6 EVALUATION OF POTENTIALLY SIGNIFICANT ISSUES

6.1 Atmospheric Emissions

Gaseous emissions contribute to global atmospheric concentrations of greenhouse gases, regional acid gas loads and local tropospheric ozone and photochemical smog formation. The principal routine operational emissions during the proposed development programme would be of combustion products (CO_2, CO, NO_X, SO_2, CH_4, and VOCs) from power generation and engines on the rig, vessels associated with subsea removal and helicopters. Fugitive emissions from cement tanks, diesel storage and cooling/refrigeration systems could potentially occur, resulting in emissions of dust/particulates, VOCs, HFC etc dependent on source.

Where atmospheric emissions have been calculated, emission factors from the EEMS-Atmospheric Emissions Calculations (Issue 1.9) (2008) have been used unless otherwise stated.

6.1.1 Evaluation

Emissions from drilling P and A activities

A total of four production wells will be plugged and abandoned during Q4 2019-Q1 2020. In addition the water injection well and a previously suspended appraisal well will be plugged and abandoned during Q1-Q2 2020.

Emissions to atmosphere and Global Warming Potential (GWP) associated with drilling plug and abandon activities have been calculated (Table 6.1) using estimates of rig and support vessels fuel use, an estimated time on location for each and the emission factors referred to above.

Table 6.1 – Summary of predicted combustion emissions from drilling activities

Emissions	Rig on location (tonnes)	Support vessels on location (tonnes)	Crew changes during drilling (tonnes)	Rig Tow in/Tow out (tonnes)	Total Mass (tonnes)	Global Warming Potential[2]	GWP[3]
CO_2	8,000.00	5,452.80	149.53	326.40	**13,928.7**	1	13,928.7
CO	39.25	26.75	0.45	1.60	**68.05**	2	136.1
NOx	148.50	101.22	0.57	6.06	**156.35**	40	6,245
N_2O	0.55	0.37	0.01	0.02	**0.95**	310	294.5
SO_2	10.00	6.82	0.04	0.41	**17.3**	0	0.0
CH_4	0.45	0.31	0.02	0.02	**0.8**	21	16.8
VOC	5.00	3.41	0.15	0.20	**8.76**	11	96.36
						Total GWP	**20,717.5**

Notes:
1. *IPPC 2001*
2. *In tonnes carbon dioxide equivalent*

In 2014, atmospheric CO_2 emissions from UKCS offshore operations amounted to 12,585,700 tonnes (EEMS June 2015). The CO_2 emissions from the Athena drilling plug and abandon activities represents less than 0.1% of this 2014 total.

Emissions from subsea removal vessels

Total fuel consumption associated with the subsea infrastructure decommissioning and removal is estimated at 2,604 tonnes of diesel. This is based on estimated durations and typical vessel consumption rates. The resulting emissions for CO_2 are 6,874 tonnes. Fuel consumption associated with the transit and sail away of the FPSO is estimated at 1,530 tonnes with resulting CO_2 emissions of 4,896 tonnes. Total CO_2 emissions associated with removal of the subsea infrastructure and FPSO are therefore estimated at 11,770 tonnes.

Nature of the effects

Gaseous emissions from the combustion of hydrocarbons and other releases of hydrocarbon gases contribute to:

- Global atmospheric concentrations of greenhouse gases including carbon dioxide (CO_2), methane (CH_4) and oxides of nitrogen (NO_x). Man-made emissions of greenhouse gases (e.g. CO_2) are implicated in amplifying the natural greenhouse effect resulting in global warming and potential climate change (IPCC 2001).
- Regional atmospheric concentrations of acid gases including sulphur dioxide (SO_2) and oxides of nitrogen (NO_x). These gases react with water vapour forming acids increasing the acidity of clouds and rain which can result in vegetation damage, acidification of surface waters and land, and damage to buildings and infrastructure. In addition these gases can transfer directly to terrestrial surfaces through dry deposition (close to the source) causing similar damage to acid rain (UKTERG 1988)
- Reduction in local air quality through inputs of contaminants such as oxides of nitrogen (NO_x), volatile organic compounds (VOCs) and particulates which contribute to the formation of local tropospheric ozone and photochemical smog's. Ozone impairs lung function and NO_x cause irritation of the airways and is particularly problematic for people with asthma (EPAQS 1996).

The principal combustion product from the proposed Athena drilling P and A and decommissioning activities is CO_2. CO_2 is the most important greenhouse gas contributing about 80% of the total EU greenhouse gas emissions.

In 2013, CO_2 emissions from UK offshore oil and gas production contributed three per cent of the total domestic CO_2 emissions. It is important to consider that the exploration, production and transportation of offshore oil and gas account for a small percentage of the overall life cycle GHG emissions – approximately nine per cent for oil and 16 per cent for gas.

The Environment Act 1995 requires Local Authorities to undertake air quality reviews. To assist local authorities in support of review and assessment of local air quality, maps of estimated ambient air pollution in 2004 and projections for other years are provided on the Local Air Quality Management website (see www.airquality.co.uk/archive/laqm/laqm.php). The Athena area is some distance from land (*ca* 116km) and is not expected to impact on local air quality.

Some pollutants may be subject to chemical reactions whereby another pollutant species is produced which may have a more significant or different affect on the environment. For example, oxides of nitrogen can undergo a photochemical reaction with unburnt hydrocarbons to produce ozone. This can cause damage to flora and fauna, but again the remote location of the Athena area will mean that this affect is not significant (DECC 2009a).

6.1.2 Conclusion

Contributions as a result of Athena drilling P and A and decommissioning activities to the UK and European CO_2 emissions totals are small. Any local effects on air quality are mitigated through the remote location of the Athena site (116km from nearest land). Given the field location and predominant air flow, the resulting atmospheric emissions will have, at most, negligible local and wider environmental impact.

In order to minimise atmospheric emissions, Ithaca will ensure that decommissioning activities are coordinated to ensure efficient use of vessels.

6.2 Physical presence and disturbance

6.2.1 Evaluation

The physical presence of the drilling rig, decommissioning vessels, flowlines and subsea facilities have been identified as a potential cause of effect, primarily for fisheries. A 500m exclusion zone has been applied for the riser base location and the existing exclusion zone for the drill centre location retained; fishing and other vessels will be excluded from these areas until the completion of the decommissioning programmes (c.a. 2020). The drilling rig will have a temporary safety exclusion zone in place. A number of vessels will be in-field for relatively short periods of time during the P&A and removal phases of the Athena field decommissioning. Given that not all of the vessels will be present at the same time and that much of the subsea decommissioning will be concentrated at the production manifold/wellheads, it is unlikely that the presence of these vessels will cause significant disturbance to fishing or other vessels.

Fishing will not be excluded from the area except for the safety exclusion zones around the riser base and the production manifold. The flowlines linking the production manifold and the STP buoy are only 2km in length and are trenched and buried.

Bottom trawling close to subsea facilities carries the risk of fishing gear snagging with consequent loss of fishing gear, or in the worst case, the vessel. Snagging can occur on seabed equipment or where free spans of the pipe have developed between the seabed and the pipeline, creating potential snags for trawl otter boards (of wood or steel and up to 1.5 tonnes each) used to hold open a demersal trawl net. These otter boards typically penetrate the seabed down to 15cm.

The Athena area is of moderate to high importance to the fishing industry with much of the fishing effort (ca. 90%) focussed on demersal trawling for *Nephrops* and demersal fish. Fishing occurs throughout the year with spring and autumn generally showing the highest levels of effort.

Free spans along the pipeline routes are not expected to develop, (integrity will be confirmed by survey) as this area of the North Sea is not subject to vigorous currents or sediment mobility. Snagging on the flowlines is considered unlikely as the flowlines are trenched and buried. Based on previous seabed mapping of the development area, the only such obstacles are seabed pockmarks which have been avoided in pipeline routeing.

The flowlines will be removed by reverse reeling which removes the potential problem of snagging. All subsea wellheads and manifolds will also be completely removed. On completion of decommissioning/removal activities, as left surveys will be conducted to ensure that no oil related items of debris remain on the seabed.

Seabed disturbance

Physical disturbance of the seabed can result in environmental effects in terms of benthic habitat degradation and direct mortality of benthic organisms. Indirect effects can potentially be caused by re-mobilisation of contaminants from existing seabed sinks, such as cuttings piles. Potentially significant sources of physical disturbance identified by screening of the proposed Athena decommissioning were rig anchoring and removal of subsea facilities; STP buoy anchor removal is also included since these secured in place by suction cans.

Rig anchoring

Eight fifteen-tonne anchors will be deployed during rig positioning over the drill centre. Each anchor will produce a linear scar of the order of 50m length during setting (to obtain adequate hold), with limited surface scrape also produced as a result of catenary contact of the anchor chain. However, each catenary contact will be linear, in contrast to that from a swinging single-point mooring. The total seabed area affected by anchoring is estimated as 2,400m^2.

On completion of P and A on wells, all anchors will be recovered. Estimated longevity of anchor scars, based on experience in similar sediment types as those found in the Athena area, of trawl scars and natural bed forms, is ten to fifteen years. Infill of scars can produce alteration of sediment type within the feature which is longer-term than topographic expression of the scar, since the infill is usually of finer sediment. Such effects are considered likely in view of the relative stability of the muddy substrate, although the extent of lateral transport of sediment in the area is poorly documented.

STP Buoy and mooring anchor removal

The STP Buoy mooring system anchors are suction cans. A high level review of removal operations is provided in Table 6.2 below.

Table 6.2 –Suction caisson operations

Aspect	Suction caisson
Time for removal	9 days
Noise produced by installation	Not particularly noisy (e.g. main source of noise likely to be from pumping machinery)
Seabed footprint	*ca.* 255m^2 for 9 caissons of 6m diameter
Decommissioning	Total removal

Wellhead and Flowline recovery operations

It is planned that the well P and A activities will be performed from a drilling rig (Section 3.4.2), which includes complete recovery of the wellhead and casing cut >3.5m below the seabed. After removal of the surface casing (which will result in a small quantity of excess cement returns being deposited on the seabed), the resulting hole section will be left to fill naturally. These operations may result in physical disturbance of the immediate vicinity (a few metres) of a wellhead.

The sensitivity of seabed habitats and communities to physical disturbance from well P and A activities is considered to be moderate in view of the following factors:

- The seabed habitat types and associated communities are widespread over the Athena area, with no evidence for significant effects from previous drilling or construction activities there.

- Below surficial sandy mud sediments, the sequence of shallow soils consisted of very soft clay (Witch Ground formation) from 0-14m depth, underlain by stiff clay, sand and silt (Swatchway formation) from 14-26m.

- There is evidence of extensive bioturbation in the area, with species such as *Nephrops* burrowing to at least 30cm depth

The flowlines between the manifold and the riser base are trenched and buried, removal will be by reverse reeling by a vessel under dynamic positioning (rather than anchored) and will therefore result in limited seabed disturbance.

Physical effects

The direct effects of seabed disturbance include mortality as a result of physical trauma, smothering by displaced and re-suspended sediment, and habitat modification due to changed physico-chemical characteristics (for example, sediment porosity and oxygenation). Macrofaunal analysis of samples from eleven stations around the Athena field, found the most commonly occurring species in the area to be the polychaete *Paramphinome jeffreysii*, juvenile Echinodea spp., *Mendicula pygmaea* and *Abra nitida* (bivalve molluscs) and the polychaete *Paradoneis eliasoni*. These species are consistent with a faunal community type typical of the fine sediments in the Athena and broad adjacent area. The numerically dominant species are widely distributed and are typically short lived and would be expected to rapidly recolonise disturbed sediment.

The duration of effects on benthic community structure are related to individual species' biology and to successional development of community structure. The majority of seabed species recorded from the European continental shelf are known or believed to have short lifespans (a few years or less) and relatively high reproductive rates, indicating the potential for rapid population recovery, typically between 1 to 5 years (Jennings and Kaiser 1998). In general, macrofaunal population levels are limited by post-settlement factors rather than larval availability. It is therefore considered probable that both the physical habitat consequences and benthic community effects of anchor and wellhead disturbance will fully recover within a five to ten year period.

The epifauna observed in seabed photographs of the area is generally not abundant and includes sea pens, anemones and hermit crabs; however, the photos frequently showed burrows of *Nephrops* and other larger burrowing infauna. No especially long lived or reef forming species were observed in the seabed photographs taken during the site or flowline route surveys. The species composition and inferred life history characteristics of the infaunal and epifaunal community present in the Athena area, indicates it is likely to be relatively resilient to the effects of sediment mobilisation and to recover from physical disturbance over a period of a few years. No hard concretions were observed in geophysical data or in seabed photos and samples from pockmarks and adjacent areas, suggesting this Annex 1 habitat of potential conservation interest was not present in the areas surveyed. Rig anchor locations and the pipeline route have been selected to minimize interactions with seabed pockmarks.

To date, no sites or objects of archaeological importance have been identified in the Athena area. Additionally, the rig-site and flowline route surveys have not identified the presence of any features of archaeological interest on the seabed in the proposed development area (Section 4.13.7). In the unlikely event that archaeological remains are observed (for example during ROV inspection of the seabed) these will be treated and reported in line with current good practice outlined in the JNAPC Code of Practice for Sea Bed Operators

6.2.2 Conclusion

While the Athena decommissioning programmes would result in some physical disturbance of the seabed within the area, the relatively limited scale and inferred general resilience of the seabed, habitat and species leads to the conclusion that significant effects at the seabed will not occur.

6.3 Drilling, vessel and subsea activity discharges

6.3.1 Evaluation

Operational chemicals/substances for use in the UKCS have to be notified and tested under the Offshore Chemical Notification Scheme (OCNS); information required on the OCNS list includes a ranking for each chemical (Hazard Quotient values or OCNS group) and an indication of whether they would have a significant environmental effect. A permit for the use and discharge of chemicals is required for each well by *The Offshore Chemicals Regulations 2002* and applications will be submitted to DECC in advance of the commencement of drilling P&A activities. Ithaca will promote the selection of the most benign chemicals for use in drilling P&A activities for these wells.

Final chemical selection for drilling P&A activities, subsea installations and pipeline removal use will be identified in the detailed engineering phase and chemicals will be selected for least harmfulness consistent with technical function. Chemicals which are candidates for substitution, with heavy metal or other warnings will be avoided unless there is no technical alternative. An indicative list of chemicals for use in the proposed decommissioning programmes and risk assessments of their potential environmental consequences is given in Appendix 3.

Permit applications for the use and discharge of chemicals are required by *The Offshore Chemicals Regulations 2002* and will be submitted to DECC in advance of the commencement of the various decommissioning operations. Term permits will be applied for, for drilling P&A and subsea equipment decommissioning.

Surface hole cuttings

The 36" and 17¼" hole sections of the wells were drilled riserless and resulted in an estimated quantity of cuttings for each well, discharged directly to the seabed, producing discrete low mounds of cuttings surrounding the conductor (see Section 6.2.1). This material consisted of shallow formation cuttings (a mixture of clay and sand and siltstone rock fragments) and is generally similar to surficial sediments in composition and characteristics. Most of the chemical additives used in the drilling of the surface sections are categorised by OSPAR as PLONOR (Pose little or No Risk to the marine environment) or inorganic and have the lowest Hazard Quotient (Gold or OCNS Group E).

Cutting pile estimates for each well

- 14/18b-15A (A5) / (P1) – 232m^3
- 14/18b-16 (A3) / (P2) - 187m^3
- 14/18b-18 (A4) / (P3) – 190m^3
- 14/18b-PH (A2) / (P4) – 137m^3
- 14/18b-A1 (W1) – 188m^3
- 14/18b-17Z – 200m^3

The environmental effects of surface hole cuttings are similar to those of physical disturbance of the seabed, since the deposited material is similar to background seabed sediments. The predicted effects are therefore localised and of short duration, involving smothering of benthic habitats and communities with relatively rapid recovery through faunal re-colonisation. The dominant species in the Athena area (discussed above), are likely to be relatively resilient to the effects of sediment mobilisation and to rapidly recolonise disturbed or displaced sediments.

Beyond the zone of physical smothering immediately around the wellhead, ecological effects of surface hole cuttings discharge are predicted to be negligible.

Other drilling P and A chemical discharges

Discharge of cement and component chemicals, probably of the order of 30 tonnes, per well, is likely both as direct annular returns at seabed and at surface following displacement of excess cement from the hole. Cement returns to seabed surface are monitored by ROV so pumping of cement can be stopped when returns appear at the seabed. The majority of the cement and cement chemicals proposed have either PLONOR or have Gold Band CHARM Hazard Quotients and significant effects are not expected.

The majority of chemicals selected for well kill operations are either ranked as Gold or E, indicating that discharge of these chemicals would not lead to significant environmental effects in the marine environment. A number of chemicals are also PLONOR listed (Appendix 3).

A variety of contingency and emergency chemical additives will be available on the rig to deal with unplanned circumstances, such as excessive fluid loss from the hole. The discharge of these chemicals is not intended, but may be necessary; in which case significant effects are not predicted in view of the limited quantities, generally low Hazard Quotients and high dispersion. At a subsequent preparatory stage for the wells, all planned and contingency drilling chemicals would be subject to a separate DECC consenting process, via the PON 15 mechanism.

Other discharges and wastes from rig and vessels

Other liquid discharges resulting from Athena decommissioning programmes and well P&A activities would include:

- Treated domestic effluents, comprising sewage and grey water (catering, sink and shower wastes) which will contain soluble and particulate organic material, and detergent residues
- Surface drainage from decks and other non-contained area drainage, which may contain detergent residues

The quantity of domestic effluent produced is broadly proportional to the total crew complement (*ca*. 65 for the support vessels and 100 on the rig) and both quantity and treatment quality are comparable to a sewage discharges from a very small coastal community (although available dispersion is likely to be much greater in the offshore environment). Typical onshore domestic effluent production is approximately 150 litres/person/day, with an organic content (specified as Biochemical Oxygen Demand, BOD) following primary treatment of 150-300mg/l (for raw sewage, 1 population equivalent = 60g/d; primary treatment typically removes 30-40% of soluble BOD and 50-70% of Total Suspended Solids). Based on an assumption of a horizontal diffusion coefficient of $100cm^2/s$ and vertical mixing depth of 10m, the available dispersion volume is of the order $10^{-11}m^3$, indicating that the effect on dissolved oxygen concentrations of the BOD will be negligible. Similarly, the ecological effects (i.e. stimulation of phytoplankton productivity) of nutrient enhancement resulting from soluble nitrate and phosphate in discharges from drilling units and support vessels are negligible due to the very high available dispersion.

Rig and other vessel utility chemicals will be selected according to the procedures outlined in Appendix 3 and included in risk assessment and Chemical Term Permit application.

In addition, the drilling rig, support vessels and subsea removal vessels, will generate a range of returnable wastes as normally associated with shipping and construction activities. All wastes will be managed according to the *UK Merchant Shipping Regulations*, MARPOL 73/78 (as amended) and the *Duty of Care* for waste and the *Hazardous Waste Regulations* (see Appendix 2).

All wastes generated will be segregated and stored in suitable containers on-board the rig or vessel, and then returned to shore for appropriate disposal at licensed waste disposal sites or for approved recycling. Offshore waste handling will be undertaken in accordance with rig/vessel specific procedures which document the segregation of waste and reduction through re-use of packaging and minimisation of hazardous waste.

Pipeline discharges

Decommissioning activity of the flowlines and associated spools is reduced to leak testing of the system isolation points prior to removal resulting in minimal discharges.

Hydraulic fluid

The hydraulic fluid HW540E Water based Hydraulic Oil does not contain a substitution warning.

Small quantities of the fluid will be released when disconnecting and capping the umbilical and jumper connections prior to removal. However, dilution and dispersion of the released hydraulic fluid will be rapid and the quantities are relatively small. Significant environmental effects are not predicted.

6.3.2 Conclusion

Drilling P&A, flowline removal and isolation testing from the proposed Athena decommissioning programmes are not predicted to result in significant effects on any environmental receptor. This conclusion is reached based on the nature of the proposed operations, mitigation measures undertaken or planned and the physical and biological conditions in the vicinity of the development. It is also supported by a number of studies of the effects of subsea and FPSO decommissioning programmes in the North Sea and elsewhere.

All chemicals will be assessed during detailed engineering and a permit application for the use and discharge of chemicals is required by *The Offshore Chemicals Regulations 2002* and will be submitted to DECC in advance of the commencement of activities.

6.4 Noise

6.4.1 Introduction

Anthropogenic noise in the marine environment is widely recognised as a potentially significant concern, especially in relation to marine mammals). Although, broadly, the noise produced by a drilling rig or support vessels is comparable to that from a large merchant vessel, the proposed decommissioning programmes will produce specific sources of noise over several shorter periods, with support activities (e.g. vessel and helicopter traffic) resulting in periodic inputs of noise.

Potential (and postulated) effects of anthropogenic noise on receptor organisms range from acute trauma to subtle behavioural and indirect ecological effects, complicating the assessment of significant effect. There is increasing recognition that masking (when an extraneous sound covers a desired signal) of communication and echolocation by marine mammals may be a significant mechanism of effect (reviewed by Weilgert 2007). In addition to sensory mechanisms of effect, it is also possible that physical effects of intense noise (e.g. explosions and military sonars) may occur, although sources of sufficient intensity are not included in the operations for the Athena field decommissioning programmes (see below).

The sources, measurement, propagation, ecological effects and potential mitigation of noise associated with exploration and production have been extensively reviewed and assessed (Richardson *et al*. 1995, McCauley *et al*. 2000, DTI 2004, MMS 2004, Weilgert 2007). Nowacek *et al*. (2007) provide a systematic update of quantitative studies of cetacean responses to anthropogenic noise, published since Richardson *et al*. (1995).

In general, assessments of acoustic disturbance have involved:

- quantification of source noise levels (as Source Level, SL)
- estimation of threshold noise levels for various categories of effect (ranging from acute trauma to behavioural responses)
- estimation of likely horizontal range of noise propagation to specified threshold level
- assessment of population density and sensitivity of marine mammals and other receptors within affected areas

Using this approach, concentric "zones of effect" may be identified, corresponding to increasing sound pressures and severity of effect.

The US NRC (2005) has proposed a Population Consequences of Acoustic Disturbance (PCAD) model framework which involves a hierarchy from stimulus (e.g. sound), through behaviour change, life functions of animals immediately affected, to vital rates within the population, and finally to population effects. Levels are related by a series of 'transfer functions' describing the nature of the relationship between effects at one level and consequences at the next. However, substantial information is required to further develop and utilise this model framework (especially in relation to "higher" level transfer functions); much of which is very difficult to generate given the experimental constraints associated with the study of marine mammal behaviour. At present, the PCAD framework does not allow for a meaningful assessment, although as discussed at a recent workshop[1], work is ongoing to identify those transfer functions which are most amenable to experimental study and have most influence on model output, to progress the necessary studies.

A general distinction may be drawn – in terms of propagation and mechanisms of effect – between sources of noise and vibration which are continuous ("chronic"), such as machinery noise and propeller cavitation; and transient or impulse sources such as seismic airguns and pile driving. These distinctions are also significant in terms of defining source levels (Madsen 2005).

[1] Assessing and managing the potential impact of marine piling noise within the evolving regulatory framework, organised by the Underwater Sound Forum, 24 February 2010

6.4.2 Noise sources associated with drilling P&A and subsea equipment removal.

The primary sources of noise on drilling rigs are various types of rotating machinery, with noise transmitted from the rig to the water column through submerged parts of the drilling unit (e.g. pontoons and riser), and (to a much smaller extent) across the air-water and seabed-water interfaces. Available measurements indicate that drilling activities produce mainly low-frequency continuous noise from several separate sources on the drilling unit (Richardson *et al*. 1995, Lawson *et al*. 2001). Characteristic mechanical noise (and vibration) at the seabed or drill floor may result from a variety of specific operational activities, e.g. running casing and cutting of conductors and casing.

Only limited studies of individual noise sources on drilling units have been carried out, with most available data consisting of empirical measurements of far-field noise from drill ships and semi-submersibles propagated to the water column (comprehensively reviewed by Richardson *et al*. 1995; see also reviews by Gordon *et al.* 1998, Evans & Nice 1996, McCauley 1994, Turnpenny & Nedwell 1994, Lawson *et al*. 2001). These measurements are subject to various practical and calibration difficulties, and to considerable variation in the reported units of measurement (see Richardson *et al*. 1995 and Madsen 2005 for discussion of noise quantification). Source levels may also vary widely at different times, according to specific drilling activities and to variations in transmission characteristics.

Sound pressure associated with one semi-submersible drilling rig was around 170dB re 1µPa[2], in the frequency range 10-2000Hz (Davis *et al.* 1990). This noise intensity is probably typical of drilling from a semi-submersible rig and is of the same order as that from large merchant vessels (e.g. McCauley 1994). Drilling noise is generally low frequency, with higher source levels and frequencies being recorded from drill ships.

Thrusters on the rig support and subsea decommissioning vessels, used for propulsion and dynamic positioning, will be an additional noise source, largely through propeller cavitation. In studies of ships, use of thrusters increased broadband sound levels, in one case by 11dB and included higher frequency tonal components up to 1 kHz (Richardson *et al*. 1995).

6.4.3 Noise sources associated with pile cutting

Removal of the manifold, riser base and riser clump weight base will all require pile cutting. Table 6.3 provides information on the characteristics of each of these piling operations. All piles will be cut using a high pressure water cutter.

Table 6.3 - Pile characteristics and estimated cutting durations

Structure	# piles	Pile diameter, weight, length	Hours per pile[1]	Total hours cutting[1]	Total days[2]	Expected removal period
Manifold	4	600mm, 25.4mm, 30m	2-3	8-12	2	Q1-Q2 2020
Riser clump weight	2	660mm, 25.4mm, 30m	2-3	4-6	1	Q1-Q2 2020
Riser base	4	660mm, 25.4mm, 30m	2-3	4-6	1	Q1-Q2 2020

Notes: [1] approximate figure; [2] total number of days over which piling operations will take place.

[2] Unless otherwise stated, all sound pressures are quoted in units of dB re 1µPa rms @ 1m

Source characteristics

Information on the source noise levels for pile cutting operations (in general), its propagation and potential for effects is limited. High pressure water cutting equipment is the preferred option and the noise level of the cutting jet is considered safe for divers and is not considered harmful to marine life.

6.4.4 Noise sources associated with support activities

Rig personnel transfers to/from the drilling rig are predicted to consist of 1-2 helicopter round trips from Aberdeen per week. There is relatively little quantitative information on the transmission of helicopter airborne noise to the marine environment (Richardson *et al*. 1995). Observations of underwater noise (at depths of 3m and 18m) from a Bell 212 helicopter indicated a peak received level of approximately 126dB re1µPa (Patenaude *et al*. (2002). Measurements of an air-sea rescue helicopter over the Shannon estuary (Berrow *et al*. 2002) indicated that due to the large impedance mismatch when sound travels from air to water, the penetration of airborne sound energy from the rotor blades was largely reflected from the surface of the water.

Supply and support vessels will visit the field periodically during drilling P&A, decommissioning and removal. However, based on the existing vessel traffic in the area (see Section 4.13.4) and the conclusions of Richardson *et al*. (1995), vessel traffic noise associated with the Athena field is not considered to be a source of significant effect.

6.4.5 Noise propagation

As with underwater noise source characterisation, quantitative aspects of noise propagation are complex (see review by Richardson *et al*. 1995). A simplified assessment can be made by assuming that in deep water, sound pressure will propagate spherically, with received Sound Pressure Level, **SPL = SL – 20log(R)**, where SL = source level (dB), R = source-receiver range (m). At longer ranges in shallow water (range >1.5 x water depth) or where significant density gradients occur, sound ducting may result in modified cylindrical spreading, approximated by **15 log(R)**. However, modified cylindrical spreading is a phenomenon that tends to occur more with quasi-continuous sounds than with short impulse sounds (MMS 2004). For pile cutting, a transmission loss (TL) of **-20log(R)** is representative of those observed in the studies presented in Table 6.6.

Additional signal attenuation may result from a combination of reflection from sub-surface geological boundaries, sub-surface transmission loss due to frictional dissipation and heat; and scattering within the water column and sub-surface due to reflection, refraction and diffraction in the propagating medium. The precise rate at which loss will occur is variable, depending upon such factors as frequency spectrum and seabed type. Long-range absorption losses are particularly frequency-dependent and have been empirically described (Jensen *et al*. 1994) by an absorption coefficient α (dB/km) as:

$$\alpha = 3.3 \times 10^{-3} + \frac{0.11f^2}{1 + f^2} + \frac{44\, f^2}{4100 + f^2} + 3.0 \times 10^{-4} f^2$$

Where f = frequency (kHz)

Drilling P&A noise propagation

Noise propagation from a nominal 170 dB re 1µPa source at the drilling location has been calculated using the general expression **SPL = SL – 15log(R) - αR**. A TL of -15log(R) reflecting modified cylindrical spreading is used throughout the grid as the resolution (1km) does not permit consideration of ranges <1.5 x water depth. Frequency-dependent absorption losses were included, based on a dominant frequency of 50Hz.

Rapid horizontal attenuation occurs, with SPL dropping to approximately 130dB at 500m from the source, and 119dB at 1km.

Pile cutting noise propagation

Due to utilising high pressure water jet cutting for the piles noise propagation is considered negligible.

6.4.6 Ecological receptors and mechanisms of effect

Marine mammals

Numerous studies have assessed potential effects of underwater noise on marine mammals, based on anatomical, physiological and behavioural observations. There is general consensus that a hierarchical sequence of effects is possible (ranging from audibility; through behavioural response; masking of communication, echolocation or environmental sound cues; to physical trauma to the ear and other resonating structures). However, there remains considerable uncertainty over the appropriate threshold sound pressures for the various categories of effect. It is also clear that different marine mammal species (e.g. Kastelein *et al*. 2006) and individuals within a species (Cook 2006 cited by Weilgert 2007) may have different sensitivities to sound intensity, frequency and duration. Two recent reviews, Nowacek *et al*. (2007) and Weilgert (2007) exemplify contrasting approaches (and interpretations) to the assessment of effect: Nowacek *et al*. (2007) concentrating on quantitative studies which reported received sound characteristics, because interpreting what elicits responses is impossible without exposure information; whereas Weilgert (2007) considered that there are other more important factors, such as perception, ability to discriminate important content in a masked signal, context, cumulative and synergistic and long-term effects.

Richardson *et al*. (1995) defined a series of zones of noise influence on marine mammals, in relation to which data on marine mammal responses have been exhaustively reviewed (e.g. Richardson *et al*. 1995, Gordon *et al*. 1998, Lawson *et al*. 2001, Simmonds *et al*. 2003, Hammond *et al*. 2004). Four zones are recognised which will generally occur at sequentially increasing sound level: (1) a zone of audibility, (2) zone of responsiveness, (3) zone of masking, and (4) zone of hearing loss, discomfort or injury. Potential acute effects include physical damage, noise-induced hearing loss (temporary and permanent threshold shifts) and short-term behavioural responses. Postulated chronic effects including long term behavioural responses, exclusion and indirect effects (e.g. through prey interactions) The most measurable physical/physiological effects are generally considered to be shifts in hearing thresholds and auditory damage; although except in captive animals, direct evidence for significant effects resulting from anthropogenic noise is sparse.

In relation to effects assessment, Weilgert (2007) makes a number of relevant points:

- In certain circumstances, non-auditory effects such as skin sensations, resonance and vestibular responses (e.g. vertigo) may be important – this is significant if animals are impacted by noise frequencies outside their hearing range

- Theoretical modelling suggests that masking may occur over considerable ranges (Erbe & Farmer 2000, Erbe 2002, Aguilar Soto *et al*. 2006, David 2006)
- The significance of temporary habitat displacement remains unclear; lack of displacement does not necessarily mean lack of effect
- Conversely, many examples of apparent tolerance to anthropogenic noise have been described
- The relationships between short-term responses and long-term impacts are very poorly understood; this is an important factor in considering the value and design of controlled exposure experiments (CEEs)
- CEEs should be conducted against meaningful significance criteria (i.e. both statistically robust and meaningful in management terms) in order to justify potential risks to subject animals; and may be compromised by limited (unrepresentative) exposure in order to reduce risk
- Cumulative, synergistic and indirect effects may be important; although the few examples cited by Weilgert (2007) are either at an ecosystem level, or indicative.

Hearing thresholds have been measured in the smaller toothed whales (dolphins and porpoises) which are most sensitive to sounds above about 10 kHz. For small cetacean and seal species, audiograms suggest a hearing threshold of 110dB at 200Hz to be representative of dominant seismic frequencies. Permanent and temporary shifts in hearing thresholds and auditory damage have been documented, with a consensus for a threshold Sound Pressure Level (SPL) of the order of 200dB based on experimental exposure (see review by Hammond *et al*. 2004), although direct evidence from wild populations for significant auditory damage resulting from anthropogenic noise is sparse (with the possible exception of military sonars).

Laboratory studies have also demonstrated varied behavioural and physiological responses to experimental (broadband) noise occurring at received levels of 150-170dB in bottlenose dolphins (e.g. Tyack *et al*. 1993) and seals (Thompson *et al*. 1998).

Considerable field research effort on the behavioural effects of anthropogenic noise on marine mammals has concentrated on seismic exploration, with a particular focus on baleen and sperm whales (since the source frequency spectrum of airguns was considered to be largely inaudible to dolphins and porpoises). More recently, attention has been given to the effects of whale-watching activities, ocean science (ATOC/NPAL studies), military sonars and acoustic deterrent and harassment devices (ADDs and AHDs) used for by-catch mitigation and deterrence. There has been much less focus on continuous industrial noise, with little significant data since the two series of field studies (Malme *et al*. 1983, 1984; Richardson *et al*. 1985, 1990) in which migrating gray and bowhead whales showed consistent avoidance at average received levels of 120dB re 1 µPa.

Although not designed specifically to assess this, distributional studies in the North Sea do not suggest any association or avoidance of permanent production facilities including FPSOs. Elsewhere Sorensen *et al*. (1984) observed distributions of several small cetacean species (including common, Risso's, bottlenose and *Stenella* dolphins), in the vicinity of drilling activities off New Jersey, and reported no difference in sightings per unit effort with and without the presence of rigs.

Reported SPL thresholds for sequential traumatic, physiological and behavioural effects in marine mammals are summarised below:

- Damage Risk Criteria for a marine mammal exposed to 100 seismic pulses ≈ 178-208dB re 1 µPa

- permanent / temporary shifts in hearing thresholds / auditory damage ≈ 200dB
- behavioural / physiological responses in captive dolphins to experimental noise ≈ 150-170dB
- avoidance behaviour in baleen whales ≈ 120-130dB re 1 µPa
- postulated hearing threshold in baleen whales ≈ 80dB at 50Hz

In a comprehensive and widely accepted assessment, Southall *et al*. (2007) proposed injury criteria composed both of unweighted peak pressures and M-weighted sound exposure levels which are an expression for the total energy of a sound wave. The M-weighted function also takes the known or derived species-specific audiogram into account. For three functional hearing categories of cetaceans, proposed injury criteria are an unweighted 230dB re 1µPa peak to peak (≈ 215dB re 1µPa rms) for all types of sounds and an M-weighted sound exposure level of 198 or 215dB re 1 $\mu Pa^2 \cdot s$ for pulsed and non-pulsed sounds. For pinnipeds the respective criteria are 218dB 1µPa peak to peak (203dB re 1µPa rms) and 186 (multiple pulse) or 203 (non-pulse) re 1 $\mu Pa^2 \cdot s$ (M-weighted). These proposals are based on the level at which a single exposure is estimated to cause onset of permanent hearing loss (parameterised as Permanent Threshold Shift, PTS), by extrapolating from available data for Temporary Threshold Shift (TTS).

Southall *et al*. (2007) concluded that developing behavioural criteria was challenging, in part due to the difficulty in distinguishing a significant behavioural response from an insignificant, momentary alteration in behaviour. Consequently, they recommended that onset of significant behavioural disturbance resulting from a single pulse is taken to occur at the lowest level of noise exposure that has a measurable transient effect on hearing (i.e. TTS-onset). For multiple pulse and non-pulse (i.e. continuous) sources, they were unable to derive explicit and broadly applicable numerical threshold values for delineating behavioural disturbance. A scoring paradigm was used to numerically rank, in terms of severity, behavioural responses observed in either field or laboratory conditions. However, due to various statistical and methodological problems, much of this data was not considered to provide sufficient scientific credence for establishment of exposure criteria. Southall *et al*. (2007) noted the importance of contextual variables in determining behavioural response; together with the presence or absence of acoustic similarities between the anthropogenic sound and biologically relevant natural signals (e.g. calls of conspecifics, predators, prey). They suggest that the concept of a context-based approach to deriving noise exposure criteria for behavioural responses will be necessary.

Threshold SPLs for various categories of effect, and nominal ranges for drilling noise (SL = 170 dB re 1 µPa) and FPSO anchor piling operations are given in Table 6.4.

Table 6.4 - Threshold SPLs and nominal ranges for drilling and piling noise

Threshold	**SPL (dB)**	**Range (m)**	
		Drilling[1]	**FPSO piling[2]**
Acute trauma threshold	200-215	-	-
Minimum DRC threshold	178	-	<200
Odontocete behavioural threshold, lower (2kHz)	150	<50	9,400
Odontocete behavioural threshold, upper (2kHz)	170	1	<500
Baleen whale avoidance (50Hz)	120	<1,000	123,000

Note: [1] for source level 170 dB re 1 µPa; [2] for source level 223 dB re 1µPa.

The Athena field lies within the SCANS-II survey block 'T' (northern North Sea) and close to the border with block 'V' (central North Sea). Table 6.5 provides density estimates for these blocks for harbour porpoise, white-beaked dolphin, *Lagenorhynchus* spp. and minke whale, along with the corresponding estimated abundance within certain SPL contours.

Table 6.5 – Cetacean density and estimated abundance within SPL contours

Species	Block	Density[1]	Estimated abundance within SPL contour				
			160dB[2]	155dB	150dB	145dB	140dB
Harbour porpoise	T	0.177	1	3	11	49	220
	V	0.294	2	6	19	82	366
	Mean[3]	**0.236**	**2**	**5**	**15**	**66**	**294**
White-beaked dolphin	T	0.011	0	0	1	3	14
	V	0.049	0	1	3	14	61
	Mean	**0.030**	**0**	**1**	**2**	**8**	**37**
Lagenorhynchus spp.	T	0.094	1	2	6	26	117
	V	0.040	0	1	3	11	50
	Mean	**0.067**	**0**	**1**	**4**	**19**	**83**
Minke whale	T	0.013	0	0	1	4	16
	V	0.028	0	1	2	8	35
	Mean	**0.021**	**0**	**0**	**1**	**6**	**26**

Notes: [1] Animals per km^2; [2] dB re 1μPa; [3] arithmetic mean density of Blocks T and V. Source: SCANS-II (2008).

From the above, together with the source characteristics and prediction of propagation from the proposed activities presented above, and marine mammal distribution in the Athena area described in Section 4.11, the following conclusions may be drawn:

The east coast of Scotland, Orkney and Shetland support important breeding colonies and haul-out sites for both grey and common seals, several of which have international conservation designations. Common seals in Scotland generally forage within 40-60km of haul-out sites, with dense foraging activity occurring in waters off eastern Scotland and coastal waters surrounding Orkney and Shetland (Thompson *et al*. 1996, Hammond *et al*. 2004). However, common seals are also recorded far from shore across much of the central and northern North Sea, including foraging trips to areas more than 200km from haul-out sites. Grey seals generally forage within approximately 40km of haul-out sites (McConnell *et al*. 1999). This species also occasionally embarks on long journeys between different haul-out sites, spending long periods of time at sea and foraging in offshore areas (McConnell *et al*. 1999, Matthiopoulos *et al*. 2004). Offshore foraging destinations are typically localised areas of gravel/sand substrates – the preferred habitat of sandeels; substrates in the Athena area are predominantly sandy mud and unsuitable for sandeels.

The Athena field is a considerable distance from important pupping and haul out sites; both common and grey seals are likely to be present in only limited numbers around the Athena field and for fairly short duration. Significant acoustic disturbance is not expected to result from the proposed decommissioning programmes.

The Athena field area is considered to be of moderate importance for several species of marine mammals in a UK national context. Significant effects on marine mammals would not be expected to result from noise disturbance associated with the proposed decommissioning programmes.

Acoustic effects on other species

In addition to marine mammals, effects of noise are possible in other species. Many species of fish are highly sensitive to sound and vibration (reviewed by MMS 2004), and effects on fishing success ("catchability") have been demonstrated following seismic survey (Pearson *et al*. 1992, Skalski *et al*. 1992, Engås *et al*. 1993). 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". However, 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 and other production platforms.

Pile cutting and other noise could potentially result in direct effects on seabirds through physical damage, or through disturbance of normal behaviour. Diving seabirds (e.g. auks) may be most at risk of physical damage. The physical vulnerability of seabirds to sound pressure is unknown, although McCauley (1994) inferred from vocalisation ranges that the threshold of perception for low frequency seismic sounds in little penguins would be high, hence only at short ranges would penguins be adversely affected. Lacroix *et al*. (2003) in a study of long tailed ducks in the Beaufort Sea, found no difference in indices of site fidelity or diving intensity between the seismic area and two control areas although they could not discount subtle effects. By extrapolation, it is therefore considered that pile cutting and decommissioning noise will not result in significant injury or behavioural disturbance to seabirds in the Athena field area.

Planktonic and benthic invertebrates generally do not have gas-filled body cavities and are considered less susceptible to acute trauma and behavioural disturbance resulting from noise and vibration. Cephalopods, with a well-developed nervous system and complex behavioural responses, are a possible exception (although they lack resonating structures analogous with the middle ears, lungs, tracheal cavities and sinuses of mammals). Cephalopods are known to be able to detect low frequency noise and vibrations (Williamson 1988, Packard *et al*. 1990) but appear to be unresponsive to such sounds (Moynihan 1985).

6.4.7 Mitigation measures

Careful planning to ensure an efficient programme to reduce vessel visits and time on location will be developed for the decommissioning programmes.

6.4.8 Conclusion

It is concluded that potential effects of noise from the proposed decommissioning programmes, including removal vessels and rig P&A operations, are negligible, and will not result in adverse behavioural or other effects on the species of marine mammals, pinnipeds, fish or birds present in the area. Those effects associated with pile cutting noise would be largely restricted to behavioural effects on various marine mammals and fish over a short duration and small part of the species' overall ranges.

6.5 Accidental events

6.5.1 Evaluation

The potential effects of hydrocarbon spills were identified by a number of consultees as an issue requiring further evaluation in the Athena Development ES. The Upper Leek reservoir hydrocarbon is a heavy (*ca.* 25 deg API) low GOR oil with 7% wax and 6% asphaltenes. Other sources of hydrocarbon associated with the development include diesel fuel, helicopter fuel and lube and hydraulic fluids. These hydrocarbons, as with drilling and other chemicals, are limited in quantity to the inventory contained on the vessels, rig, in use, or being transferred.

Risk assessment of accidental events involves the identification of credible accident scenarios, evaluation of the probability of incidents, and assessment of their ecological and socio-economic consequences. Overall risk is the product of likelihood and consequence. The following discussion therefore considers:

- Possible mechanisms of loss of well control, spillages and other accidental events
- Historic frequency of relevant incidents
- Environmental consequences of relevant historic events
- Consideration of the environmental fate of spilled oil, and quantitative modelling of spill trajectories
- Environmental sensitivities of potentially affected habitats, species and human activities
- Mitigation and oil spill response

A variety of unplanned incidents and contingencies have been considered by the Environmental Assessment for the proposed Athena decommissioning programmes. These include (for example) drilling contingencies (e.g. downhole kill fluid loss, stuck string etc.), spills of oil and chemicals during handling, loading and transfers, dropped objects, fire/explosion, collision with other vessels, helicopter accidents and extreme weather events. In all cases, a risk-based approach is used, which considers probability and consequence. Potential oil spill incidents can be grouped as follows:

- Serious loss of well control (“blowout”) involving loss of reservoir fluids during P&A
- Loss of containment of oil, fuel or lubricants during storage, transfer or use (due to operator error, equipment failure, collision, etc) from drilling rig, construction vessels and support vessels during decommissioning phase

The rig will also carry a range of cementing and other chemicals required to kill the well or as contingencies. Chemical inventories on the rig will be relatively small and of generally low environmental risk.

Detailed oil spill contingency likelihood planning was undertaken prior to development drilling, installation and operations, and Oil Spill Contingency Plans (OSCP) detailing appropriate response resources prepared and approved by DECC in compliance with the *Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998* and the *Offshore Installations (Emergency Pollution Control) Regulations 2002.*

Spill mechanisms and likelihood

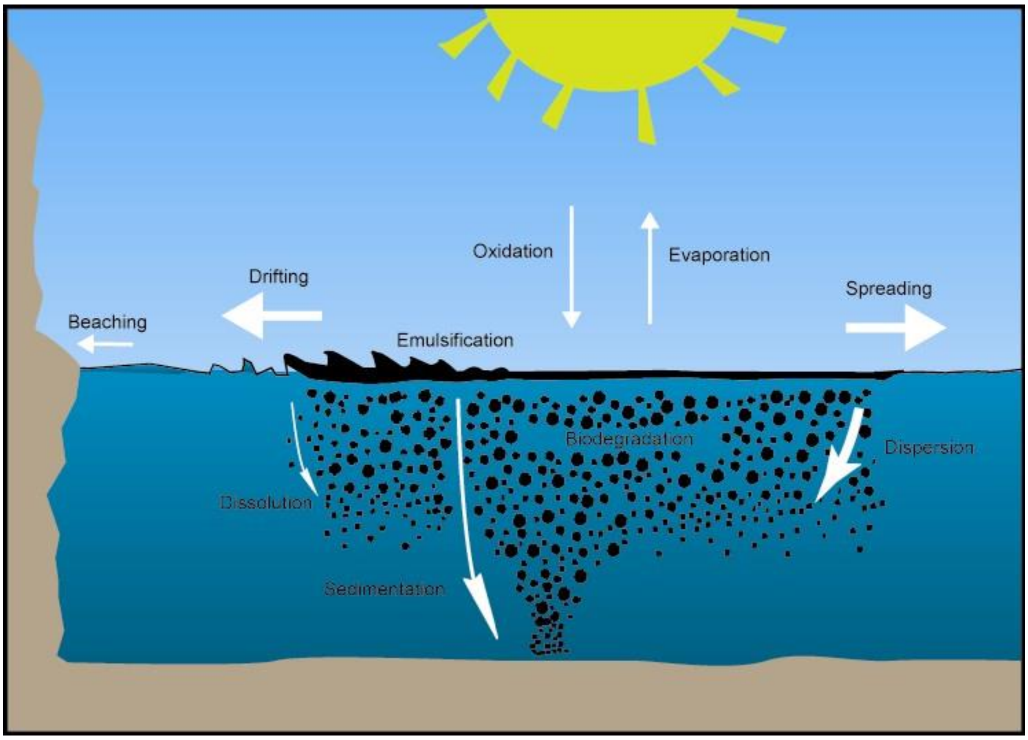
Event	Frequency and magnitude
Reservoir fluid spill, through loss of well control (“blowout”) during well P&A	Blowouts are defined as uncontrolled flows of reservoir fluids into the wellbore, and subsequently to the environment. The historic frequency of blowouts during offshore drilling is extremely low (see below); therefore, to a large extent the consideration of blowout scenarios is hypothetical. With current drilling P&A procedures, a blowout during P&A would require sequential failure of several methods of well control: primary control through kill fluid density, and secondary control through Blow-out Preventers (BOPs). Intervention methods for blowout control include operation of the BOP, well kill using a high-density mud, re-entry of the well in the event that the riser has unlatched or failed, or in extreme cases, drilling of a relief well. Blowout frequencies, expressed as number-per-well or number-per-year, are extremely low. Although there has been compulsory reporting of all significant spills on the UKCS since 1975, well control incidents resulting in significant oil spills have been too infrequent on the UKCS for a meaningful analysis of frequency based on historic data (DTI 2003). Blowout frequencies used in previous environmental assessments for exploration/appraisal and development drilling, in the UK, US and Canada, range from 2.8x10-5 to 2.1x10-4 (i.e. 1 in 35,714 to 1,075 well-years), with the higher frequencies (>10-4/well-year) related to gas blowouts with no significant oil content. Drilling blowouts resulting in large oil spills (>150,000 bbl) are generally considered to have a historical frequency of ≈10-5/wells drilled. These

Event	Frequency and magnitude
	values are generally consistent with derived annual frequencies based on the SINTEF and Scandpower worldwide databases (DTI 2003). Possible release locations of reservoir fluids from a blowout may be subsurface (with possible escape to the seabed outside the well conductor), subsea through loss of containment at the riser, or from the rig (e.g. at the drill floor). Blowout rates and durations may vary significantly, according to reservoir and formation conditions and to intervention. Recorded durations range from a few minutes to several months. Under most conditions, initial flow rates reduce relatively quickly due to natural bridging (reduction in permeability of the rock formations and well bore). For contingency planning purposes a worst case scenario for blowout scenario has been modelled of 1000 bopd (136 tonnes pd) flowing for 24 hours. This was based on the maximum production rate achieved from the 2006 appraisal well of 1300bopd and that in practice it is considered that an Athena well would only flow for a short period at this rate, reducing to approximately half this rate within 6 hours of commencing production and ceasing to flow unassisted altogether after a few days. Once in production the Athena wells will require artificial lift via the ESPs and would not be expected to flow un aided. As a result of the control measures in place (see Table 6.7) and the nature of the reservoir, the likelihood of a blow-out occurring during the drilling P&A from Athena is considered extremely remote.
Fuel oil, diesel, lubricating or hydraulic oil spill from drilling rig, construction vessels and support vessels during decommissioning phase	Hydrocarbon and chemical inventories on the drilling rig and construction vessels include bunker fuel (diesel – maximum inventory 1000 tonnes), helifuel (aviation turbine kerosene, ATK – maximum inventory 8 tonnes), and small quantities of lubricating oils and hydraulic fluids (maximum inventory 10 tonnes). Initiating events which may result in a spill include mechanical failures, corrosion, dropped objects, hose failures, fire and explosion. Control measures are in place for all identified risks, and most spillages are likely to be small-scale and contained by drainage systems on the rig. Fuel transfer operations represent the most significant credible scenarios for spillage (see below). Data collated by DECC since 1975 indicate that the major types of spill from mobile drilling rigs have been organic phase drilling fluids (and base oil), diesel and crude oil. A high proportion of these incidents result from flexible hose transfers, and associated risk can be mitigated through good operational practice (see Table 6.4). Spill quantities vary widely, and older data may be subject to reporting bias towards larger spillages; however, it is clear that the majority of reported spills from drilling units are small (< 5 tonnes). Spillages will be at relatively low rates and pressures, and if not contained, will reach the sea surface and spread rapidly to form a slick. Evaporation and dissolution of some components may be very rapid. The rig will also carry a range of P&A, cementing and other chemicals required to kill the well. Chemical inventories on the rig will be of low environmental risk (mainly drilling fluid constituents, see Section 3 and Appendix 3).Historic contributions to total number of spills on the UKCS are: fuel oil 0.1%, diesel 14.6%, lubricating oil 2.0%, hydraulic oil 4.7%, with the relative number of diesel and hydraulic oil spills increasing over the least 10 years (UKOOA 2002). Contributions to total oil spilled (tonnes) are: fuel oil 0.0%, diesel 3.5%, lubricating oil 0.3%, hydraulic oil 0.3%. Diesel is therefore the principal risk in terms of frequency and spill size, with spills associated mainly with hose failures and level control failure during bulk transfers. Maximum diesel inventory is rig- and vessel-dependent, but rig capacity is expected to be ≈ 1000 tonnes.

Behaviour of spills

On the sea surface, eight main oil weathering processes are generally recognised: spreading, evaporation, dispersion, emulsification, dissolution, oxidation, sedimentation and biodegradation (Figure 6.6). The rates of individual processes are inter-dependent, and also influenced by hydrocarbon characteristics, temperature and turbulence. In general, oils with a large percentage of light and volatile compounds and low viscosity (including diesel and ATK) will evaporate, disperse and dissolve more rapidly than oil predominantly composed of higher molecular weight compounds (e.g. crude oils).

Figure 6.6 – Fate of spilled hydrocarbon at sea



After ITOPF

Oil on the sea surface will move due to a combination of tidal currents and wind stress. Generally, the slick front will be wind-driven on a vector equivalent to current velocity plus approximately 3% of wind velocity and 100% of the current.

In general, the fate and consequence processes which affect spilled chemicals are comparable to those for hydrocarbon components, and are dependent on the partitioning of individual compounds between dissolved, oil and particulate phases in the water column.

Oil spill trajectory modelling

In addition to weathering, oil on the sea surface will spread and be moved under the influence of tidal currents and wind-drift. As oil spills can impact environmental sensitivities at distance, risk assessment requires the prediction of slick trajectory. For a given scenario, with defined spill volume and characteristics, weather conditions and tidal regime, the behaviour of a slick can be modelled. Oil spill trajectory modelling can be carried out **deterministicall**y (i.e. with defined arbitrary metocean conditions, usually "worst case") or **stochastically** (i.e. using statistical distributions for wind and current regimes). Both types of modelling were carried out as part of the oil spill risk assessment for the Athena Development. The scenarios (Table 6.6) were modelled using the Oil Spill Information System (OSIS). Scenarios were modelled originating from the proposed Athena drill centre. Stochastic modelling utilises input data in the form of identified spill scenarios, actual statistical wind speed/direction frequency data (supplied by the Meteorological Office) and predicted current vectors (from the Proudman Oceanographic Laboratory database). This is then modelled iteratively to provide a probability range of sea surface oiling representative of the prevailing conditions. The characteristics of Clair (*ca.* 23ºAPI) crude were used to approximate the behaviour of oil expected from the Upper Leek formation.

The modelling results are to be used for guidance purposes only. As with any other model, results are dependent on the quality of the environmental parameters and scenario inputs used in the scenario. If the same scenario was conducted in another oil spill modelling programme, with identical parameters and inputs, the results may show a degree of variance. This is expected as different fate and weathering models have been developed and programmed independently.

Table 6.6 – Modelled spill scenarios

Source	Initiating event	Wind Direction	Quantity	Oil type	Model type
Diesel Storage See Figure 6.3a	Collision	Onshore	1500 tonnes	Diesel	Trajectory Deterministic
Reservoir See Figure 6.3b	Small spill	Onshore (UK)	10 tonnes	Clair Crude	Trajectory Deterministic
Reservoir See Figure 6.3c	Small spill	Offshore towards median line	10 tonnes	Clair Crude	Trajectory Deterministic
Reservoir See Figure 6.4a	Blow out	Prevailing	136 tonne/d for 24h	Clair Crude	Stochastic
Diesel Storage See Figure 6.4b	Collision	Prevailing	1500 tonnes	Diesel	Stochastic
Storage See Figure 6.4c	Collision	Prevailing	6,000 tonnes	Clair Crude	Stochastic

Notes: Deterministic scenarios were modelled using a sustained 30knot wind.

A range of additional scenarios were also considered, including lubricating oil (single 205 litre drum) but involved spill volumes considered too small for reliable modelling.

The results of the deterministic trajectory and stochastic modelling are given in Figure 6.7a, b & c and 6.8a, b & c.

Deterministic modelling

Under deterministic modelling conditions even the 1,500 tonne diesel spill scenario does not beach, dispersing and evaporating within about 8 hours. The shortest time to beach for a crude oil spill under these worst-case circumstances was around 51 hours. Deterministic modelling is conducted largely to inform contingency planning (in terms of required response times), and the scenarios involved – in particular the continuation of high wind velocity from a constant direction - are not considered to represent an actual course of events.

Stochastic modelling

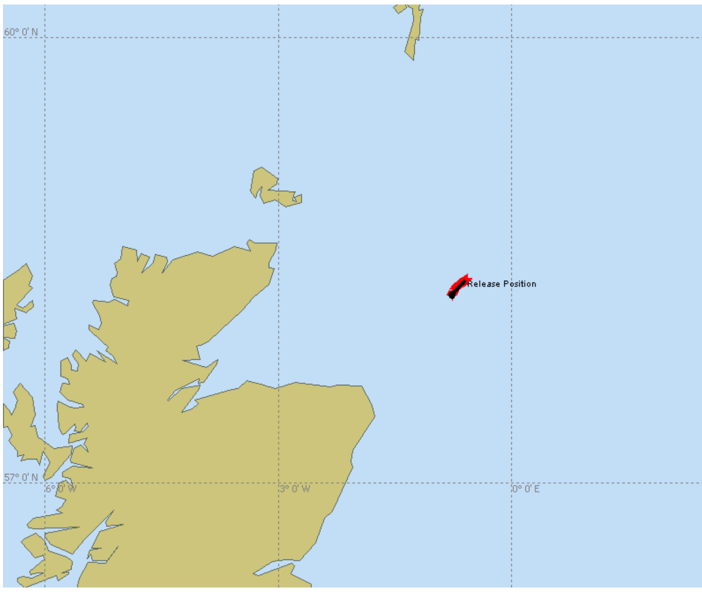
Although the absolute magnitude of modelled probabilities should be considered as indicative, results of stochastic modelling also indicate that a 1500 tonne diesel spill would not beach.

In contrast, the probabilities of oil beaching somewhere on the coast for the more persistent crude spill scenarios are higher. This is a consequence of the more persistent behaviour of spilled crude.

It should be noted that the probability contours shown in Figure 6.7 represent the position of the slick front under the range of conditions modelled; the actual spatial extent of any slick would be a very small proportion of the area enclosed by the probability contour. As with deterministic modelling, the assumption of sustained wind velocity and direction is highly conservative (since most high wind events are a result of depressions, in which wind direction varies rapidly with the passage of weather fronts).

Figure 6.7 - Deterministic oil spill trajectories from the Athena drill centre

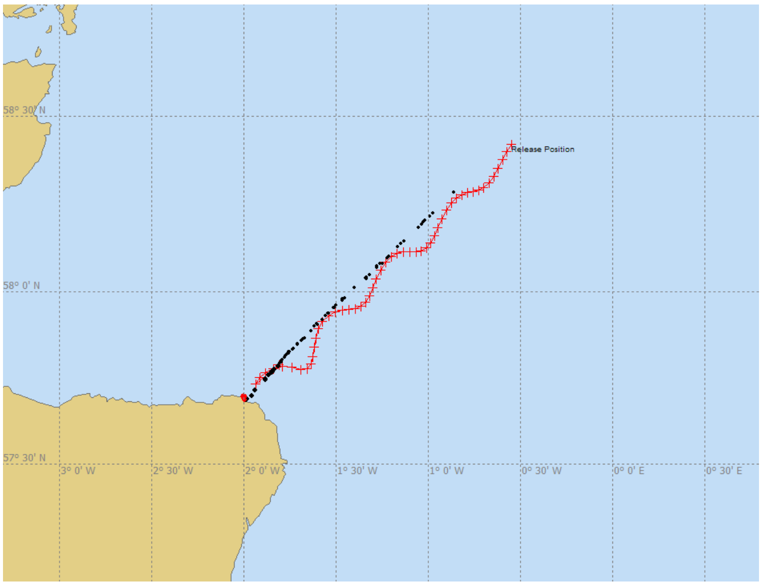
6.7a - Deterministic results for 1500 tonne instantaneous release of diesel towards Scottish coast



Observations:
A worst case scenario of a 30 knot onshore wind is used for modelling the diesel spill. Evaporation and dispersion levels remain high for the duration of the spill. Slick became insignificant after 8 hours - no beaching occurs.

*It should be noted that an event of this scale is **extremely unlikely***

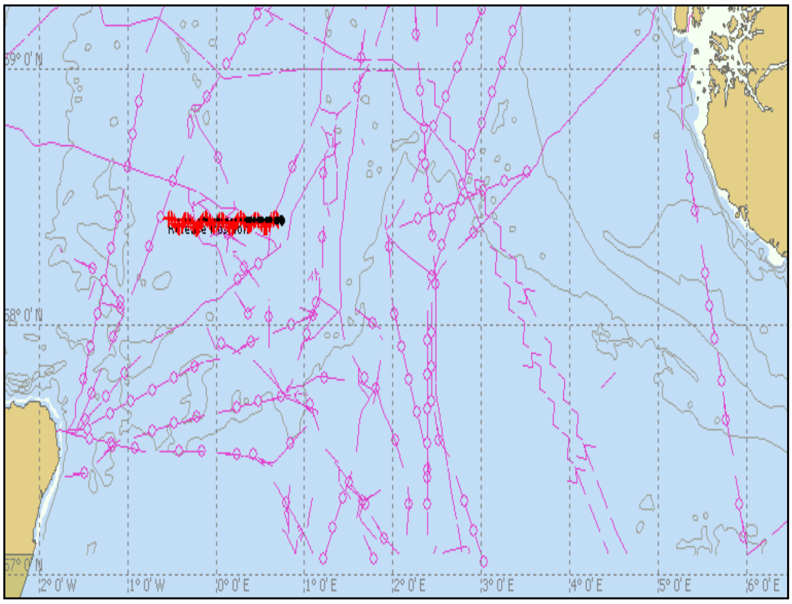
6.7b - Deterministic results for 10 tonne release of similar Athena crude towards Scottish coast



Observations:
A worst case scenario of a 30 knot onshore wind is used for modelling the crude oil spill. Beach impact after ca. 51 hours.

*It should be noted that an event such as this is **unlikely** and that continuous winds from the same direction for a 50hours would be unusual*

6.7c - Deterministic results for 10 tonne release of similar Athena crude towards Norwegian median line

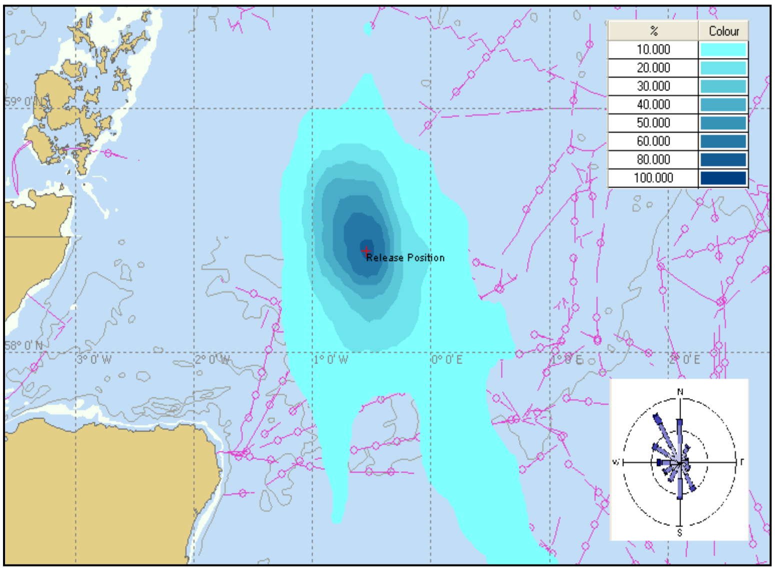


Observations:
A worst case scenario of a 30 knot offshore wind is used for modelling the crude oil spill. Slick crosses the median line

It should be noted that an event such as this is ***unlikely***

Figure 6.8 - Stochastic probability of oiling, Athena drill centre

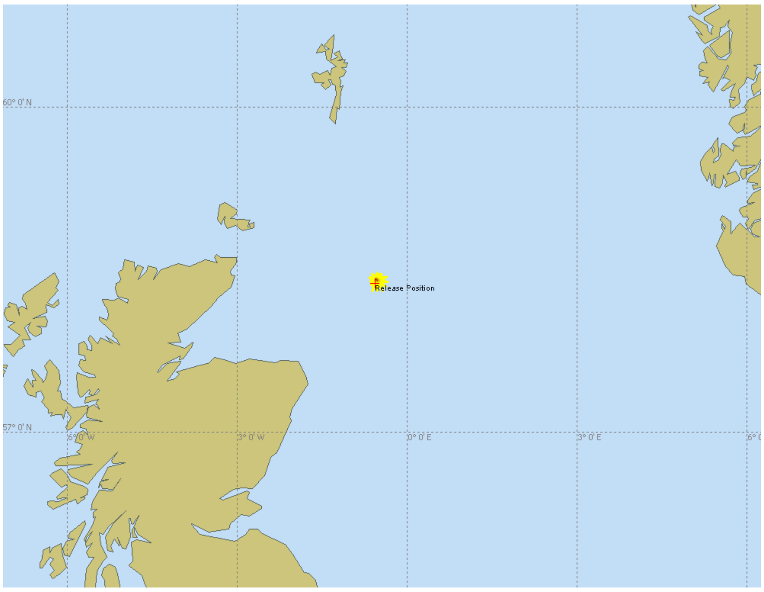
6.8a - Stochastic results for Model Run of 24 hour Blow-out of 136 tonnes/d of similar Athena crude oil run for 800 hours – surface oiling probability



Observations
The model indicates that a spill of this size may result in beaching.

It should be noted that an event of this scale is ***extremely unlikely****.*

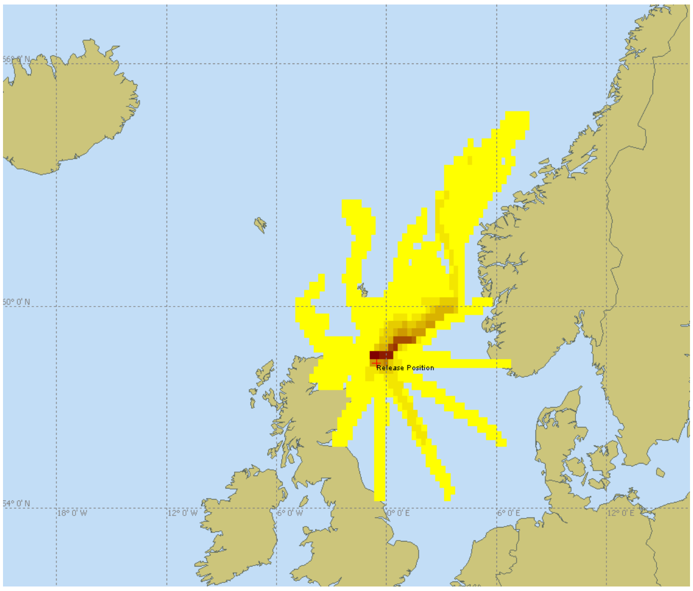
6.8b - Stochastic results for 1500 tonne instantaneous release of diesel – surface oiling probability



%	Colour
1.000	
10.000	
20.000	
30.000	
40.000	
50.000	
60.000	
70.000	
80.000	
90.000	
100.000	

Observations:
The model indicates that there is 0% probability of the diesel beaching.

6.8c - Stochastic results for 6,000 tonne instantaneous release of similar Athena crude – surface oiling probability



%	Colour
1.000	
10.000	
20.000	
30.000	
40.000	
50.000	
60.000	
70.000	
80.000	
90.000	
100.000	

Observations
The model indicates that a spill of this size may result in beaching.

It should be noted that an event of this scale is extremely unlikely

Rig or installation loss by collision is a very infrequent event and given the control measures put in place by Ithaca it is considered that this event would be extremely unlikely – assessment carried out in support of consent to locate the rig and support vessels based on the vessel traffic information

presented in Section 4.13.4 and the presence of a semi-submersible drilling rig over the proposed drill centre.
Blowout and other events resulting in crude oil spillage of these magnitudes is very infrequent (see above) and given the control measures in place it is considered that such an event would be extremely unlikely. In addition, the model was run to complete dispersion and assumes that no oil spill response is undertaken. In reality there will be immediate attempts on site to stem the spill as stopping any spill is the key point in commencing management of any incident. Oil spill contingency measures that would be implemented in such an event are discussed below.

Sensitivities

Offshore, ecological sensitivities to oil spills are associated principally with surface oiling effects on seabird and marine mammal populations. The sensitivity of planktonic and pelagic communities (e.g. fish and cephalopods) is believed to be lower, both in terms of exposure pathways and the higher recovery potential associated with reproductive capacity.

Mechanisms of impact on seabird populations include oiling of plumage and loss of insulating properties, and ingestion of oil during preening causing liver and kidney damage (Furness & Monaghan 1987). Indirect effects, associated with bioaccumulation of contaminants from prey, and reduced prey availability, are also possible, although generally not at a population level as a result of reasonable spill scenarios associated with offshore drilling.

The vulnerability of seabirds to surface oiling (see Section 4, Figure 4.9 and Table 4.7), is related to individual species' behavioural patterns, distribution and ecological characteristics such as potential rate of population recovery. Overall vulnerability is moderate in the vicinity of the proposed well with seasonal vulnerability very high in July and August, mainly as result of flightless auks in the area at this time of year. Recoveries of guillemots ringed at breeding sites and subsequently found as oiled casualties near sites of spills may include a high proportion of immature birds (Mavor *et al.* 2004). There is little evidence that guillemot mortality from spills around the UK have affected numbers at breeding colonies. Mortality would have to be very great and over a wide area to cause a detectable change, given that the mortality rate of immature birds is naturally very high. Drilling is expected to be complete by the end of June.

Generally, marine mammals (which rely on blubber for insulation) are less vulnerable than seabirds to fouling by oil, but they are at risk from hydrocarbons and other chemicals that may evaporate from the surface of an oil slick at sea within the first few days. In contrast to seabirds, there is relatively little evidence of direct mortality associated with oil spills (Geraci & St. Aubin 1990, Hammond *et al*. 2003), although the aggregated distribution of some species (especially dolphins) may expose large numbers of individuals to localised oiling. In the unlikely event of mortality from a spill, population recovery rates are likely to be lower than for most bird species.

Coastal sensitivities to oil spills are well-recognised, and the range of features potentially at risk in the North East of Scotland is described in Section 4.

Even the maximum hypothetical diesel spill from the proposed Athena development activities, complete loss of the fuel inventory (1000 tonnes) at the well location, would be disperse naturally through evaporation and dispersion in the water column before beaching. Only the extremely unlikely scenario of a large spillage of crude oil from the proposed well has the potential to directly impact on coastal features.

Oil and Other Spill Prevention, Mitigation and Response

Oil spills from operations, drilling rigs, construction and support vessels are largely preventable through provision of appropriate equipment, maintenance and training. Awareness of environmental sensitivities, and practical measures to reduce risks, will be integral to the contractual and management arrangements for the proposed well. Specific prevention measures which will be implemented for the Athena Development are listed below and in Table 6.7.

- Pre-operations audit of support vessel and rig management systems, procedures, equipment and equipment maintenance
- Audit of supply and standby vessel management systems, procedures, equipment and equipment maintenance
- Environmental awareness training for all pertinent personnel
- Ongoing spill prevention inspection programme throughout the period of hire

Table 6.7 – Scenario specific spill prevention measures

Source	Initiating event	Control Measures
Reservoir/subsea infrastructure	Loss of well control Corrosion, Impact	Analysis of analogue wells Well design kill fluid design (density, hydrostatic head) Deployment of Blow-out Preventer (BOP) Independent audit of blowout prevention equipment and integrity of the well design BOP test every 21 days Isolation valves on subsea trees. Wells require artificial lift and would not be expected to flow without ESPs. 500 metre exclusion zone around subsea manifold Fishing protection structures on trees and manifold Risers within FPS exclusion zone Pipelines trenched & buried Control room and stand by vessel monitor vessel activity Corrosion monitoring Exclusion zone vessel entry procedures
Storage (crude, diesel, helifuel, lubes, drilling chemicals etc)	Collision, Corrosion, Fire & Explosion, Dropped Object	500m Exclusion Zone High-specification stand-by vessel with automatic radar plotting aid in field at all times to enforce exclusion zone Timely rig move signals promulgated through the Hydrographic Office at mobilisation and de-mobilisation of rig Kingfisher Notice to Mariners Notifications to HM Coastguard and Northern Lighthouse Board Rig Operator corrosion prevention, monitoring and audit fire & gas detection systems Crane management procedures Permit to Work System Spill containment equipment on board the standby vessel.
Bunkering and supply operations (diesel, helifuel, drilling chemicals etc)	Hose Rupture, Over Pressure of Hose, Dropped Object	Hoses to be stored in safe area, away from risk of physical damage and according to manufacturer guidance Hoses and couplings to be subject to inspection for integrity, wear and tear prior to each bunkering event Hoses to be colour coded, with float collars and Avery Hardoll or similar breakaway coupling fittings Critical valves will be locked and controlled by permit and

Source	Initiating event	Control Measures
		designated person NWEA Guidelines for the Safe Management of Offshore Supply and Rig Move Operations (version 2 June 2009) Crane Management Procedures and Permit to Work System Bunkering will be conducted in favourable sea states and according to the selected rig operator's procedures. Bunkering procedures will be audited by Ithaca as part of the rig selection and contracting process. Ithaca recognises that there are periods of very high seabird vulnerability during the drilling period, and so far as practicable, bunkering will be conducted during daylight hours.
Rig Operations and General Housekeeping	Drips, Deck spills	Areas of the rig where spillage may occur will drain to an oil water separator or other tank, and not be allowed to drain directly overboard Rig will operate to MARPOL standards for Special Area Critical valves will be locked and controlled by permit and designated person Drums will only stored be in bunded areas Drip trays will be used Provision of deck spill containment and clean-up kits on the rig

The decommissioning programmes, P&A and subsequent field equipment removal is covered by an approved Oil Spill Contingency Plan (OSCP) prepared in accordance with regulations including *The Merchant Shipping (Oil Pollution Preparedness, Response and Cooperation Convention) Regulations 1998* (OPRC) and *The Offshore Installations (Emergency Pollution Control) Regulations 2002*. The plans include risk assessment and trajectory modelling (consistent with that presented above) and clearly set out:

- interfaces with other relevant plans including National Contingency Plan
- individual responsibilities of key Ithaca and contractor personnel
- details of training and exercises
- actions to be taken in the event of an oil spill, including notifications and consultations and implementation of response
- procedures for the setting up of an Operations Control Unit as may be required by the SOSREP
- contact details for relevant statutory authorities, response contractors and other relevant agencies
- resources available for monitoring, containment, recovery and dispersal of any spill and procedures for mobilising them

In the event of an oil spill entering Norwegian waters it may be necessary to implement the NORBRIT Agreement (the Norway-UK Joint Contingency Plan). The NORBRIT Agreement sets out command and control procedures for pollution incidents likely to affect both parties, as well as channels of communication and resources available.

Ithaca will ensure strict reporting of oil and chemical spills to the relevant authorities using the format prescribed in Petroleum Operations Notice No. 1.

DECC's Guidance Note (April 2009) to the OPRC Regulations (DECC 2009c) gives guidance on required response times and levels for exploration and production operations located outside

'Essential Element' blocks and located outside any block wholly or partly within 25 miles of the coastline. The guidance on response levels and times indicated below has been developed in consultation with MCA, JNCC and Marine Scotland.

Athena Upper Leek crude is Group 3 oil and for these oil types, where seabird vulnerability is very high, a capability to respond within 1 hour is required at an average combat rate of 10 tonnes/hr.

In common with standard industry practice, the actions and resources specified by the plan will relate to a tiered response capability:

- Tier 1: immediately available on location including stand-by vessel equipped with 5 tonnes of concentrated dispersant and spraying equipment and slick sampling kit and access to shoreline response equipment
- Tier 2: supplied from a regional centre
- Tier 3: supplied from national and international sources in response to very large spills.

Tier 2/3 capability is available to Ithaca via standing contractual arrangements as part of membership of Oil Spill Response Ltd. (OSRL) include:

- Cessna 310 aerial surveillance aircraft (based Coventry), response time <4h
- Cessna 406 aircraft (based Coventry) with spray pod and dispersant stockpile, capable of dispersing up to 25 tonnes amenable hydrocarbon / sortie, response time <6h
- L382 Hercules aircraft (based Southampton), capable of dispersing up to 340 tonnes amenable hydrocarbon / sortie, response time <7h
- Containment booms and recovery equipment, stockpiled in Southampton, effective capability 2 x 30,000 tonnes

Appropriate oil spill response training is provided to all relevant Ithaca personnel, and regular spill exercises are undertaken to support ongoing drilling and production activities in the North Sea. Prior to P&A the wells, a specific training exercise will be undertaken to identify any problems or shortcomings with the emergency response procedures and oil spill contingency plan for the decommissioning programmes.

6.5.2 Conclusion

Overall, it may be concluded that risks of significant environmental, socio-economic or amenity impacts, resulting from an accidental event during the proposed decommissioning programmes, are very small.

Principal considerations are:

- The low historic frequency of significant incidents associated with drilling P&A
- Technical, operational and management measures to prevent accidental spills
- The Athena wells will not flow unaided (ESPs are required)
- Very high vulnerability of seabirds in the vicinity of the well location, during July and August
- No coastal oiling resulting from diesel spills at the Athena location are predicted
- Oil spill prevention measures and response capability to cover decommissioning activities

6.6 Cumulative and synergistic effects

Guidance to *The Offshore Petroleum Production and Pipe-lines (Assessment of Environmental Effects) Regulations 1999* (DECC, August 2009) states that:

"The assessment should also evaluate any direct or indirect effects (including secondary, short, medium and long-term, permanent and temporary, positive and negative) resulting from the existence of the activity, the use of natural resources and the emission of pollutants, the creation of nuisances and the elimination of waste. The assessment should seek to set the activities and potential impacts in the context of all other activities taking place in the area of the decommissioning programmes and determine the additive, which is the cumulative, effects of the new activities."

DTI (2003) defined three categories of "additive" effects in the context of Strategic Environmental Assessment:

Incremental effects are considered within the EA process as effects from decommissioning programmes and well P&A activities, which have the potential to act additively with those from other oil and gas activity, including:

- forecast activity in newly licensed areas
- new exploration and production activities in existing licensed areas
- existing production activities
- forecast decommissioning activities
- "legacy" effects of previous E&P activities, post-decommissioning (e.g. unrecovered debris and cuttings material)

Cumulative effects are considered in a broader context, to be potential effects of E&P activities which act additively or in combination with those of other human activities (past, present and future), notably:

- fishing
- shipping, including crude oil transport
- military activities, including exercises (principally in relation to noise)

Synergistic effects – synergy occurs where the joint effect of two or more processes is greater than the sum of individual effects – in this context, synergistic effects may result from physiological interactions (for example, through inhibition of immune response systems) or through the interaction of different physiological and ecological processes (for example through a combination of contaminant toxicity and habitat disturbance). Effects from the planned activities or accidents associated with the proposed development, which are considered to have potential to act in an incremental, cumulative or synergistic manner are summarised below.

Physical presence	Incremental: The only other long term exclusion areas in the vicinity relate to the Claymore and Scapa fields and there are few temporary exclusion areas. Incremental loss of fishing access is not significant in commercial terms. Cumulative: No other significant access bans or restrictions to navigation exist in the area, although it is possible that fishing may be managed if conservation areas are established in future, none are currently anticipated in

	the vicinity of the proposed decommissioning area. Synergistic: None
Physical disturbance	Incremental: disturbance will be incremental with that resulting from decommissioning activities. However, well P&A and equipment removal locations in the area are generally widely separated and the spatial extent of disturbance is limited, with only limited footprint overlap. Total area affected is a small proportion of benthic habitat area. Cumulative: although intensity is moderate in comparison to other areas, fishing probably represents the principal source of seabed disturbance in the central North Sea. Trawl scarring in some areas is likely to be extensive. Contribution of oilfield decommissioning programmes is currently minor. Synergistic: None
Noise	Incremental: Athena decommissioning associated noise would be incremental to other drilling, seismic exploration and production facility noise in the central North Sea and adjacent areas. Pile cutting noise is low and of relatively short duration, and is variable in comparison to drilling P&A, decommissioning and support vessel noise, which will not propagate widely. The increment associated with the Athena decommissioning programmes, drilling P&A and subsea facility removal is not considered to have significant synchronous effects (i.e. additive to other acoustic disturbance at the time of operations) and in terms of temporal effect (i.e. additive to previous and subsequent disturbance by seismic and other activities). Cumulative: Other sources of anthropogenic noise include shipping and military sources – the cumulative increment from the proposed Athena decommissioning will be minor in the context of existing noise levels from shipping transiting the area. Synergistic: No synergistic effects have been conclusively demonstrated, although military sonar noise is speculated to be a contributory factor to tissue damage observed in stranded cetaceans (e.g. Jepson *et al*. 2003). This involves much higher source levels than are predicted from the proposed decommissioning programmes, drilling P&A and subsea facility removal.
Drilling and subsea discharges	Incremental: Contamination will be incremental with that resulting from previous exploration, appraisal and development wells and activities in the area. However, well and field/pipeline locations in Block 14/18 and adjacent areas are widely separated and spatial extent of detectable contamination is limited, generally without footprint overlap. Total area affected is a small proportion of benthic habitat area. Cumulative: No other significant local sources of discharge, and no cumulative interaction with more distant inputs of contaminants of concern (e.g. persistent chemicals, PCBs, PAHs etc) Synergistic: No synergistic interactions of WBM components are known. Synergistic effects of chemical contaminants in produced water and drilling discharges from adjacent fields are conceivable (DTI 2003), although substantive data is almost entirely lacking and significant synergistic effects are considered unlikely.

Other discharges	Incremental: No significant incremental (or cumulative) effects, in view of very high available dispersion. Cumulative: None Synergistic: None
Emissions	Incremental: No significant incremental effects, in view of very high available dispersion. Cumulative: Greenhouse and acid gas emissions will be cumulative in a global context, although the contribution associated with the proposed Athena decommissioning programmes is minor. Synergistic: None
Accidental events	Incremental: The combined probability of ecologically significant oil spills from decommissioning programmes activity in the central North Sea is extremely low. Cumulative: The adjacent coasts (the closest is some 116km away), are exposed to risks associated with oil/product tanker and other vessel traffic through the region and to adjacent ports. Some of these routes are comparatively close to shore and limited time is available for effective response measures in the case of accidents. The contribution to overall risk of the proposed Athena decommissioning programmes, drilling P&A and subsea facility removal is however, extremely small. Synergistic: None

6.7 Transboundary effects

The UK has ratified *The Convention on Environmental Impact Assessment in a Transboundary Context* (the *Espoo Convention)* and thus an assessment is needed of the potential for the proposed Athena decommissioning programmes to result in significant transboundary effects. The proposed offshore activities have a very limited likelihood of transboundary effects as the location is distant from international boundaries, being 119km from the UK-Norway median line. The noise, atmospheric and aqueous emissions and risk of oil spills from the decommissioning programmes, drilling P&A, and removal operations, are either unlikely to be detectable or to significantly affect Norwegian national waters and air quality. A crude oil spill from Athena may cross the median line under certain conditions.

In addition, the fishing vessels of several European states are entitled to fish in the region and the establishment of a temporary 500m exclusion zone around the rig for the duration of drilling P&A and the 500m exclusion zone round the production manifold and the riser base has the potential to affect fishing interests. Based on the nature of the fishery (Section 4.13.2) and the assessment made in Section 6.2.1, any interference to fishing interests would be of negligible significance.

6.8 Internationally important habitats and species

There are a number of Special Protection Areas and Special Areas of Conservation (Natura 2000 Sites) on the coasts adjacent (albeit 116km distant) to the Athena field location. Similarly, the closest offshore conservation sites to the proposed decommissioning activity are the Scanner pockmark and Braemar pockmarks (proposed Special Areas of Conservation) some 89km to the east and 130km to the northeast respectively. The potential for planned decommissioning programmes, well P&A and removal activities to affect any of these sites has been considered and in no case were significant effects expected. Of the accidental events assessed, a large spill of crude oil would be expected to beach under some wind and tidal conditions as indicated above such an event is considered very unlikely.

As described in Section 4.2, the Athena seabed surveys have recorded the presence of numerous pockmark features around the Athena field and along the proposed flowline route. Geophysical, photographic and physical sample information provided by the Athena surveys (Gardline 2006, 2007a&b) indicated that pockmark features in the proposed decommissioning programmes area do not qualify as Annex I habitat since they do not contain carbonate cemented rock. However, pockmarks were avoided were possible in the flowline route, STP buoy and rig anchor, and subsea facility locations.

It is an offence under the *Conservation (Natural Habitats &c.) Regulations 1994* and the *Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007* (as amended) to deliberately disturb wild animals of a European Protected Species (species listed in the Annex IV of the Habitats Directive) in such a way as to be likely significantly to affect: a) the ability of any significant group of animals of that species to survive, breed, or rear or nurture their young; or b) the local distribution or abundance of that species.

Marine European Protected Species (EPS) include all species of cetaceans, a number of which occur in the vicinity of the Athena field. It is not expected that the Athena field decommissioning programmes, well P&A and removal activities will require a wildlife licence to exempt them from regulation 39(1)(b). This is because their potential for disturbance is considered or anticipated to be below the threshold that would cause significant effects since mitigation measures would be put in place. Ithaca will follow the Guidance from Marine Scotland March 2014 on the protection of marine EPS from injury and disturbance for the Athena decommissioning programmes.

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