

# **Unconventional Oil and Gas: Regulatory Workshop**

## **Overview of the Current Regulatory Framework**

November 2016



Scottish Government  
Riaghaltas na h-Alba  
gov.scot

# UNCONVENTIONAL OIL AND GAS: REGULATORY WORKSHOP

## OVERVIEW OF THE CURRENT REGULATORY FRAMEWORK

### Background and Purpose

The Scottish Government is taking a cautious and evidence-led approach to Unconventional Oil and Gas (UOG). On 28 January 2015, the Scottish Government announced a moratorium on UOG so that further evidence could be gathered before holding a full public consultation.

On 08 October 2015 the Scottish Government published details of a comprehensive programme of research and the timetable for the consultation on unconventional oil and gas.

This workshop on regulation is part of this programme of evidence-gathering.

The evidence considered at the workshop included the review of UOG carried out by the [Independent Expert Scientific Panel](#), as well as the research projects commissioned in 2016, namely:

- Health Impact Assessment (Health Protection Scotland)
- Transport - Understanding and mitigating community level impacts (Ricardo).
- Decommissioning, site restoration and aftercare – obligations and treatment of financial liabilities (AECOM)
- Understanding and monitoring induced seismic activity (the British Geological Survey)
- Economic impacts (KPMG)
- Climate Change Impacts (UK Committee on Climate Change)

This paper summarises the overarching framework of regulation that currently exists to minimise hazards, and mitigate the risks to public health and the environment across the lifetime of a UOG project. In doing so it draws heavily on the research projects listed above and other materials in the public domain such as explanatory documents published on websites of the regulatory bodies. Where publications by other bodies or academics are used a reference is given.

This paper does not describe detailed processes and procedures for each stage of regulation.

“Hazard” is used here to refer to a potential source of harm. “Risk” refers to a combination of the likelihood of a hazard having an impact and the impact it would have if realised. No estimates of risk are given in this paper.

The Scottish Government has a moratorium on UOG and is not proposing to make any changes to regulation at this time. The Scottish Government’s approach to UOG will be informed by the evidence that is being gathered and the public consultation.

## Acronyms

CAR	Water Environment (Controlled Activities) (Scotland) Regulations
COMAH	Control of Major Accident Hazard Regulations
COSHH	Control of Substances Hazardous to Health Regulations
DCR	Offshore Installations and Wells (Design and Construction etc) Regulations
EIA	Environmental Impact Assessment
HSE	Health and Safety Executive
NOx	Nitrogen Oxides
NORM	Naturally Occurring Radioactive Materials
PA	Planning Authority
PM	Particulate Matter
PPC	Pollution, Prevention and Control (Scotland) Regulations
PPD	Public Participation Directive
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RSA	Radioactive Substances Act
SEA	Strategic Environmental Assessment
SEPA	Scottish Environment Protection Agency
SPP	Scottish Planning Policy
SNH	Scottish Natural Heritage
SPP	Scottish Planning Policy
UOG	Unconventional Oil and Gas
VOC	Volatile Organic Compound

## SECTION 1: OVERVIEW OF THE REGULATORY FRAMEWORK

In common with other industrial developments, a number of public bodies are involved in the regulation and control of activities associated with the development and decommissioning of an unconventional oil and gas site.

The Scottish Government is committed to [Better Regulation](#), which is founded on five principles of good regulation:

**Consistent** - rules and standards must be joined up and implemented fairly.

**Transparent** - be open and keep regulations (and how they are implemented) simple and user- friendly.

**Accountable** - be able to justify decisions and be subject to public scrutiny.

**Proportionate** - only intervene when necessary. Remedies should be appropriate to the risk posed and costs identified and minimised.

**Targeted** - regulation should be focused on the problem and minimise side effects.

### Regulatory Bodies

[The Oil and Gas Authority](#) is currently responsible for granting exclusive rights to oil and gas in a given area. The **Scotland Act 2016** includes provisions to transfer licensing powers to the Scottish Ministers. At the point of transfer, **Scottish Ministers** will have the power to legislate for the granting and regulation of licences to search and bore for and get petroleum within the Scottish onshore area; determine the terms and conditions of licences; and regulate the licensing process.

A license conferring exclusive rights to explore for and produce petroleum does not confer any exemption from other legal and regulatory requirements and licensees must have permissions from **the Planning Authority, Scottish Environment Protection Agency (SEPA)** and in some cases the **Coal Authority**, and submit a notification to the **Health and Safety Executive** before undertaking work.

[Planning Authorities](#) are responsible for determining applications for planning permission where required under the Town and Country Planning (Scotland) Act 1997. **SEPA** is a statutory consultee to minerals applications and **Scottish Natural Heritage** must also be consulted in specified circumstances.

**Local Authorities** have responsibility for air quality, waste management and investigating and taking appropriate action where an activity is causing a statutory nuisance such as smoke, fumes, gases, dust, steam, or odour.

[The Scottish Environment Protection Agency \(SEPA\)](#) is Scotland's principal environmental regulator, particularly with regard to industrial processes. Relevant regulatory roles include pollution prevention and control, protection of the water environment and EU Emissions Trading. SEPA also have duties regarding local air

quality management and are a statutory consultee on major planning applications, Environmental Impact Assessments and Strategic Environmental Assessments (SEAs). Together with the Health and Safety Executive, SEPA is the competent authority for the Control of Major Accident Hazard Regulations (COMAH) regime. Some sites could potentially come into scope of the COMAH Regulations if they produce, store or handle significant quantities of dangerous substances.

**The Health and Safety Executive (HSE)** regulate to ensure the operator is managing the health and safety risks throughout the life cycle of the well (from design, construction, operation, maintenance, through to decommissioning and abandonment). HSE specialist inspectors scrutinise the operator's well design and construction plans, and the operator must also have a well examination scheme that ensures that the well is examined by an independent and competent person who is able to make recommendations to the operator to ensure that the well is designed, constructed and maintained in such a way that the operator is able to maintain control of the well throughout its life-cycle.

The **Coal Authority** regulates access to coal in the United Kingdom. Operators need a licence for coal mining operations, including Coal Bed Methane, or a permit for any activity which enters or passes through the Coal Authority's property.

**Scottish Natural Heritage** functions as a licensing authority under Part III of the Conservation (Natural Habitats, &c.) Regulations 1994 as regards European Protected Species (as well as carrying out various wildlife licensing functions under the Wildlife and Countryside Act 1981); has an advisory role with regard to the responsibilities of competent authorities under Part IV of the Conservation (Natural Habitats, &c.) Regulations 1994; and is a statutory consultee for SEAs, EIAs, and for any proposals that could affect Sites of Special Scientific Interest, National Scenic Areas, Special Protection Areas, and Special Areas of Conservation.

**Figure 1- Summary of core regulatory responsibilities**



## Licences and Strategic Environmental Assessments

The powers to legislate for the granting and regulation of licences are given to the **Oil and Gas Authority** by the **Petroleum Act 1998**. Sections 47 to 49 of the **Scotland Act 2016**, when commenced by Order at Westminster, will transfer the powers to **Scottish Ministers**.

All regulations laid under the **Petroleum Act 1998** must comply with the **Hydrocarbon Licensing Directive 1994** which provides the criteria that can be considered in assessing applications to include the technical and financial capability of the applicant; the way in which the applicant proposes to carry out the activities; and any lack of efficiency and responsibility displayed by the applicant in operations under previously held licences. The Directive allows for licences to impose terms and conditions that concern:

- the proper performance of the activities
- national security
- public safety
- public health
- security of transport
- protection of the environment
- protection of biological resources and of national treasures possessing artistic, historic or archaeological value
- safety of installations and of workers
- planned management of hydrocarbon resources
- the need to secure tax revenues.

Licences are issued under regulations laid for the purpose, the most recent being the **Petroleum Licensing (Applications) Regulation 2015**. Licences issued by the **UK Government** prior to 2015 were issued under earlier regulations.

In addition to laying regulations in Parliament, before a public plan or programme can be adopted the **Environmental Assessment (Scotland) Act 2005** requires those that are likely to have significant environmental effects, to be subject to **Strategic Environmental Assessment (SEA)**. SEA is a key component of sustainable development, protecting the environment and extending a clear and transparent opportunity for public participation in decision making. SEA achieves this by:

- Systematically assessing and monitoring the significant environmental effects of public strategies, plans and programmes
- Ensuring that expertise and views are sought at various points in the process from SNH, SEPA, Historic Environment Scotland and the public

- Requiring a public statement that outlines how opinions and views have been taken into account in the final plan or programme.

Areas that are likely to be open to licensing will also require a [Habitats Regulations Appraisal](#) if the area has some connectivity to a Natura site (Special Areas of Conservation and Special Protection Areas). This appraisal seeks to ensure that only those plans and projects which will not adversely affect the integrity of European protected sites are allowed to proceed. These assessments must ascertain no adverse effect before consent can be granted and must accompany any licensing round that could have an impact on protected sites.

Licences are comprised of model clauses that are set out in regulations, the most recent being the **Petroleum Licensing (Exploration and Production) (Landward Areas) Regulations 2014**. Again, licences issued by the **UK Government** prior to 2015 were issued under earlier regulations.

Licences can be revoked if the licensee does not comply with all conditions given. Licences set out a series of 'terms' which correspond to the stages of a UOG development (Figure 2). At the end of each term License Holders can request that the licence continues in force to the next term. Permission is subject to satisfactory performance of the operator.

As part of the licence conditions, the licence holder is required to seek the licence authority's consent for work programmes, appointment of operators, seismic surveys, to commence or recommence drilling, to flare any gas or to increase pressure for maintaining petroleum, or to plug or abandon a well. (Appropriate planning, environmental and health and safety authorisations are also required at these stages).

Consent to drill or to recommence drilling is given only when the necessary planning permissions and environmental permits are in place, the HSE is satisfied with the well design, and British Geological Survey has been notified and appropriate insurance policies are in place.

**Figure 2:** Stages of a typical UOG development. Timeframes are indicative and do not include the time taken to secure relevant consents.



All activity subjected to obtaining planning permission and all relevant regulatory permits

The moratorium on unconventional oil and gas means that the only part of a prospective UOG development permitted in Scotland are boreholes to take core samples.

With respect to Coal Bed Methane, permission is required from The Coal Authority. The Coal Authority will not grant access for the purpose of coal methane extraction unless a Petroleum Licence and Planning Permission are already in place, or a timescale for these being obtained is set out. The Coal Authority determines applications for Coal Methane Agreements in line with the **Coal Industry Act 1994**.

## Overview of the role of planning

The [Scottish Planning Policy \(SPP\)](#) sets out national planning policies which reflect Scottish Ministers' priorities for operation of the planning system and for the development and use of land. The SPP promotes consistency in the application of policy across Scotland whilst allowing sufficient flexibility to reflect local circumstances. It directly relates to: the preparation of development plans; the design of development and the determination of planning applications and appeals.

The statutory definition of development includes any building, engineering, mining or other operations in, on, over or under land. Underground operations as well as above ground development can only be undertaken once planning permission has been granted.

**The Town and Country Planning (Scotland) Act 1997** requires planning applications to be determined in accordance with the development plan unless material considerations indicate otherwise. As a statement of Ministers' priorities, the content of the SPP is a material consideration that carries significant weight, though it is for the decision-maker to determine the appropriate weight in each case.

Policies within the SPP set out the planning issues that development proposals are expected to address. Planning policies specific to mineral extraction, including UOG, are primarily addressed in the Promoting Responsible Extraction of Resources section of the Scottish Planning Policy. Other sections – such as those relating to the natural and historic environment – are also likely to be relevant.

Development plans should set out the factors that specific proposals will need to address, including:

- disturbance, disruption and noise, blasting and vibration, and potential pollution of land, air and water;
- impacts on local communities, individual houses, sensitive receptors and economic sectors important to the local economy;
- benefits to the local and national economy;
- cumulative impact with other mineral and landfill sites in the area;
- effects on natural heritage, habitats and the historic environment;
- landscape and visual impacts, including cumulative effects;
- transport impacts; and

- restoration and aftercare (including any benefits in terms of the remediation of existing areas of dereliction or instability).

The SPP states that applicants should undertake a risk assessment for all proposals for shale gas and coal bed methane extraction in consultation with statutory consultees and local communities. Where appropriate, this assessment can be undertaken as part of any environmental impact assessment required. This should identify onsite activities that pose a potential risk using a source-pathway-receptor model and explain measures for monitoring, managing and mitigating any identified risks to health, amenity and the environment. The evidence from this assessment should lead to the identification of buffer zones being proposed as part of applications to protect all sensitive receptors from unacceptable risks.

Other regulatory regimes covering health and safety and environmental protection will be relevant to the consideration of an application for planning permission. However, the focus of the planning system should be on determining whether a proposal is an appropriate use of land. It should not seek to control activities regulated by other regimes, but does have an important role to play in protecting communities and the environment from the impacts of site operations. **Planning authorities** can assume that other regulatory regimes will operate in accordance with the requirements of the respective regulators. However, the potential effects of a regulated activity on local communities and the environment will be a material consideration that must be taken into account when determining planning applications.

Development proposals may require an EIA. EIA ensures that a **planning authority**, when deciding whether to grant planning permission for a project likely to have significant environmental effects, does so in the full knowledge of what these effects are likely to be. The **Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2011** set out the procedures that apply to EIA.

EIA is mandatory before planning permission can be granted for UOG development if the amount to be extracted will exceed 500 tonnes per day for petroleum or 500,000m per day for gas (Schedule 1 development under The **Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2011**). Schedule 2 of the Regulations establishes that an EIA will be required if the area of the development for any surface industrial installations associated with petroleum extraction exceeds 0.5 hectares and the development is screened as likely to have significant environmental effects. Within 'sensitive areas' as defined in the Regulations, the 0.5 hectare threshold does not apply and developments smaller than 0.5 hectares will require to be screened for likely significant environmental effects.

The **Town and Country (General Permitted Development) (Scotland) Order 1992** confirms the classes of development that benefit from permitted development rights. Class 55 and Class 56 permits the carrying out of some ancillary mining operations that take place at the surface of a mine, such as temporary sheds and the carrying out of seismic surveys, without the need to obtain permission from the planning authority. However, Class 53 and 54 states that development on any land consisting of the drilling of boreholes for the purpose of mineral exploration, and the provision/assembly of any structure required in connection with those operations is not permitted under Class 53 or 54 if it consists of the drilling of boreholes for petroleum exploration. Permitted development rights do not apply where a development requires an environmental impact assessment.

The **Conservation (Natural Habitats, & c.) Regulations 1994** require that certain plans which are likely to have a significant effect on a 'Natura 2000' site must be subject to an "Appropriate Assessment" by the plan-making authority: Habitats Regulations Appraisal. [Natura 2000](#) is the Europe-wide network of protected sites developed under the **Habitats Directive** (Directive 92/43/EEC) and the **Birds Directive** (79/409/EEC).

Where an appropriate assessment is required, plan-making bodies may not usually adopt the plan unless, following that assessment, they can conclude that the plan would not adversely affect the integrity of any Natura 2000 site. Plan making authorities must consult **SNH** as part of any appropriate assessment.

## Public participation in decision making

The **Public Participation Directive (PPD)** requires effective public participation in decision-making and regulation in relation to certain environmental matters, through access to information, access to justice and consultation. Plans for extraction of petroleum and natural gas for commercial purposes where the amount extracted exceeds 500 tonnes/day in the case of petroleum and 500,000 m<sup>3</sup>/day in the case of gas would be within scope of the PPD.

Public consultation is a statutory element of the SEA process ahead of Petroleum Exploration and Development licences being offered for award, and there are opportunities for everyone to engage in the development decisions which affect them throughout the planning system. Organisations such as community councils have a formal role in the planning system as they are consulted when development plans are being prepared, during pre-application consultation and when a planning application has been submitted. Further information on engagement in the planning system can be found in [PAN 2/2010: Community Engagement](#).

Information about licences, drilling consents and drilling activity, are currently published by the **Oil and Gas Authority**. Geophysical data are available at the UK Onshore Geophysical Library.

The **Coal Authority** publicise all applications for 30 days and maintain a list of all applications which is available to the public.

**SEPA** has statutory obligations to maintain a number of Registers which are open to public inspection. These registers contain details of permits and authorisations. Each regulation, such as Schedule 8 of **The Water Environment (Controlled Activities) Scotland Regulations 2011**, specifies the documentation required to be held on any public register and in some cases the time scale for this information to be held.

The **Pollution Prevention and Control (PPC)** permitting regime requires public consultation in certain circumstance for example for new or substantial changes to permits. Decision on granting (including draft permits and variation notices), reconsideration, updating or cessation of a permit as well as the results of emissions monitoring have to be made publicly available.

Under the **Water Environment (Controlled Activities) (Scotland) Regulations 2011**, **SEPA** will normally only require applications to be advertised where the proposed controlled activity is likely to have a 'significant adverse impact on the water

environment'. In most cases, a significant adverse impact will be indicated where a proposal would be likely to cause a breach of an environmental standard.

**SEPA** will consult with public authorities on applications where it considers the proposal is likely to have a significant adverse effect on the water environment or interests of other users. In certain circumstances SEPA will consult other public bodies. When consulting another public body, SEPA should make clear to that body the information being sought and the reason for seeking that information.

If the **HSE** takes enforcement action against a company by issuing a notice or prosecuting, details are made available on the website which also contains information and guidance on the health and safety regulatory regime. The guidance and any regulatory changes are open to public consultation prior to changes being made.

## SECTION 2: ACTIVITIES, HAZARDS AND CONTROLS

### Air and Climate

#### Activity

Air pollutants can occur during groundworks and well pad construction, where there may be releases to air such as dust and particulate matter (PM), as well as diesel emissions (including PM) from heavy equipment and trucks; borehole installation; on site generators producing power for on-site activities will likely generate diesel emissions (including PM), or predominantly emissions of nitrogen oxides if produced gas (methane) is used instead of diesel; the injection of fracturing fluid and the handling and mixing of drilling and fracture chemicals; the storage, treatment and disposal of produced and flow-back water; and the storage, treatment and disposal of solid and liquid waste use of proprietary chemicals associated with gas treatment (nitrogen, glycol), as well as fugitive releases of methane and Volatile Organic Compounds (VOCs) from site processing and transportation infrastructure; on-site flaring; and ultimately well abandonment and site restoration.

The Committee on Climate Change report on The Compatibility of UK Onshore Petroleum with Meeting The UKs Carbon Budgets (2016)<sup>1</sup> consider four categories of Greenhouse Gas emissions:

- **Fugitive emissions**, which include both vented emissions and unintentional leaks. Vented emissions are a result of planned releases, where permitted, as a result of maintenance operations and safety concerns. Unintentional methane leaks include those from valves and pipe joints, compressors, well heads and accidental releases above and below ground from the well through to injection into the grid or before being put to use.
- **Combustion emissions** that occur from on-site burning of fossil fuels. The emissions come from engines, such as those used for drilling and hydraulic fracturing, as well as from any flaring of gas.
- **Indirect emissions** that result from transporting materials and waste to and from site.
- **Land-use change emissions**, which include the CO<sub>2</sub> released (e.g. from the soil) when land is converted from one use to another, as well as any emissions relating to land remediation during decommissioning.

#### Potential Hazards

Methane is a more potent greenhouse gas than carbon dioxide, trapping more heat in the atmosphere molecule-for-molecule. But it is much shorter-lived: it decays on a timescale of around 12 years, whereas around a fifth of the effect from carbon dioxide remains even after 1,000 years. This means a unit emission of CO<sub>2</sub> today will affect the climate in 2100 and beyond. In contrast, the same unit emission of methane will have little effect on climate in 2100, but a stronger effect on the climate of the next few decades<sup>1</sup>.

Further sources of air pollutants can occur during groundworks and well pad construction, where there may be releases to air such as dust and particulate matter (PM), as well as diesel emissions (including PM) from heavy equipment and trucks.

On site generators producing power for on-site activities will likely generate diesel emissions (including PM), or predominantly emissions of nitrogen oxides (NOx) if produced gas (methane) is used instead of diesel.

Pollution may arise from the use of proprietary chemicals associated with gas treatment (nitrogen, glycol), as well as fugitive releases of methane and VOCs from site processing and transportation infrastructure.

Other activities with potential associated air emissions include fugitive emissions (leakage) – methane, hydrocarbons – from gas storage, as well as NOx from flaring activities.

During well abandonment and site restoration, dust may arise from onsite activity and diesel emissions may be associated with heavy equipment and large trucks.

## Controls

**The Climate Change (Scotland) Act 2009** sets targets to reduce Scotland's emissions of greenhouse gases by at least 42% by 2020 and 80% by 2050, compared to the baseline period. The Act creates a framework for managing the transition towards a low carbon Scotland. Annual emissions targets are set by order in batches, consistent with achieving the long-term 2020 and 2050 targets. The **Climate Change (Annual Targets) (Scotland) Order 2010** sets targets for 2010-2022. The **Climate Change (Annual Targets) (Scotland) Order 2011** sets targets for 2023-2027. A draft order setting annual targets for 2028-2032 was laid in the Scottish Parliament on 7 September 2016.

After setting annual targets, policies and proposals for meeting those targets are published in draft for the Scottish Parliament to scrutinise. The second [Report on Proposals and Policies \(RPP\)](#) was published in 2013; it set out how Scotland planned to deliver on its statutory annual targets for the period 2013-2027. A new Climate Change Plan, setting out policies and proposals to deliver the statutory emissions reduction targets for the period up to 2032, will be published in draft in winter 2016/17.

Any extractive waste arising, such as drilling muds and fluids and flowback and produced waters, fall under the **Management of Extractive Waste (Scotland) Regulations 2010**. **Local Authorities** require these wastes to be managed in a way that minimises risk to human health and the impact on the environment.

If the activity (part or all) requires a permit from **SEPA** under the **Pollution Prevention and Control (Scotland) Regulations 2012 (PPC)** the permit will contain measures to control emissions to air and suitable emission limit values. Whether an activity requires a permit will depend on whether it is an activity prescribed in the regulations, for example, refining of natural gas. Permits will control both point and fugitive sources of emissions to air, for certain substances and require monitoring. **SEPA** assess compliance by the site with these controls. Under PPC, controls may also be placed upon any 'directly associated activities' to the prescribed activity which can have an effect on pollution. Any PPC permit would cover aspects such as vehicle movements but do not cover vehicle emissions from exhausts. In setting permit conditions **SEPA** must have regard to the requirements of [The Air Quality Strategy](#)

[for England, Scotland, Wales and Northern Ireland \(2007\)](#) to meet relevant environmental quality standards for emissions to air.

Under the **Environment Act 1995**, **Local Authorities** are regularly required to review and assess air quality against the objectives contained in The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Air quality objectives are prescribed for benzene, 1,3 – butadiene, carbon monoxide, lead, nitrogen dioxide, particulate matter and sulphur dioxide. Where a **Local Authority** identifies a risk of an air quality objective being exceeded at a relevant location (outside of buildings where members of the public are regularly present) it must produce a detailed assessment. This may ultimately lead to the declaration of an Air Quality Management Area after which the **Local Authority** must prepare an action plan for tackling the issues of concern. Local Air Quality Management is limited to the named substances and subject to a specific assessment process. **SEPA** has powers under Section 85 of the Environment Act (with the approval of the Scottish Ministers), to direct Local Authorities to fulfil their duties under Local Air Quality Management.

Emissions to air which are not captured by PPC may be controlled under the provisions of the **Clean Air Act 1993** by **Local Authorities** in response to environmental complaints. The Clean Air Act seeks to control emissions of dark smoke, smoke, grit, dust and fumes from smaller-scale/non-PPC activities (and the provisions can cover both domestic and commercial premises). **Local Authorities** can monitor for pollution from these activities and also take action via investigations, notices and prosecutions.

Under the provisions of the **Environmental Protection Act 1990**, Part III, where an activity is causing a statutory nuisance a **Local Authority** is responsible for investigating this and taking suitable action. This covers a huge range of potential pollution types from any premises including smoke, fumes, gases, dust, steam, smell and other effluvia. As with the Clean Air Act, these provisions do not apply to an activity which is permitted under PPC. Also, as with the Clean Air Act, **Local Authorities** can monitor for pollution from these activities and also take action via investigations, notices and prosecutions.

Any unplanned release of fluids (liquid or gas) from an oil or gas well must be reported to **HSE** under Schedule 2, Part 1, Section 20 of the **Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013**.

### Activity: Water Usage

Water is required for the hydraulic fracturing and the drilling processes. This can be either supplied from the local water environment (e.g. watercourses) or from off-site sources. The amount of water required depends on a number of factors including the stage of the development, number of wells and the geological formations.

### Potential Hazards

Over abstraction can impact the local environment and ecosystem and other users. Increased water demand from surface waters, groundwater, river or the sea can effect local ecosystems and may result in reduced public and private water quality and quantity, leading to water being drawn from different sources of varied quality.

### Controls

Abstraction of water from surface water or groundwater is licensed under the **Water Environment (Controlled Activities) (Scotland) Regulation 2011 (CAR)**. Under this regime, applicants must demonstrate the potential impacts of the abstraction on the surrounding water environment. Each application is considered by **SEPA** and may be refused if abstraction is likely to have a significant adverse impact on the water environment.

### Activity: Borehole construction, operation and decommissioning

The exploration for and extraction of coal bed methane and shale gas involves the drilling, both vertically and horizontally, of boreholes to depths of typically 1–3km. Vertical drilling is accompanied by horizontal drilling that can extend for 1-2km. The boreholes are drilled, cemented and cased, then tested for integrity. The number and depth of the boreholes per well pad or within a given geographical area depends on a number of factors including geology, hydrogeology, the resource itself as well as other potential environmental, geographical, social and economic limitations.

Decommissioning involves the removal of surface equipment, the restoration of the ground surface and the permanent closure of any wells. The permanent closure of the well to prevent migration of well fluids and gas, including hydrocarbons, into the environment or the surface is termed plug and abandonment. All wells including dry exploratory wells and production wells that have reached the end of their commercial lifespan must be plugged and abandoned.

Well decommissioning may involve:

- inserting steel bridge plugs overlain by cement plugs in key locations within the well;
- if necessary, cutting off and plugging casings at depth to ensure that hydrocarbons or other fluids cannot migrate within the well or to the surface;
- removing the well head and upper 1-2 m of casing below the ground surface and welding a cap on the well before burying the well;
- recording the location of the abandoned well; and

- restoring the wellsite in accordance with the planning permission and any other regulatory requirements.

Cement plugs are placed adjacent to rocks of low permeability, which overlie rocks containing hydrocarbons. Cement is used as the primary sealant for plugging wells because of its similarity in behaviour to solid rock. Bridge plugs provide physical support to the cement. Cement plugs are also used to isolate groundwater bodies including those used as a water resource by sealing the base of the surface casing. Well design should have regard both to effective decommissioning and to long term repair in the event of any issues following plug and abandonment.

## Potential Hazards

If the borehole is not constructed, maintained and decommissioned correctly it can act as a pathway between different water environments, which may be of different chemical composition, as well as be a pathway for the release of fluids or gases into the water environment.

Following decommissioning, poorly constructed wells might leak hydrocarbon fluids affecting groundwater and drinking water. Some well integrity issues are specific to the horizontal wells used in UOG developments. Casing in the horizontal part of the well is subject to gravity making it more difficult to keep the casing properly centred to allow it to be effectively cemented in place. Repeated pressure changes along the horizontal length of pipe during hydraulic fracturing may also induce stress in the casing and cement and may cause the cement to debond from the casing and crack<sup>2</sup>.

Even in well-constructed wells, cement shrinkage in cement plugs and behind casing may lead to development of circumferential fractures in the longer term, after well construction and toward the end of or after the productive life of the well. Such fractures develop over time and with use of the well, even in cases where the cement bond is assessed as being reasonable over substantial sections of the casing<sup>3</sup>. Cement shrinkage leads to a residual risk that leakage may occur some years after construction and/or abandonment<sup>4</sup>.

## Controls

There are a number of regulatory controls that prevent or minimise the potential water hazards associated with borehole construction, operation and decommissioning.

**CAR** allows **SEPA** to control activities which are, inter alia:

- liable to cause pollution of the water environment; or
- result in the direct or indirect discharge, and any activity likely to cause a direct or indirect discharge, into groundwater of any hazardous substance or other pollutant.

The operator will be required to have a CAR licence from **SEPA** for boreholes drilled to or below a depth of 200m. Applicants (operators) are therefore required to provide information enabling SEPA to carry out a risk assessment to determine if the borehole will pose an unacceptable risk to the water environment or not. If the risks to the water environment are deemed acceptable then a licence would be issued to allow the borehole to be constructed, subject to conditions relating to, for example, maintenance or monitoring.

The information that **SEPA** require includes, for example:

- The purpose of the borehole
- Location, depth and diameter of the borehole
- Drilling techniques and fluids used
- Details of borehole construction
- Details of the strata, fault, mining works in the area
- Water features survey
- Decommissioning plan

Prior to the surrender of any licence, **CAR** requires **SEPA** to have sufficient information to demonstrate there would be no impact on the water environment exceeding regulatory standards posed by cessation of the UOG project. Post-operation monitoring must be sufficient to demonstrate this.

In addition the **Health and Safety Executive** is the competent authority for the **Borehole Sites and Operations Regulations 1995**, and the **Offshore Installations and Wells (Design and Construction etc) Regulations 1996 (DCR)**.

These regulations require notifications to be made to **HSE** about the design, construction and operation of such wells and the operator must prepare a health and safety plan which sets out how health and safety risks are managed on site. The latter include specific requirements for all wells, whether onshore or offshore, and include well integrity provisions which apply throughout the life of the wells. Well operators must provide **HSE** with regular reports of any activities on the well where there is a risk of an unplanned release of fluids from the well and they must appoint an independent well examiner to undertake regular assessments of well integrity. The **HSE** also requires that wells are designed and constructed with well abandonment in mind (DCR Regulation 15). During the decommissioning phase, operators must notify the **HSE** before wells are abandoned and show that the process complies with **Oil and Gas UK** guidelines and the requirements of DCR.

**HSE** specialist inspectors scrutinise the information provided by the operator and further information provided each week during the abandonment process to ensure that the well is being abandoned to the correct standards and to comply with the requirements of the **Offshore Installations and Wells (design and construction, etc) Regulations 1996**. Regulation 15 states that the well should be designed in such a way that after it is abandoned there can be no escape of fluids from it or the reservoir to which it is attached so far as is reasonably practicable.

Any unplanned release of fluids or use of safety equipment to prevent an unplanned release must be reported to **HSE** under the **Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (2013)**. The failure of any part of the well designed to prevent an unplanned release of fluids is also reportable.

At the end of the UOG project the Petroleum Exploration and Development Licence is given up, requiring the completion of a Licence Determination Form and Relinquishment Report providing details of wells within the area and plans for plugging and abandonment, details of all seismic surveys and new wells drilled.

In the event of land contamination, remediation can be required by **SEPA** under the environmental permitting system. If remediation does not otherwise occur is regulated

by the **Environmental Protection Act 1990** Part IIA and the **Contaminated Land (Scotland) Regulations 2000**. **Local Authorities** are responsible for identifying and securing remediation of contaminated land to ensure it is suitable for use and does not cause harm to the public or environment.

### Activity: Management of hydraulic fracturing and drilling fluids

Hydraulic fracturing involves pumping fracturing fluid into the source rock, which is typically located 1-3 km below ground, at high pressure so that the rock fractures and releases the trapped gas. This fluid is predominately water but it may also contain a small percentage of sand (~5%) and chemicals (<1%) to improve efficiency of the operation.

### Potential Hazards

Potential hazards to the water environment arising from the transport, storage, treatment, use and disposal of the fracturing fluid include:

- Surface (water and soil) pollution from leakage and spillage from handling and equipment of fracturing fluid storage, transport, mixing, treatment and the injection process.
- Leakage of fracturing fluid from borehole due to well integrity failures.
- The fracturing process itself can cause cross contamination of different quality aquifers caused by the pathways created from the forced fractures.

### Controls

**SEPA** only consider granting authorisation under CAR for proposals involving the release of substances, such as fracturing fluid, below the water table or that have potential to cause such a release, when it is satisfied that the water environment can be protected from pollution and that the environmental objectives are not compromised. The deposit or in situ generation of pollutants in to groundwater resources is likely to pose significant risk and would not be authorised.

**SEPA** also consider the risk to the water environment associated with surface water run-off from the site and ensure there is an appropriate Sustainable Urban Drainage System in place. As part of the assessment **SEPA** consider, for example, what is being held on site, potential contaminants and the permeability of the ground and risk to the water environment. **SEPA** can require the operator to carry out remedial action if a pollution incident to the water environment occurs and may take appropriate enforcement action.

Workplace exposure to harmful substances, including respirable crystalline silica, is regulated under the **Control of Substances Hazardous to Health Regulations 2002 (COSHH)** by **HSE**. In the UK, there is a Workplace Exposure Limit for Respirable Crystalline Silica which is  $0.1\text{mg/m}^3$  and employers must reduce exposure to below this level. With the required exposure controls in place, respirable crystalline silica is usually reduced to significantly below  $0.1\text{mg/m}^3$ . The WEL was set at a level which was considered to represent good occupational hygiene control, taking account of the severity of the likely health effects, costs and effectiveness of the control measures.

Where sand is used on well sites, the risks of exposure to Respirable Crystalline Silica must be controlled by the operator. One of the most effective ways to achieve this is to

ensure that the sand is transported to the site and introduced to the hydraulic fracturing fluid in a way that worker exposure is minimised.

**The REACH Enforcement Regulations 2008** put into effect Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals. All additives in fracturing fluids that exceed the one metric tonne threshold and other requirements set by REACH Regulation must be registered at European Chemicals Agency by the manufacturer or importer. **HSE, SEPA** and the **Local Authority** (as local health and safety authority) are the enforcement authority.

**COMAH** seeks to prevent major accidents involving dangerous substances and limit the consequences to people and the environment of any accidents which do occur. The scope of the COMAH Regulations is determined by Regulation 3 and Schedule 1 but is broadly dependent on the quantity and type of dangerous substance the operator handles. If COMAH applies, the operator will be required to identify their major hazard scenarios and demonstrate to the Competent Authority that they have taken control measures to prevent major accidents and made arrangements for mitigatory action in the event of an accident occurring, The enforcement authority (**HSE** and **SEPA**) can prohibit operation where these measures are seriously deficient.

**The Water Environment (Oil Storage) (Scotland) Regulations 2006** apply to industrial or commercial businesses with above ground oil storage devices including fixed tanks, intermediate bulk containers, drums and mobile bowsers. **SEPA** will consider the requirements such as bunding design and the construction and maintenance of storage equipment and enforce the regulations. The regulations do not apply where oil is stored in accordance with a permit under PPC in respect of a Part A activity as defined in Schedule 1 to those regulations.

The **HSE** scrutinise activity on the well to ensure that the operator is managing the risks to well integrity in such a way that there can be no unplanned release of fluids so far as is reasonably practicable. **HSE** inspectors have a range of enforcement powers including prosecution where there has been a breach of the health and safety regulations.

### Activity: Management of Waste Water

Coal Bed Methane extraction requires water, known as produced water, to be drained from the coal seam to release pressure (known as dewatering), rather than employing the technique of hydraulic fracturing.

Following hydraulic fracturing, a percentage of the fracturing fluid returns to the surface as flowback water.

Both produced water and flowback water will need to be stored, treated, transported and disposed of. Treatment and disposal can in limited cases occur on site in a central facility, but is more likely to be taken to an offsite treatment facility. Following treatment, produced and flowback water could be discharged in the local water/marine environment, subject to the water meeting relevant water quality standards.

### Potential Hazards

Surface (water and soil) pollution from leakage and spillage from the transport, storage, treatment, use and disposal of the produced and flowback water processes and equipment.

Once hydraulic fracturing is complete a period of ‘flowback’ follows over a period of three to ten days, during which some of the fluids return to the surface mixed with increasing volumes of oil and gas. In the US, the gas mixed in with the flowback fluid has historically been predominantly vented to the atmosphere.

## Controls

The **Mining Waste Directive** sets out requirements for how waste resulting from the prospecting, extraction, treatment and storage of minerals must be managed.

Any extractive waste arising, such as drilling muds and fluids and flowback and produced waters, fall under the **Management of Extractive Waste (Scotland) Regulations 2010**. The **local authority** requires this waste to be managed in a way that minimises risk to human health and the impact on the environment. Management includes measures to prevent, minimise and manage the extractive waste. In practice, transport of waste waters may be by pipeline or truck.

Any discharge of treated water in Scotland requires a CAR licence. Under this regime, **SEPA** impose discharge concentrations limits for particular contaminants to ensure the discharge does not contribute to deterioration in water quality class, failure of any water quality standards or compromise achievement of the objectives of the Water Framework Directive. **SEPA** also ensure appropriate monitoring of any discharge, to assess and demonstrate compliance with the relevant Environmental Quality Standards.

It is a site operator’s responsibility to identify appropriate outlets for waste water treatment that can meet the authorisation conditions and achieve the necessary Environmental Quality Standards. If these facilities do not exist, then industry would need to collaborate to promote investment in suitable licenced treatment and disposal facilities or technologies.

**SEPA** are also responsible for assessing any risks to the water environment associated with surface water run-off from the site and for ensuring there is an appropriate Sustainable Urban Drainage System in place. As part of the assessment, **SEPA** consider, for example, what is being held on site, potential contaminants and the permeability of the ground and risk to the water environment. **SEPA** can require the operator to carry out remedial action if a pollution incident to the water environment occurs and may take appropriate enforcement action.

**COMAH** aims to prevent major industrial accidents which can cause serious damage/harm to people or the environment. Whether a site is a COMAH site depends on the quantity and type of substance the operator handles, with specific thresholds. If COMAH applies, the operator of a UOG development must demonstrate, site by site, that the activity will not cause a major accident to the environment. Where COMAH applies, it places duties on operators to put in place necessary measures, have accident prevention policies, emergency plans, produce safety reports and provide information to the public. The enforcement authority (**HSE** and **SEPA**) can prohibit operation where these measures are seriously deficient. The authorities also have a role in considering “domino” effects, ie where one site could have an impact on another.

## Soil

### Activities

Leakage and spills from solid or liquid chemical and waste handling, storage, treatment and transport may result in contamination of surface soil.

### Hazards

Contaminated land can present significant threats to the environment and risks to users of the land and act as a pathway to the water and air environment. The environmental, financial and legal implications of this can be substantial.

### Controls

The management and remediation of contaminated land that is causing or has the potential to cause significant harm or significant pollution of the water environment, is regulated by Part IIA of the **Environmental Protection Act 1990**. The purpose of Part IIA is specifically to deal with the legacy of historic contamination. Impacts of industry and these are monitored, controlled and regulated by **SEPA** under a comprehensive collection of other legislation such as the **PPC**, **CAR** and the **Environmental Liability (Scotland) Regulations 2009**. Except in relation to special sites, **Local Authorities** are responsible for identifying and securing remediation of contaminated land to ensure it is suitable for use and does not cause harm to the public or environment.

Indirect soil contamination is prevented through control protection measures applied under **CAR** and Sustainable Urban Drainage System where the soil is a potential pathway to the water environment. There is a requirement for a site condition report, including soils, as part of a **PPC** Permit.

Under **COSHH**, assessment and control of the hazard posed by fluids containing chemicals that may be harmful to worker health is required, therefore it may also, indirectly, contribute to providing some protection measures against soil contamination.

The **Management of Extractive Waste Regulations 2010**, the Waste Management Licence regime and **Pollution Prevention and Control Regulations 2012**, where they apply, have to consider and reduce the impacts on soil from the relevant activity.

## Naturally Occurring Radioactive Materials

### Activity (source)

Naturally Occurring Radioactive Materials (NORM) are ubiquitous in the environment and are present in many geological formations, including oil- and gas-bearing rock strata.

Temporary and long term borehole installation may involve vertical and horizontal drilling. Drilling mud and cuttings brought to the surface may contain NORM. Produced water abstracted from coal seams, as well as flowback fluids that are generated during hydraulic fracturing may also contain NORM.

Solid and liquid wastes may be transported from the well pads where they are generated to a central well pad for storage before being transported offsite for treatment and disposal or recovery.

Transport of waste may be via pipeline or truck. Refining and gas processing may occur on site or gas may be stored and then piped offsite for processing. NORM may be present in the storage, transport, disposal of solid and liquid waste streams, as well as the storage, transport and processing of gaseous substances. NORM may also adhere in the form of insoluble sediments to the surface of gas or water process vessels and pipework.

### Potential hazards

NORM can be hazardous to human health and inadequate treatment and disposal of these radioactive substances may result in contamination of the local environment and ecosystems.

Leakage and spills from solid or liquid waste storage, treatment and transport may result in NORM contamination of surface soil and water. Radioactive substances may accumulate in some disposal and spill sites.

### Controls

**SEPA** is responsible for regulating the management of wastes that contain NORM. Authorisation under the **Radioactive Substances Act 1993 (RSA)** is required if activities include the disposal of water, sediments or scales returning to the surface which contain naturally occurring radioactive materials and are above a certain threshold defined in the Act. Based on offshore oil and gas experience, **SEPA** is adopting a position that unless the drilling operator can demonstrate, by measurements, that the concentrations of NORM are below the RSA threshold values, all developments will require an authorisation before the operator accumulates or disposes of any wastes that containing NORM. If granted by **SEPA**, the RSA authorisation puts conditions and limitations on the accumulation and disposal of the produced and flowback waters and solids produced.

A Notification may be required by **HSE** for a company to treat produced water. Whether this is required depends on the level of NORM and the treatment process required. **Ionising Radiations Regulations 1999** may apply to employers working with materials containing NORM depending on if they are used above the specified level.

## Light, Noise and Odour

### Activities

**The Workplace (Health, Safety and Welfare) Regulations 1992** require every workplace to have suitable and sufficient lighting, ensuring that lighting or lack of it does not present a risk to health and safety. Lighting is necessary during drilling, which may occur 24 hours a day for a number of weeks. Light is also a consequence of flaring where open flares are used.

A range of activities associated with unconventional oil and gas extraction, from waste management to flaring, may result in odorous emissions.

Site preparation, well drilling, hydraulic fracturing, flaring and onsite pumps and generators as well as increased traffic movements are likely to be the primary source of noise. During the drilling phase, there may be elevated noise levels for 24 hours a day.

Noise and increased traffic from UOG developments may be more noticeable in rural areas where background noise can be lower than in urban areas. Noise sensitive receptors such as housing may therefore be adversely impacted depending on the particular circumstances at any individual location.

Traffic movements could be sustained at around 190 per week for a period of approximately 2 years during development of a pad with 15 wells. Drilling rig exploration phases may operate 24 hours a day, which reduces the time a drilling rig is on site. Non continuous drilling may help reduce impacts from increased noise, but it can have a detrimental effect on well integrity and therefore increase the risk of other hazards, such as groundwater pollution.

### Potential Hazards

Artificial light can constitute a statutory nuisance and there is evidence that light pollution can have impacts on wildlife and ecosystems<sup>5</sup>.

An odour can be experienced as objectionable and offensive when an odorous compound is present in very low concentrations, usually far less than the concentration that could harm physical health. An objectionable or offensive odour can result in annoyance, nuisance or cause actual harm.

Noise can be a nuisance, cause stress, sleep disruption, impede concentration, mask sounds that are important to hear (such as warning signals), and at high levels or over sustained periods can damage hearing.

### Controls

#### Light

Light pollution can be minimised by using spotlights that focus light on the working area, within the operational constraints of a site, flaring and truck movements can be restricted to daylight hours. These can be conditions of **planning**, which can be identified through engagement with other regulators, in particular **HSE**.

By law, every workplace must have suitable and sufficient lighting, ensuring that lighting or lack of it does not present a risk to health and safety. It is important that lighting in the workplace:

- allows people to notice hazards and assess risks;
- is suitable for the environment and the type of work (for example, it is not located against surfaces or materials that may be flammable);
- provides sufficient light (illuminance on the task);
- allows people to see properly and discriminate between colours, to promote safety;
- does not cause glare, flicker or stroboscopic effects;
- avoids the effects of veiling reflections;
- does not result in excessive differences in illuminance within an area or between adjacent areas.

## Noise

If the activity (part or all) requires a PPC permit from **SEPA**, it will contain appropriate measures to control noise. Whether an activity requires a permit will depend on whether it is an activity prescribed in the regulations, for example a refining of natural gas. PPC permits cover aspects such as vehicle movements.

**Control of Noise at Work Regulations 2005** may apply. Employers should control noise exposure and, where necessary, provide hearing protection.

The **Workplace (Health, Safety and Welfare) Regulations 1992** set out requirements for onsite traffic management to manage the risks from workplace transport effectively, the operator will need to consider three key areas: Safe site, Safe vehicle, Safe driver.

## Odours

The controls that may apply will depend on the activity concerned and how it is being regulated. Odour impacts may, for instance, be considered during the planning process. Odours may also be viewed as a statutory nuisance under Part III of the **Environmental Protection Act 1990** should complaints arise.

Odours may also be viewed as a statutory nuisance under Part III of the **Environmental Protection Act 1990** should complaints arise. In addition, where an activity is regulated under **PPC** all appropriate preventative measures must be taken against pollution and no significant pollution should be caused by the operator, this includes odour. Waste management licenced activities must be carried out without causing nuisance through odours for example.

## Landscape

### Activities

Visual impact will depend on the scale of the operation and situation. The visual impact will differ over the course of the operation. The initial drilling requires a rig with a mast typically 30m in height. Once initial drilling is complete, this rig is replaced with a work-over rig (typically with a mast 22m high), this will remain in place for several weeks if hydraulic fracturing is undertaken. These rigs are temporary structures and the drillhole is then capped with an extraction point and protective cage approximately 3m high.

The extraction configuration may influence visual impact. For instance, drilling and workover for shale gas can occur on multiple individual pads, or multiple boreholes for shale gas can be operated from one large pad (roughly the size of a football pitch), which could be operational for 20 or 30 years.

### Hazards

The use of drilling rigs, where multiple pads are developed in a given area can be considered to have a risk of significant visual effects, especially in more residential greenfield sites.

### Controls

Within National Scenic Areas, there are a number of requirements relating to development management and this includes a need for planning authorities to consult **SNH** for certain types of proposal.

Visual impacts are assessed at the planning stage by the **Planning Authority** and statutory consultees. The **Planning Authority** would assess and consider imposing requirements relating to removal of all surface facilities erected for operations when the project is completed, as part of the planning permission process. The **Planning Authority** can also control restoration and aftercare of the site; for example by requiring a Restoration or Habitat Management Plan or a planning obligation under Section 75 of the **Town and Country Planning (Scotland) Act 1997**.

## Biodiversity, Flora and Fauna

### Activities

A range of activities associated with onshore unconventional oil and gas extraction, from the construction and presence of well-pads on the landscape, associated traffic movements, through to noise and light from construction, traffic and drilling.

### Hazards

Impacts can be direct and indirect ranging from loss of habitats to wider scale habitat fragmentation and loss if multiple well-pads are developed over large areas of the landscape or if development takes place in areas of conservation interest or protection. Drilling activity and truck movements could lead to the displacement of species that are susceptible to noise, light or vibration. Poorly constructed wells may contaminate the site by leaking hydrocarbon fluids after the well had been abandoned, posing hazards to the local ecosystem and wildlife habitats.

### Controls

The **Conservation (Natural Habitats &c.) Regulations 1994** require competent authorities to undertake a Habitat Regulations Appraisal in consultation with **SNH** of the implications for any plan or project likely to have a significant effect on a European site (i.e. a Special Protection Area of Special Area of Conservation which collectively form the pan-EU Natura 2000 network).

A Habitats Regulations Appraisal seeks to ensure that only those plans and projects which will not adversely affect the integrity of European protected sites are allowed to proceed. These assessments, must ascertain no adverse effect on site integrity before consent can be granted and must accompany any licensing round that could have an impact on protected sites.

Where a Sites of Special Scientific Interest is involved, **SNH** consent is required for any Operations Requiring Consent (ORC) unless SNH have already been consulted as part of certain statutory consultation processes, e.g. planning.

Under the **Conservation (Natural Habitats &c.) Regulations 1994** (as amended), a licence from **SNH** is required for any proposal that may disturb or harm any European Protected Species, and this licence must be granted before any other consent, such as planning, is determined. A number of other species are protected under the **Wildlife & Countryside Act 1981**, including badgers, red squirrels, pine martins and freshwater pearl mussels. Most bird species, their eggs and nests are also protected under this Act. Licences are generally required for proposals which may disturb or harm these species.

Seals and their haul out sites are protected under the **Marine (Scotland) Act 2010**.

## Seismic activity

### Activities

The process of hydraulic fracturing in order to increase the permeability of reservoir formations and stimulate the recovery of hydrocarbons is generally accompanied by microseismicity, commonly defined as earthquakes with magnitudes of less than 2.0 that are too small to be felt.

Studies of earthquake activity in the Raton Basin (United States), an area that has produced coal-bed methane since 1994, suggest that this induced seismic events are related to the subsequent disposal of wastewater from the coal-bed methane extraction process by injection into deep wells, rather than from the extraction process itself.

Recent increases in earthquake rates and significant earthquakes in many areas of the Central and Eastern United States have been linked to the disposal of wastewater by injection into deep wells rather than hydraulic fracturing, and provide a considerable body of evidence that this activity has a non-negligible contribution to the seismic hazard.

### Potential Hazards

Very few felt earthquakes have been linked to hydraulic fracturing globally, and no induced seismic activity has been linked to structural damage.

### Controls

The **UK Government** introduced specific measures through their onshore oil and gas licencing regime for the mitigation of earthquake activity; monitoring seismic activity during and after fracturing, and using a traffic light system that controls whether injection can proceed or not, based on the seismic activity.

The current UK Government traffic light system requires the cessation of operations if events with magnitude of 0.5ML or greater are induced.

## LINKS TO ALL LEGISLATION REFERENCED

[Birds Directive](#)

[Borehole Sites and Operations Regulations 1995](#)

[Clean Air Act 1993](#)

[Climate Change \(Scotland\) Act 2009](#)

[Climate Change \(Annual Targets\) \(Scotland\) Order 2010](#)

[Climate Change \(Annual Targets\) \(Scotland\) Order 2011](#)

[Coal Industry Act 1994](#)

[Control of Major Accident Hazard Regulations 2015](#)

[Conservation \(Natural Habitats, &c.\) Regulations 1994](#)

[Contaminated Land \(Scotland\) Regulations 2000](#)

[Control of Substances Hazardous to Health Regulations 2002](#)

[Control of Noise at Work Regulations 2005](#)

[Environment Act 1995](#)

[Environmental Assessment \(Scotland\) Act 2005](#)

[Environmental Protection Act 1990](#)

[Environmental Liability \(Scotland\) Regulations 2009](#)

[Habitats Directive](#)

[Hydrocarbon Licensing Directive 1994](#)

[Ionising Radiations Regulations 1999](#)

[Management of Extractive Waste \(Scotland\) Regulations 2010](#)

[Marine \(Scotland\) Act 2010](#)

[Mining Waste Directive 2006](#)

[Offshore Installations and Wells \(Design and Construction etc\) Regulations 1996](#)

[Petroleum Act 1998](#)

[Petroleum Licensing \(Applications\) Regulation 2015](#)

[Petroleum Licensing \(Exploration and Production\) \(Landward Areas\) Regulations 2014](#)

[Planning etc \(Scotland\) Act 2006](#)

[Pollution Prevention and Control \(Scotland\) Regulations 2012](#)

[Public Participation Directive](#)

[Radioactive Substances Act 1993](#)

[REACH Enforcement Regulations 2008](#)

[Registration, Evaluation, Authorisation and Restriction of Chemicals 2006](#)

[Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013](#)

[Scotland Act 2016](#)

[Town and Country Planning \(Environmental Impact Assessment\) \(Scotland\) Regulations 2011](#)

[Town and Country Planning \(General Permitted Development\) \(Scotland\) Order 1992](#)

[Town and Country Planning \(Scotland\) Act 1997](#)

[Water Environment \(Oil Storage\) \(Scotland\) Regulations 2006](#)

[Water Environment \(Controlled Activities\) \(Scotland\) Regulation 2011](#)

[Wildlife and Countryside Act 1981](#)

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Any enquiries regarding this publication should be sent to us at  
The Scottish Government  
St Andrew's House  
Edinburgh  
EH1 3DG

Published by The Scottish Government, November 2016

Produced for The Scottish Government by APS Group Scotland, 21 Tennant Street, Edinburgh EH6 5NA  
PPDAS82759 (11/16)

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