placement would be rapid in light of the strong tidal currents in the Lune Deep area and the shallow nature of Shell Flat. Further mitigation measures are available (Section 5.1.3) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

The requirement for rig stabilisation measures would be determined by site survey of local conditions. In soft sediments, rock placement may cause smothering of existing sediments and a physical change of seabed type. With respect to Block 110/5, there are significant areas outside of the site boundaries in which rig siting and stabilisation would be possible, and therefore interaction with the qualifying features could be avoided. If located within the site, it is assumed that if rock placement is required it would be within 500m of a rig and based on a review of submitted ESs could cover an area of 0.001-0.004km^2 (Table 2.2). Further mitigation measures are available (see Section 5.1.3) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

41 https://designatedsites.naturalengland.org.uk/Marine/FAPMatrix.aspx?SiteCode=UK0030376&SiteName=shell+flat&SiteNameDisplay=Shell+Flat+and+Lune+Deep+SCI&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

Drilling discharges
It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2) and therefore drilling discharges will not significantly impact the extent and distribution or the structure and function of the qualifying features given the distance of Blocks 110/3b and 113/29 from the site. With respect to Block 110/5, as mentioned above there are significant areas outside the site in which drilling discharges would not impact the site. However, if located within the site, the maximum spatial footprint within which smothering by drilling discharges may occur (0.8km^2) is small but the qualifying features are sensitive to smothering and siltation rate changes. Recovery from smothering of the scale associated with drilling discharges would be rapid in light of the strong tidal currents in the Lune Deep area and the shallow nature of Shell Flat. The small scale and temporary nature of potential smothering, and mandatory mitigation requirements with respect to drilling chemical use and discharge (Section 2.3.1), will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

In-combination effects
No intra-plan in-combination effects are likely with respect to the spatial footprints associated with rig siting and drilling discharges given that Block 110/5 is the only one that transects the site. Section 5.3 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

5.1.3 Further mitigation measures

Further mitigation measures are available which are identified through the EIA process and operator's environmental management and the BEIS permitting processes. These considerations are informed by project specific plans and the nature of the sensitivities identified from detailed seabed information collected in advance of field activities taking place. Site surveys are required to be undertaken before drilling rig placement (for safety and environmental reasons) and the results of such surveys (survey reports) allow for the identification of further mitigation including the re-siting of activities (e.g. wellhead or rig leg positions) to ensure sensitive seabed surface features (such as reefs) are avoided and potential rig stabilisation issues (e.g. from scouring around spud cans, or soft sediment conditions) are minimised. Where rig stabilisation is required, BEIS will expect operators to provide adequate justification for the stabilisation option proposed, minimise the volume of rock deposited[42] or consider utilising systems (e.g. anti-scour mats, mud mats) that can be removed following drilling. For those Blocks where proposed activities could result in the physical disturbance of overwintering divers by vessels and aircraft traffic, available mitigation measures include strict use of existing shipping and aircraft routes, and timing controls on temporary activities to avoid sensitive periods.

Survey reports are used to underpin operator environmental submissions (e.g. EIAs) and where requested, survey reports are made available to nature conservation bodies during the consultation phases of these assessments[43].

In all instances, consent for project-level activities will not be granted unless the operator can demonstrate that the proposed exploration activities will not have an adverse effect on the integrity of relevant sites. The information provided by operators in their applications must be

[42] This will be informed by a BEIS study currently underway comparing rock volumes estimated in operator applications with those actually used (from returns) which will report later this year.
[43] Whether within or outside an SAC, rig site survey typically includes a consideration of the presence of, amongst other sensitivities, Annex I habitats.

detailed enough for BEIS (and its advisors) to make a decision on whether the activities could lead to a likely significant effect.

5.1.4 Conclusions

Likely significant effects identified with regards to physical damage to the seabed, drilling discharges and other effects (see Section 5.1.2) when considered along with project level mitigation (Section 5.1.3) and relevant activity permitting (see Sections 2.3.1 and 5.1.3), will not have an adverse effect on the integrity of the Natura 2000 sites considered in this assessment. There is a legal framework through the implementation of the EIA Regulations and the Habitats Directive, to ensure that there are no adverse effects on the integrity of Natura 2000 sites. These would be applied at the project level, at which point there will be sufficient definition to make an assessment of likely significant effects, and for applicants to propose project specific mitigation measures.

Taking into account the information presented above, it is concluded that activities arising from the licensing of those Blocks listed in Table 5.1, in so far as they may generate physical disturbance and drilling effects, will not cause an adverse effect on the integrity of the relevant sites identified. Consent for activities will not be granted unless the operator can demonstrate that the proposed activities which may include the drilling of a number of wells and any related activity including the placement of a drilling rig, will not have an adverse effect on the integrity of relevant sites.

5.2 Assessment of underwater noise effects

5.2.1 Blocks and sites to be assessed

The nature and extent of potential underwater noise effects are summarised in Section 4.3. On the basis of this information, in conjunction with the location of Blocks applied for in the 30th Round and the location of sites with relevant qualifying features, potential likely significant effects are considered to remain for five Blocks (or part Blocks), in respect of three sites (Figure 5.2).

Descriptions of the three sites and their qualifying features, which are also assessed for physical and drilling effects, are provided earlier in Section 5.1.1. Qualifying features of relevance to underwater noise effects are noted below in Table 5.2.

5.2.2 Implications for site integrity of relevant sites

The site conservation objectives and other relevant information relating to site selection and advice on operations has been considered against indicative Block work programmes (see Section 2.2.1) to determine whether they could adversely affect site integrity, i.e. impacts the site features, either directly or indirectly, and result in disruption or harm to the ecological structure and functioning of the site and/or affects the ability of the site to meet its conservation objectives. The results are given in Table 5.2 below. In terms of mitigation, all mandatory requirements (as given in Section 2.3.2) are assumed to be in place as a standard for all activities assessed at this stage.

Importantly, the work programmes do not propose to shoot new 2D or 3D seismic survey within any of the southern Irish Sea Blocks offered in the 30th Round, and there are also no relevant sites with marine mammal qualifying features. Therefore, the assessment is focussed on potential underwater noise impacts to diving birds associated with rig site survey, VSP and conductor piling (as described in Section 4.3).

Figure 5.2: Sites and Blocks to be subject to further assessment for underwater noise effects

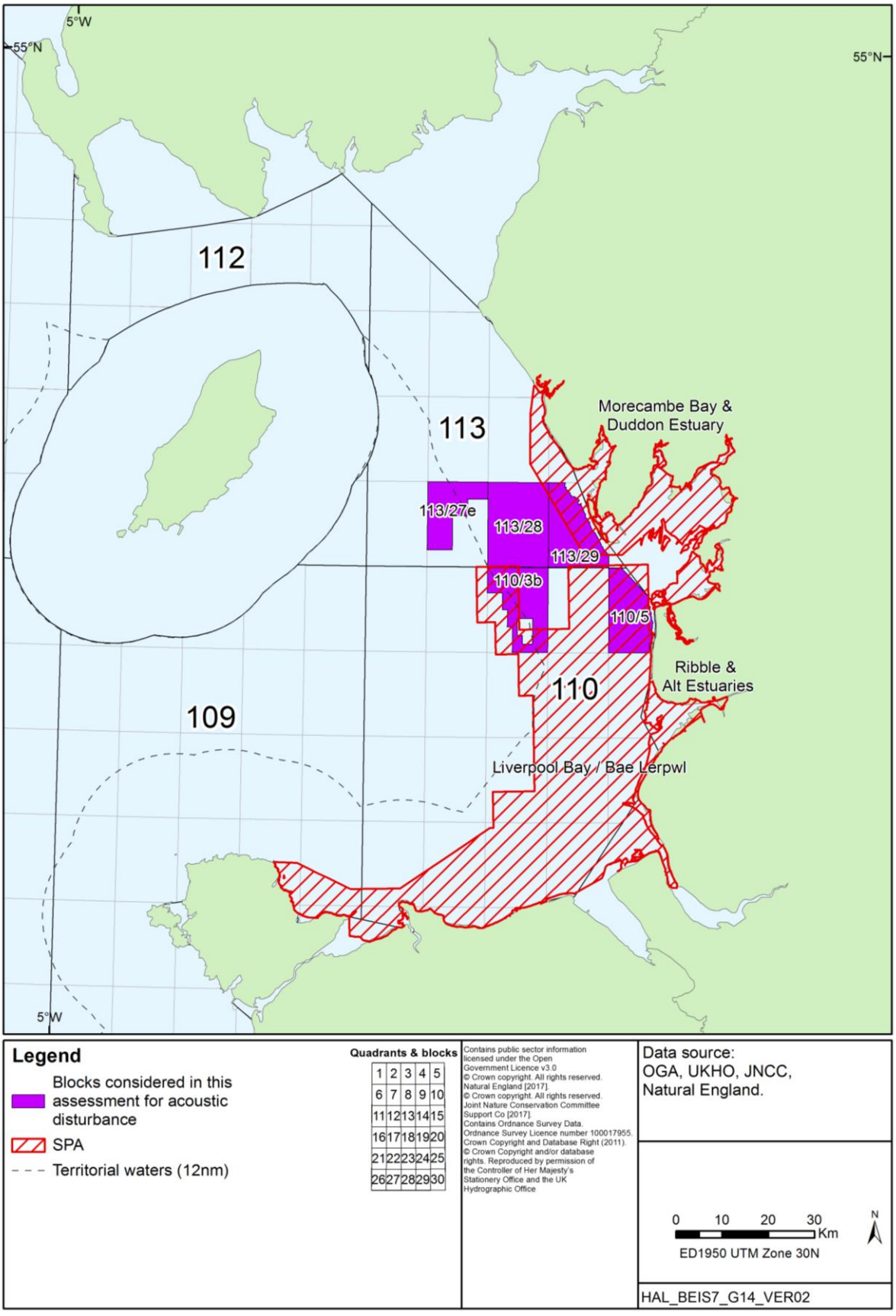


Table 5.2: Consideration of potential underwater noise effects and relevant site conservation objectives

Liverpool Bay / Bae Lerpwl SPA
Site information
Area (ha): 252,757.73 **Relevant qualifying features:** See Table 5.1 above. **Conservation objectives:** See Table 5.1 above.
Relevant Blocks for underwater noise effects
110/3b, 110/5, 113/27e, 113/28, 113/29
Assessment of effects on site integrity
Rig site survey and VSP The relevant Blocks for underwater noise effects are located at the northern end of Liverpool Bay SPA: Block 113/27e is 6.5km from the site boundary; Blocks 113/28 and 113/29 are adjacent to the northern boundary of the site, with a small area of overlap between the site and Block 113/29; Block 110/3b partially overlaps; and, Block 110/5 almost completely overlaps with the site. The areas within the site identified as supporting the highest densities of red-throated diver over winter are to the south of Blocks 110/5 and 110/3b. While the distribution of these mobile species within the site will vary, there appears to limited spatial overlap between the Blocks and those areas of greatest importance for divers and therefore a low potential for underwater noise effects. The southern half of Block 110/5 partially overlaps an area identified as supporting high densities of common scoter density over winter; all other relevant Blocks show no overlap with surveyed areas in the greater Liverpool Bay region shown to be of particular importance to common scoter. As detailed in Section 4.3.2, there is very little information on the potential impact of underwater noise on diving birds. Mortality of seabirds has not been observed during extensive seismic operations in the North Sea and elsewhere, and flushing disturbance associated with the physical presence of survey vessels and rigs would be expected to displace most diving seabirds from close proximity to noise sources, particularly in the case of divers and scoters which are known to display a large avoidance radius of vessels and surface infrastructure (up to several kilometres). Such avoidance behaviour is also expected to reduce the potential for diving birds to be exposed to noise levels which may result in potential behavioural disturbance, although it is noted that very little evidence for such effects exist and they would be expected to be short-term, temporary and, considering the nature of VSP and rig-site survey activities, of limited spatial extent. Negative indirect effects of rig site survey and VSP activities on qualifying features may arise through effects on prey species, primarily small fish, if those prey are subject to injury or disturbance which reduce their availability to qualifying seabirds. Such effects relate to the primarily piscivorous red-throated diver, as the winter diet of common scoter is largely restricted to sessile bivalves on the seabed (Fox 2003). While there is some evidence that a reduction in fish catches can be associated with seismic survey activity, these effects are temporary in nature. Any such effects associated with VSP or rig site survey are expected to be minor, considering their shorter duration, smaller spatial extent and lower amplitude source relative to the 2D and 3D seismic surveys (to which most reported effects relate). Additionally, the disturbance of sensitive spawning periods for potential fish prey species will be considered through the activity consenting process. Consequently, any underwater noise effects on fish associated with the licensing of relevant Blocks are not anticipated to result in significant effects on the food resources of the qualifying seabird features. Considering the above, it is concluded that underwater noise effects from VSP and rig-site survey associated with the licensing of relevant Blocks will not represent an adverse effect on the integrity of the site. **Conductor piling** The impulsive underwater noise produced should conductors need to be piled into the seabed is of significantly lower magnitude than that generated in the piling of offshore wind turbine monopile foundations (see Table 2.2). Considering the noise source characteristics, the location of the majority of the Blocks relative to the distribution of qualifying features within the site, the propensity of strong avoidance of surface structures by the qualifying features, the short duration of the activity, and the only occasional use of this technique to meet technical requirements; when combined with mandatory mitigation measures (Section 2.3.2), any disturbance to qualifying features or their prey will be highly localised, short-term, and will not result in an adverse effect on site integrity.

In-combination effects
Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above and the limited area of overlap between relevant Blocks and the site. Section 5.3 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

Morecambe Bay & Duddon Estuary SPA

Site information

Area (ha): 66,899
Relevant qualifying features: See Table 5.1 above.
Conservation objectives: See Table 5.1 above.

Relevant Blocks for underwater noise effects

110/3b, 110/5, 113/27e, 113/28, 113/29

Assessment of effects on site integrity

Rig site survey and VSP
Block 113/29 has considerable overlap with the site, Block 113/28 has a small area of overlap, Block 110/5 is adjacent to the site at the southern end of Morecambe Bay, and the other two Blocks are both >8km from the nearest site boundary. The diving species of eider, goldeneye, red-breasted merganser and cormorant are present within the site and have the potential to be affected by noise from rig site surveys and/or VSPs occurring in overlapping Blocks or those immediately adjacent to the site.

As detailed in Section 4.3.2, there is very little information on the potential impact of underwater noise on diving birds. Mortality of seabirds has not been observed during extensive seismic operations in the North Sea and elsewhere, and flushing disturbance associated with the physical presence of survey vessels and rigs would be expected to displace most diving seabirds from close proximity to noise sources. Such avoidance behaviour is also expected to reduce the potential for diving birds to be exposed to noise levels which may result in potential behavioural disturbance, although it is noted that very little evidence for such effects exist and they would be expected to be short-term, temporary and, considering the nature of VSP and rig-site survey activities, of limited spatial extent.

Negative indirect effects of rig site survey and VSP activities on qualifying features may arise through effects on prey species, primarily small fish, if those prey are subject to injury or disturbance which reduce their availability to qualifying seabirds. Such effects are not anticipated for eider or goldeneye, as their diet in coastal habitats is largely restricted to molluscs and crustaceans. While there is evidence that a reduction in fish catches can be associated with seismic survey activity, these are temporary in nature. Any such effects associated with VSP or rig site survey are expected to be minor, considering their shorter duration, smaller spatial extent and lower amplitude source relative to the 2D and 3D seismic surveys (to which most reported effects relate). Additionally, the disturbance of sensitive spawning periods for potential fish prey species will be considered through the activity consenting process. Consequently, any underwater noise effects on fish associated with the licensing of relevant Blocks are not anticipated to result in significant effects on the food resources of the qualifying seabird features.

Considering the above, it is concluded that underwater noise effects from VSP and rig-site survey associated with the licensing of relevant Blocks will not represent an adverse effect on the integrity of the site.

Conductor piling
Considering the noise source characteristics, the location of the majority of the Blocks, the short duration of the activity, and the only occasional use of this technique to meet technical requirements; when combined with mandatory mitigation measures (Section 2.3.2), any disturbance to qualifying features or their prey will be highly localised, short-term, and will not result in an adverse effect on site integrity.

In-combination effects
Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above and the limited area of overlap between relevant Blocks (largely restricted to 113/29) and the site. Section 5.3 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

Ribble and Alt Estuaries SPA

Site information

Area (ha): 12,449.92
Relevant qualifying features: See Table 5.1 above.
Conservation objectives: See Table 5.1 above.

Relevant Blocks for underwater noise effects
110/5
Assessment of effects on site integrity
Rig site survey and VSP Block 110/5 is located a minimum of 6km from the site. Given the location of the site relative to the Block, and the amplitude and likely propagation of noise from rig site survey and/or VSP, the likelihood of significant behavioural disturbance of the qualifying features due to underwater noise is considered remote. The diet of common scoter in the non-breeding season is dominated by sessile bivalve molluscs; as such, underwater noise effects on prey species are not anticipated. While cormorant are piscivorous and their fish prey species have the potential to be temporarily displaced by underwater noise; however, such effects are considered highly unlikely to significantly impact upon the qualifying feature given nature of the noise source and distance between the Block and the site. Considering the above, it is concluded that underwater noise effects from VSP and rig-site survey associated with the licensing of relevant Blocks will not represent an adverse effect on the integrity of the site. **Conductor piling** Given the location of the site relative to the Block, and the amplitude and likely propagation of noise from conductor piling, the likelihood of significant behavioural disturbance of the qualifying features or their prey is considered remote and will not represent an adverse effect on the integrity of the site. **In-combination effects** Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above and that only one Block is considered relevant (but non-overlapping) to the site for such effects. Section 5.3 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

5.2.3 Further mitigation measures

The assessment concluded that no further mitigation measures were required beyond existing regulatory controls (see Section 2.3.2) in order to avoid adverse effects on the integrity of the relevant sites. BEIS require operators to provide sufficient information in the EIA on the potential impact of proposed activities on relevant sites and their qualifying features as well as proposed further mitigation measures in their applications for a Geological Survey consent, though it should be noted that no seismic survey has been proposed in any of the Irish Sea Block work programmes. The information provided by operators must be detailed enough for BEIS to make a decision on whether the activities could lead to a likely significant effect, and whether the activities should therefore be subject to the requirement for HRA. Depending on the nature and scale of the proposed activities (e.g. area of survey, source size, timing and proposed mitigation measures) and whether likely effects are identified for these, BEIS may undertake further HRA to assess the potential for adverse effects on the integrity of sites at the activity specific level. As part of consent condition, operators would be required to follow the JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys.

Consent for project-level activities will not be granted unless the operator can demonstrate that the proposed activities, which may include small-scale geophysical rig site survey, VSP and drilling (which may incorporate conductor piling), will not have an adverse effect on the integrity of relevant sites.

5.2.4 Conclusion

The risks of injury and disturbance to relevant qualifying features is limited both by the nature of the indicative work programmes for the Blocks applied for and controls currently in place, such that it is concluded that activities arising from the licensing of those Blocks listed in Table 5.2, in so far as they may generate underwater noise effects, will not cause an adverse effect on the integrity of the relevant sites identified. Consent for project specific activities will not be granted unless the operator can demonstrate that the proposed activities which may include rig site survey, VSP or conductor piling, will not have an adverse effect on the integrity of relevant sites. These activities may be subject to activity level EIA and where appropriate, HRA.

5.3 In-combination effects

5.3.1 Introduction

Potential incremental, cumulative, synergistic and secondary effects from a range of operations, discharges and emissions (including noise) were considered in the latest Offshore Energy SEA (DECC 2016; see also OSPAR 2000, 2010[44]). There are a number of potential interactions between activities that may follow licensing and those existing or planned activities in the Irish Sea, for instance in relation to renewable energy, fishing, shipping and aggregate extraction. These activities are subject to strategic level and individual permitting or consenting mechanisms, or are otherwise managed at a national or international level. In English waters the North West Inshore and Offshore Marine Plans are in preparation[45], and the Welsh National Marine Plan is presently subject to consultation[46]. Each plan aims to set out objectives and policies to guide development in English and Welsh sectors of the Irish Sea over a 20-year period.

The potential for effects in-combination with other plans or projects was considered and a number of sites were highlighted in Sections 5.1 and 5.2 for which there is the potential for intra-plan in-combination effects (i.e. that multiple Blocks have the potential to be licensed within the same site).

5.3.2 Sources of potential effect

Table 5.3 and Figures 5.3-5.4 highlight projects which have recently been granted consent or are currently subject of an application for consent and have the potential for interaction with operations that could potentially arise from 30th Round Block licensing. Interactions were identified on the basis of the nature and location of the proposed activities, using a combination of documents submitted as part of project applications and related spatial datasets in a Geographic Information System (GIS). Additionally, potential interactions with existing activities are considered including those associated with oil and gas, shipping, military practice and exercise and fisheries.

The principal sources of in-combination effects are regarded to be related to noise, physical disturbance, and physical presence, primarily arising from offshore wind development. OWF development will introduce noise and disturbance sources (particularly during construction) and present an additional physical presence in the marine environment. Offshore wind zones (e.g. Round 3) have already been subject to SEA and HRA, and any related projects have been or will be subject to their own individual assessment and HRA processes[47]. Figure 5.3

[44] Note that an intermediate assessment was published by OSPAR in 2017: https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/
[45] https://www.gov.uk/government/collections/north-west-marine-plan
[46] https://consultations.gov.wales/consultations/draft-welsh-national-marine-plan
[47] For those sites having already been subject to HRA, note that the competent authority is under an obligation to reconsider and review consents for projects that are likely to have a significant effect on new SAC and SPA sites once they become a candidate site.

indicates the location of wind farms/wind farm zones in relation to the Blocks subject to this assessment and relevant Natura 2000 sites.

The UK Government believes that the oil & gas and renewables industry can successfully co-exist, as stated in OGA's Other Regulatory Issues for the 30th Round, "…*we [(OGA)] advise that potential applicants on such blocks [(areas where oil and gas licenses and proposed or actual wind farm sites exist and indeed overlap)] should make early contact with the holders of any relevant wind farm lease or Agreement for lease (AfL), or the relevant zone developer(s), and establish in good time a mutual understanding of the respective proposals and time frames envisaged (acknowledging that not all aspects of the future plans of either side will necessarily be definitively decided at that time)*"[48]. Early discussions between the developers will ensure that any potential conflict can be mitigated so that both developments can proceed with minimal delay and without the need to determine any part of an existing Crown Estate Lease or Agreement for Lease. In addition to renewables activities, early engagement with other users (e.g. through fisheries liaison, vessel traffic surveys, consultation with the MoD or holders of other Crown Estate offshore interests)[49] where scheduling overlaps may occur should allow both for developer cooperation, and the mitigation of potential cumulative or in-combination effects.

Marine plans and their related policies also clarify this position, for example the draft Welsh National Marine Plan, noting that the Blocks are some distance from Welsh waters, (see paragraphs 659-666 and policies including ECON_02, O&G_03, O&G_04); "*Future oil and gas activity has the potential to require access to the same area of seabed or sea surface as other activities. Interactions with other sea users will vary depending on the technology, location and intensity of use of other marine activities. In most cases, the consequence of this will be minor due to the current offshore location of oil and gas interests, the small footprint of oil and gas production infrastructure and the limited duration of any exploration activities, e.g. regional or site-specific seismic surveys and drilling operations. Other activities may therefore continue in proximity outside of a safety buffer zone."* (Paragraph 659).

Policies for other marine plans of relevance to the Irish Sea Blocks (North West Inshore and Offshore) are yet to be drafted, but may be expected to be consistent with those of the adopted East Marine Plans, and also the draft Welsh National Marine Plan. Though considered as context to the following consideration, no blocks have been applied for in Welsh waters.

[48] OGA 30th Round Other Regulatory Issues
[49] https://www.ogauthority.co.uk/licensing-consents/overview/the-crown-estate-interests/

Table 5.3: Projects relevant to the in-combination effects assessment

Relevant projects	Project summary	Project status/indicative timing	Relevant sites[1]
Offshore Renewables			
Barrow Offshore Wind Farm	Located approximately 7km from the Cumbrian coast, the project area contains 30 turbines and together have an overall installed capacity of 90MW. The wind farm export cable runs in parallel with those of the Ormonde, West of Duddon sands and Walney I offshore wind farms in the nearshore, having its landfall near Heysham.	In operation	Liverpool Bay SPA, Morecambe Bay and Duddon Estuary SPA, Shell Flat & Lune Deep SAC
Ormonde Offshore Wind Farm	Located approximately 9km from the Cumbrian coast, the wind farm contains 30 turbines with an overall capacity of 150MW. The wind farm export cable runs in parallel with those of Ormonde, West of Duddon sands and Walney I in the nearshore, having its landfall near Heysham.	In operation	Liverpool Bay SPA, Morecambe Bay and Duddon Estuary SPA, Shell Flat & Lune Deep SAC
West of Duddon Sands Offshore Wind Farm	West of Duddon Sands is located approximately 14km offshore, and contains 108 turbines, with an overall installed capacity of 389MW. The export cable has its landfall at Heysham.	In operation	Liverpool Bay SPA, Morecambe Bay and Duddon Estuary SPA, Shell Flat & Lune Deep SAC
Walney I Walney II	Located approximately 14km from the Cumbrian coast, each project area contains 51 turbines and together have an overall installed capacity of 367MW. Walney I and II export cables make their landfalls near Heysham and Fleetwood respectively.	In operation	Liverpool Bay SPA, Morecambe Bay and Duddon Estuary SPA, Shell Flat & Lune Deep SAC
Walney extension	Located approximately 19km from the Cumbrian coast, and to the north west of the Walney I and II windfarms, the extension is due to have an installed capacity of 659MW generated from 87 turbines. The export cables are routed to the south of the Walney and West of Duddon Sands wind farms, and have a landfall near Heysham. Monopile.	Under construction. Full operation expected from late 2018-early 2019	Liverpool Bay SPA, Morecambe Bay and Duddon Estuary SPA, Shell Flat & Lune Deep SAC
Rhyl flats	Located approximately 8km from the coast, with a cable landfall at Towyn. Has an installed capacity of 90MW generated by 25 turbines.	In operation	Liverpool Bay SPA
North Hoyle	Located approximately 7km from the coast, with a cable landfall at Rhyl. Has an installed capacity of 60MW generated by 30 turbines.	In operation	Liverpool Bay SPA
Burbo Bank	Located approximately 7km from the coast, with a cable landfall at Wallasey. Has an installed capacity of 90MW generated by 20 turbines.	In operation	Liverpool Bay SPA
Burbo Bank extension	Located approximately 7km from the coast, with a cable landfall between Rhyl and Prestatyn. Has an installed capacity of 258MW generated by 32 turbines.	In operation	Liverpool Bay SPA
Gwynt y Mor	Located approximately 13km from the coast, with a cable landfall at Pensarn. Has an installed capacity of 574MW generated by 160 turbines.	In operation	Liverpool Bay SPA

Relevant projects	Project summary	Project status/indicative timing	Relevant sites[1]
Oil & gas projects			
Gateway gas storage project	An Agreement for Lease area is located approximately 24km offshore within Block 110/3. It is proposed that natural gas is stored in artificially created salt caverns, connected to the shore at Barrow-in-Furness via pipeline.	EIA consent decision was made in 2008. No development activities have taken place to date.	Liverpool Bay SPA, Morecambe Bay and Duddon Estuary SPA, Shell Flat & Lune Deep SAC
Aggregate areas			
Aggregates production area 392 and 457	As part of the wider north west region, 1.52km^2 were actively dredged in 2016, representing 1.75% of the total licenced area, with 90% of effort in 0.59km^2. Dredging intensity in the 392 area is considered to be high, covering 0.16km^2, with the wider remaining area dredged (including area 457) being low to moderate.	Active production area.	Liverpool Bay SPA
Exploration and option area 518	No production to date.	n/a	Liverpool Bay SPA

Sources: RenewableUK (2017), relevant Development Consent Orders and related post-consent modifications (https://infrastructure.planninginspectorate.gov.uk/ – accessed 7/12/2017), OGA Project Pathfinder current list of projects (https://itportal.decc.gov.uk/pathfinder/currentprojectsindex.html – accessed 05/12/2017), DECC (2016), The Crown Estate (2017).
Notes: [1] – those sites considered to be relevant to 30th seaward round exploration activities

Figure 5.3: Location 30th Round Blocks in relation to other projects

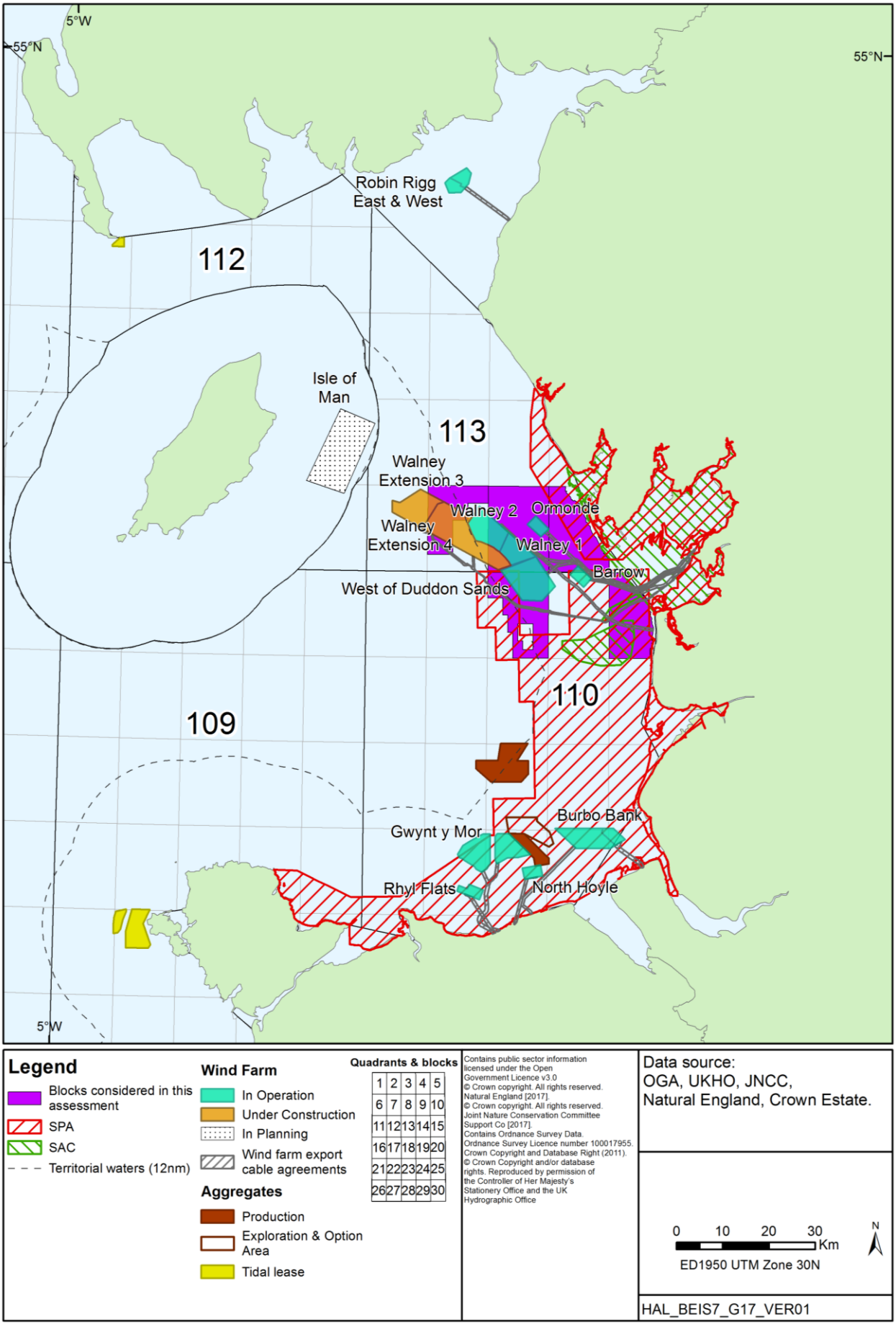
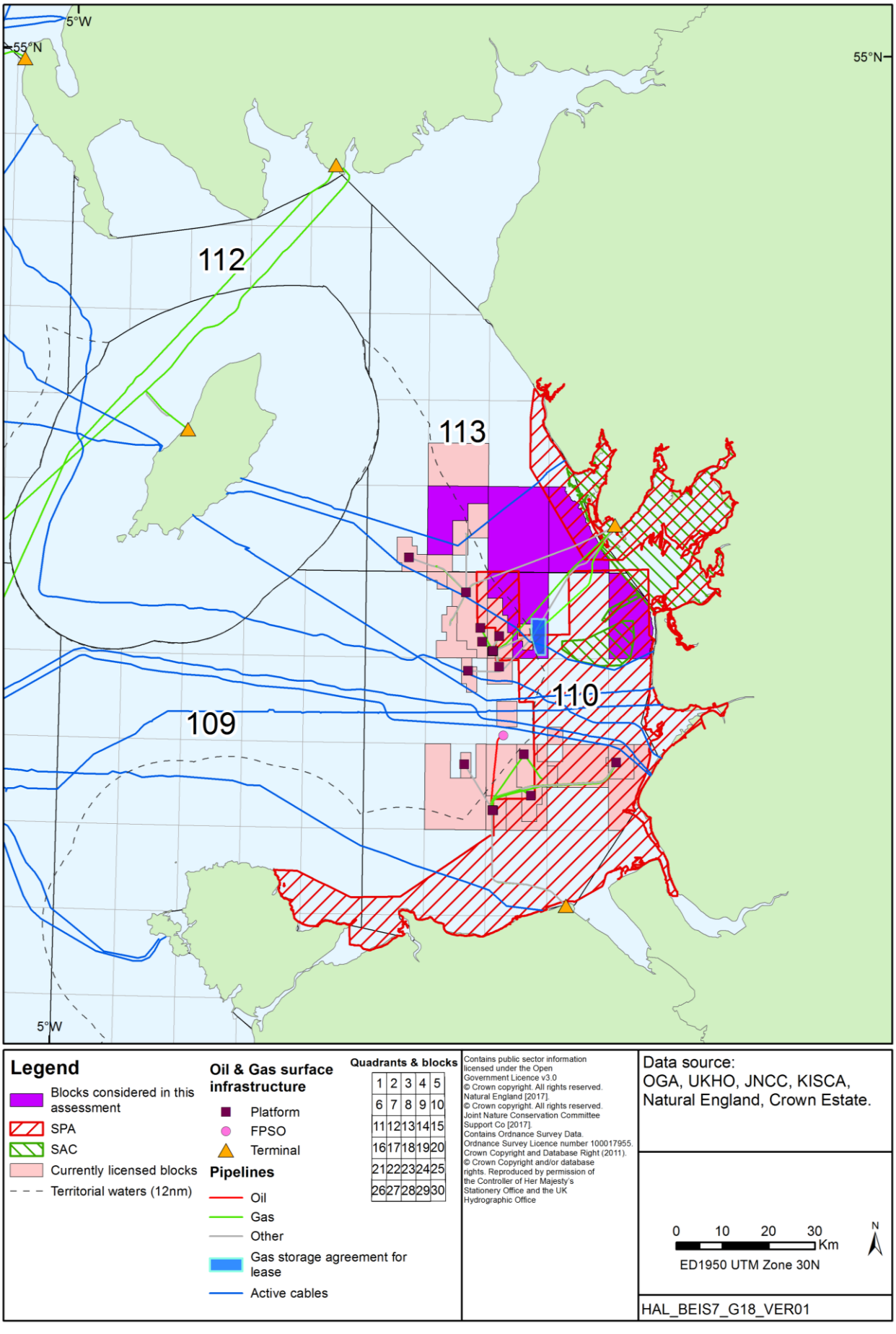


Figure 5.4: Location 30th Round Blocks in relation to other projects (continued)



5.3.3 Physical disturbance and drilling

Potential sources of physical disturbance to the seabed, and damage to biotopes, associated with oil and gas activities that could result from licensing were described in Section 4.2 and Section 5.1 and include the siting of jack-up drilling rig and wellhead placement and recovery.

Existing or proposed oil & gas projects and gas storage lease/licence areas

Existing oil and gas infrastructure is widespread in the eastern Irish Sea (Figure 5.4), although the relative density and footprint of these is small. A review of field development and decommissioning projects (as of November 2017) published by OGA's Project Pathfinder[50] includes the Gateway Gas Storage Project, an Agreement for Lease for which is located in Block 110/3b but firm project plans are not presently known. Where appropriate, BEIS will undertake Habitats Regulations Assessment in relation to oil and gas development and decommissioning activities, including a consideration of in-combination effects.

Given the small and temporary seabed footprint associated with drilling activities which may follow the licensing of 30th Round Blocks, and those standard and additional mitigation measures set out already in Section 2.2 and 5.1.3, significant in-combination effects associated with those other oil and gas related activities discussed are not expected.

With respect to drilling discharges, previous discharges of WBM cuttings across relevant parts of the UKCS have been shown to disperse rapidly and to have minimal ecological effects (See Section 4.2). Dispersion of further discharges of mud and cuttings could lead to localised accumulation in areas where reduced current allows the particles to accumulate on the seabed. However, in view of the scale of the proposed activity, extent of the region, the water depths and currents, this is considered unlikely to be detectable and to have negligible cumulative ecological effect (DECC 2016). Similarly, the potential for in-combination effects relating to chemical usage and discharge from exploratory drilling is limited by the existing legislative and permitting controls that are in place, which the UK Marine Strategy[51] has identified as making an ongoing contribution to managing discharges.

Offshore renewables

OWFs are the only type of renewable energy projects in the Irish Sea of relevance to 30th Round licensing. The majority of these projects are already operational, with only the Walney extension presently under construction, and which is likely to be completed or close to completion in advance of 30th Round licence awards. Sources of effect from physical disturbance associated with these projects have included installation of turbines (using monopile and jacket foundations) and associated infrastructure such as interconnecting and export cables. As indicated above, early engagement between any Block licence holder and wind farm operator, or developer, can help to avoid spatial conflict and applicants taking part in

[50] https://itportal.decc.gov.uk/pathfinder/currentprojectsindex.html
[51] https://www.gov.uk/government/publications/marine-strategy-part-three-uk-programme-of-measures

the 30th Round were made aware of relevant Crown Estates interests[52] which include offshore renewables zones and developments.

Four Blocks were identified on the basis of a potential for likely significant effect in relation to the Liverpool Bay SPA, and were considered in Section 5.1.2, and of these all also coincide with the Ormonde, Barrow, Walney (I, II and extension) and West of Duddon Sands wind farms, all of which are operational. Portions of Blocks 110/3b, 113/28 and 113/29, which were screened in for physical disturbance and drilling effects, interact with these wind farm zones (Figure 5.3), though none of the wind farm areas entirely cover any Block. Mitigation may be provided by the ability to locate any drilling rig, if used, outside of the wind farm boundaries or through dialogue to avoid any conflict of interest. Further mitigation is available in relation to the Walney extension area through activity timing/phasing, such that those sources of effect from wind farm installation (e.g. localised and temporary increases in suspended sediment concentrations) are not compounded by rig installation – note that the footprint of any drilling rig would be small (approximately 0.001km^2 – also see Table 2.2) and temporary. It is therefore not regarded that activity which could take place in the initial term of licences offered as part of the 30th Round would lead to a physical change significant enough to lead to an adverse effect on site integrity on its own or in-combination with OWF projects.

Once firm project proposals are known, existing statutory and planning processes allow for further consideration of interactions between other activities and, where applicable, subject to project level HRA. Should one or more Blocks be granted a licence which overlaps with any wind farm zone for which an interaction with a Natura 2000 site has also been established, the in-combination effects of the proposed work programme must be considered as part of any project level HRA. Given the small and temporary seabed footprint associated with drilling activities, significant in-combination effects associated with offshore renewables projects are not expected.

Fisheries

Fishing and particularly bottom trawling has historically contributed to seabed disturbance over extensive areas, and was identified as an ongoing problem in the UK initial assessment for MSFD[53]. It was also noted that depending on the nature of future measures (e.g. in relation to MPA management in the wider environment and within MPAs), such effects are likely to be reduced and therefore some improvement in benthic habitats could be expected. The management of fisheries in relation to Article 6 of the Habitats Directive is fundamentally different to other activities such as offshore energy development, and a revised approach to the management of commercial fisheries in European sites[54] has sought to implement steps to ensure that they are managed in accordance with Article 6.

[52] https://www.ogauthority.co.uk/licensing-consents/overview/the-crown-estate-interests/
[53] https://www.gov.uk/government/publications/marine-strategy-part-one-uk-initial-assessment-and-good-environmental-status
[54] https://www.gov.uk/government/publications/revised-approach-to-the-management-of-commercial-fisheries-in-european-marine-sites-overarching-policy-and-delivery and see http://www.gov.scot/Topics/marine/marine-environment/mpanetwork/SACmanagement

In England, management is coordinated between the Inshore Fisheries and Conservation Authorities (IFCAs) and the Marine Management Organisation for sites within 12nm[55] (note that any measure which may influence vessels of other member states can only be adopted after consultation with the Commission, other Member States and the Regional Advisory Councils) and for offshore sites beyond 12nm from the coast, measures are required to be proposed by the European Commission in accordance with the CFP[56]. In relation to specific sites of relevance to this AA, there is a bylaw prohibiting towed gear for the reef component of the Shell Flat & Lune Deep SAC[57], although further fisheries management measures have not been implemented. Management of inshore fisheries in Wales is undertaken by the Welsh Government, though in view of the widespread nature of fishing, liaison takes place with IFCAs, MMO and Regional Fisheries Advisory Councils (as noted in the draft Welsh National Marine Plan). Natural Resources Wales are progressing a project to evaluate that impact of fisheries on Marine Protected Areas in Welsh waters to inform potential management measures[58].

Whilst fishing may be linked to historical damage to site features, and presents an ongoing risk to these, future management measures should limit the potential for in-combination effects with other activities, particularly when considered in addition to mitigation which is available to avoid effects on sites from exploration activity (see Section 5.2), and other activities including offshore renewables which are subject to statutory environmental impact assessment and where appropriate, an HRA.

It should also be noted that when oil and gas surface structures (fixed and floating installations) become operational, safety zones with a radius of 500m are created under the *Petroleum Act 1987* such that other activities are excluded from taking place there, including fishing. This includes mobile drilling rigs and is notified to other users of the sea (e.g. through notices to mariners and Kingfisher charts). Additionally, appropriate fisheries liaison between operators proposing to undertake exploration activities and fishermen can avoid negative interactions. In view of the differences in relative scale of physical impacts resulting from trawling and from oil and gas exploration (both spatially and temporally), significant incremental effects may be considered unlikely.

Aggregate extraction

There are a number of licences for the extraction of aggregates held in the Irish Sea, these are also indicated on Figure 5.3 (also see Table 5.3). No active aggregate production or

[55] For example see bylaws relating to Haisborough, Hammond and Winterton SAC and Inner Dowsing, Race Bank and North Ridge SAC.
[56] See: http://ec.europa.eu/environment/nature/natura2000/marine/docs/fish_measures.pdf and also refer to Regulation (EU) No. 1380/2013 on the Common Fisheries Policy.
[57] http://nw-ifca.gov.uk/app/uploads/NWIFCA-Byelaw-6.pdf
[58] https://naturalresources.wales/about-us/our-projects/marine-projects/assessing-welsh-fishing-activities/?lang=en

exploration and option areas overlap with any of the Blocks considered in this assessment, the closest area being approximately 18km to the south of Block 110/3b[59].

Analogous to the advice provided in relation to offshore wind farms, applicants should make contact with the relevant aggregates companies in order that proposed oil and gas activity is undertaken in co-operation with the relevant lease or licence holders. In view of the limited spatial overlap with Blocks applied for, the potential to site rigs away from licence areas, and the nature and scale of physical effects associated with activity which may follow licensing (see Section 5.1), in-combination impacts which could lead to adverse effects on the integrity of sites considered in this AA are not anticipated.

5.3.4 Physical presence

Physical presence of offshore infrastructure and support activities may potentially cause behavioural responses in fish, birds and marine mammals (see Section 5.6 of BEIS 2018). Previous SEAs have considered the majority of behavioural responses resulting from interactions with offshore oil and gas infrastructure (whether positive or negative) to be insignificant; in part because the number of surface facilities is relatively small (of the order of a few hundred) and because the majority are at a substantial distance offshore. The larger numbers of individual surface or submerged structures associated with offshore wind developments, the presence of rotating turbine blades and considerations of their location and spatial distribution (e.g. in relation to coastal breeding or wintering locations for waterbirds and important areas for marine mammals), indicate a higher potential for physical presence effects. Potential displacement and barrier effects have been an important consideration at the project level for the large offshore wind developments located in the Irish Sea (Figure 5.3), and formed an important part of associated HRAs[60]. The Walney extension wind farm is due to be completed in 2019, following which all wind farms in the Irish Sea will be in their operational phases. In view of this construction timetable and the likely timing of any licence awards and any associated activity as part of the 30th Round licensing process, it is anticipated that in-combination effects with offshore wind farm construction activities can be avoided through early engagement with lease holders. Though representing an incremental source of activity in and around operational OWFs, it is not regarded that the temporary addition of a drilling rig and associated shipping will lead to adverse effects on the integrity of relevant sites considered in this AA. At present no further extensions to existing wind farms in the Irish Sea are known, though it is noted that The Crown Estate intend to consider new leasing areas for offshore wind in the future[61].

Shipping densities over the relevant Blocks range from high (110/3b, 113/27e, 113/28, 113/29) to very high (113/5). Additional vessels associated with drilling and site survey will represent a

[59] There are wider areas within the Irish Sea which have been identified as prospective for sand and gravel extraction (see: https://www.thecrownestate.co.uk/energy-minerals-and-infrastructure/downloads/mineral-resource-assessments/ and the draft Welsh National Marine Plan) though there is only limited overlap with a single relevant Block (113/30).
[60] For example refer to those HRAs in relation to Burbo Bank Extension and Walney Extension
[61] https://www.thecrownestate.co.uk/news-and-media/news/2017/the-crown-estate-to-consider-new-leasing-for-offshore-wind-projects/

small increment to existing traffic. For example typical supply visits to rigs while drilling may be in the order of 2 to 3 per week, in the context of 2015 weekly average vessel densities within routes around Morecambe Bay being in the range 20 to >100[62]. As the Blocks applied for are within an existing mature hydrocarbon basin, helicopters and vessels are also likely to use established routes.

The limited spatial and temporal presence of a rig and related shipping (see Table 2.2) is not considered likely to lead to adverse effects on site integrity. Further consideration of in-combination effects relating to interactions between offshore windfarm construction and operation would need to be considered as part of project-level assessments, including in HRA where appropriate.

5.3.5 Underwater noise

A number of projects are relevant to the consideration of in-combination effects with activities which may follow the licensing of 30th Round Blocks (see Table 5.3) as they have associated activities which can generate noise levels which are known to have the potential to result in disturbance or injury to animals associated with relevant sites (see DECC 2016).

Of most relevance to the Blocks being considered is the construction of the Walney Extension offshore wind farm. While the operation, maintenance and decommissioning of offshore wind energy developments will introduce noise into the marine environment, these are typically of low intensity. The greatest noise levels arise during the construction phase, and it is these which have the greatest potential for acoustic disturbance effects (see DECC 2016). Pile-driving of mono-pile foundations or pin piles used in jacket-type foundations is the principal source of construction noise, which will be qualitatively similar to pile-driving noise resulting from harbour works, bridge construction and oil and gas platform installation. Of those wind farms listed in Table 5.3, all are operational other than the Walney extension which is under construction and due for completion in 2019.

Given the spatially limited, temporary nature and limited scale of noise generating activity associated with the 30th Round Blocks (see Section 5.2), and that there is significant scope to avoid concurrent OWF construction and site survey activity either through dialogue with relevant leaseholders or by virtue of wind farm construction timelines, significant in-combination effects are considered to be unlikely. Additionally, mitigation measures (including HRA, where appropriate, at the activity specific level) are available to avoid such effects.

There is the potential for seismic surveys to take place in adjacent Blocks which are yet to be fully explored or which have been developed (not covered by the plan being assessed). The timing, location and scale of any such surveys are unknown and a meaningful assessment of these cannot be made at this time, but they will be subject to activity specific permitting, including HRA where appropriate.

[62] https://data.gov.uk/dataset/vessel-density-grid-2015

In addition to those activities which may follow licensing of the Irish Sea Blocks and the other potentially relevant projects listed in Table 5.3, there are a variety of other existing (e.g. oil and gas production, fishing, shipping, military exercise areas, wildlife watching cruises) and planned (e.g. oil and gas exploration and production) noise-producing activities in overlapping or adjacent areas. Despite this, BEIS is not aware of any projects or activities which are likely to cause cumulative and in-combination effects that, when taken in-combination with the likely number and scale of activities likely to result from Block licensing (Section 2.2), would adversely affect the integrity of the relevant sites. This is due to the presence of effective regulatory mechanisms (Section 5.2 and also Appendix 3 of DECC 2016) which ensure that operators, BEIS and other relevant consenting authorities take such considerations into account during activity permitting. These mechanisms generally allow for public participation in the process, and this has been strengthened by recent Regulations[63] amending the offshore EIA regime which came into force in May 2017. These reflect Directive 2014/52/EU (amending the EIA Directive) which provides for closer co-ordination between the EIA and Habitats Directives, with a revised Article 3 indicating that biodiversity within EIA should be described and assessed "with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC".

5.3.6 Conclusions

Available evidence (see e.g. UKBenthos database and OSPAR 2010) for the Irish Sea indicates that past oil and gas activity and discharges has not lead to adverse impacts on the integrity of European sites in the area. Any activities relating to the work programmes, and any subsequent development that may occur if site appraisal is successful, will be judged on its own merits and in the context of wider development in the Irish Sea (i.e. any potential incremental effects). The current controls on terrestrial and marine industrial activities, including oil and gas operations that could follow licensing, can be expected to prevent significant in-combination effects affecting relevant European sites.

BEIS will assess the potential for in-combination effects whilst considering project specific EIAs and, where appropriate, through HRAs; this process will ensure that mitigation measures are put in place to ensure that activities, if consented, will not result in adverse effects on integrity of European sites. Therefore, bearing this in mind, it is concluded that the in-combination effects from activities arising from the licensing of the relevant 30th Round Blocks with those from existing and planned activities in the Irish Sea will not adversely affect the integrity of relevant European Sites.

[63] *The Offshore Petroleum Production and Pipe-lines (Environmental Impact Assessment and other Miscellaneous Provisions) (Amendment) Regulations 2017*

6 Overall conclusion

Taking account of the evidence and assessment presented above, the report determines that the licensing through the 30th Licensing Round of the five Blocks considered in this AA will not have a significant adverse effect on the integrity of the relevant sites (identified in Section 1.3), and BEIS have no objection to the OGA awarding seaward licences (subject to meeting application requirements) covering Blocks 110/3b, 110/5, 113/27e, 113/28 and 113/29. This is because there is certainty, within the meaning of the ECJ Judgment in the Waddenzee case, that implementation of the plan will not adversely affect the integrity of relevant European Sites (as described in Section 5), taking account of the mitigation measures that can be imposed through existing permitting mechanisms on the planning and conduct of activities (as described in Sections 2.3, 5.1 and 5.2).

These mitigation measures are incorporated in respect of habitat and species interest features through the range of legislation and guidance (see https://www.gov.uk/guidance/oil-and-gas-offshore-environmental-legislation) which apply to activities which could follow licensing. Where necessary, project-specific HRA based on detailed project proposals would be undertaken by BEIS to ensure that permits/ consents are only granted where the proposed activity will not result in adverse effects on integrity of relevant sites.

Even where a site/interest feature has been screened out, or where a conclusion of no adverse effect on integrity has been reached at plan level, it is likely that a project level HRA will be necessary if, for example, new relevant sites have been designated after the plan level assessment; new information emerges about the nature and sensitivities of interest features within sites, new information emerges about effects including in-combination effects; or if plan level assumptions have changed at the project level.

7 References

Bakke T, Klungsøyr J & Sanni S (2013). Environmental impacts of produced water and drilling waste discharges from the Norwegian offshore petroleum industry. *Marine Environmental Research* **92**: 154-169.

BEIS (2017). Guidance notes on the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended). https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/644775/OPRED_EIA_Guidance_-_130917.pdf

BEIS (2018). Offshore Oil & Gas Licensing. 30th Seaward Round. Habitats Regulations Assessment Stage 1 – Block and Site Screenings. Department for Business, Energy and Industrial Strategy, UK, 114pp.

BOWind (2008). Barrow Offshore wind farm post construction monitoring report: First annual report, 60pp.

Bulleri F & Chapman MG (2010). The introduction of coastal infrastructure as a driver of change in marine environments. *Journal of Applied Ecology* **47**: 26–35.

Centrica Energy (2009). Rhyl & Castletown Exploration Wells Environmental Statement Licence P1483. DECC Project Reference No.: W/4052/2009, 168pp

Chapman C & Tyldesley D (2016). Small-scale effects: How the scale of effects has been considered in respect of plans and projects affecting European sites - a review of authoritative decisions. Natural England Commissioned Reports, Number 205, 112pp.

Cooper J (1982). Methods of reducing mortality of seabirds caused by underwater blasting. *Cormorant* **10**: 109-113.

Cranmer G (1988). Environmental survey of the benthic sediments around three exploration well sites. Report No 88/02. Report to the United Kingdom Offshore Operators Association. Aberdeen University Marine Studies Ltd, Aberdeen, UK, 33pp.

Crowell S (2014). In-air and underwater hearing in ducks. Doctoral dissertation, University of Maryland.

Crowell SE, Wells-Berlin AM, Carr CE, Olsen GH, Therrien RE, Yannuzzi SE & Ketten DR (2015). A comparison of auditory brainstem responses across diving bird species. *Journal of Comparative Physiology A* **201**: 803-815.

Currie DR & Isaacs LR (2005). Impact of exploratory offshore drilling on benthic communities in the Minerva gas field, Port Campbell, Australia. *Marine Environmental Research* **59**: 217-233.

Daan R & Mulder M (1996). On the short-term and long-term impact of drilling activities in the Dutch sector of the North Sea. *ICES Journal of Marine Science* **53**: 1036-1044.

Danil K & St. Leger JA (2011). Seabird and dolphin mortality associated with underwater detonation exercises. *Marine Technology Society Journal* **45**: 89-95.

DCLG (2012). National Planning Policy Framework. Department for Communities and Local Government, Eland House, Bressenden Place, London.

DeBlois EM, Paine MD, Kilgour BW, Tracy E, Crowley RD, Williams UP & Janes GG (2014). Alterations in bottom sediment physical and chemical characteristics at the Terra Nova offshore oil development over ten years of drilling on the grand banks of Newfoundland, Canada. *Deep-Sea Research II* **110**: 13-25.

DECC (2009). Offshore Energy Strategic Environmental Assessment, Environmental Report. Department of Energy and Climate Change, UK, 307pp plus appendices. http://www.offshore-sea.org.uk/site/scripts/book_info.php?consultationID=16&bookID=11

DECC (2011). Offshore Energy Strategic Environmental Assessment 2, Environmental Report. Department of Energy and Climate Change, UK, 443pp plus appendices. http://www.offshore-sea.org.uk/site/scripts/book_info.php?consultationID=17&bookID=18

DECC (2016). Offshore Energy Strategic Environmental Assessment 3, Environmental Report. Department of Energy and Climate Change, UK, 652pp plus appendices.

Defra (2012). The Habitats and Wild Birds Directives in England and its seas. Core guidance for developers, regulators & land/marine managers. December 2012 (draft for public consultation), 44pp.

Defra (2015). Validating an Activity-Pressure Matrix, Report R.2435, pp73. Available from: http://randd.defra.gov.uk/Document.aspx?Document=13051_ME5218FinalReport.pdf

EC (2000). Managing NATURA 2000 Sites. The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC, 69pp.

Emblow CS (1992). Survey of the sublittoral hard substrata from Morecambe Bay to Whitehaven. JNCC Report No. 28 (Marine Nature Conservation Review, report no. MNCR/SR/19).

Engås A, Løkkeborg S, Ona E & Soldal AV (1996). Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*). *Canadian Journal of Fisheries and Aquatic Sciences* **53**: 2238-2249.

English Nature (1997). Habitats regulations guidance notes. Issued by English Nature.

Envision (2015). Shell Flat and Lune Deep Sensitive Special Area of Conservation & Fylde Marine Conservation Zone interpretation and mapping 2015. Prepared by Envision Mapping for Natural England, 49pp.

Evans PGH, Pierce GJ, Veneruso G, Weir CR, Gibas D, Anderwald P & Santos BM (2015). Analysis of long-term effort-related land-based observations to identify whether coastal areas of harbour porpoise and bottlenose dolphin have persistent high occurrence & abundance. JNCC Report No. 543, Joint Nature Conservation Committee, Peterborough, UK, 152pp.

Foden J, Rogers SI & Jones AP (2009). Recovery rates of UK seabed habitats after cessation of aggregate extraction. *Marine Ecology Progress Series* **390**: 15-28.

Fox AD (2003). Diet and habitat use of scoters *Melanitta* in the Western Palearctic - a brief overview. *Wildfowl* **54**: 163-182.

Frost PGH, Shaughnessy PD, Semmelink A, Sketch M & Siegfried WR (1975). The response of jackass penguins to killer whale vocalisations. *South African Journal of Science* **71**: 157-158.

Gardline Geosurvey (2013). Walney Extension offshore wind farm cable route geophysical survey, April-July 2011. Report prepared for Dong Energy Walney Extension (UK) Ltd., 66pp.

Garthe S & Hüppop O (2004). Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. *Journal of Applied Ecology* **41**: 724-734.

Hansen KA, Maxwell A, Siebert U Larsen ON & Wahlberg M (2017). Great cormorants (*Phalacrocorax carbo*) can detect auditory cues while diving. *The Science of Nature* **104**: 45.

Harvey M, Gauthier D & Munro J. (1998). Temporal changes in the composition and abundance of the macro-benthic invertebrate communities at dredged material disposal sites in the Anseà Beaufils, Baie des Chaleurs, Eastern Canada. *Marine Pollution Bulletin* **36**:41–55.

Hassel A, Knutsen T, Dalen J, Skaar K, Løkkeborg S, Misund O, Østensen Ø, Fonn M & Haugland EK (2004). Influence of seismic shooting on the lesser sandeel (*Ammodytes marinus*). *ICES Journal of Marine Scienc*e **61**: 1165-1173.

HM Government (2011). UK Marine Policy Statement. HM Government, Northern Ireland Executive, Scottish Government, Welsh Assembly Government, 51pp.

Holmes R & Tappin DR (2005). DTI Strategic Environmental Assessment Area 6, Irish Sea, seabed and surficial geology and processes. British Geological Survey Commissioned Report, 81pp.

Hoskin R & Tyldesley D (2006). How the scale of effects on internationally designated nature conservation sites in Britain has been considered in decision making: A review of authoritative decisions. English Nature Research Reports, No 704.

HSE (20014). Guidelines for jack-up rigs with particular reference to foundation integrity. Prepared by MSL Engineering Limited for the Health and Safety Executive, 91pp.

Hyland J, Hardin D, Steinhauer M, Coats D, Green R & Neff J (1994). Environmental impact of offshore oil development on the outer continental shelf and slope off Point Arguello, California. *Marine Environmental Research* **37**: 195-229.

IAMMWG (2015). Management units for marine mammals in UK waters (January 2015). Inter-agency Marine Mammal Working Group. JNCC Report No. 547.

Intermoor website (accessed: 31st October 2017). Case studies for piled conductor installation for Shell Parque das Conchas fields, Brazil http://www.intermoor.com/assets/uploads/cms/rows/files/164-4.pdf and Petrobas/Chevron Papa Terra field, Brazil http://www.intermoor.com/assets/uploads/cms/rows/files/1685-4-Papa-Terra-Case-Study-final.pdf

Jiang J, Todd VL, Gardiner JC & Todd IB (2015). Measurements of underwater conductor hammering noise: compliance with the German UBA limit and relevance to the harbour porpoise (*Phocoena phocoena*). EuroNoise 31 May - 3 June, 2015, Maastricht. pp.1369-1374.

JNCC (2002). JNCC committee meeting – December 2002. JNCC 02 D07. http://jncc.defra.gov.uk/PDF/comm02D07.pdf

JNCC (2010). The protection of marine European Protected Species from injury and disturbance. Guidance for the marine area in England and Wales and the UK offshore marine area. Joint Nature Conservation Committee, 118pp.

JNCC (2013). Progress towards the development of a standardised UK pressure-activities matrix. Paper for Healthy and Biologically Diverse Seas Evidence Group Meeting - 9th-10th October 2013, 13pp.

JNCC (2017a). Advice on operations guidance note, 6pp.

JNCC (2017b). JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys. August 2017, 28pp.
http://jncc.defra.gov.uk/pdf/jncc_guidelines_seismicsurvey_aug2017.pdf

Jones DOB, Gates AR & Lausen B (2012). Recovery of deep-water megafaunal assemblages from hydrocarbon drilling disturbance in the Faroe-Shetland Channel. *Marine Ecology Progress Series* **461**: 71-82.

Jones EL, McConnell BJ, Smout S, Hammond PS, Duck CD, Morris CD, Thompson D, Russell DJF, Vincent C, Cronin M, Sharples RJ & Matthiopoulos J (2015). Patterns of space use in sympatric marine colonial predators reveal scales of spatial partitioning. *Marine Ecology Progress Series* **534**: 235-249.

Judd AD, Backhaus T & Goosir F (2015). An effective set of principles for practical implementation of marine cumulative effects assessment. *Environmental Science & Policy* **54**: 254-262.

Kaiser MJ (2002). Predicting the displacement of common scoter *Melanitta nigra* from benthic feeding areas due to offshore windfarms. Centre for Applied Marine Sciences, School of Ocean Sciences, University of Wales, BANGOR. Report for COWRIE, 8pp.

Kaiser MJ, Galanidi M, Showler DA, Elliott AJ, Caldow RWG, Rees EIS, Stillman RA & Sutherland WJ (2006). Distribution and behaviour of common scoter *Melanitta nigra* relative to prey resources and environmental parameters. *Ibis* **148**: 110-128.

Lawson J, Kober K, Win I, Allcock Z, Black J, Reid JB, Way L & O'Brien SH (2016). An assessment of the numbers and distributions of wintering waterbirds and seabirds in Liverpool Bay/Bae Lerpwl area of search. JNCC Report No 576, 47pp.

Løkkeborg S, Humborstad O-B, Jørgensen T & Soldal AV (2002). Spatio-temporal variations in gillnet catch rates in the vicinity of North Sea platforms. *ICES Journal of Marine Science* **59**: S294-S299.

Marine Scotland (2014). The protection of marine European Protected Species from injury and disturbance: guidance for Scottish inshore waters. Scottish Government, 22pp.

Mathieu C (2015). Exploration well failures from the Moray Firth & Central North Sea (UK). 21st Century exploration road map project. Oil and Gas Authority presentation, 21pp.
https://www.gov.uk/.../21CXRM_Post_Well_Analysis_Christian_Mathieu_talk.pdf

Matthews M-NR (2014). Assessment of airborne and underwater noise from pile driving activities at the Harmony Platform: Preliminary Assessment. JASCO Document 00696, Version 5.1. Technical report by JASCO Applied Sciences Ltd. for ExxonMobil Exploration Co., 20pp.

McCauley RD (1994). Seismic surveys. In: Swan, JM, Neff, JM and Young, PC (Eds) Environmental implications of offshore oil and gas developments in Australia. The findings of an independent scientific review. Australian Petroleum Exploration Association, Sydney, NSW. 696pp.

Melvin EF, Parrish JK & Conquest LL (1999). Novel tools to reduce seabird bycatch in coastal gillnet fisheries. *Conservation Biology* **13**: 1386-1397.

MMO (2014). Strategic Framework for Scoping Cumulative Effects. A report produced for the Marine Management Organisation, MMO Project No: 1055, 224pp.

Neff JM, Bothner MH, Maciolek NJ & Grassle JF (1989). Impacts of exploratory drilling for oil and gas on the benthic environment of Georges Bank. *Marine Environmental Research* **27**: 77-114.

Newell RC & Woodcock TA (Eds.) (2013). Aggregate dredging and the marine environment: an overview of recent research and current industry practice. The Crown Estate, 165pp.

Newell RC, Seiderer LJ & Hitchcock DR (1998). The impact of dredging works in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. *Oceanography and Marine Biology: An Annual Review* **36**: 127–178

NMFS (2016). Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing: underwater acoustic thresholds for onset of permanent and temporary threshold shifts. National Marine Fisheries Service, U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178pp.

OSPAR (2000). Quality Status Report 2000. OSPAR Commission, London, 108pp.

OSPAR (2009). Assessment of impacts of offshore oil and gas activities in the North-East Atlantic. OSPAR Commission, 40pp.

OSPAR (2010). Quality Status Report 2010. OSPAR Commission, London, 176pp.

Pearson WH, Skalski JR & Malme CI (1992). Effects of sounds from a geophysical survey device on behaviour of captive rockfish (*Sebastes* spp.). *Canadian Journal of Fisheries and Aquatic Science* **49**: 1357-1365.

Peña H, Handegard NO & Ona E (2013). Feeding herring schools do not react to seismic air gun surveys. *ICES Journal of Marine Science* **70**: 1174-1180.

Pichegru L, Nyengera R, McInnes AM & Pistorius P (2017). Avoidance of seismic survey activities by penguins. *Scientific Reports* **7**: 16305.

Popper AN, Hawkins AD, Fay RR, Mann DA, Bartol S, Carlson TJ, Coombs S, Ellison WT, Gentry RL, Halvorsen MB, Løkkeborg S, Rogers PH, Southall BL, Zeddies DG & Tavolga WN (2014). Sound exposure guidelines for fishes and sea turtles: A technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.

Rutenko AN & Ushchipovskii VG (2015). Estimates of noise generated by auxiliary vessels working with oil-drilling platforms. *Acoustical Physics* **61**: 556-563.

Schwemmer P, Mendel B, Sonntag N, Dierschke V & Garthe S (2011). Effects of ship traffic on seabirds in offshore waters: implications for marine conservation and spatial planning. *Ecological Applications* **21**: 1851-1860.

SEERAD (2000). Nature conservation: implementation in Scotland of EC directives on the conservation of natural habitats and of wild flora and fauna and the conservation of wild birds ("the Habitats and Birds Directives"). June 2000. Revised guidance updating Scottish Office circular no. 6/199.

Skalski JR, Pearson WH & Malme CI (1992). Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes* spp.). *Canadian Journal of Fisheries and Aquatic Science* **49**: 1343-1356.

Skaret G, Axelsen BE, Nøttestad L, Ferno, A & Johannessen A (2005). The behaviour of spawning herring in relation to a survey vessel. *ICES Journal of Marine Science* **62**: 1061-1064.

Slotte A, Hansen K, Dalen J & Ona E (2004). Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. *Fisheries Research* **67**: 143-150.

SNH (2015). Habitats Regulations Appraisal of Plans: Guidance for plan-making bodies in Scotland – Version 3.0. Scottish Natural Heritage report no. 1739, 77pp.

Stanley DR & Wilson CA (1991). Factors affecting the abundance of selected fishes near oil and gas platforms in the northern Gulf of Mexico. *Fishery Bulletin* **89**: 149-159.

Stemp R (1985). Observations on the effects of seismic exploration on seabirds. In: GD Greene, FR Engelhardt & RJ Paterson Eds. *Proceedings of the workshop on effects of explosives use in the marine environment*. Jan 29-31, 1985, Halifax, Canada.

Stone CJ (2015). Implementation of and considerations for revisions to the JNCC guidelines for seismic surveys. JNCC report, No. 463b, 72pp.

Strachan MF & Kingston PF (2012). A comparative study on the effects of barite, ilmenite and bentonite on four suspension feeding bivalves. *Marine Pollution Bulletin* **64**: 2029-2038.

Strachan MF (2010). Studies on the impact of a water-based drilling mud weighting agent (Barite) on some benthic invertebrates. PhD Thesis, Heriot Watt University, School of Life Sciences, February 2010.

Suga T, Akamatsu T, Sawada K, Hashimoto H, Kawabe R, Hiraishi T & Yamamoto K (2005). Audiogram measurement based on the auditory brainstem response for juvenile Japanese sand lance *Ammodytes personatus*. *Fisheries Science* **71**: 287-292.

Tillin HM & Tyler-Walters H (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes. JNCC Report 512B, 270pp.

Tillin HM, Hull SC & Tyler-Walters H (2010). Development of a sensitivity matrix (pressures-MCZ/MPA features). Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102 Task 3A, Report No. 22, 947pp.

Todd VLG & White PR (2012). Proximate measurements of acoustic emissions associated with the installation and operation of an exploration jackup drilling rig in the North Sea. In: Popper AN & Hawkins A (eds), The Effects of Noise on Aquatic Life. Advances in Experimental Medicine and Biology 730: 463.

Trannum HC, Setvik Å, Norling K & Nilsson HC (2011). Rapid macrofaunal colonization of water-based drill cuttings on different sediments. *Marine Pollution Bulletin* **62**: 2145–2156.

Vabø R, Olsen K & Huse I (2002). The effect of vessel avoidance of wintering, Norwegian spring-spawning herring. *Fisheries Research* **58**: 59-77.

Van Dalfsen JA, Essink K, Toxvig Madsen H, Birklund J, Romero J & Manzanera M (2000). Differential response of macrozoobenthos to marine sand extraction in the North Sea and the western Mediterranean. *ICES Journal of Marine Science* **57**:1439-1445.

Wardle CS, Carter TJ, Urquhart GG, Johnstone ADF, Ziolkowski AM, Hampson G & Mackie D (2001). Effects of seismic air guns on marine fish. *Continental Shelf Research* **21**: 1005-1027.

Webb A (2016). Operational effects of Lincs and LID wind farms on red-throated divers in the Greater Wash. Presentation at the International Diver Workshop, Hamburg, 24-25 November 2016. http://www.divertracking.com/international-workshop-on-red-throated-divers-24-25-november-2016-hamburg/

Wever EG, Herman PN, Simmons JA & Hertzler DR (1969). Hearing in the blackfooted penguin, *Spheniscus demersus*, as represented by the cochlear potentials. *Proceedings of the National Academy of Sciences* **63**: 676-680.

Yelverton JT, Richmond DR, Fletcher ER & Jones RK (1973). Safe distances from underwater explosions for mammals and birds. Report to the Defense Nuclear Agency. National Technical Information Service, US Department of Commerce, 64pp.

Department for Business, Energy & Industrial Strategy
www.gov.uk/beis