Unconventional Gas Exploration and Extraction (UGEE) Joint Research Programme

Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
Department of Communications, Climate Action & Environment

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Final Report 5: Regulatory Framework for Environmental Protection

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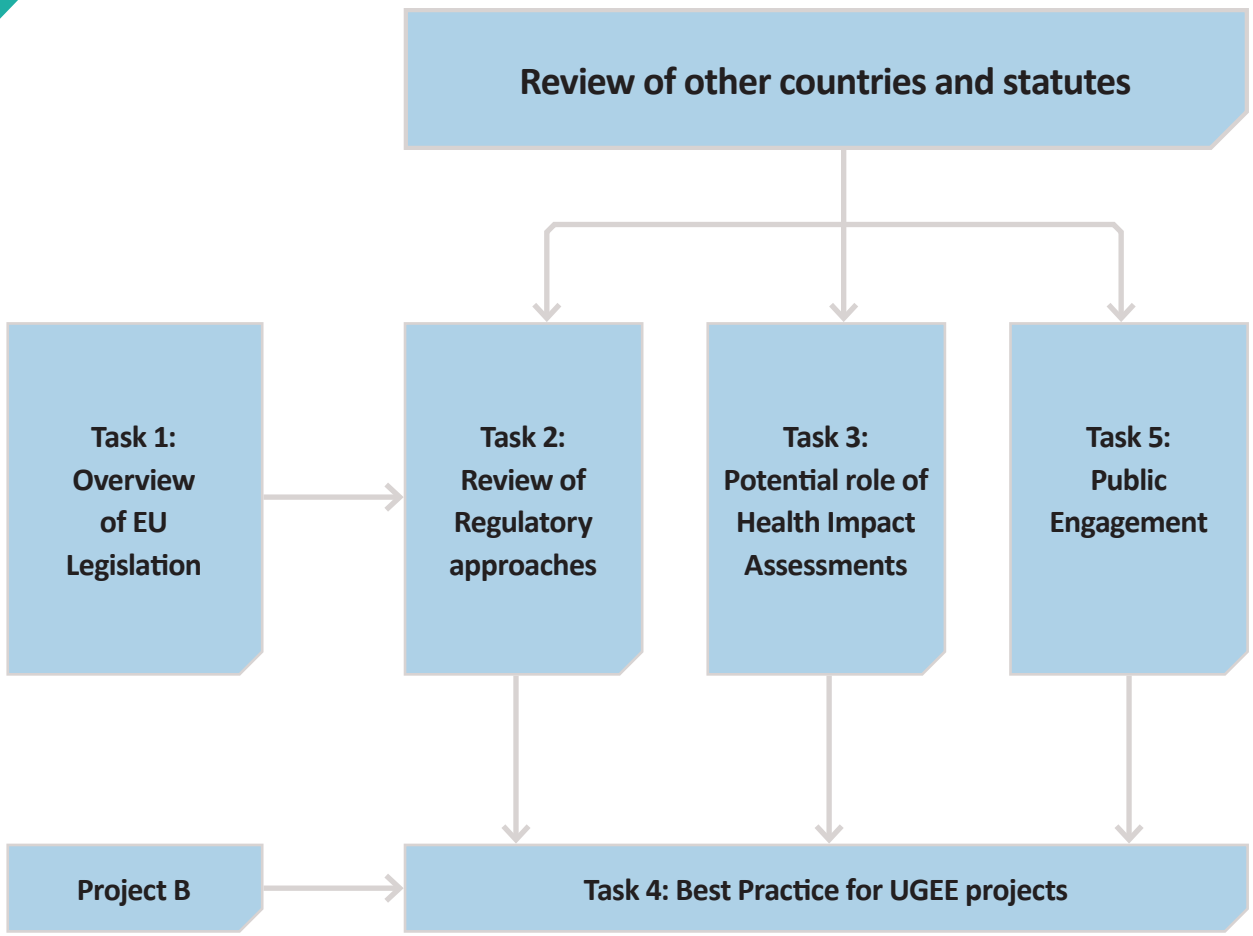

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Funding Organisations

The Environmental Protection Agency (EPA) is an independent statutory body, established under the Environmental Protection Agency Act with a wide range of responsibilities including regulation of large scale industrial and waste facilities, monitoring and reporting on the state of the environment, overseeing local authorities' environmental responsibilities, coordinating environmental research in Ireland, promoting resource efficiency and regulating Ireland's greenhouse gas emissions. Through the Department of Communications, Climate Action and Environment (DCCAE) (and formerly through the Department of Environment, Community and Local Government - DECLG), the EPA has provided funding for environmental research since 1994. The current EPA Research Programme 2014-2020 is designed to identify pressures, inform policy and develop solutions to environmental challenges through the provision of strong evidence-based scientific knowledge.

On the 23rd of July 2016, the Department of Communications, Energy and Natural Resources (DCENR) became the DCCAE. Along with a name change, the new Department incorporates functions that were formerly held within the Environment Division of the DECLG. The Department retains responsibility for the Telecommunications, Broadcasting and Energy sectors. It regulates, protects, develops and advises on the Natural Resources of Ireland. Of particular relevance is the role of the Petroleum Affairs Division (PAD) to maximise the benefits to the State from exploration for and production of indigenous oil and gas resources, while ensuring that activities are conducted safely and with due regard to their impact on the environment and other land/sea users. The Geological Survey of Ireland (GSI) is also within DCCAE and provides advice and guidance in all areas of geology including geohazards and groundwater and maintains strong connections to geoscience expertise in Ireland.

The Department of Agriculture, Environment and Rural Affairs (DAERA) in Northern Ireland has responsibility for food, farming, environmental, fisheries, forestry and sustainability policy and the development of the rural sector in Northern Ireland. As an executive agency of DAERA, the Northern Ireland Environment Agency (NIEA) seeks to safeguard the quality of the environment as a whole through effective regulation of activities that have the potential to impact on the environment.

Administration of the Research Programme and Steering Committee

This Research Programme is being administered by the EPA and steered by a committee with representatives from DCCAE (formerly DCENR and the Environment Division of the DECLG), the Commission for Energy Regulation (CER), An Bord Pleanála (ABP), the GSI, NIEA, the Geological Survey of Northern Ireland (GSNI), as well as a Health representative nominated by the Health Service Executive (HSE).

UGEE Joint Research Programme

Environmental Impacts of Unconventional Gas Exploration and Extraction (UGEE)

(2014-W-UGEE-1)

Final Report 5:

Regulatory Framework for Environmental Protection

by

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References to government departments (DCENR and DCELG) throughout the report use the names of these departments prior to July 2016. References to the Department for the Economy (DfE) throughout the report use the name of its predecessor, the Department of Enterprise Trade and Investment (DETI), the department responsible for petroleum licensing in Northern Ireland until May 2016.

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1 More details available at: http://www.epa.ie/pubs/reports/research/ugeejointresearchprogramme/ugeejrptasksorganisations.html

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Executive Summary

Unconventional Gas Exploration & Extraction (UGEE) involves hydraulic fracturing of low permeability rock to permit the extraction of natural gas on a commercial scale from unconventional sources such as shale gas deposits, coal seams and tight sandstone. The Environmental Protection Agency (EPA), the Department of Communications, Energy and Natural Resources (DCENR) and the Northern Ireland Environment Agency (NIEA) awarded a contract in August 2014 to a consortium led by CDM Smith Ireland Limited, to carry out a 24-month research programme looking at the potential impacts on the environment and human health from UGEE projects and operations (including construction, operation and after-care).

The UGEE Joint Research Programme (JRP)[2] is composed of five interlinked projects and involves field studies (baseline monitoring of water and seismicity), as well as an extensive desk-based literature review of UGEE practices and regulations worldwide. The UGEE JRP has been designed to produce the scientific basis, which will assist regulators – both North and South – in making an informed decision about whether it is environmentally safe to allow hydraulic fracturing. As well as research in Ireland, the UGEE JRP is looking at and collating evidence from other countries. This report presents the findings of Project C, the overall purpose of which is to: provide evidence to support the future development of appropriate regulatory requirements; and the identification of operational best practice for environmental protection in the context of the Island of Ireland. Project C was undertaken as five discrete tasks.

Task 1: An overview of the EU environmental legislation applicable to UGEE projects/operations

This task assessed EU legal instruments in terms of the extent to which they address environmental risks from UGEE. It found a comprehensive framework at the EU level but potential gaps as most Directives and Regulations do not specifically address UGEE projects. This legislation has been implemented on the Island of Ireland and forms the regulatory framework for oil and gas activities, including UGEE. The legislative framework does not explicitly address the deep underground environment. The European Commission (EC) Recommendation "on minimum principles...." indicates how gaps should be addressed. The EC is reviewing the scope of the Best Available Techniques (BAT) reference document (BREF) regarding the Mining Waste Directive and also considering the development of a BREF focussed on hydrocarbon exploration and production which would encompass UGEE.

Task 2: Regulatory approaches of other countries

Regulatory approaches in Denmark, Germany, the United Kingdom (UK) and United States of America (USA) (Pennsylvania and Colorado) were reviewed. It was found that an EU-wide approach to well integrity standards and compulsory EIA would be of benefit. Specific legislation would clarify issues where variation in interpretation across Europe may lead to significantly different approaches. Public engagement appears to need development in the EU countries analysed (except Denmark). The USA states provide examples of how a mature, rule-based system leads to specific controls and guarantees related to UGEE; however, it is inefficient because each state has different controls and requirements and competent authorities. The UK "roadmap" of the permitting and permissions process for exploratory work in oil and gas development, onshore was found to be a beneficial guide.

Task 3: Potential role of Health Impact Assessment (HIA) in regulation of UGEE projects/operations

HIA provides a framework for the assessment of potential effects of UGEE on the health of a population and the distribution of those effects. Case study analysis found that HIA can raise awareness amongst stakeholders of health implications and be an aid to transparent decision making. It also ensures that assessments are evidence based. HIA can be a tool to engage stakeholders and support the identification

2 http://www.ugeeresearch.ie

of mitigation measures. A potential disadvantage of HIA is the absence of a legal basis, which may limit its influence. HIAs can also be resource intensive and have a long duration. There is also limited and mixed experience of HIA on the Island of Ireland and a lack of baseline data. The need for HIA for UGEE requires careful consideration and may not be appropriate in all circumstances. It is also of note that there may be duplication between HIA and other types of assessment such as Environmental Impact Assessments (EIA), which should be avoided where possible.

Task 4: Best practice for UGEE projects/operations

The regulatory enforcement requirements and best operational practices for UGEE projects and operations in Ireland and Northern Ireland were examined. Extensive use was made of an earlier study for the EC, which identified 237 risk mitigation measures. The analysis of measures considered whether they were either definitely required by EU legislation or only may be required. The analysis also considered whether regulation on the Island of Ireland would definitely require some measures that only "may be" required by EU legislation. Those measures not definitely required by EU or Island of Ireland legislation but which may be required could be applied through: land use planning; Petroleum authorisation or licensing conditions issued by DCENR (Ireland) and Department of Enterprise, Trade and Investment (DETI) (NI); and conditions set in EPA licences (Ireland) or environmental permits and licences (NI). Such measures may cover: discharges to groundwater; water abstraction; waste management; pollution prevention; radioactive substances; and protection of conservation areas and typical practice by industry, which would include measures likely to be adopted by operators regardless of legislation or regulatory requirements. A work programme for each stage of UGEE, as required in the UK, is a potentially useful means of incorporating specific conditions included in, for example, planning permission.

Task 5: Public engagement

Case studies of public engagement processes for UGEE projects were reviewed to identify good practice and potential areas for enhancing engagement. The key findings were that: geographic scope, duration and scale of consultation should be relevant to the scale of the plan or programme being consulted upon; and stakeholder input is required at all stages. A broad range of stakeholders and consultees should be engaged; the consultation process should be managed by advocates of the consultation and engagement process; and evaluation of a consultation process needs to be an integral part of the whole process and should be continuous and responsive to change.

1 Introduction[3]

1.1 Background

Unconventional gas exploration & extraction (UGEE) involves hydraulic fracturing of low permeability rocks to permit the extraction of natural gas on a commercial scale from unconventional sources such as shale gas deposits, coal seams and tight sandstone. The Environmental Protection Agency (EPA), the Department of Communications, Energy and Natural Resources (DCENR) and the Northern Ireland Environment Agency (NIEA) awarded a contract in August 2014 to a consortium led by CDM Smith Ireland Limited to carry out a 24-month research programme looking at the potential impacts on the environment and human health from UGEE projects and operations (including construction, operation and after-care).

The UGEE Joint Research Programme (JRP)[4] comprised five interlinked projects and involved field studies (baseline monitoring of water and seismicity) as well as extensive desk-based literature reviews of UGEE practices and regulations worldwide. The UGEE JRP was designed to produce the scientific basis from which regulators – both North and South – could make informed decisions regarding whether it is environmentally safe to allow hydraulic fracturing. As well as research in Ireland, the UGEE JRP looked at and collated evidence from other countries.

The environmental impacts of UGEE projects/operations considered were those arising from UGEE projects/operations in their totality, not just from hydraulic fracturing. All stages of UGEE projects/operations were considered (i.e. including construction, commissioning, operation, decommissioning and aftercare, as well as off-site and other developments).

1.2 Context

UGEE is an emerging issue on the Island of Ireland. In Ireland, Onshore Petroleum Licensing Options were awarded in May 2011, as preliminary authorisations, to three exploration companies seeking to assess shale gas potential within the Northwest Carboniferous Basin (NCB) and the Clare Basin (CB). In Northern Ireland (NI), one exploration company secured a Petroleum Licence from the Department of Enterprise, Trade and Investment (DETI) to explore the potential for shale gas reserves in County Fermanagh, within the NCB. The specific UGEE exploration areas are shown in Figure 1.1, based on exploration licences that were held until recently. Descriptions of the NCB and CB are presented in Sections 2 and 3.

In Ireland, exploration drilling, including drilling that would involve hydraulic fracturing, is not allowed under current Licensing Options. Nonetheless, two of the three companies have submitted applications for follow-on licences, which would include exploration drilling.

3 Note: sections 1.1, 1.2 and 1.3 provided by the UGEE Joint Research Programme Steering Committee.
4 www.ugeeresearch.ie

Figure 1.1. Overview of the case study areas of the UGEE Joint Research Programme.

The DCENR is not considering these applications further until the findings of the UGEE JRP have been published. Also, the DCENR will not consider any applications for exploration authorisations in other onshore areas until the UGEE JRP has concluded.

In NI, the referenced DETI licence was terminated as the licence conditions (a “drill or drop” work programme requiring pre-drilling exploration in the first three years and, before the end of year three a commitment to drilling and exploration well within the following two years) were not met.

In May 2012, the Environmental Protection Agency (EPA) released the report from a preliminary study “Hydraulic Fracturing or “Fracking’: A Short Summary of Current Knowledge and Potential Environmental Impacts”. This desk study was conducted for the EPA by the University of Aberdeen and provided an introduction to the environmental aspects of UGEE projects/operations, including a review of regulatory approaches used in other countries and areas for further investigation and research. In brief, the study highlighted:

- The importance of adequate knowledge of local geology to assess potential impacts on groundwater quality and the possibility of induced seismic activity;
- The importance of well integrity for preventing groundwater contamination;

- The uncertainty regarding the "carbon footprint" of shale gas in comparison to conventional natural gas;
- Baseline studies and monitoring are needed before drilling begins (e.g. surface water; groundwater; seismicity); and
- Hydraulic fracturing is a relatively new area of research (i.e. only a limited number of published, peer-reviewed, scientific studies are available).

The information provided by the preliminary research project was used along with other sources, such as European Commission reports, to develop the Terms of Reference for a more comprehensive Research Programme. Between the 11th January and 8th March 2013, the EPA administered a Public Consultation in relation to the draft Terms of Reference for the UGEE JRP. Submissions were assessed and relevant comments taken into account when finalising the document.

To assist government bodies in making informed decisions about the future licensing and management of UGEE projects/operations on the Island of Ireland, comprehensive knowledge of the potential impacts of this process on the environment and human health is required. This knowledge will be generated from a number of sources including EU and international research, as well as through this programme of research.

The key questions to be addressed by the UGEE JRP were:

1. Can UGEE projects/operations be carried out in the Island of Ireland whilst also protecting the environment and human health?
2. What is "best environmental practice" in relation to UGEE projects/operations?

1.3 Overview of the UGEE Joint Research Programme

The main aim of the UGEE JRP is to further the understanding of potential impacts on the environment and human health from UGEE projects/operations. The JRP comprises five separate but interlinked projects as follows:

- Baseline characterisation:
    - Project-A1: Groundwater, surface water and associated ecosystems);
    - Project-A2: Seismicity);
    - Project-A3: Air quality);
- Impacts and mitigation measures:
    - Project-B: UGEE projects/operations: impacts and mitigation measures;
- Regulatory Framework:
    - Project-C: Regulatory framework for environmental protection.

Project A1 covered baseline characterisation and monitoring of groundwater, surface water and associated ecosystems in the case study areas. Project A2 covered baseline characterisation and monitoring of seismicity. Project A3 assessed the requirements and needs for baseline air quality monitoring as guidance for Environmental Impact Statement(s) (EIS) in particular. Project B involved an assessment of potential, cumulative environmental impacts of "commercially probable scenarios"

of UGEE projects/operation as well as potential mitigation measures which may be needed or recommended to counteract such impacts. Finally, Project C was designed to assist regulators (both North and South) in fulfilling their statutory roles regarding UGEE.

1.4 Project C: Regulatory Framework for Environmental Protection

Project C focused on the regulatory framework for environmental protection in respect to UGEE projects/operations. Project C, summarised by its scope in Figure 1.2, has five primary components:

- Review of EU environmental legislation;
- Review of regulatory approaches in other countries;
- Assessment of the potential role of Health Impact Assessment;
- Best practice for UGEE projects/operations; and
- Review of examples of public engagement in UGEE.

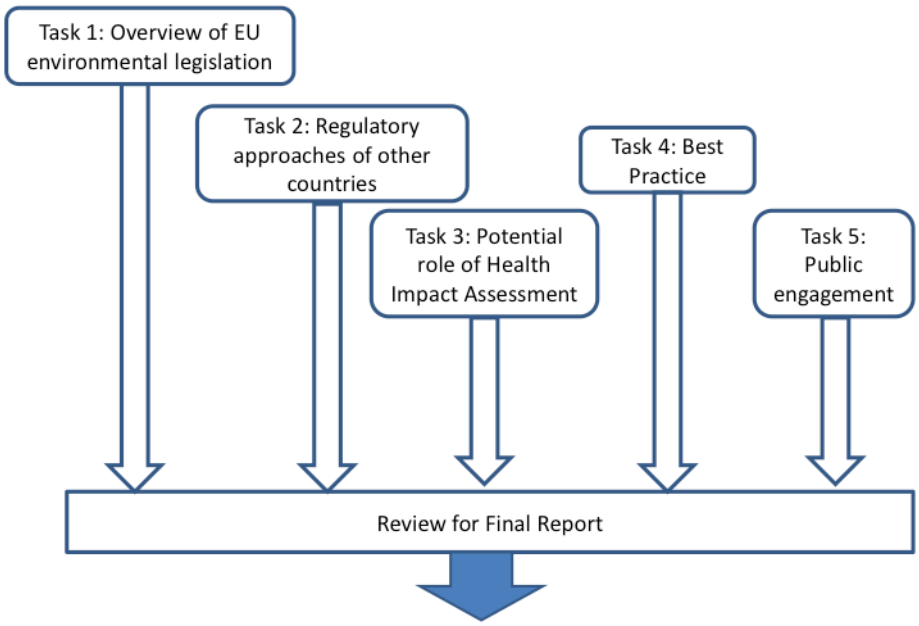

Figure 1.2. Tasks of Project C of the UGEE Joint Research Programme.

1.4.1 Purpose of this document

The purpose of this document is to present the outputs of Project C of the study "Environmental Impacts of Unconventional Gas Exploration & Extraction (UGEE)" which is a joint research programme commissioned by the Environmental Protection Agency (EPA), Department of Communications, Energy and Natural Resources (DCENR) and Northern Ireland Environment Agency (NIEA). Project C focusses on the regulatory framework for environmental protection in respect to UGEE.

1.4.2 Aim and scope of Project C

The aim of Project C is to progress the identification of regulatory requirements and the identification of operational best practice for environmental protection in the context of the Island of Ireland. This was achieved through the following scope of work:

- Task 1: Provision of an overview of European Union (EU) environmental legislation applicable to UGEE including legislation that relates to projects and operations from the planning of to the cessation of activities, including aftercare requirements;
- Task 2: Examination of the regulatory approaches of other countries that have experience with UGEE;
- Task 3: Examination of the potential role of "Health Impact Assessment" (HIA) in the regulation of UGEE projects and operations, based on the experience in other countries, and formulation of recommendations towards developing a HIA protocol in the Island of Ireland context;
- Task 4: Examination of best practice for UGEE projects and operations through examining regulatory requirements and best practices, in relation to aspects such as water resource management, waste management, emissions control, risk quantification and management, avoidance or mitigation of detrimental seismic events, use of chemicals, well construction, well and site remediation, air emissions management and financial provisions; and
- Task 5: Examination of public engagement in the context of UGEE through assessment of case studies of public engagement in UGEE projects and operations (or other similar projects) to identify best practices and make recommendations for the approach of island of Ireland.

2 The European Environmental Legislative Framework Applicable to UGEE

2.1 Introduction

This section presents an overview of the EU environmental legislative framework applicable to UGEE projects and operations. It includes an assessment of key legal instruments of the existing *acquis communautaire* [i.e. the accumulated legislation, legal acts, and court decisions which constitute the body of European Union law (https://en.wikipedia.org/wiki/European_Union_law)] in terms of the extent to which they address the environmental risks associated with UGEE.

2.2 Method

The assessment of the EU environmental legislative framework was carried out through the following activities:

- A review and assessment of the key aspects of the *acquis* including particular reference to the European Commission (EC) Recommendation 2014/70/EU "on minimum principles for the exploration and production of hydrocarbons (such as shale gas) using high-volume hydraulic fracturing" and the legislation referred to therein.
- Mapping of the relevant legislation to the UGEE lifecycle.
- Indication of the principal requirements of the legislation and what these may mean in terms of operator practice.
- Indicating how the EU *acquis* translates to Ireland and Northern Ireland legislation and indicating potential gaps in scope and how these might be addressed.

2.3 Results

2.3.1 Key aspects of the EU acquis relevant to UGEE

The starting point for this regulatory analysis on UGEE was the European Commission (EC) Recommendation (2014/70/EU) "on minimum principles for the exploration and production of hydrocarbons (such as shale gas) using high-volume hydraulic fracturing" (the "Recommendation') published on 22 January 2014.

The Recommendation is not legally binding on Member States or operators, however, it lays down the minimum principles to be applied as a common basis for hydrocarbons exploration and production activities in the EU that may involve the use of high-volume hydraulic fracturing (HVHF). These Recommendations establish minimum requirements and are complementary to existing EU legislation applicable in the field of environment and safety legislation (the "*acquis communautaire*").

Table 2.1 presents a list of the Directives and Regulations referenced in recommendation 2014/70/EU and hence considered to be the central pieces of EU legislation applicable to UGEE. Table 2.2 presents additional legislation that may influence UGEE but which does not have such a significant role as those referred to in Recommendation 2014/70/EU. In both tables, a summary of the aims and objectives of the items of legislation is provided together with an indication of their relevance to UGEE, the key UGEE life-cycle stages to which they are relevant and possible measures that may be required to meet environmental requirements. The tables also indicate how applicable EU legislation translates to the Ireland and Northern Ireland regulations and the relevant requirements.

The review has been carried out with reference to the following key source documents:

- Transmission Note on the EU environmental legal framework applicable to shale gas projects "Note for the attention of Matthias Groote, Chair of the ENVI Committee, European Parliament', Brussels, 26th January 2012;
- An analysis of legal and regulatory requirements undertaken as part of the project "Technical Support for Assessing the Need for a Risk Management Framework for Unconventional Gas Extraction', AMEC 2012 (unpublished working document). Assesses whether the EU regulatory framework requires specific risk mitigation for UGEE;
- Regulatory Provisions Governing Key Aspects of Unconventional Gas Extraction in Selected Member States, Milieu, for DG ENV, July 2012. A comparative analysis of selected Member State regulatory approaches to UGEE;
- Report on Unconventional Gas in Europe, Philippe & Partners, report for DG ENER, November 2011. This explores the regulatory framework available with case studies from a selection of European countries;
- Direct reference to the various legislative documents (i.e. Directives, Regulations, Recommendations).

2.3.1.1 Stages of UGEE Development

EU legislation has been mapped to the following stages of UGEE project development:

- Pre-development: activities prior to drilling;
- Exploration/Appraisal/Production: activities involving drilling and hydraulic fracturing;
- Decommissioning/Closure/Post-closure.

2.3.1.2 Key EU legislation applicable to UGEE

The EU legislation mentioned in Recommendation 2014/70/EU (and listed in Table 2.1) addresses numerous issues relevant to UGEE (water protection, chemical regulation, waste management, emission regulation, noise regulation, environmental impact assessment, etc.), however the scope of application and potential implications on UGEE activities is diverse and dependent on a range of factors, such as: the size and location of the installation; the lifecycle stage; the materials used; and the waste generated. Therefore, whereas some pieces of legislation are likely to be relevant to any UGEE development, others will only be applicable under specific circumstances or in relation to particular aspects. Moreover, not all legislation listed is relevant for implementing measures to address environmental impacts associated with UGEE but cover other aspects such as the safety and health protection of workers. Therefore, this section summarises and discusses the scope of application and requirements of some of the main Directives and Regulations of the *acquis* with regards to environmental protection, based on the findings presented in Table 2.1 and Table 2.2.

To facilitate analysis and identification of the most relevant legislation when it comes to UGEE, the following families of Directives/Regulations are defined:

- Horizontal Directives, i.e. Directives that cut across other environmental legislation and environmental compartments. Horizontal Directives are procedural in character and provide methods and mechanisms aimed at improving decision-making, legislative development and implementation. Namely:

- Directive 2001/42/EC on the Strategic Environmental Assessment of Plans and Programmes (SEAD);
- Directive 2011/92/EU on Environmental Impact Assessment (EIAD) as amended by Directive 2014/52/EU (such amendments to take effect by or before May 2017); and
- Directive 2004/35/CE on environmental liability (ELD) (included in this group even though it does not impose procedural requirements. In this sense, it deals with all types of environmental liability and its scope of application is defined by reference to the *acquis communautaire*).

- The Directives that are relevant to specific aspects of operation or to the protection of individual parts of the environment including:
  - The Waste Directives, namely Directive 2008/98/EC on Waste (WD) and Directive 2006/21/EC on the management of waste from extractive industries (MWD);
  - The Water Directives, namely the Water Framework Directive 2000/60/EC (WFD) and Directive 2006/118/EC on the protection of groundwater (GWD);
  - Those relevant to the environmental protection of air, namely Directive 2010/75/EU on industrial emissions (IED) and Directive 2008/50/EC on Air Quality (AQD);
  - Those relevant to biodiversity protection, namely Directive 1992/43/EC on the conservation of natural habitats and of wild fauna and flora and Directive 2009/147/EC on the conservation of wild birds (HD);[5]
  - The Directives and Regulations related to chemicals and other substances/products, namely, REACH Regulation 1907/2006 REACH and Regulation 528/2012 on Biocidal Products (BPR), but also the SEVESO III Directive 2012/18/EU.

Horizontal Directives

The SEAD and EIAD apply at an early plan, programme and project stage, when initial assessment of environmental effects of plans, programmes and projects are addressed. These Directives also involve transboundary consultation, where applicable.

The *SEAD* is a systematic decision-support process, that aims to ensure that environmental aspects are effectively considered in public plans and programmes (rather than individual projects) developed and adopted at the legislative/regulatory/administrative level in various fields, including energy. The SEA process is intended to inform the development of public plans and programmes, notably with respect to forward planning/zoning objectives and in relation to plans, programmes and schemes which set the framework for future development consent. The UGEE sector will be affected by the outcomes of this process where it is applied, for example in relation to new licensing rounds, and in the adoption of relevant national, regional and local plans and variations to plans. There may be gaps in implementation in specific cases where relevant authorities have not carried out prior SEA of proposed plans or programmes, or where no such plans or programmes were formally adopted.

The SEAD does not cover specific projects nor does it impose specific requirements on operators, but it is a regulatory tool that can be used by competent authorities to implement some limits or measures on the development of UGEE projects.

5 While the HD is focused on an individual aspect of the environmental, it is more akin to a horizontal measure in the way that it imposes procedural obligations across a wide range of decisions.

Of special relevance to UGEE at the planning stage is the *EIAD*, as it establishes the procedures for assessing whether an UGEE project will have any significant effects on the environment, the extent of such effects, and the need for adoption of mitigation measures. The EIAD requires a mandatory environmental impact assessment (EIA) for Annex I projects and requires carrying out a screening procedure to determine whether an EIA is needed for all activities listed in Annex II, according to the criteria laid down in Annex III of the Directive. Where there is doubt over the magnitude/significance of effects, an EIA must be carried out. Therefore, if any part of an UGEE project involves a class of project or activity listed in either Annex I or Annex II of the EIAD, and if significant effects on the environment cannot be ruled out based on objective information, an EIA will be required prior to the grant of development consent. EIAD provides for public participation and transboundary consultation, where applicable.

Annex II (2) (d) of the EIAD lists "deep drilling" and includes an indicative (but non-exhaustive) list of deep drillings.[6] While the term "deep drilling" has not been legally defined at either an EU or national level, the Commission has offered Guidance that it should be interpreted to include UGEE projects that use deep drillings, whether at exploratory or production stage and whether or not hydraulic fracturing is used.[7] The European Court has held that the depth of drilling alone should not solely determine whether EIA is required.[8] The European Commission has recently re-stated this view with approval, noting that all of the relevant criteria in determining the significance of effects as outlined in Annex III of the EIAD should be taken into account, including the sensitivity of the receiving environment.[9] The relevant competent authority must also take into account potential transboundary effects and, where there is a reasonable doubt as to the absence of significant effects, the precautionary principle must be applied.[10] The EIAD further provides for public participation at an early stage in the decision-making process. This is in accordance with the requirements of the Aarhus Convention on access to information on the environment, public participation and access to justice (1998) which is as relevant to UGEE as it is to any other activity which is likely to effect the environment[11].

The EIAD requires an assessment to be carried out of the potential significant effects of the proposed project on the environment, both in terms of the project itself and in relation to the "*in combination*" effects of the project together with other plans and projects. The Irish High Court recently confirmed that the obligation to assess the cumulative effects of a proposed project (i.e. any projects, not just UGEE projects) relates to the whole project, including all subsidiary and ancillary elements[12] which are intrinsic to or necessary for the project. At both the screening stage and the EIA stage, it will be necessary to assess the entire project for which consent is required, considered as a whole, including for example any ancillary infrastructure, pre-construction works and decommissioning phases. Therefore, for UGEE, an EIA is likely to be required prior to granting consent for a project involving exploratory deep drilling. A separate EIA would be required prior to the granting of consent for any UGEE project involving production, which will generally come within the scope of the EIA requirements under Annex II of the EIAD, unless any part of the UGEE project involves a class of project or activity listed in Annex I (reaching the required thresholds) which will make the EIA mandatory.

6 In Case C-531/13, Kornhuber and Others, the Court ruled that exploratory drillings are a form of a deep drilling, within the meaning of Annex II (2) (d).
7 http://ec.europa.eu/environment/integration/energy/pdf/guidance_note.pdf
8 Case C-531/13, Kornhuber and Others.
9 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0052&from=EN
10 Case C-127/02, Case C-127/02, *Waddenvereniging and Vogelbeschermingsvereniging*, paragraph 44.
11 Members of the public are entitled to information relating to the environment, including information which is relevant to environmental decision-making. The definition of environmental information is broad, and the grounds for non-disclosure are limited. The provisions apply to information held by or on behalf of public authorities. It does not, therefore, apply to information which is held by private entities operating in a private capacity.
12 *O'Grianna v An Bord Pleanála, High Court, Mr Justice Peart, 15 December 2014.*

The proponent of a UGEE project is required to propose mitigation actions where potential significant adverse impacts to the environment is identified, and any mitigation measures imposed by the competent authority will result in the determination of operational conditions. At the same time, consideration of cumulative effects of a project and other existing or forthcoming projects will play an important role. Moreover, the EIA process also ensures public participation in decision-making.

The EIAD 2014/52/EU proposes the introduction of penalties for non-compliance with domestic legislation giving effect to the EIAD, and requirements for post-consent monitoring and analysis, in particular to determine whether the mitigation proposed for the project has achieved what it was intended to achieve. The EIAD further provides that the competent authority evaluating the EIA must have, or have access, to experts with relevant expertise to enable the competent authority to evaluate the EIA and reach a reasoned conclusion. EIAD and SEAD do not provide for disclosure of chemicals planned for use at sites however requirements for disclosure may potentially form part of permit conditions (i.e. in planning permits or permits to operate).

While the EIAD provides for transboundary consultation, the procedures are not prescribed in detail.

The *ELD* approach differs from other horizontal Directives as it does not impose procedural requirements but rather deals with liability. The ELD is therefore relevant at a later stage, when activities have started (and damage is imminent or has occurred).

The *HD* has many of the characteristics of the horizontal Directives, even though it is legislation addressing a particular element of the environment, namely biodiversity. The horizontal effect of the HD is due to the fundamental role of Appropriate Assessment (AA) in the preparation and adoption of plans and programmes, and of projects, which may have a significant effect on a European site designated under the HD or BD. All plans, programmes and projects must be screened for potential significant effects on a European site, and if such effects cannot be ruled out on the basis of objective scientific information, a full AA must be completed prior to the adoption of the plan or programme or approval of the project. AA is applicable at all stages of UGEE.

If it cannot be demonstrated through the AA process that the proposed plan, programme, project or activity is not going to have an adverse impact on the integrity of a European site, the particular plan, programme, project or activity may not be adopted or approved without further modifications and mitigation to eliminate such adverse impacts. While the EIAD informs the decision-making process, the AA process under the HD actually determines the outcome and the manner in which the decision-making process must be undertaken. For this reason, it may be classed as a Horizontal Directive.

Legislation addressing particular environmental elements or operations

Waste Directives

The Commission has confirmed that used fracturing fluid in UGEE operations is to be considered as extractive waste and that flowback water must be treated according to the requirements of the MWD (Potočnik, 2012). This has important implications for UGEE operations because the MWD provides the legal basis, at the EU level, for establishing a “permit to operate” regime with regards to the management of waste, including wastewater such as flowback or produced water, and the management of the waste facility. Only a closed-loop use of flowback water may avoid the classification as waste. The classification of flowback as waste may require treatment prior to reuse for further hydraulic fracturing.

A permit to operate under the MWD may include a wide range of measures including incident response measures and monitoring of underground conditions. Moreover, by virtue of the application of the MWD to fracturing fluid, a permit based on Best Available Technology (BAT) and related BAT

Reference Documents (BREFs) must be obtained by the operator. Thus far however, BREFs under the MWD do not specifically cover UGEE practice.

Whilst waste aspects of UGEE operations will be mainly covered under the MWD, it is important to note that the MWD falls under the broader framework of the WD. Thus the WD also needs to be considered in the context of UGEE. The WD establishes the definition of "waste" used in the MWD and the conditions applicable to the reusing of fluids that emerge at the surface following high-volume hydraulic fracturing and during production (recital 7 Recommendation).

Water Directives

The *WFD* and its daughter Directive the *GWD*, are objective-orientated Directives and are prescriptive with respect to Member States but not directly to operators. They require Member States to set up a programme of measures aimed at ensuring their environmental objectives are met. These programmes and measures and objectives will be indirectly relevant to UGEE operations.

As UGEE is a water intensive activity the WFD is relevant with respect to:

- Water resource depletion (requirement for authorisation); and
- Protection of water from pollution, with the discharge of pollutants into groundwater being prohibited.

Potential measures required from operators to meet environmental objectives may include: investigation of underground conditions; water resource management practices; and measures to address risks related to surface water.

The Commission has confirmed that the exception clause under Article 11(3)(j) of the WFD regarding the injection of pollutants into groundwater does not apply to practices involving the combined use of HVHF and horizontal drilling (Potočnik, 2012). This means that produced wastewater cannot be reinjected into deep geological strata. They have also confirmed that the exception clause is to be interpreted in a restrictive manner.

Biodiversity Directives

The HD and BD establish a network of sites of European importance (Natura 2000 network of European sites) which support species of fauna and flora whose conservation status is under threat. The objectives of the Directives are to enhance the populations of species and the resilience of habitats to support biodiversity. Proposed plans, programmes, projects and activities which are likely to have a significant effect on any European site must be assessed prior to their adoption or approval, and such adoption or approval must be refused unless it can be shown that the proposed plan, programme, project or activity is not likely to have an adverse effect on site integrity. Even a small but relatively significant impact on the conservation objectives of a European site has been found to constitute an adverse effect on site integrity.[13]

Directives and Regulations related to chemicals and other substances/products

The REACH obligations may be applicable to UGEE operators with respect to the chemicals that are used in fracturing fluid (Point 10 of the Recommendation). REACH requires registration of chemical substances manufactured or placed in the EU market in quantities greater than 1t/year (by the supplier) and potentially preparation of a chemical safety report (by the supplier and/or potentially the downstream user). Operators of UGEE projects are likely to be considered as "downstream users" of the chemical substances used in the fracturing fluid, and not the manufacturers/importers, which means that they will not be subject to the main registration obligations. However, when exposure scenarios provided by a supplier during the registration/authorisation process do not cover specific

13 Sweetman v An Bord Pleanála & Others – Case C-258/11.

UGEE use, the downstream user is obliged to report and provide relevant information to European Chemicals Agency (ECHA) and eventually to prepare its own chemical safety report. ECHA has clarified the reporting of substances used in hydraulic fracturing (ECHA/NI/15/08) to allow more explicit reference to the use of substances in hydraulic fracturing and to encourage downstream users to request the registrants to cover their dossiers.

Regarding disclosure of the risks of the use of chemicals, there should be full disclosure of potential risks to the regulator/enforcement authority under REACH. In essence, companies (chemicals manufacturers) are required to register substances. Downstream users adhere to safety requirements defined for the registered uses of chemicals. If a use is not assessed (potentially the case in fracturing), the downstream user would inform the manufacturer so that risk assessment for the use can be carried out (and disclosed). For site specific disclosure, there should be a possibility of requiring disclosure as a permit condition (i.e. in planning permits/permits to operate as required under the mining waste directive).[14]

The *BPR* do not impose particular requirements on downstream users, such as UGEE operators. Biocidal products used in UGEE operations will need to comply with the approval and authorisation process set out in the BPR.

The *SEVESO III Directive***,** which aims to prevent major accidents involving dangerous substances may also be relevant. Due to the fact that its scope of application depends on the quantities of hazardous substances (e.g. natural gas) and the application of thresholds to sites falling under its remit, Seveso requirements are only applicable on a case by case basis depending on the characteristics of the substances used for hydraulic fracturing, the volume of dangerous substances and gas stored and processed onsite. Therefore, Seveso might not be applicable at the exploration phase due to the low volume of chemicals used in the fracturing fluid and the fact that natural gas is unlikely to be stored on-site in large quantities and processed at this stage but could be applicable at production.

Directives relevant to the environmental protection of air

The *IE Directive* does not cover UGEE operations. This Directive would only be applicable to UGEE if an activity listed in the IE Directive were “directly associated’, had a “technical connection” or operated on the same site as UGEE activities. It cannot be determined at this time whether these conditions are met with respect to UGEE projects because this depends on the scale of activities of a given project.

14 Note that companies may participate in the International Association of Oil & Gas Producers (IOGP) voluntary initiative on well disclosure. For Northern Ireland, operators that are part of UKOOG are committed to publishing data on chemicals used under its Community Engagement Charter and its guidelines for exploration and appraisal.

Table 2.1. Legislation referenced in the EU Recommendation and relevance to UGEE

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
BPR	Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products (OJ L 167, 27.6.2012, p. 1–123) Directive 98/8/EC of the European Parliament and of the Council of 16 February	The BPR requires all biocides to be subject to approval (of active biocidal substances) and authorisation (of biocidal products containing active substances), on the basis of an assessment of the risks of the intended uses, within specified product types. The BPR notably intends to harmonise the market at the EU level, simplify the authorisation and approval of active substances and introduce timelines for Member State evaluations, opinion forming and decision-making[17].	Operators of UGEE projects are most likely to be considered as a "downstream users" of biocidal substances (and not the ones manufacturing/ importing). The BPR does not impose any particular requirements on downstream users. However, any biocidal products used in UGEE operations will need to comply with the BPR.	Exploration/Appraisal/ Production	See REACH	The Chemicals (Hazard Information and Packaging for Supply) Regulations (Northern Ireland) 2009 The Biocidal Products and Chemicals (Appointment of Authorities and Enforcement) Regulations (Northern Ireland) 2013 The Biocidal Products (Fees and Charges) Regulations (Northern Ireland) 2015 Regulator – Health and Safety Executive (NI)	EU (Biocidal Products) Regs. 2013 (SI 427 of 2013) and 2014 (SI 344/2014) Regulator – Minister for Agriculture Food and Marine

15 Stages are defined as: Pre-development (activities prior to pad construction and drilling such as planning, licence applications, baseline monitoring, studies); Exploration/Appraisal/Production (including exploration activities, pad construction, drilling, well completion, fracturing, flow testing, gas production, monitoring and well integrity testing); and Decommissioning (including well plugging, site deconstruction, post-closure monitoring, licence relinquishing).

16 Note that measures are examples of those that it may be possible to stipulate against the legislation. They do not represent specific measures already required.

17 See: http://echa.europa.eu/regulations/biocidal-products-regulation/understanding-bpr (accessed in January 2013).

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
	1998 concerning the placing of biocidal products on the market (OJ L 123, 24.4.1998, p. 1–63)						
EIAD	Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (OJ L 26, 28.1.2012, p. 1–21). As recently amended by Directive 2014/52/EU	The EIAD requires a mandatory environmental impact assessment (EIA) for Annex I projects. This includes projects involving the extraction of petroleum and natural gas for commercial purposes if the amount extracted exceeds 500 tonnes/day in the case of petroleum and 500,000 m^3 per day in the case of gas. If an EIA is not required, a screening procedure is to be carried out for all activities listed in Annex II, according to the criteria laid down in Annex III of the Directive. The Member	In line with point 3.3 of the Recommendation, UGEE projects are subject to an EIA in line with requirements under Annex I and II of the EIAD if it cannot be excluded, on the basis of objective information, that the project will have significant environmental effects. Moreover, the EIA process also ensures public participation in decision-making and addresses the consideration of cumulative effects of	Pre-development Exploration/Appraisal/ Production Decommissioning/ Closure/Post-closure	Deep drilling, exploration, gas pipelines and petroleum production activities, including refining, and waste activities must be screened to ensure no significant effects before consent may be granted. All aspects of proposed activity will be subject to screening ("whole project" approach) Performing of EIAs and associated activities (e.g. baseline monitoring, mitigation measures development, etc.). Associated with *public engagement*	The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2015 (No. 74 of 2015) Regulator – Department of Environment and NI Planning Service	Deep drilling - EU (EIA) (Planning and Development) Regulations 2014 (SI 543/2014) Regulator – Planning Authority or Planning Board Exploration - EU (EIA) (Petroleum Exploration) Regs.2013 (SI 134/2013) Regulator – Minister for Communications, Energy and Natural Resources (MCENR) Gas Pipeline – EU (EIA) (Gas)

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
	of the European Parliament and of the Council of 16 April 2014	States shall determine whether the project shall be made subject to an EIA on a case-by-case or by setting thresholds or criteria set by the Member State. Annex II includes deep-drilling projects and surface installations for extracting oil and gas.	UGEE However, a full EIA might not be legally required in all cases. It is unlikely that projects will reach the thresholds of Annex I (or at least not during all stages/period) and the results of Member States screening of Annex II exploration and exploitation UGEE projects, might consider that there is no need for full EIA of the project. The Commission has produced a guidance note on the application of the EIAD to UGEE projects[18], which determines that EIAD is applicable to both exploration and production phases. Hence, UGEE projects, even		*and consultation* measures could include making public the results of baseline and monitoring surveys; well integrity tests; resource use and any environmental or safety incidents. Requirements could be attached to operator environmental permits (under MWD). Measures could include requiring operators to conduct public consultation at regular stages and preclude the use of non-disclosure agreements.		Regs.2012 (SI 403/2012) Production – EU (EIA) (Petroleum) Regs.2012 (S.I.404/2012) Regulator – MCENR Production – EU (EIA) (IPPC) Regs. 2012 (SI 457 of 2012) Regulator – EPA Waste – EU (EIA) (Waste) Regs. (SI 283/2012 and 505/2013) Regulator – EPA

18 See relevant study available September 2012 at: http://ec.europa.eu/environment/integration/energy/pdf/guidance_note.pdf

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
			exploratory ones, which use deep drillings, are covered by Annex II.2. d.				
ELD	Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage (OJ L 143, 30.4.2004, p. 56–75)	Does not impose procedural requirements but deals with liability. The ELD's scope of application is defined by reference to the *acquis communautaire* (installations/activities falling under the scope of IED, MWD, etc.) and not by reference to a given industry/activity, installation or project. The ELD is applicable to the prevention and restoration of "environmental damages', which include three limited types of specific natural resources, that is: – damage to protected species and habitat; – damage to water; and –	In principle, if an UGEE project leads to significant environmental damage the operator will be held liable under the ELD (Potočnik, 2012). Most of the activities of UGEE would fall under Annex III and be subject to the corresponding strict liability system. In line with Point 12.1 of the Recommendation, Member States should apply the ELD provisions to all activities taking place at an installation site including those that currently do not fall under the scope of	Exploration/Appraisal/ Production Decommissioning/Closure/Post-closure	None specific.	The Environmental Liability (Prevention and Remediation) Regulations (Northern Ireland) 2009 as amended by 361/2009, 210/2011, 231/2015 Regulator – Department of Environment	EC (Environmental Liability) Regulations 2008 SI 547 of 2008 as amended by the European Communities (Environmental Liability) (Amendment) Regulations 2011 Regulator – EPA

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
		damage to land. Strict liability[19] applies to damages or imminent threats caused by activities listed in Annex III of the ELD (e.g. occupational activities encompassing activities such as the management of waste and water abstraction).	Directive 2004/35/EC. UGEE activities not falling under Annex III, will be only fault based and limited to damage or threat of damage to protected species and natural habitats. Operators should provide a financial guarantee or equivalent prior to the start of operations involving HVHF (in line with point 12.2. of the Recommendation)				
GWD	Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against	Objective-orientated Directive. Complements the provisions preventing or limiting inputs of pollutants into groundwater obtained in the WFD (Directive 2000/60/EC), and aims to prevent and control groundwater pollution. Article 6 requires Member States to set	It is relevant in relation to the protection of water from pollution. Whilst the GWD provides a basis for the adoption of general measures at Member State level, it is not sufficiently prescriptive to ensure that specific	Pre-development Exploration/Appraisal/ Production Decommissioning/Closure/Post-closure	See WFD	Groundwater Regulations (Northern Ireland) 2009 (254/2009) as amended 359/2009, 211/2011, 208/2014) Department of Environment/ NIEA	Environmental Objectives (Groundwater) Regulations (SI 9/2010, 389/2011 and 149/2012) Regulator – EPA

19 Under strict liability regime, there is no need to provide proof of intent or negligence that the operator has caused environmental damage or an imminent threat of such damage.

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
	pollution and deterioration (OJ L 372, 27.12.2006, p. 19–31)	up a programme of measures aimed at ensuring these objectives are met. The WFD is prescriptive with respect to Member States and not directly to operators.	identified measures to manage UGEE risks are implemented. The details of such measures are left to the discretion of Member States and harmonised implementation of measures in relation to specific projects is uncertain. It is of note that the exception clause under Article 11(3)(j) of the WFD regarding the injection of pollutants into groundwater does not apply to flowback water from UGEE practices, as this would be in contradiction of the WFD objectives. This has been confirmed by the Commission (Potočnik, 2012).				
HLD	Directive 94/22/EC of	Focuses on equal access to resources by	The HLD is not relevant for	Pre-development Exploration/Appraisal/	None specific	The Hydrocarbons	European Communities

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	**Ireland**
	the European Parliament and of the Council of 30 May 1994 on the conditions for granting and using authorisations for the prospection, exploration and production of hydrocarbons (OJ L 164, 30.6.1994, p. 3–8)	operators by imposing a (limited or full-blown) tendering procedure before granting permits/licences for the exploration and/or exploitation of hydrocarbons.	implementing measures to address environmental impacts associated with UGEE.	Production		Licensing Directive Regulations (Northern Ireland) 2010. SR 2010/170 Regulator – Department of Enterprise, Trade and Investment	(Hydrocarbons) (Prospection, Exploration and Production) Regulations, 1998. S.I.77 of 1998 Regulator – DCENR
IED	Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)	Regulates industrial emissions in an integrated way by requiring measures to prevent or reduce emissions. Applies to industrial activities falling under their scope of application	Does not cover the exploration or extraction of UGEE specifically. The Directive would only be applicable to UGEE if an activity listed in the IE Directive were directly associated, had a technical connection or operated *in situ* with UGEE exploration and exploitation.	Pre-development Exploration/Appraisal/ Production Decommissioning/ Closure/Post-closure	A range of pollution prevention, control and mitigation measures (see WFD and MWD). Financial provisions for remediation, closure and decommissioning.	The Pollution Prevention and Control (Industrial Emissions) Regulations (Northern Ireland), 2013 as amended by 304/2014 Regulator – Department of Environment, District Council/NIEA	European Union (Installations and Activities Using Organic Solvents) Regulations 2012. SI 565 of 2012 - (Chapters I, V & VII of Directive) European Union (Large Combustion Plants) Regulations 2012

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
	(OJ L 334, 17.12.2010, p. 17–119)		The relevance and applicability of the Directive would be thus conditional on specific projects meeting certain conditions. It is currently inconclusive whether those conditions (e.g. for scale of combustion of fuels, disposal or recovery tonnage of hazardous waste) are met in respect of UGEE projects (due to this depending on the specific scale of activities of a given project).				SI 566 of 2012 (Chapter III, Annex V and further effect to Ch. I & VII) European Union (Industrial Emissions) Regulations 2013, SI 138 of 2013 (give effect to Directive) Environmental Protection Agency (Industrial Emissions) (Licensing) Regulations 2013 SI 137 of 2013(give effect to Directive) Environmental Protection Agency Act 1992 (First Schedule) (Amendment) Regulations 2011 (SI 308 of 2011). Note "The extraction, other than offshore extraction, of

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
							petroleum, natural gas, coal or bituminous shale." (No. 9.1 in the First Schedule to EPA Act as amended) requires a licence at production stage similar in some aspects to an IED licence. Regulator – EPA
MWD	Directive 2006/21/EC of the European Parliament and of the Council of 15 March 2006 on the management of waste from extractive industries and amending Directive 2004/35/EC (OJ L 102, 11.4.2006, p. 15–34)	Provides for a comprehensive framework for the safe management of waste resulting from extractive activities. Applies to waste resulting from the prospecting, extraction, treatment and storage of mineral resources and the working of quarries, known as "extractive waste'. Falls under the broader framework of the WD. Imposes requirements/measures with respect to the	The MWD is of high relevance for UGEE operations. Provides the legal basis at the EU level for regulating the management of waste, including waste water such as flowback or produced water, and the management of the waste facility. Used fracturing fluid is to be considered as extractive waste and flowback water must be treated according to the	Pre-development Exploration/Appraisal/ Production Decommissioning/ Closure/Post-closure	The licence to operate under the MWD may include a wide range of measures: Operational risk management and mitigation focussed on *underground/well related risks:* e.g. contingency planning and remedial actions in the event of well failure; well safety (blowout preventers, pressure and temperature monitoring and fire and gas detection	The Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2015 (No. 85 of 2015) Regulator – Department of Environment/ district councils	Waste Management (Management of Waste from the Extractive Industries) Regulations 2009 SI 566 of 2009 Regulator – EPA

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
		"waste facility'.	MWD (Potočnik, 2012). However, a closed-loop use of flowback water may avoid the classification as waste. By virtue of the application of the MWD to fracturing fluid left underground in geological formations or treated at the surface, Best Available Technology (BAT) and related BAT Reference Documents (BREFs) should be applied to UGEE practices. A permit based on BAT must be obtained by the operator. Thus far, BREFs under the MWD do not cover UGEE practices specifically, but only mining waste management		systems); well integrity testing; minimum vertical distances between wells and aquifers; modelling to predict the extent of fracture growth; pre-injection testing and ground prediction modelling to assess the implication of potential earth tremors. For *investigation of underground conditions* (including geology, hydrology and seismicity) see WFD. *Incident response* measures such as development of emergency response plans (e.g. in the event of underground leaks, contamination or spillages); notification of incidents, including making details available to the public.		

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
			aspects. The Commission is currently reviewing the existing BREF on extractive waste, so as to cover the management of waste from hydrocarbon exploration and production[20].		*Monitoring* of underground conditions (groundwater, induced seismic effects and gas seepages). Measures related to *air quality*, would aim at mitigating risk by minimising the level of air pollutant emissions from various sources. For example, use of low emission on-site power generation equipment and vehicles, baseline and on-going monitoring of air quality, reduction of flaring and gas venting. Regarding *wastes* (including drilling muds and flowback) measures may aim to assure proper management, treatment and		

20 DG Environment website on Environmental Aspects on Unconventional Fossil Fuels: http://ec.europa.eu/environment/integration/energy/unconventional_en.htm (accessed in November 2014).

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
					disposal. For wastewaters, characterisation and determination of appropriate treatment is important followed by waste water treatment to the required discharge standards. Regarding drilling muds, closed-loop system may be used to contain (and recycle) muds. Regarding *post-closure requirements*, measures may focus on: abandonment surveys for various parameters to establish the condition of the site; inspections and maintenance to ensure that any releases to the environment are identified and can be managed; and retention of ownership and		

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
					liability for damage, transfer of responsibilities. Appropriate provisions for liability may be required over several years following well closure. Requirement for *financial guarantees* by operators. Such guarantees may also be able to address environmental and civil liability claims covering accidents or unintended negative impacts caused by operator activities or those outsourced to others. Assessment of the *technical and financial capacity* of an operator. *Public participation* in the application process		
REACH	Regulation (EC) No 1907/2006 of the	Aims to ensure a high level of protection of human health and the environment from the	UGEE operators may be subject to REACH obligations with respect to the	Exploration/Appraisal/ Production Decommissioning/	Requires *registration of substances* (by the supplier) and potentially	REACH Enforcement Regulations 2008 (SI 2008/2852) as	Chemicals Act 2008 No. 13 of 2008

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
	European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council	risks that can be posed by chemicals. REACH establishes procedures for collecting and assessing information on the properties and hazards of substances. REACH in principle requires all companies manufacturing or placing a substance on the EU market in quantities greater than 1 t/year to register that substance with the European Chemicals Agency (ECHA) and to assess risks to health and the environment. Communication along the supply chain is a key aspect. Suppliers should provide information on the conditions of safe use of hazardous substances to downstream users. Downstream users may, in turn, contact the supplier if the conditions of use that are described do not match	chemicals they use in the fracturing fluid (in line with point 10 of the Recommendation). Operators of UGEE projects are most likely to be considered as a "downstream users' of such substances (and not the ones manufacturing/importing). Under REACH, the main registration obligations lie upon the manufacturers/importers of chemicals. However, if the operator identifies that the exposure scenarios provided by its supplier during the registration/authorisation process do not cover its specific UGEE use, in its capacity of downstream user, the operator is obliged to report to	Closure/Post-closure	preparation of a *chemical safety report* (supplier and potentially operator). *Further measures* could include those that relate to: appropriate assessment and management of the environmental and health risks of the chemicals used; selection of chemicals with lower associated hazards and/or risks to minimise the risks in a given location; disclosure of information on chemicals usage to the authorities and to the public.	amended by SI 2013/2919 and 2014/2882 Regulator – Department of Enterprise Trade and Industry/Department of Environment/Health and Safety Executive for Northern Ireland	As amended by Chemicals (Amendment) Act 2010 (No. 32 of 2010)) Chemicals (Asbestos Articles) Regulations 2011 SI 248 of 2011 gives further effect Regulator – Health and Safety Authority (HSA) and EPA (in relation to environmental protection)

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
	Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC (OJ L 396, 30.12.2006, p. 1–849)	their actual conditions of use. ECHA must as well establish and maintain database(s) with information on all registered substances.	ECHA and to provide relevant information in accordance with Article 38 of REACH. Eventually, the operator will have to prepare its own chemical safety report in accordance with Article 37 of REACH under certain conditions. Alternatively, the operator may ask its supplier to develop an exposure scenario covering its use or find an alternative substance or process. It then is up to ECHA to check the compliance of registration dossiers and request, if necessary, additional information[21]. This has been confirmed by the Commission				

21 Articles 41 and 42, REACH.

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
			(Potočnik, 2012). The Commission plans to propose ECHA to make certain changes in the existing database of registered chemicals, so as to improve and facilitate the search of information on registered substances used for hydraulic fracturing purposes[22].				
SEAD	Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the	Systematic decision support process, aiming to ensure that environmental aspects are effectively considered in plans and programmes developed and adopted at the legislative/regulatory/administrative level. Requires the performance of a strategic environmental assessment (SEA) according to the	It is relevant for UGEE as it requires a SEA for public plans/programmes which are prepared in the fields of land use, transport, energy, waste/waste management or for the projects which must be assessed under the Habitats Directive. In line with point 3.1 of the Recommendation	Pre-development	Preparation of an *SEA* (by the relevant Government Department) of a proposed gas licensing plan and local authority with respect to any land use plans. Possible requirement for assessment of impacts on health (population and human health)	The Environmental Assessment of Plans and Programmes Regulations (Northern Ireland) 2004 (SI 2004/280) Regulator – Department of Environment	EC (Environmental Assessment of Certain Plans and Programmes) Regulations 2004. SI 435 of 2004 (amended SI 200/2011 Planning and Development (SEA) Regulations 2004

22 DG Environment website on Environmental Aspects on Unconventional Fossil Fuels: http://ec.europa.eu/environment/integration/energy/unconventional_en.htm (accessed in November 2014).

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	**Ireland**
	environment (OJ L 197, 21.7.2001, p. 30–37)	procedure defined in the Directive.	Member States should prepare a SEA.				(SI 436/2004) amended by SI 201/2011 Regulator – relevant Department, local authority and EPA
SEVESO II SEVESO III	Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances (OJ L 10, 14.1.1997, p. 13–33) Directive 2012/18/EU of the European Parliament	Aims to prevent major accidents involving dangerous substances, while limiting their consequences and ensuring high level of protection in a consistent and effective manner. The scope of application notably depends on the quantities of hazardous substances (e.g. natural gas) that may be present on site (thresholds defined in Annex I). The Directive exempts from its scope the	If the presence/storage of natural gas and/or of other listed dangerous substances such as hydraulic fracturing fluids are being considered not being part of the exploitation (exploration, extraction and processing) activity/operation of minerals, then SEVESO III may likewise be applicable on the basis of the	Pre-development Exploration/Appraisal/ Production	If SEVESO applied, measures related to the prevention and control of major accidents would be required. Specific planning requirements apply to SEVESO type developments and activities.	Control of Major Accident Hazards Regulations (Northern Ireland) 2000/2015 (2000 Regulations were due to be revoked from 1 June 2015) The Planning (Control of Major-Accident Hazards) Regulations (Northern Ireland) 2009 (SI 2009/399) The Planning (Hazardous Substances)	European Communities (Control of Major Accident Hazards Involving Dangerous Substances) Regulations, 2006(as amended by 571/2013) Regulator – Health and Safety Authority (HSA)

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
	and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (OJ L 197, 24.7.2012, p. 1–37)	exploitation, namely the exploration, extraction and processing, of minerals in mines and quarries, including by means of boreholes, but covers chemical and thermal processing operations and storage related to those operations which involve dangerous substances, as well as operational tailings disposal facilities, including tailing ponds or dams, containing dangerous substances.	definition of establishment[23], lower-tier establishment[24] and upper-tier establishment[25]. Seveso requirements would only be applicable on a case by case basis depending on the characteristics of the substances used for hydraulic fracturing, the volume of dangerous substances and gas stored and processed onsite. Therefore, Seveso might not be applicable for the exploration phase due to low volume of chemicals used in fracturing fluid and			Regulations (Northern Ireland) Regulator – Department of Environment	

23 "Establishment" being defined as "the whole location under the control of an operator where dangerous substances are present in one or more installations, including common or related infrastructures or activities; establishments are either lower-tier establishments or upper-tier establishments" (Art. 3, §1, SEVESO III).

24 "Lower-tier establishment" being defined as "an establishment where dangerous substances are present in quantities equal to or in excess of the quantities listed in Column 2 of Part 1 or in Column 2 of Part 2 of Annex I, but less than the quantities listed in Column 3 of Part 1 or in Column 3 of Part 2 of Annex I, where applicable using the summation rule laid down in note 4 to Annex I" (Art. 3, §2, SEVESO III).

25 "Upper-tier establishment" being defined as "an establishment where dangerous substances are present in quantities equal to or in excess of the quantities listed in Column 3 of Part 1 or in Column 3 of Part 2 of Annex I, where applicable using the summation rule laid down in note 4 to Annex I" (Art. 3, §3, SEVESO III).

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
			because natural gas is unlikely to be stored on-site and processed at this stage.				
SHPWEI	Council Directive 92/91/EEC of 3 November 1992 concerning the minimum requirements for improving the safety and health protection of workers in the mineral-extracting industries through drilling (eleventh individual Directive within the meaning of Article 16 (1) of Directive 89/391/EEC) (OJ L 348, 28.11.1992,	SHPWEI addresses workers' health and safety related risks in the mineral-extracting industries.	Although the SHPWEI is certainly an applicable piece of legislation when it comes to UGEE, is not considered of relevance in the context of environmental impacts.	Exploration/Appraisal/ Production Decommissioning/ Closure/Post-closure	Health and safety requirements in NI are managed by HSE (NI) in consultation with DETI and NIEA. In Ireland general Health and Safety requirements are managed by HSA. Requirement for detailed safety plans for each stage in the process.	Offshore Installations and Wells (Design and Construction) Regulations 1996 Offshore Installations and Pipeline Works (Management and Administration) Regulations (Northern Ireland) 1995 The Borehole Sites and Operations (Northern Ireland) Regulations 1995 Regulator – Health and Safety Executive	Safety, Health and Welfare at Work (Extractive Industries) Regulations, 1997. SI 467 of 1997 Safety Health and Welfare at Work Act, 2005 (of general application) Regulator – Health and Safety Authority

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
	p. 9–24)						
WD	Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (OJ L 312, 22.11.2008, p. 3–30)	Sets the basic concepts and definitions related to waste management and lays down waste management principles such as the "polluter pays principle" or the "waste hierarchy". Defines the overall framework for EU waste policy, which also covers the MWD.	Waste aspects of UGEE operations will be mainly covered under the MWD. However, the MWD falls under the broader framework of the WD, which will need to be considered. In this sense the MWD uses the definition of "waste" in the WD, namely "any substance or object which the holder discards or intends or is required to discard'. Also, the WD sets out the conditions applicable to the reusing of fluids that emerge at the surface following high-volume hydraulic fracturing and during production (recital 7 Recommendation).	Exploration/Appraisal/ Production Decommissioning/ Closure/Post-closure	See MWD	The Waste Regulations (Northern Ireland) 2011 SI 127/2011 as amended by 241/2013 The Waste Management Licensing Regulations (Northern Ireland) 2003 as amended by 147/2014 The Hazardous Waste (Amendment) Regulations (Northern Ireland) 2015 Regulator – Department of Environment	EC (Waste Directive) Regulations 2011 SI 126 of 2011 as amended by 323/2011 Waste Management Act 1996, as amended Pollutant Release and Transfer Register Regulations 2011 Regulator – EPA
WFD	Directive 2000/60/EC	Objective-orientated Directive to protect,	The exception clause under Article	Pre-development Exploration/Appraisal/	*Investigation of underground*	The Water Environment	EC (Water Policy)

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
	of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (OJ L 327, 22.12.2000, p. 1–73)	enhance and restore surface water, groundwater and protected areas (Article 4). Article 11 requires Member States to set up a programme of measures aimed at ensuring these objectives are met. The WFD is prescriptive with respect to Member States and not directly to operators.	11(3)(j) of the WFD regarding the injection of pollutants into groundwater does not apply to practices involving the combined use of HVHF and horizontal drilling meaning flowback and produced wastewater cannot be re-injected into deep geological strata. This exception clause is to be interpreted in a restrictive manner. Applying it to flowback water from UGEE practices would be in contradiction of WFD objectives. This has been confirmed by the Commission (Potočnik, 2012). As UGEE is a water intense activity the WFD is relevant with respect to water resource depletion	Production Decommissioning/ Closure/Post-closure	*conditions* (including geology, hydrology and seismicity): e.g. to ascertain baseline underground conditions against which any change in conditions could be compared; hydrological surveys; geological surveys; seismic surveys; underground 2D and 3D surveys; identification of methane gas near the surface and of existing underground wells/structures. Regarding *water resource management*, measure may include: improving the understanding of the available water resources and origin and the expected/actual demands for water from UGEE exploration and production (e.g. developing demand	(Water Framework Directive) Regulations (Northern Ireland) 2003 Water Supply (Water Quality) Regulations (Northern Ireland) 2007 as amended Groundwater Regulations (Northern Ireland) 2009 The Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015 The Water (Northern Ireland) Order 1999 Water Abstraction and Impoundment (Licensing) Regulations (Northern Ireland)	Regulations 2003 SI 722 of 2003 as amended by EU (Water Policy) Regulations 2014 SI 350/2014. EU (Drinking Water) Regulations 2014 SI 122/2014 Environmental Objectives (Surface Waters) Regulations 2009 SI 272 of 2009 Environmental Objectives (Groundwater) Regulations 2010 SI 9 of 2010 Water Services Act 2007 as amended Regulator – Department of Environment and EPA

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
			(requirement for authorisation). It is also relevant in relation to the protection of water from pollution, with the discharge of pollutants into groundwater being prohibited. Whilst the WFD provides a basis for the adoption of general measures at Member State level, it is not sufficiently prescriptive to ensure that specific identified measures to manage UGEE risks are implemented. The details of such measures are at the discretion of Member States and harmonised implementation of measures in relation to specific projects is uncertain. The WFD does not provide explicit		profiles, monitoring water availability and use); managing the use of water to minimise use and associated risks of water quality deterioration (e.g. site water management plans, reuse of flowback and produced water for fracturing and use of lower quality water for fracturing such as non-potable and rainwater). Note treatment is likely to be required prior to reuse of flowback. Measures to address *risks related to surface water*, are relevant through prevention of leaks and spills of flowback/produced water, chemicals, drilling mud, etc. This would require the operator to deploy good site management practice, establish	2006 as amended by 122/2007 Regulator – Department of Environment	

Abbreviation	Legislation	Aims/objectives/scope	Relevance to UGEE	Main UGEE stages[15]	Examples of measures that may meet requirements[16]	Regulations and regulators	
						Northern Ireland	Ireland
			guidance on how to identify "the body of surface water" nor "the body of groundwater'. Consequently, certain water bodies impacted by UGEE may not be assessed for compliance with environmental objectives. Monitoring is required periodically with respect to a limited number of substances which may or may not be sufficient when it comes to monitoring UGEE impacts.		baseline conditions and monitor surface water quality and use certain storage equipment and/or runoff control techniques (e.g. spill kits, berm around the site, collection and control of Surface runoff, bunding of storage tanks, tank level alarms, double-skinned storage tanks, impervious, puncture-proof liner under the pad. Requirement for abstraction consenting regime.		

Table 2.2. Further EU legislation and relevance to UGEE

Abbreviation	Legislation	Aims/objectives/ scope	Relevance to UGEE	Main UGEE stages[26]	Examples of measures that may meet requirements[27]	Regulations and regulators	
						Northern Ireland	Ireland
AUTOMOTIVE	Regulation (EC) No 595/2009 of the European Parliament and of the Council of 18 June 2009 on type-approval of motor vehicles and engines with respect to emissions from heavy duty vehicles (Euro VI) and on access to vehicle repair and maintenance information and amending Regulation (EC) No 715/2007 and Directive 2007/46/EC and repealing	Establishes common technical requirements for the type-approval of motor vehicles, engines and replacement parts with regard to their emissions (CO_2, NO_2, etc.). Imposes obligations on manufacturers, repairers and operators of vehicles for access to the market and not for operations.	As it is not project/ activity specific, it does not provide for a basis for implementing specific technical UGEE project measures. However, it provides for a basis for implementing measures that would apply more widely and/or upstream of projects, e.g. obligations imposed on manufacturers of vehicles. It thus has only an indirect effect on emissions	Exploration/Appraisal/ Production Decommissioning/ Closure/Post-closure	None specific	There are a number of statutory instruments which refer to the Regulation including The Road Vehicles (Registration and Licensing) Regulations 2002 as amended by The Road Vehicles (Registration and Licensing) (Amendment) (No. 2) Regulations 2012 The Road Vehicles (Approval) Regulations 2009 (2009 No. 717). The Motor Vehicles (Approval)	European Communities (Road Vehicles: Type-Approval) (Amendment) Regulations 2010. SI 169 of 2011 give effect to Art 8, 9 & 11 European Communities (Motor Vehicles Type Approval) (Amendment) Regulations 2010 SI 171/2011 give effect to Art 8, 9 & 11 European Communities (Mechanically Propelled Vehicle Entry into Service) (Amendment) Regulations 2011 SI 234 of

26 Stages are defined as Pre-development (activities prior to pad construction and drilling such as planning, licence applications, baseline monitoring, studies); Exploration/Appraisal/Production (including exploration activities, pad construction, drilling, well completion, fracturing, flow testing, gas production, monitoring and well integrity testing); Decommission (including well plugging, site deconstruction, post-closure monitoring, licence relinquishing).

27 Note that measures are examples of those that it may be possible to stipulate against the legislation. They do not represent specific measures already required.

Abbreviation	Legislation	Aims/objectives/ scope	Relevance to UGEE	Main UGEE stages[26]	Examples of measures that may meet requirements[27]	Regulations and regulators	
						Northern Ireland	**Ireland**
	Directives 80/1269/EEC, 2005/55/EC and 2005/78/EC (OJ L 188, 18.7.2009, p. 1–13)		associated with traffic during UGEE.			(Amendment) Regulations (Northern Ireland) 2011 (2011 No. 3) further implement specifically to Northern Ireland The Motor Vehicles (Construction and Use) Regulations (Northern Ireland) 1999 as amended	2011 give effect to Art 11
AQD	Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe (OJ L 152, 11.6.2008, p. 1–44)	Objective-orientated Directive. Sets limit values for a range of pollutants for concentrations in ambient air. If they are exceeded Member States must then establish air quality management areas and take actions to prevent and control any exceedance. The AQD is	The AQD does not specify measures per se, but could be a relevant driver for the adoption of measures by operators involved in UGEE activities if emissions were to threaten the achievement of limit values set up by the	Exploration/Appraisal/ Production Decommissioning/ Closure/Post-closure	None specific	The Air Quality Standards Regulations (Northern Ireland) 2010 (SI 2010/188) Regulator – Department of Environment	Air Quality Standards Regulations 2011 SI 180 of 2011 Regulator – EPA/Minister for the Environment, Heritage and Local Government

Abbreviation	Legislation	Aims/objectives/ scope	Relevance to UGEE	Main UGEE stages[26]	Examples of measures that may meet requirements[27]	Regulations and regulators	
						Northern Ireland	Ireland
		prescriptive with respect to Member States and not directly to operators. It does not prescribe specific measures on operators nor does it regulate specific site emissions and monitoring.	AQD. In this sense, the AQD can potentially affect a permit required under the IED, on the basis of Article 10 of the IED.				
END	Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise – Declaration by the Commission in the Conciliation Committee on the Directive relating to the assessment	Sets an overall framework to address exposure to environmental noise. It does not set specific emission limits nor does it prescribe specific measures on operators or regulate specific site emissions (noise) and monitoring. The END imposes on authorities the obligation to set up an action plan, including limit values and noise abatement measures, which in theory should be	Measures imposed in the Action Plans must be taken into account during the environmental impact assessment and/or the screening procedure under the EIAD (if applicable). However, the END itself/as such is not directly/per se relevant for implementing the noise-related	Pre-development Exploration/Appraisal/ Production	Measures may be related to EIA and MWD permits to operate, for example: specify maximum noise levels; noise screening at the installation (e.g. enclosure of drilling and fracturing rigs, acoustic perimeter fencing); specify operational hours, vehicle routes; baseline and operational monitoring.	The Environmental Noise Regulations (Northern Ireland) 2006 (SI 2006/387) Regulator – Depends on source of noise. For noise from "industry" regulator is the District Council	Environmental Noise Regulations 2006 SI 140 of 2006 Regulator – EPA

Abbreviation	Legislation	Aims/objectives/ scope	Relevance to UGEE	Main UGEE stages[26]	Examples of measures that may meet requirements[27]	Regulations and regulators	
						Northern Ireland	Ireland
	and management of environmental noise (OJ L 189, 18.7.2002, p. 12–25)	sufficient to address noise impacts (regardless of its origin).	measures related to UGEE projects.				
HD/BD	Directive 92/43/EC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora	Provides for the establishment of "European sites" forming the Natura 2000 network Strict protection regime for certain habitat types and species Procedures to ensure that before consent is granted for any plan or project which is likely to have a significant effect on a Natura 2000 site, an appropriate assessment is carried out. Consent may not be granted for any plan or project which is likely to have an adverse effect on the	All proposed UGEE activities will be subject to the obligation to carry out a screening to ensure no significant effects on a Natura 2000 sites If such effects cannot be excluded on the basis of objective scientific evidence, an appropriate assessment will be required to ascertain whether the proposed activity is likely to have an	Pre-development Exploration/Appraisal/ Production Decommissioning/ Closure/Post-closure	Screening of Government/Department licensing plans, land use plans Screening and AA of proposed exploration/appraisal/production activities Screening and AA of proposed Decommissioning	The Conservation of Natural Habitats (Northern Ireland) Regulations 1995, as amended (2005/435, 2007/345, 2009/8, 2011/216, 2012/368) Regulator – Department of Environment/NIEA and other consenting authorities	EC (Birds and Natural Habitats) Regulations 2011, as amended Planning and Development Act 2000, as amended Regulator – Minister for Arts Heritage and the Gaelteacht/ National Parks and Wildlife Service (NPWS) and other consenting authorities

Abbreviation	Legislation	Aims/objectives/ scope	Relevance to UGEE	Main UGEE stages[26]	Examples of measures that may meet requirements[27]	Regulations and regulators	
						Northern Ireland	Ireland
		integrity of a Natura 2000 site, save in exceptional circumstances and where there are no alternative solutions	adverse effect on the integrity of a Natura 2000 site Consent may not be granted for any UGEE activity if adverse effects on a Natura 2000 site cannot be excluded on the basis of objective scientific evidence Applicable to plans (including plans subject to SEA), programmes and projects or activities.				
NORMS	Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection	NORMS addresses workers' health related risks	Although the NORMS is certainly an applicable piece of legislation when it comes to UGEE, it is not considered	Exploration/Appraisal/ Production	None specific	Radioactive Substances Act 1993 The Radioactive Substances Exemption (Northern Ireland) Order 2011	The Radiological Protection Act, 1991 (Ionising Radiation) Order, 2000 (S.I.125 of2000) Radiological Protection Act

Abbreviation	Legislation	Aims/objectives/ scope	Relevance to UGEE	Main UGEE stages[26]	Examples of measures that may meet requirements[27]	Regulations and regulators	
						Northern Ireland	**Ireland**
	of the health of workers and the general public against the dangers arising from ionising radiation (OJ L 159, 29.6.1996, p. 1–114)		of relevance in the context of environmental impacts.			The Radioactive Substances Act 1993 (Amendment) Regulations (Northern Ireland) 2011 The Ionising Radiation Regulations (Northern Ireland) 2000 (No. 375 of 2000) The Radioactive Contaminated Land Regulations (Northern Ireland) 2006 (No. 345 of 2006) Regulator – Department of Environment	1991 (Responsible and Safe Management of Radioactive Waste) Order 2013 Regulator – Office of Radiological Protection, an office within the EPA
NRMMD	Directive 97/68/EC of the European Parliament and of the Council of 16 December 1997 on the approximation of the laws of the Member States relating	Establishes common technical requirements for the type-approval applicable to non-road mobile machinery with regard to their emissions. Imposes obligations on manufacturers, for	As it is not project/ activity specific, it does not provide for a basis for implementing specific technical UGEE project measures. However, it	Exploration/Appraisal/ Production Decommissioning/ Closure/Post-closure	None specific	The Non-Road Mobile Machinery (Emission of Gaseous and Particulate Pollutants) Regulations as amended Regulator – The Department of Enterprise, Trade and Investment	European Communities (Control of Emissions of Gaseous and Particulate Pollutants from Non-Road Mobile Machinery) Regulations 2007 to 2013

Abbreviation	Legislation	Aims/objectives/ scope	Relevance to UGEE	Main UGEE stages[26]	Examples of measures that may meet requirements[27]	Regulations and regulators	
						Northern Ireland	Ireland
	to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery (OJ L 59, 27.2.1998, p. 1–86)	access to the market but does not limit emissions of non-road mobile machinery during their use.	provides for a basis for implementing measures that would apply more widely and/or upstream of projects, e.g. obligations imposed on manufacturers. It thus has an indirect effect on emissions associated with NRMM used in UGEE (e.g. diggers and other machinery and generators).				
OMND	Directive 2000/14/EC of the European Parliament and of the Council of 8 May 2000 on the approximation of the laws of the Member States relating to the noise	Regulates access to the market of (noisy) equipment for use outdoors. For such kinds of equipment, the OMND defines maximum produced levels (Art. 12). Imposes obligations on	As it is not project/activity specific, it does not provide for a basis for implementing specific technical UGEE project measures. However, it provides for a	Exploration/Appraisal/ Production	None specific	The Noise Emission in the Environment by Equipment for use Outdoors Regulations as amended Regulator – Department of Environment, Vehicle Certification	European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001 SI 632 of 2001 Regulator – Minister for Enterprise,

Abbreviation	Legislation	Aims/objectives/ scope	Relevance to UGEE	Main UGEE stages[26]	Examples of measures that may meet requirements[27]	Regulations and regulators	
						Northern Ireland	**Ireland**
	emission in the environment by equipment for use outdoors (OJ L 162, 3.7.2000, p. 1–78)	manufacturers for access to the market but does not limit the use of such equipment during operations.	basis for implementing measures that would apply more widely and/or upstream of projects, e.g. obligations imposed on manufacturers. It thus has an indirect effect on emissions associated with such kinds of equipment likely to be used in UGEE.			Agency	Trade and Employment
PAEID	Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information and repealing Council Directive 90/313/EEC	Sets the framework to guarantee the right of access to environmental information held by or for public authorities and sets out the conditions and arrangements for, its exercise (Article 1). Applies to all	Although this Directive is, in principle, not project specific related, we note several interactions between the PAEID and other Directives of the *acquis* examined in the present	Pre-development Exploration/Appraisal/ Production Decommissioning/ Closure/Post-closure	See EIAD and REACH	The Environmental Information Regulations 2004 (No.3391 of 2004) The Pollution Prevention and Control (Industrial Emission Regulations) 2013	European Communities (Access to Information on the Environment) Regulations 2007 (SI 133 of 2007) Regulator – Commissioner for Environmental Information/

Abbreviation	Legislation	Aims/objectives/ scope	Relevance to UGEE	Main UGEE stages[26]	Examples of measures that may meet requirements[27]	Regulations and regulators	
						Northern Ireland	Ireland
	(OJ L 41, 14.2.2003, p. 26–32)	environmental information held by or on behalf of a public authority, including project-specific information, subject to exceptions and the public interest The PAEID organises two general ways for granting the public access to environmental information, which is upon request, as organised by Articles 3 and 4 of the Directive, and following systematic dissemination of (general) environmental information to the public, as organised by Article 7.	table. Notably, Article 4 lists a series of grounds why authorities are entitled to refuse to grant the public access to environmental information, including confidentiality grounds.				Minister for the Environment, Heritage and Local Government
SOOGO	Directive 2013/30/EU of the European Parliament and of the Council of 12	Establishes minimum requirements for preventing major accidents in offshore oil and	The Directive focuses only on offshore operations and is thus not applicable to	Pre-development Exploration/Appraisal/ Production Decommissioning/ Closure/Post-closure	None specific	The Environmental Liability (Prevention and Remediation) Regulations	Petroleum (Exploration and Extraction) Safety Act 2015 transposes the Directive and

Abbreviation	Legislation	Aims/objectives/ scope	Relevance to UGEE	Main UGEE stages[26]	Examples of measures that may meet requirements[27]	Regulations and regulators	
						Northern Ireland	**Ireland**
	June 2013 on safety of offshore oil and gas operations and amending Directive 2004/35/EC	gas operations and limiting the consequences of such accidents. Sets rules covering the whole lifecycle of all exploration and production activities from design to the final decommissioning of an oil or gas installation.	onshore UGEE. However, it provides an example of a sectoral piece of EU law addressing exploration and production activities. [See above re petroleum safety framework for onshore oil and gas exploration in Ireland (Commission for Energy Regulation)] The grounds for refusal of disclosure, including commercial sensitivity, must be interpreted in a restrictive way, and in determining a request for information,			(Northern Ireland) 2009 (No. 252 of 2009) as amended by 361/2009, 210/2011 and 231/2015 Regulator – Department of the Environment	set up the Petroleum Safety Framework Act Petroleum Safety Framework Act 2010 and implementing regulations for both on-shore and offshore petroleum exploration and extraction Regulator – CER

Abbreviation	Legislation	Aims/objectives/ scope	Relevance to UGEE	Main UGEE stages[26]	Examples of measures that may meet requirements[27]	Regulations and regulators	
						Northern Ireland	Ireland
			the public authority is obliged to weigh the public interest served by disclosure against the public interest served by the refusal. Public authorities are generally not permitted to refuse a request on grounds of commercial sensitivity where it relates to information on emissions into the environment.				
WSR	Regulation (EC) N° 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L	Lays down procedures for the transboundary shipment (i.e. transport) of waste.	In the context of UGEE, the WSR is applicable and it is relevant for measures requiring traceability of waste.	Exploration/Appraisal/ Production Decommissioning/Closure/Post-closure	None specific	The Transfrontier Shipment of Waste Regulations 2007 (No.1711 of 2007) as amended by 9/2008, 861/2014 Regulator- Department of	European Communities (Shipments of Hazardous Waste exclusively within Ireland) Regulations 2011 SI 324 of

Abbreviation	Legislation	Aims/objectives/ scope	Relevance to UGEE	Main UGEE stages[26]	Examples of measures that may meet requirements[27]	Regulations and regulators	
						Northern Ireland	**Ireland**
	190, 12.7.2006, p. 1–98)					Environment	2011 Waste Management Act 1996, as amended [Regulator – Environmental Protection Agency/Dublin City Council]

2.3.2 Legislation and the UGEE lifecycle

The life cycle of a UGEE project can be described in a series of stages, with different scales and types of activity at each stage:

- Pre-development;
- Exploration;
- Appraisal;
- Development and production; and
- Decommissioning, closure and post-closure.

Table 2.3 provides a summary map of where key items of the EU *acquis* may impose requirements across the project life cycle stages. The blue shading in Table 2.3 indicates where key EU legislation may impose requirements through the UGEE lifecycle.

Table 2.3. Summary of where key EU legislation[a] that may impose requirements through the UGEE lifecycle

Stage	Description and activities	UGEE Recom	BRP	EIAD	ELD	GWD	HD/BD	HLD	IED	MWD	REACH	SEAD	SEVESO	SHIPWEI	WFD
Pre-development	Preparation and planning Studies Licence and permit applications Consultations														
Exploration	Identification of resource through review of information Exploration licensing Non-intrusive exploration (no drilling) to understanding underground environment Intrusive exploration (with drilling): to collect core samples and evaluate hydrocarbon presence/productivity														
Appraisal	Mobilisation, well pad construction, drilling, casing installation, well completion/fracturing, flowback management, flow testing Evaluation of technical and economic viability Develop plans for production and associated permit and licence														

Stage	Description and activities	UGEE Recom	BRP	EIAD	ELD	GWD	HD/BD	HLD	IED	MWD	REACH	SEAD	SEVESO	SHIPWEI	WFD
	applications														
Development and Production	Multiple well pad construction, drilling, casing installation, well completion/fracturing, flowback management Infrastructure development Gas production														
Decommissioning/ Closure/Post-closure	Decommissioning of equipment and infrastructure Plugging of wells Removal of well pads Monitoring														

The blue shading indicates where key EU legislation may impose requirements through the UGEE lifecycle.

[a]For definition of abbreviations, refer to Table 2.1 and Table 2.2 and the Glossary.

Table 2.4 maps the stages of UGEE development used in Project C to those used in Project B. In general, the same terminology has been used, however, there are some variations that reflect the emphasis on operations in Project B and on regulatory frameworks in Project C.

Table 2.4. Mapping of UGEE stages from Project B to Project C

Project B		**Project C**	
Stage	**Activities**	**Stage**	**Activities**
Predevelopment: Exploration, Well pad identification and initial site access	Site identification and selection; Site characterisation (baseline conditions for air, water, land, geology/deep-ground conditions initial evaluation of potential environmental impacts initial development of geological conceptual model and geological risk assessment; Drilling of exploratory boreholes for evaluation of geology and the reserve Seismic surveys Obtaining development and operation permits. Exploratory drilling is performed to identify if gas can be produced profitably. May include pad construction and site preparation (e.g. construction of roads and water storage structures)	Pre-development	Preparation and planning Studies Licence and permit application Consultations
		Exploration	Identification of resource through review of information Exploration licensing Non-intrusive exploration (no drilling) to understanding underground environment Intrusive exploration (with drilling): to collect core samples and evaluate hydrocarbon presence/productivity
Well design and construction, hydraulic fracturing and well completion	Pilot well drilling Initial horizontal wells drilled to determine reservoir properties and required well completion techniques; Further development of geological conceptual model following test fractures; Wellhead and well design and construction (drilling, casing, cementing, integrity testing); Multi-stage hydraulic fracturing (injection of	Appraisal	Mobilisation, well pad construction, drilling, casing installation, well completion/fracturing, flowback management, flow testing Evaluation of technical and economic viability Develop plans for production and associated permit and licence applications

Project B		Project C	
	fracture fluid and management of flowback and produced water and emissions) Well completion		
Production (gas extraction): the commercial production of shale gas	Well pad expansion for HVHF facilities including storage tanks, impoundments, and secondary containment Provision and establishment of equipment, water and chemical additives at the site. Horizontal drilling is followed by hydraulic fracturing and gas production.	Development and production	Multiple well pad construction, drilling, casing installation, well completion/fracturing, flowback management. Infrastructure development. Gas production.
Project cessation, well closure and decommissioning: The well is decommissioned once it reaches the end of its producing life	Sections of the well are filled with cement to prevent gas flow into water-bearing zones or the surface. Well is capped Site returned to satisfactory state Post completion monitoring	Decommissioning, closure and post-closure	Decommissioning of equipment and infrastructure. Plugging of wells Removal of well pads Monitoring

2.3.3 Transposition of the EU legislation in Ireland and Northern Ireland and potential gaps

The basis of the current environmental regulatory framework for all oil and gas activities in Ireland and Northern Ireland, including UGEE, is driven by European legislation described in section 2.3.1. How European legislation has been implemented into the regulatory framework on the Island of Ireland is summarised in Table 2.1, which shows legislation relating to the assessment and permitting processes applicable to UGEE. While there may be gaps in implementation, EU legislation relevant to UGEE has largely been transposed into the domestic legal systems. However, potential weaknesses in the scope of the EU *acquis* relating to the environmental risks presented by UGEE can be noted:

- Most of the Directives and Regulations do not address specifically UGEE projects and thus do not impose specific measures or requirements relevant for these types of projects. As such, requirements are not specific regarding risks arising from UGEE. For instance, requirements for prohibited/restricted areas or buffer zones around sensitive sites may only be implemented indirectly, at a high level (e.g. through Strategic Environmental Assessment and Appropriate Assessment) and/or during Environmental Impact Assessment and Appropriate Assessment at the project level. Similarly, permits required under the MWD may be limited in their capacity to address all environmental aspects if not directly related to

extractive waste. The current BREF under the MWD does not specifically cover UGEE practice.[28]

- Several of the Directives identified as relevant for UGEE are objective-orientated, allowing Member States flexibility in implementing regulatory frameworks aimed at ensuring that common environmental objectives are achieved. Member States can determine the best measures to meet these objectives which could lead to different interpretations on how to address UGEE risks.

- The current European legislative framework does not explicitly address the deep underground environment and therefore may not adequately cover the geological, hydrogeological and induced seismicity aspects of UGEE.

Currently there is no single legislative instrument at national or EU-wide level with regard to UGEE. The only comprehensive instrument that does exist is the EU Recommendation, but this is voluntary in nature. In contrast to the EU, states in the US have experience of permitting production and more extensive experience of exploration; however, legislation on UGEE in the US is piecemeal and differs from state to state.

The EU Recommendation states that risks associated with UGEE "are not comprehensively addressed in current Union legislation" and "the Union's environmental legislation was developed at a time when high-volume hydraulic fracturing was not used in Europe". The DG Environment 2012 study "Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe" also illustrates gaps in the EU regulatory framework such as the lack of legislation to deal with the novel issue of induced seismicity (AEA, 2012).

Primary responsibility for ensuring environmental protection at any stage of the exploration or development cycle rests with the developer. In terms of consenting responsibility in Ireland, DCENR is likely to be the only consenting authority at the early stages of the exploration however, others may also have responsibilities. Although there is no statutory obligation to do so, it is understood that DCENR requires that every application for an exploration licence under the Petroleum and Other Minerals Development Act 1960 (as amended) must be accompanied by an EIS or, where applicable, a screening report demonstrating that the proposed activity will not have any significant effect on the environment (EU (EIA) (Petroleum Exploration) Regulations 2013).

In terms of consenting responsibility in Northern Ireland, DETI will only permit exploration drilling to commence once an operator has completed an environmental risk assessment; obtained planning permission from DOE (including preparation of an EIA where a need is identified by scoping) and planning conditions have been discharged; all necessary environmental permits from NIEA have been obtained; the Health and Safety Executive Northern Ireland (HSE) has had notice of and is satisfied with the well design; the well design has been examined by an independent, competent well examiner; and the Geological Survey of Northern Ireland (GSNI) has been notified of the intent to drill.

An EIS is not required in Northern Ireland at the licence application stage because a licence applicant would not know where, or if, they were going to drill in the future. The requirement for an EIS is determined by the DOE Northern Ireland and is applied to the drilling project stage of the exploration programme. At the drilling stage an EIA is likely to be required.

28 Note the MWD is under review by the European Commission. Future MWD BREF is anticipated to include UGEE activities in its scope.

The WFD requires Member States to implement a system of prior authorisation and monitoring for water abstraction. Currently there is no licensing system in place for water abstraction. Industrial abstractions are only subject to a licensing regime where they are in connection with IPC/IED licensed activities. As noted above, exploration is not licensed by the EPA. Accordingly, there is a lack of environmental regulatory control over water abstractions outside of the drinking water and IPC/IED regimes. Planning permission may also be required for certain classes of water abstraction which form part of a "development" which requires planning consent. It will be necessary to ensure that all water abstractions associated with UGEE are subject to a prior authorisation and monitoring regime in accordance with the WFD, rather than mere registration under the Local Government (Water Pollution) Act 1990, as amended.

In Northern Ireland, the Water Abstraction and Impoundment (Licensing) Regulations (Northern Ireland) 2006 require all water abstractions above 20 m^3/day to be licensed.

Under the Aarhus Convention, the right of access to justice must be at a cost that is not prohibitively expensive. This provision has been implemented by Member States in a variety of different ways. In Ireland, the requirements of the Aarhus Convention in relation to access to justice are implemented through the Planning and Development Act 2000, as amended, and the Environmental (Miscellaneous Provisions) Act 2011, and have been the subject of a number of Court judgments over the last five years. The principal objective is to ensure that any person bringing a legal challenge to a proposed plan or project or activity is protected against the risk of an adverse costs order being made against them if the proceedings are unsuccessful. In certain circumstances a protective costs order may be obtained, limiting the party's potential exposure to costs[29]. However, it is unclear whether access to justice has improved in practice as a result of the provision for protective costs orders.

2.4 Conclusions

2.4.1 Overview

There is a comprehensive framework at the European level addressing UGEE activities from the planning process up to and including the closure/decommissioning phase. As UGEE is an activity that has the potential to have a significant impact on the environment it is subject to the requirements for the adoption of mitigation measures present in various legislation (e.g. SEAD, EIAD, MWD, WFD, and GWD). This legislation has been implemented in the Island of Ireland and forms the current regulatory framework for oil and gas activities, including UGEE, as described in Table 2.1 and Table 2.2. There are, however, potential gaps in the scope of the EU *acquis* relating to the environmental risks presented by UGEE (see Section 2.3.1) as most Directives and Regulations do not address specifically UGEE projects and thus do not impose specific measures or requirements relevant for these types of projects and the current legislative framework does not explicitly address the deep underground environment and, therefore, may not adequately cover the geological, hydrogeological and induced seismicity aspects of UGEE.

In view of this, in January 2014, the European Commission published its Recommendation "on minimum principles for the exploration and production of hydrocarbons (such as shale gas) using high-volume hydraulic fracturing'. Member States should refer to the Recommendation where particular issues or risks associated with UGEE are not specifically addressed or subject to open interpretation by the current European legislative framework. Current EU legislative framework is piecemeal with regards to the regulation of the specific risks of UGEE and its impact on areas outside the current environmental legislative framework such as the underground environment. To ensure "harmonised provisions for the protection of human health and the environment apply across

29 McCoy & anor -v- Shillelagh Quarries Limited & ors [2014] IEHC 511 (Baker J.) upheld on appeal [2015] IECA 28 (Hogan J.).

all Member States", the EU Recommendation introduced as an overarching framework that can be referred to by Members States on a voluntary basis where gaps in the legislature emerge. As the Recommendation is non-binding, the gaps in the current European legislative framework need not be dealt with by reference to the Recommendation and are "subject to open interpretation'. The requirement that the Recommendation be implemented at a national level within six months of publication is also a non-binding "best practice" requirement.

The Recommendation leaves options open to the adoption of legally binding requirements in the short term. As noted in point 16 of the Recommendation, the Commission may decide to put forward legislative proposals with legally-binding provisions on the basis of the results of a review to be carried by 8th August 2015. Moreover, the Commission is also initiating steps to develop an overall reference document (BREF) on hydrocarbon exploration and production that addresses UGEE practices.[30]

The classification of flowback as a waste under the MWD means that it is likely to require treatment prior to reuse in further hydraulic fracturing.

2.4.1.1 Regulations and Directives relevant to the regulation of UGEE and translation in the Island of Ireland

Some of the existing European Regulations and Directives relevant to the regulation of UGEE relate to specific aspects of operation or to protect individual parts of the environment, while others have wider application to the operation of a facility (i.e., they have a horizontal nature).

Of particular importance at the plan and project level are the Environmental Impact Assessment Directive (EIAD), the Birds and Habitats Directives, and the Mining Waste Directive (MWD) as these determine the requirements of operational permits and conditions throughout the project lifecycle, from pre-development to closure/decommissioning. In addition, requirements for zoning or buffer zones may be implemented indirectly through the SEA process as well as during the project-specific EIA. The Water Framework Directive (WFD) is also important due to its potential to determine operational practice within permits and impose regulatory and economic obligations in relation to activities such as water abstraction.

The Aarhus Convention is as relevant to UGEE as it is to any other activity which is likely to effect the environment. The SEAD and EIAD incorporate public participation provisions, to ensure early and effective engagement with the public concerned with environmental decision-making. The EIAD, WD and IED incorporate access to justice provisions, providing members of the public and environmental NGOs with a right of access to a Court or other judicial tribunal to appeal or review environmental decision-making.

30 http://ec.europa.eu/environment/integration/energy/unconventional_en.htm

3 Regulatory Approaches in Other Countries

3.1 Introduction

This section presents case studies of the regulatory approaches of three EU Member States (Denmark, Germany and the UK) and two USA states (Colorado and Pennsylvania) relevant to UGEE. It includes a description of the overall approaches adopted by the case study states and a comparison of practices. Two USA states were selected for review because the primary relevant legislation affecting UGEE in the USA is made at the state level rather than at Federal level (hence each state represents different legislative approaches to regulating UGEE). UGEE is also a mature industry in these states and therefore regulation is well developed compared to other countries.

3.2 Method

The assessment of regulatory approaches of other countries was carried out through the following activities:

- Compilation of a list of candidate countries and US and Canadian states that may be selected for examination and subsequent discussion and agreement with the project Steering Committee on those to select;
- A desk study of information and the preparation of country/state "datasheets" identifying the regulatory approach and specific requirements through the project lifecycle together with a comparative analysis of the approaches. Stakeholder interviews (where necessary) to verify information and ensure correct interpretation;
- Consideration of potential cross-border issues from a regulatory perspective; and
- A comparative analysis of the ways in which different UGEE activities are regulated in the countries subject to review.

3.3 Results

In order to analyse current practices and regulatory approaches in other countries, three EU countries and two US States have been assessed. The value of the analysis of the European countries is that they have to comply with the common European legislative framework also required of NI and Ireland. Therefore, regulatory practice in these countries will be affected by any decision taken, or specific requirements drafted, at European level. The detailed datasheets and references can be found in section 3.3.1.3 and Table 3.1 and are the principal output of this task. The value of the analysis of US States is that they have greater practical experience of UGEE than European countries albeit with very different regulatory regimes.

3.3.1 Horizontal analysis of practices

3.3.1.1 General approach and context

Most of the regulations that apply to conventional activities also apply to unconventional sources. EU Member States with a long history of conventional hydrocarbon exploitation have a mature and reasonably comprehensive legislative framework that is able to address a number of issues associated with UGEE.

There are, however, a number of differences between conventional hydrocarbon exploration and production and UGEE, principally:

- The extensive use of horizontal drilling to access the resource;

- The use of high volume hydraulic fracturing to open up the rock to release oil or gas. This requires large volumes of water and can generate large volumes of waste water;
- The large area of the resource and the large area over which exploitation takes place; and
- The greater density of the wells required to exploit a resource;

This review has considered the approaches to regulation of UGEE adopted by the reviewed countries.

3.3.1.2 Current situation

The general situation in the reviewed countries is as follows:

- *Germany:* There is long history of onshore hydrocarbon exploitation focussed on gas in the Cloppenburg region in northwest Germany, including the extensive use of hydraulic fracturing. The Government has generally been in favour of UGEE activities, as a means of providing increased energy security; however, in 2013a Governmental decision was made to impose a moratorium on further development until 2021. At the end of 2014, the Government indicated its intention of maintaining the moratorium for activities at depths of less than 3000 m below ground but proposed that hydraulic fracturing for commercial purposes could be allowed below this depth after 2018/2019 following test drilling and the approval by a special committee. According to this proposal, groundwater and drinking water protection zones will be protected regardless of depth. Public and political opposing groups have expressed concern that the proposal does not include an explicit prohibition of deep injection of flowback and that it is not clear how the members of this special committee will be elected. The Government argues that it would be useful to set up a legal framework for this activity, given that some companies may be able to start operating in less than five years. [31]
- *Denmark:* Denmark granted three licences for the exploration and production of unconventional hydrocarbons (one of which was abandoned), although the Government stated that it would not grant any more licences until more information on the test drilling of these two licences was available. Both were granted in June 2010 to the same company (Devon Energy Netherlands BV, with a 20% share owned by the Danish North Sea Fund), which later transferred its rights to Total E&P Denmark BV. Within the scope of these licences the local authority of Frederikshavn has granted the first permit to drill in one of the two concessions, which will only involve initial tests to assess the potential of the area.
- *United Kingdom:* The UK has a large conventional hydrocarbon industry focussed on the off shore North Sea but including a number of onshore oil fields. Of the EU member states reviewed here, the United Kingdom has expressed the greatest and provided the most significant governmental support to UGEE. The UK has established an Office for Unconventional Gas and Oil within the Department for Energy and Climate Change (DECC). Exploration activity involving hydraulic fracturing has been limited to two wells in Lancashire. All hydraulic fracturing activities were suspended for some time following a seismic event at Preese Hal but this restriction has now been removed. A recent licensing round in July 2014 for England, Scotland and Wales covers large areas of the country and was the first since unconventional gas has been identified as a significant prospect. The licensing round was preceded by a SEA which was undertaken for the new areas. The SEA included public

31 Note that the current situation in Germany is described at the time of the main period of research (November 2014 to April 2015). It is noted that on 1st April 2015 the German Bundeskabinett introduced a bill regarding the regulation of hydraulic fracturing in Germany that will take some months to be considered prior to any formal legislative proposals being made.

participation through stakeholder meetings and a public consultation. After that the level of public participation can be variable and depends on specific locations and whether an EIA is required. Following the temporary suspension of all hydraulic fracturing activities due to the seismic episodes at a Cuadrilla site near Blackpool (England), the UK Government announced a series of additional controls as well as a compulsory environmental risk assessment but has lifted the suspension. The particular characteristics of this EU Member State and its constituent countries mean that certain aspects of UGEE regulation are dealt with differently in all or some countries within the UK. Scotland has applied a moratorium to all unconventional hydrocarbon activities, including those involving hydraulic fracturing. Wales has announced an intention of implementing a similar moratorium. However, it is not clear whether this will be possible.

- *United States of America:* The Regulatory Framework for UGEE has been widely developed in the USA where the industry is well-established. Colorado and Pennsylvania have been some of the more active States in the country and have a mature conventional and unconventional hydrocarbon industries. The basis of the framework is a set of rules (see Tables 3.1 to 3.4).

    - *Colorado:* This state has a well-developed and comprehensive set of Rules that set out requirements that are specific to UGEE. Operators must comply with the rules (e.g. prescriptive rules on zoning), although exemptions to some rules can be made.

    - *Pennsylvania:* The regulatory system in Pennsylvania is **s**imilar to that in Colorado, i.e. it is rule based, although the rules are different for specific activities. This state has a very long-history of the exploitation of conventional, onshore hydrocarbons from which the regulation of UGEE has developed.

3.3.1.3 Analysis

Datasheets for each country are provided in Appendix 1. Tables 3.1 to Table 3.4 provide a comparative analysis of the way that the different stages of UGEE are regulated in the countries. For the purposes of this review these stages are:

- Pre-development;
- Exploration;
- Appraisal, development and production; and
- Decommissioning, closure and post-closure.

Table 3.1. Pre-development

Stage	Germany	Denmark	United Kingdom	Colorado (US)	Pennsylvania (US)
Licensing and permitting	The permitting system for conventional and UGEE does not differ. A licence for each stage of the lifecycle is required. This does not allow operators to undertake the activities *per se*, as further requirements are needed (an operational plan and separate permits for each stage). The Seismic Mining Ordinance requires that wells should not have direct contact with the surface and fluid/gas leaks into other rock layers must be avoided. The drilling site should be restored after the activity. This is not specific to UGEE.	The permitting system for conventional and UGEE does not differ. Combined licences for exploration and production (6 years). Extension is possible up to 30 years. Local authorities have to be notified. Specific permit for activities in rural areas.	Open licensing round followed by the granting of licences. Further permits required to conduct specific activities, except in Northern Ireland. Northern Ireland operates an "open door " licensing system without licensing rounds and assesses each application as it is received. An Environmental Awareness Statement is required for licence applications.	Regulated with the submission of several forms: Form 1 (Registration for Oil and Gas Operations): Form 1A (Designation of representative Agent), Form 2 (Permit to drill, deepen, re-enter, recomplete, operate). Form 2A (Oil and Gas Location Assessment).	Permit required for drilling or to modify a well.
Work/operational plans	Special operational plans required in most Länder for hydraulic fracturing activities.	A work programme has to be agreed for each phase (exploration, production, decommission). Operators must comply with specific requirements or relinquish the licence.	A licence covers all stages but a work programme is required per stage (Initial term/second term/third term or production phase)	Comprehensive drilling plan (Voluntary, but if the same information is required at a later stage, it will be considered fulfilled).	Containment plan for spill prevention. Water management plan.
Baseline	German law does not establish baseline	Daily monitoring and reporting of water and air	Work programme may include monitoring of	Baseline monitoring of an available water source	Not required but mostly done because companies

Stage	Germany	Denmark	United Kingdom	Colorado (US)	Pennsylvania (US)
monitoring	monitoring requirements prior to fracturing or drilling.	quality; and seismicity	seismicity. Air quality and water monitoring can be included in specific conditions in the planning permission. It is expected that operators will be requested to conduct site monitoring and publish the results. Groundwater monitoring only if authorities identify a risk.	(any water source for which the owner has given consent for its use as testing point)	are incentivised for liability reasons.
SEA/EIA	National regulations do not go beyond the EIA Directive. UGEE is not considered one of the Annex 1 or 2 activities. Compulsory for the commercial exploitation of gas > 500,000 m^3 and involves an area > 25 ha. Some UGEE activities could be excluded. The Government has proposed that EIA is required for all cases where hydraulic fracturing is used.	No SEA was carried out for the areas where the two granted licences belong. There is a screening process to establish if a full EIA is required, with public participation. A full EIA is required for hydraulic fracturing activities. Groundwater, residential areas, flood-prone areas and seismic-prone areas are protected depending on what is established in the EIA rather than protection standards	SEA has been carried out for all the areas in the latest licensing round. At the moment, the requirement of EIA depends on the local planning authority's assessment.	NA (not present as such)	NA (not present as such)

Stage	Germany	Denmark	United Kingdom	Colorado (US)	Pennsylvania (US)
Risk assessment	Within the discretion of the individual permitting authorities	Assessed on a case by case basis. Covered by EIA.	Compulsory Environmental Risk Assessment	Nothing specific	Nothing specific
Public participation	Only the engagement of urban development authorities enables some degree of public participation, unless there is EIA.	Public and stakeholder participation must be undertaken before a rural land zone permit is granted. Parliamentary Committee must agree before a licence is granted. Landowner agreement. Public must be informed in cases of incidents, inspections and sanctions.	Public consultation is required as part of the Environmental Awareness Statement. A higher grade of public participation is required where an EIA is undertaken. Licence holders require individual landowner consent, but if opposition is deemed unreasonable, Authorities may grant access without consent, with the exception of Northern Ireland, where Authorities do not have this power.	The relevant authorities are able to amend or apply exemptions for several requirements of the Rules. In general, a public hearing is needed when this occurs (e.g. when an exemption is applied with regard to an aquifer protection). Some subjects may lead to a local public forum (e.g. increase in well density). Landowners and other relevant stakeholders (e.g. owners of buildings within a certain area) are notified by operators. Permits to drill/operate are only approved after publication for comments from the general public and/or authorities. Approved Comprehensive Drilling plans need to be published on the Colorado Oil and Gas Conservation Commission webpage. Several consultations	A copy of the plan (most of the information in an application) is sent to surface owners, persons that operate public water supplies and municipalities (where the development is and those within a specific buffer area).

Stage	Germany	Denmark	United Kingdom	Colorado (US)	Pennsylvania (US)
				before commencement of operation (land owner, tenant, local Government, Department of Public Health, Colorado Wildlife) and if there is an application for underground water disposal.	
Financial guarantee	Financial guarantee and collaboration in a fund to cover cases of insolvency.	Licence has to be covered by an irrevocable bank or company guarantee. There is no time limit for this coverage and there is strict and unlimited liability related to pollution or environmental damage. Insurance to cover liability (employees, and any injury to a third party, or potential pollution damages).	A financial guarantee is required in the UK as part of the permitting process to comply with the requirements of the Mining Waste Directive for facilities managing hazardous waste. Financial capacity is not compulsory in England, Scotland and Wales but is assessed in the licensing process. Northern Ireland assesses financial capacity when studying licence applications.	Specific financial guarantee with quantities set up for several processes/items (e.g. financial guarantee with an associated quantity for each inactive well, if underground injection is intended, etc.). Environmental Response Fund.	Specific financial guarantee for wells, in which the amount depends on the length and characteristics of the wells.

Table 3.2. Exploration

Stage	Germany	Denmark	United Kingdom	Colorado (US)	Pennsylvania (US)
Zoning restrictions	No special zoning restrictions related to hydraulic fracturing. Minimum restrictions linked to indirect legislation.	No specific zoning restrictions. No specific minimum depth. This is assessed on a case by case basis.	Specific conditions required in the planning permission and environmental permit	Very specific rules. 61 m from buildings, public roads, major utility lines or railways. 46 m from a property line unless allowed by owner.	460 m from private water supplies and buildings. 900 m from public water supply intake. 275 m from perennial streams, 90 m from the

Stage	Germany	Denmark	United Kingdom	Colorado (US)	Pennsylvania (US)
				Designated Outside Activity Areas: No well or production facility < 107 m) from them. Mitigation measures will be required for oil and gas operations < 305 m of these areas. Exception zone: No well or production facility < 152 m from buildings unless owners give consent. Once approved, they have to be notified of commencements of activities. Buffer zone: Within 305 m of activities. Stakeholders within this area have to be consulted and, once approved, notified of commencement of operations. Depth: Wells ≥ 762 m depth: Minimum 183 m from any lease line, and 366 m from any other well unless authorised. Wells <762 m depth: Minimum 61 m from any lease line and 91 m from any other well unless exceptions apply. Exceptions: Authorities may grant exceptions for	edge of the well site, plus 90 m from the edge of any disturbed area. 275 m from wetlands > 0.4 hectares. Some waivers apply to these restrictions: For private water supplies: If owner agrees. For wetlands and streams if operator submits a plan with additional measures to protect these areas. A Supreme Court decision overturned this possibility in December 2013. Still unclear if this waiver can be used in the future. Other considerations (effects to parks, wildlife, and endangered species) assessed on a case by case basis.

Stage	Germany	Denmark	United Kingdom	Colorado (US)	Pennsylvania (US)
				various reasons, including specific waiver provided by affected stakeholders. Additional zoning restrictions specifically for public water systems. Additional setbacks for seismic works (Blasting safety setbacks)	
Groundwater protection	Permit required for water abstraction. Protection of shallow and deep groundwater. A new proposal would amend this if approved and full protection would only cover the first 3000 m	It depends on what is established during the EIA and in the permits. In one of the two licensed areas, the operator can withdraw up to 3000 m^3 per year. Approval of drilling programme	Specific conditions required in the planning permission and environmental permit. Permit is required if the water abstracted > 20 m^3 per day.	No re-injection allowed if groundwater that can be used may be polluted. Authorisation and public notice required for underground wastewater disposal. Public water systems have additional zoning restrictions and buffer requirement, including baseline and ongoing monitoring.	
Well design and integrity	Permits and strict cementing and casing standards. Controls and design take into account rock layers and pressure. Drilling report after each drilling activity. Nothing particular for UGEE	Casing and cementing: General practice. No specific provisions on this matter exist for wells where hydraulic fracturing is practised.	Offshore Regulations apply to onshore wells. Wells have to be maintained in as good a condition as reasonably practical throughout the whole lifecycle. Operators have to keep records of well development and abandonment and provide them to authorities if/when requested.	Requirements: • Wellhead tests. • Wellbore diagram. • Subsurface pressure measurements. • Mechanical integrity tests. • Reports of these tests to be submitted to authorities	Specific casing and cementing for the prevention of water pollution. Quarterly inspection of each operating well.

Stage	Germany	Denmark	United Kingdom	Colorado (US)	Pennsylvania (US)
				regularly. • Casing and cementing have a specific chapter of the Rules with requirements on materials, monitoring and reporting programme as well as prevention measures.	
Monitoring: Induced seismicity	No requirements on potential risks of induced seismicity specifically related to the fracturing. Some specific deep geothermal had seismicity limit values but these were particular of those projects.	No general requirements to manage the risk. Seismicity should be monitored daily and any changes should be communicated. Equipment for the detection and monitoring for hydraulic fracturing activities.	Monitoring scheme included in the fracturing plan. This will have a precautionary approach with frequent tests and Additionally, wells will be equipped with “Traffic Light” system.	Any activity that could lead to induced seismicity has to be authorised.	Nothing specific seems to be in place

Table 3.3. Appraisal, development and production

Stage	Germany	Denmark	United Kingdom	Colorado (US)	Pennsylvania (US)
Hydraulic fracturing	Proposal of full EIA requirement if hydraulic fracturing proposed. Prohibited until 2021 except for scientific purposes and always below 3000 m. Proposed: Commercial exploitation possible after 2018 if approved by an expert panel (below 3000 m and excluding drinking water protection areas and natural areas. Shut-off device for wells	Daily reporting: (performed hydraulic and chemical treatment, surface monitoring of seismicity). Fracturing plan (Approval required).	Fracturing plan with detailed description of activities, geological information and seismicity monitoring plan (before, during and after fracturing). Each site requires a permit. Conditions will be assessed by the environmental authority (case by case). There is aim to unify all permits. There is an aim to include flowback re-injection as best practice for waste minimisation, where there is not risk of groundwater contamination.	Authorities must receive notification 48h before treatment. The technology and equipment used have to be authorised and there are requirements for the disclosure of the chemicals used.	Nothing specific in place
Waste Management	Waste is considered “mining waste”. Waste Management Plan. Drilling cuttings: They are not considered liquid waste and can be disposed of at landfill sites outside of the drilling area. General requirements for waste management facilities common to all oil and gas activities.	Waste is considered “Mining waste”. No distinction between exploration and production waste. Special permit required if the waste is treated. No specific Regulation is expected	Flowback fluids and waste gases are considered mining waste and require a permit. Waste management plan required. In the future, these are likely to include flowback re-injection when this is not a risk. Permit requirements on a case-by-case basis. Waste from the construction of the borehole is treated as non-	Authorisation needed for the injection of non-produced fluids. Drilling pits have very detailed requirements on conditions, construction standards and maximum concentration of certain pollutants. Specific and detailed requirements for each of the wastes that may be produced with best practice for a safe	Waste management plan required. This is published online and should be available to authorities when required. Pollutants and waste (other than gases) to be stored in a pit or tank. Transportation, treatments and disposal records of the wastewater generated during hydraulic fracturing operations. These have to be kept and

Stage	Germany	Denmark	United Kingdom	Colorado (US)	Pennsylvania (US)
			hazardous waste.	treatment, transportation and disposal (drilling cuttings, drilling fluids, produced water, non-hazardous waste). Produced water may be re-injected following approval by authorities.	provided to authorities upon request. Those provided to authorities are available to the public.
Disclosure of information (chemicals used)	No specific provision with regard to the quantities and composition of fracturing fluids other than what arises from REACH. Some disclosure requirements from the Lander Committee but with H&S criteria (not environmental criteria)	Authorities require a detailed description of fracturing fluids (type, density, composition, volume used, standard). Also a detailed description of the equipment used is requested. This information must appear in the Fracturing Plan. Authorities do not require the publication of this information but the operator of the 2 licences granted as of April 2015 (Total E&P Denmark) has expressed its willing to do so.	The environmental regulator will normally require this information to assess whether a permit is needed. This information may be available to the public.	Operators are required to provide authorities with very detailed information of the chemicals used during hydraulic fracturing operations, including name, composition, concentration, properties; and where, when and why it was used; unless it is a trade secret. This information is public and everyone can have access to it. Trade secret chemicals may be disclosed to health professionals if requested by authorities. These professionals have to sign a confidentiality agreement.	Well completion report with the following information: Descriptive list of the chemicals additives used. % mass of each chemical used, total volume, water sources, unless it is a trade secret. There is a public online registry of chemicals used during hydraulic fracturing (except in the case of trade secret).
Monitoring: production	Well pressure monitoring during cementation. No specific requirements for hydraulic fracturing Data recording during operations (pressure,	Water and air quality is monitored. As EIA is compulsory when hydraulic fracturing is used, a monitoring plan will be included in the EIA.	Specific requirements have to be set up in clauses of the planning permission	Water samples are taken from public water systems that are within 800 m to compare with baseline samples. If there is risk of groundwater or soil	Emissions of air pollutants from operations at unconventional wells including development, production, transmission, and processing must be monitored and annually

Stage	Germany	Denmark	United Kingdom	Colorado (US)	Pennsylvania (US)
	quantities and composition of fracturing fluids). Production book. Constant monitoring of hydraulic pressure of wells.			contamination, there are requirements for monitoring and assessing concentrations of pollutants against the established maximum concentrations.	reported to authorities.

Table 3.4. Decommissioning, closure and post-closure

Stage	Germany	Denmark	United Kingdom	Colorado (US)	Pennsylvania (US)
Temporary abandonment	On a case by case basis (Described in Operational Plan)	Allowed in special circumstances. Needs to be approved	Abandonment plan required. Consent is needed to resume activities.	Allowed for 6 months after mechanical integrity test and casing.	Nothing specific.
Integrity of well	Compulsory to maintain integrity after well closure (requirement for all oil and gas activities)	All wells have to be plugged before abandonment. Application for permission to abandon is compulsory. Elaborated details of how the plugging should be done are available in Guidelines. When a well is abandoned the original state of the well site shall be re-established. This will be monitored by the authorities.	Abandonment plan required. Wells have to be plugged and sealed. Specific requirements are described in the permit. Authorities will allow abandonment unconditionally or with conditions.	Well abandonment report required. Wells must be plugged.	Plugging and casing for all abandoned wells.
Dismantling of operation	Very detailed (described in a Mining Closure Operational Plan). This is common to all oil and gas activities.	Licences include detailed rules. A dismantling plan has to be approved by the	Restoration requirements are included in the planning permission.	The closure of waste management facilities requires 2 closure plans (preliminary and detailed). Restoration has to meet	Well sites must be restored, including removal or filling any pits used for produced fluids or industrial wastes, within

Stage	Germany	Denmark	United Kingdom	Colorado (US)	Pennsylvania (US)
		authorities. Remediation until achieving the best environmental state possible (not necessarily the environmental status before the activities, as this is affected by other factors).		certain criteria (established in the Regulations).	nine months after drilling is completed. Any remaining facilities used for production and storage must be removed nine months after the well has been plugged. The purpose is to restore the site up to a state that is approximate to the original status.

3.3.2 Issues and benefits of the approaches

3.3.2.1 Europe

Although open to interpretation, certain European legislation provides a minimum level of environmental protection that applies to all Member States. Specific requirements applying to UGEE at EU-level may be efficient for operators working in different countries (same requirements and best practice across Europe) as well as for Member States (clear understanding of what is required as well as fair competition and a similar level of health and environmental protection).

In the US each state appears to have developed separate standards with different approaches, Regulations and slightly different requirements (e.g. disclosure of chemicals, waste management requirements). This reflects the fact that legislation has been developed primarily at the state rather than federal level.

Within the three European countries analysed, there are various practices that could be considered best practice and go beyond what is required by existing Directives:

- *Rural zone permit system (Denmark).* This permit system includes a plan with legally binding clauses that aims to protect rural areas from any significant changes that may arise from these activities. It also provides a consultation process and a level of public participation by the affected stakeholders in these municipalities. The island of Ireland could benefit from this additional level of protection and consideration for rural populations, given the rural characteristics of the proposed exploration areas.

- *Fracturing plan (UK and Denmark).* The fracturing plan provides a means of setting out the requirements for the equipment, materials and issues arising from hydraulic fracturing. This can be used to demonstrate the effectiveness of mitigation measures used to reduce the risk of environmental and health issues related to the technology. Such a plan may be useful in communicating how risks are managed to stakeholders. The fracture plan mitigation measures may include management of induced seismicity, groundwater protection, public participation, well integrity and monitoring schemes. In addition to this, the UK requires a work programme to be provided for each stage of the UGEE process and will establish a compulsory Environmental Risk Assessment for each site.

- *Public participation (Denmark).* Current European legislation does not enforce public participation and consultation scheme in the cases where an EIA is not deemed necessary. In Denmark, local authorities provide public and stakeholder participation within the permit granting system, especially in the case of rural populations. Also, although local authorities are in charge of granting a licence, a Parliamentary Committee must approve this, which provides state-wide protection of the environment and the population. Landowners must also agree on any activities conducted in their property, and the general public must be informed of any incidents or inspections.

- *Baseline monitoring (UK, Denmark).* Monitoring in advance of drilling is used to establish a baseline. This can include monitoring and reporting of water quality, air quality, noise and seismicity. Monitoring requirements may be risk-based.

- *Monitoring Plan (Denmark).* When hydraulic fracturing is used, a monitoring plan will be included in the EIA.

- *Operational plan, licence and separate permits for each stage (Germany and Denmark).* This provides continuous control of how activities are conducted. Authorities ensure that operators will comply with requirements that are specific of that stage and can reject

planning and permit applications when these do not comply with the highest standards. Also, it is ensured that operators comply with the agreed timescales.

- *EIA for all hydraulic fracturing (Denmark, proposed in Germany).*
- *SEA for licensing rounds (UK).* A SEA considering this activity at a national level and taking into account synergies and the combined effects of all the activities in all the available concessions is essential to take preventative action. Individual EIAs may be suitable at the local/regional level but may disregard the cumulative effects. SEA also promotes early public engagement. Note that NI and Ireland do not operate licensing rounds.
- *Regulatory roadmap (UK).* The DECC roadmaps provide clarity on regulatory requirements at different stages to operators, regulators and other stakeholders. In Ireland, the CER has produced a guide to the permissioning process for petroleum activities (CER, 2014), which could form the basis for a roadmap covering wider issues.
- *Induced Seismicity Management (UK).* The use of a simple "traffic light" system provides a clear method for managing and mitigating risks of seismic activity.
- *Financial guarantee and fund.* These provide financial guarantees in case of an adverse event. The specific requirements for financial guarantees are not prescribed in the European countries. In contrast, in Colorado and Pennsylvania there are specific and detailed requirements based on the activity undertaken and/or equipment used.

Issues:

- Lack of opportunities for public participation (Germany).
- *Lack of specific legislation for UGEE (EU).* For instance, there is not specific legislation related to cementing and casing in Denmark. This may not be an issue for countries with extensive experience and track record in hydrocarbons exploration and production which have established standards and requirements. However, some EU Member States that may have significant unconventional reserves may not have experience to ensure appropriate controls unless specific legislation is enacted.
- Lack of specific zoning restrictions (Germany).
- *Moratorium vs regulation.* Strong public and political opposition to UGEE in Germany has led to a temporary moratorium, despite attempts from the Government to enact key legislation for the Regulation of UGEE and industry initiatives to promote UGEE. The German Government argues that Regulation is the best way to avoid disruptions and environmental and health issues arising from a technology that is necessary for the country.
- *Variability and number of competent authorities (e.g. Germany and the different authorities depending on the "Land", different approaches within individual countries in the UK).*
- *Specific conditions (UK).* Specific conditions included in each environmental permit and/or planning permission that are assessed on a case-by-case basis can address specific issues at each site.
- *Re-injection of fracture fluids (EU).* There are different interpretations and approaches. This would benefit from EU-level clarity as current legislation may imply a de facto prohibition of re-injection for disposal.

3.3.2.2 United States

Best practice identified in the analysed US States:

- *Baseline monitoring (Colorado).* Monitoring in advance of drilling is used to establish a baseline (may include water quality, air quality, noise and seismicity).
- *Comprehensive Drilling Plan (Voluntary) (Colorado).* This provides a way of alleviating the administrative process. All the documentation provided by operators when the plan is submitted will not be requested again by authorities.
- *Water Management Plan (Pennsylvania).* This requires approval from authorities and ensures that the operators' withdrawals from streams and wells are conducted sustainably. It also includes a reuse plan for fluids used at hydraulic fracturing operations.
- *Buffer and setbacks (Colorado and Pennsylvania).* The Regulations in each State contain very specific and detailed setback and zoning restrictions with variable requirements depending on the proximity of activities. These are focused on protecting groundwater and especially vulnerable areas but are rule-based rather than risk-based.
- *Liability as an incentive (Pennsylvania).* Baseline monitoring is not specifically required but usually conducted by companies to reduce the risk of liability.
- *More mature reporting system in Colorado and Pennsylvania.*
- *Guarantees (Colorado and Pennsylvania).* Operators are required to have various financial guarantees for a variety of activities (e.g. financial assurance for operations; guarantees for soil protection, well plugging, well abandonment, gas gathering, processing and underground storage; bonds for wells that are released when the well is properly plugged or transferred**.**

The review found that regulatory structures in Colorado and Pennsylvannia have been developed to address gaps in regulatory frameworks and address issues specific to UGEE that were not otherwise addressed.

Issues:

- *Exceptions.* There are exceptions to several of the most restrictive rules in Colorado and Pennsylvania if authorities grant a waiver or accept a company's request. If something similar was granted at EU-level, a thorough implementation assessment would be necessary.

3.3.3 Cross-border aspects

There are potential cross-border issues in the case studies analysed. Within the EU Member States included in this study, Germany borders with Denmark to the north. The current de facto moratorium in Germany contrasts with the Danish approach, where the first drilling permit was granted for one of the two concessions with a licence to extract unconventional gas. However, this will occur in Frederikshavn, which is in the north of Denmark and will not imply any cross-border issue with Germany. Cross-border issues do not seem to be dealt with in the current German or Danish legislation specific to UGEE and no mechanisms seem to be in place in this regard.

As for the UK, although England and Scotland share a border, the slightly different legislation applying to these countries, especially after a moratorium was put in place in Scotland has not implied any cross-border challenge as yet.

The situation in the states studied in the United States could potentially lead to issues in the border between Pennsylvania and New York, as companies need to deal with landowners directly and the approach to unconventional hydrocarbons is very different in both states (Pennsylvania is one of the most active areas, whereas New York has put a moratorium in place). However, nothing specific was identified in Pennsylvanian Rules.

Dedicated measures have not been identified for addressing cross-border issues between Ireland and Northern Ireland nor between other countries. Implementation of EIA, SEA, WFD and the Habitats Directives however, will necessitate, at the very least transboundary consultation where impacts have the potential for a transboundary nature. Specific cross-border procedures are not prescribed between Ireland and Northern Ireland and processes are part of the normal statutory consultation process.

3.4 Conclusions

An EU-wide approach to well integrity standards and compulsory EIA would be of benefit for a suitable implementation of the industry in the EU. This would imply common environmental standards and a level playing field across Europe. Specific legislation would clarify certain issues where interpretation across Europe could lead to significantly different approaches (e.g. with regard to fluid re-injection). Public engagement seems to need development in the EU countries analysed (except Denmark). If experts, activists and the general public are able to express their views and learn more on the advantages and drawbacks of the technologies involved in UGEE, the whole process would be better understood and companies will also be incentivised to disclose information of how the technology works and the chemicals that are used.

Colorado and Pennsylvannia provide good examples of how a more mature, rule-based system leads to specific controls and guarantees related to UGEE. However, it is also noted that it is inefficient to have states with slightly different controls and requirements. For instance, the zoning restrictions of Colorado and Pennsylvania provide a similar outcome but are not exactly the same, which has to be taken into account for companies that operate in various US States. Litigations and administrative procedures may also be inefficient if each USA State has its own rules, enforcements and competent authorities.

It is noted that the DECC in the UK has issued a “roadmap” document for Northern Ireland (and for other UK countries) that is intended as a first point of reference for anyone seeking to understand the permitting and permissions process for exploratory work in onshore oil and gas development. It is noted that the roadmap was produced to clarify requirements for the UK which has a pro-UGEE position (DECC, 2013). If it were the case that Ireland developed a similar position to the UK, where UGEE was to be supported, it may be beneficial for a similar roadmap and guide to be developed analogous to that produced for Northern Ireland to inform those interested in understanding the regulatory and permitting process.

4 The Potential Role of Health Impact Assessment in Regulation of UGEE

4.1 Introduction

This chapter considers the extent to which Health Impact Assessment (HIA) is an appropriate tool, in the context of the Island of Ireland, to assess health impacts that may arise from UGEE plans (for example, licensing plans) and projects (i.e. development proposals). It seeks to determine: whether application of HIA to UGEE projects would be beneficial; when HIA might be undertaken; who might be responsible for HIA; and the scope of HIA including specific methodological requirements in the context of UGEE.

4.2 Method

To inform this evaluation, a high level review of literature concerning the potential health impacts of UGEE projects and operations is provided (Section 4.5) alongside an overview of the existing regulatory framework as it relates to health impacts arising from UGEE (Section 4.6. A case study analysis of health assessments (both HIA and non-HIA) undertaken in respect of UGEE plans and projects is then provided to help determine the scope and effectiveness of HIA elsewhere and lessons that could be applied to the context of the Island of Ireland (Section 4.7). Section 4.8 reviews existing guidance on HIA in Ireland and Northern Ireland. The conclusions arising from the evaluation are set out in Section 4.9.

4.3 HIA for UGEE

There is well documented, widespread public concern in respect of the human health impacts of UGEE and particularly with regard to operations involving hydraulic fracturing. The Scottish Government, for example, announced in January 2015 a moratorium[32] on all planning consents for unconventional oil and gas development to allow for a public consultation on the hydraulic fracturing process and to commission a public health impact assessment.

Like Scotland, the Irish UGEE industry is in its infancy and the uncertainty created by the lack of familiarity with the technology means that it is essential that the potential impacts that could arise from the construction, operation and decommissioning of UGEE projects on human health are identified and assessed and that, where necessary, appropriate mitigation is implemented.

In this context, this chapter considers the potential role of HIA in the regulation of UGEE projects and operations and in furthering awareness and understanding of health impacts associated with such activity.

The World Health Organization (WHO) defines health as "*a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity*" (WHO, 1947). Health by this definition goes beyond purely biophysical factors to include a range of factors that can influence the health of individuals and communities. In this regard, the WHO identifies the following key determinants of health: the social and economic environment; the physical environment; and a person's individual characteristics and behaviours (WHO, undated).

A social determinants framework, such as the model developed by Dahlgren and Whitehead in 1991, (Dahlgren, 1995) (see Figure 4.1a), allows consideration of how a proposal may impact in different ways on different groups of people, and focuses on the particular contexts in which people live. This

32 See http://news.scotland.gov.uk/News/Moratorium-called-on-fracking-1555.aspx (accessed June 2015).

model has been adapted and developed by Barton and Grant (1998) to provide an ecologically based framework that is aligned more with the planning of people's lived environments (Figure 4.1b).

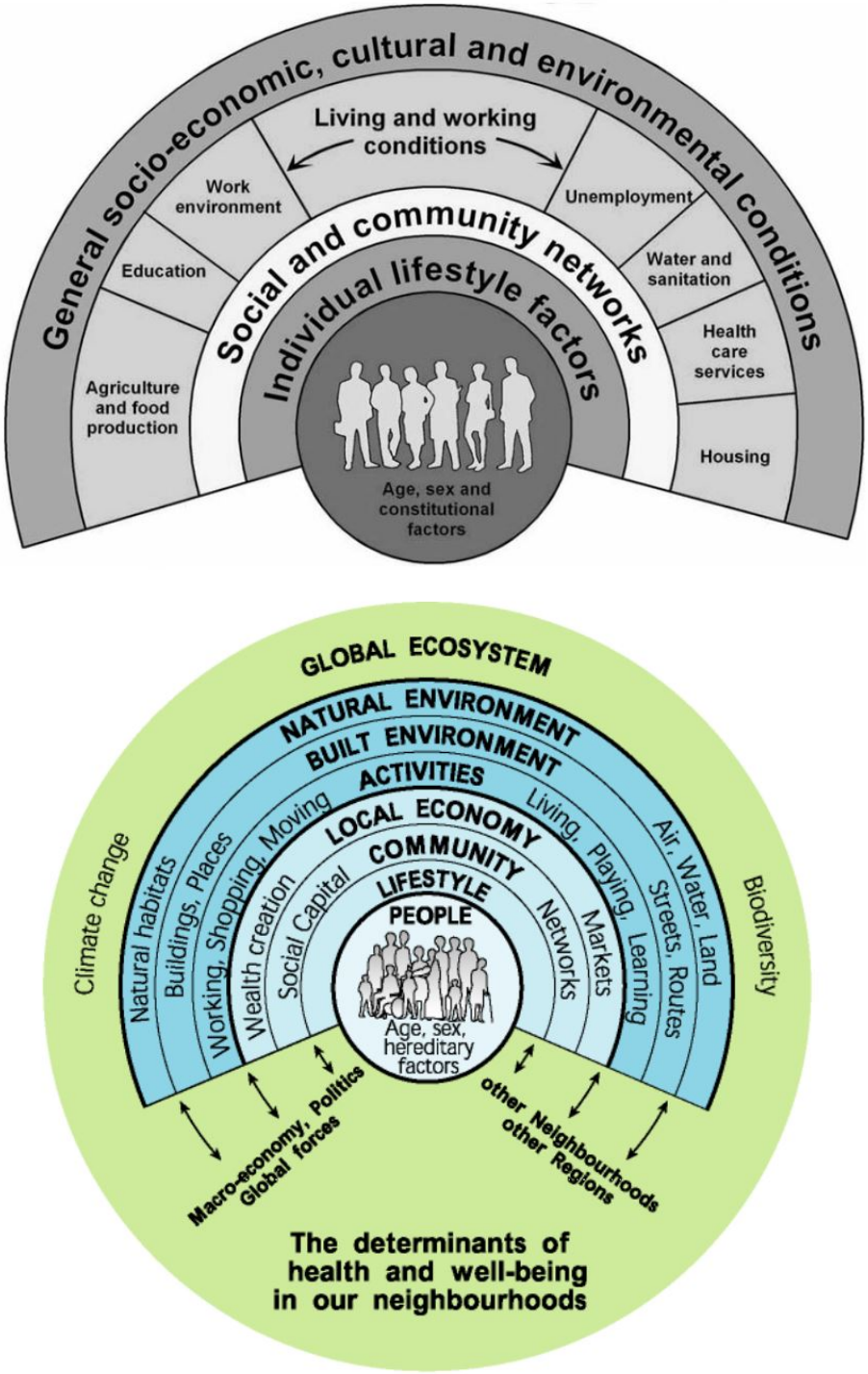

Figure 4.1. Determinants of Health. (a) Social determinants framework; (b) Ecologically based framework. Sources: Adapted from Dahlgren (1995) and Barton H. and Grant M (2006).

In assessing the health impacts of UGEE, it is therefore important to ensure that these wider health determinants are fully considered. Impacts on these determinants may be long or short term, direct, obvious and/or intentional, whilst others may be indirect, difficult to identify and unintentional (Wales Health Impact Assessment Support Unit, 2012).

A range of tools are available that could be used to identify and assess the health impacts of UGEE plans and projects. These tools include, for example: Environmental Impact Assessment (EIA); Strategic Environmental Assessment (SEA); and Health Impact Assessment (HIA).

HIA is defined by the WHO European Centre for Health Policy (1999) as "a combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population and the distribution of those effects within the population". As such, HIA is a management tool to assess complex societal decisions that may have health implications and to provide options for managing health effects.

HIA can contribute to improved health by: raising awareness among decision makers of the relationship between health and the physical, social and economic environments; demonstrating how a proposal may affect the health of a population; and providing recommendations on how a proposal could be modified to maximise opportunities for health gain and minimise chances of health loss (IPHI, 2009).

Despite the potential benefits of HIA, it is not a statutory requirement in Northern Ireland or Ireland and the need for such an assessment of UGEE plans and projects must be considered in the context of the existing European Union (EU) legislative framework and where, in particular, the EIA and SEA Directives already require an assessment of the impacts of proposed plans and projects on topics that include human health. Further, there are a range of potential challenges to undertaking successful and effective HIA including the resources required to undertake such assessments, the availability of data and lack of knowledge and expertise amongst communities and stakeholders (see also Section 4.6).

4.4 The HIA Process

There are three main types of HIA - prospective, concurrent and retrospective (Wales Health Impact Assessment Report Unit, 2012).

- Prospective HIA is undertaken at the start of the development of a project, proposal or plan;
- Concurrent HIA runs alongside the implementation of a project (or policy); and
- Retrospective HIA assesses the effect of an existing project or policy and can be used as an evaluation tool.

HIA can take one of three different forms, depending on the focus and the time and resources available. A Desktop HIA is conducted quickly, using limited resources and only takes into account easily accessible evidence. It is usually conducted when there is only a short timeframe available or where the scale of the proposal does not warrant in-depth investigation. A rapid HIA considers a broader range of evidence but is still conducted within tight time and resource constraints. Comprehensive HIA is undertaken over a longer period of time and involves more resources. It is useful when the potential scale and severity of health impacts warrant an in-depth investigation.

The HIA process itself usually comprises the following six stages (see Figure 4.2):

1. Screening: The decision to undertake HIA.
2. Scoping: Determining the parameters for the HIA and the governance and management arrangements.
3. Appraisal: Identifying the potential impacts on health and mitigation measures.

4. Recommendations: development and dissemination of findings and recommendations of the HIA.
5. Implementing the Recommendations: Amending the policy or proposal to reflect the findings of the HIA.
6. Monitoring and evaluation: This can be process evaluation, effectiveness evaluation or (health) outcome evaluation (Merseyside Health Impact Assessment Steering Group, 2001).

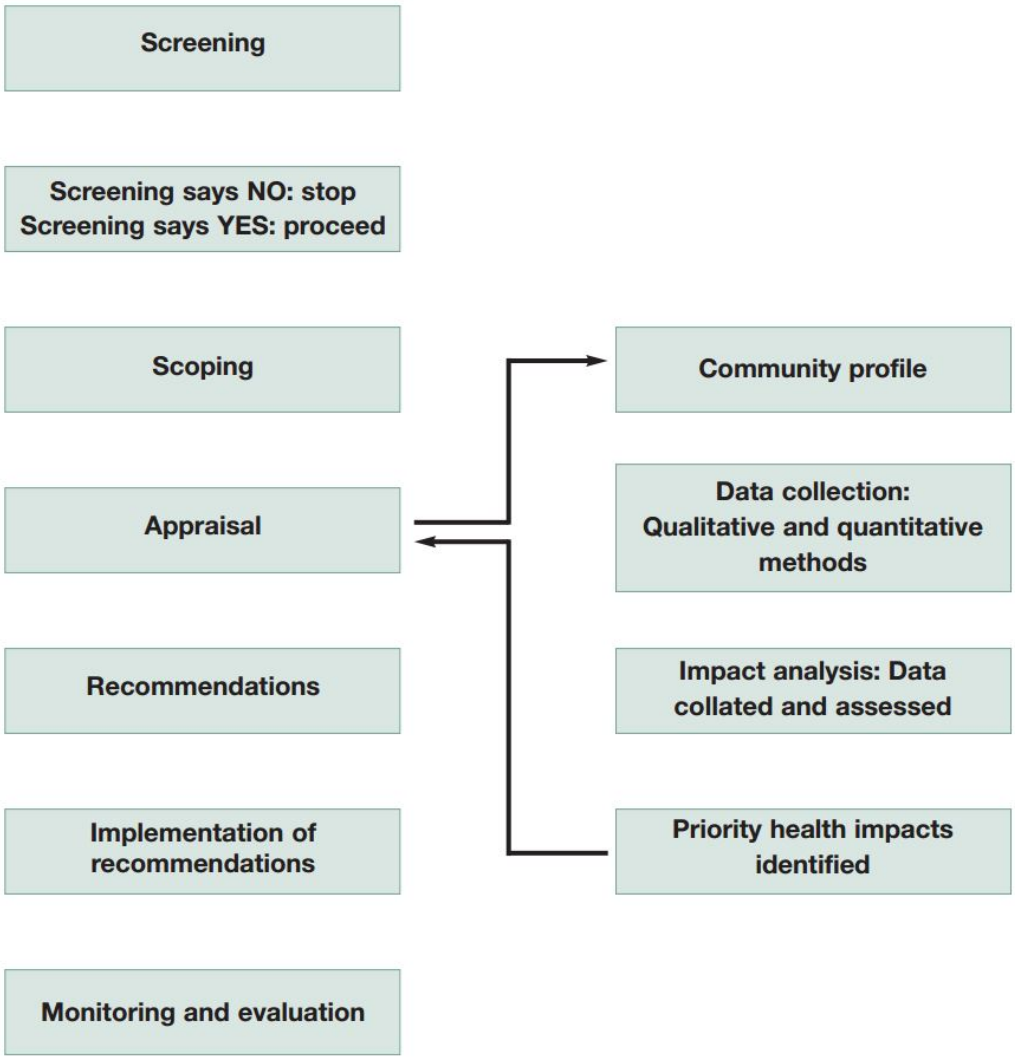

Figure 4.2. The HIA Process. Source: Institute of Public Health Ireland (2009).

Methods for undertaking HIA typically involve:

- Policy analysis (where appropriate);
- Profiling the areas and communities affected;
- Involving stakeholders and key informants in predicting potential health impacts, using a predefined model of health;
- Evaluating the importance, scale and likelihood of predicted impacts; and

- Considering alternative options and making recommendations for action to enhance or mitigate impacts.

Further information relating to the methods outlined above is detailed in the *Merseyside Guidelines for Health Impact Assessment* produced by Merseyside Health Impact Assessment Steering Group (2001).

4.5 The Potential Health Impacts of UGEE

Whilst UGEE is not a new activity (from a US perspective at least), evidence regarding the potential health impacts of projects and operations has historically been limited. However, there is an expanding volume of literature on the topic, reflecting both the growing interest in the potential of unconventional oil and gas outside the US and public concern with respect to the process of hydraulic fracturing in particular.

Potential causes of health impacts associated with UGEE identified in existing literature are wide-ranging and include:

- Deterioration in air quality;
- Groundwater contamination and reduced water resource availability;
- Surface water contamination and runoff and reduce water resource availability;
- Noise;
- Induced seismicity;
- Climate change effects;
- Occupational health risks (arising from, for example, on-site accidents leading to worker injury, exposure to emissions and chemicals used in UGEE operations and mental distress due to the transient nature of the work); and
- Socio-economic impacts (such as jobs creation, increased pressure on services and facilities, crime and increased traffic).

To provide context to the evaluation of the potential role of HIA in respect of UGEE plans and projects, the following sub-sections provide a high level summary of the principal health impacts that could arise during the five key stages of the exploration and production lifecycle (defined here as non-intrusive exploration, exploration drilling and hydraulic fracturing, production development, production/operation/maintenance and decommissioning and site restoration).

It is important to note that this section does not constitute a detailed review or assessment of all potential health impacts that may be associated with UGEE (this chapter is concerned with the process of HIA rather than health impacts per se which are provided as part of *Project B*).

4.5.1 Non-intrusive exploration

Activities associated with UGEE at this stage are expected to be largely desk based, with minimal noise and disturbance generated from site seismic surveys. As a result, no significant health impacts would normally be expected.

4.5.2 Exploration drilling and hydraulic fracturing

Health impacts may arise from various activities during this stage, many of which are likely to be similar to general construction activity and occur over a relatively short time period.

Pad preparation and construction in particular can result in noise and dust generation. Heavy Goods Vehicle (HGV) movements to transport materials and the use of diesel generators for site equipment and drilling processes would result in emissions to air, such as particulate matter (PM_{10}), nitrogen oxides (NO_X), carbon monoxide (CO), volatile organic compounds (VOCs) and sulphur dioxide (SO_2). These emissions could potentially affect residents with respiratory problems whilst noise and vibrations may cause stress and anxiety. However, the potential for negative health impacts would depend on factors such as the number of HGV movements, the proximity of HGV routes to residential or other sensitive areas and the existing background levels of pollution/noise. It is important to note that the number of HGV movements could be more substantial if the water required for hydraulic fracturing and flowback is tankered to/from site. In respect of a proposed UGEE development in Lancashire, UK, the developer (Cuadrilla) estimated that vehicle movements would peak at 250 truck movements per day during the most intense periods of activity, although this would be sustained for short intervals only (Cuadrilla Bowland Ltd, 2014).

Drilling is an activity with high noise levels and continuous operations over a period of several weeks or months. For construction equipment used in the preparatory stages, the maximum calculated composite noise level at 75 m is typically 70 dBA and for horizontal drilling, the maximum noise level is typically 64 dBA (AEA, 2012). Depending on the distance from the noise source, any attenuation and ambient noise levels, noise at 64 dBA could disturb local residents, particularly in sensitive areas and noise controls would be necessary.

There is a growing body of research examining the potential for hydraulic fracturing to contaminate groundwater used as public drinking water supplies through leakage of fracturing fluid as a result of spills and containment vessel failures and the migration of methane and contaminants due to well integrity failure (e.g. MIT, 2011; Considine *et al*., 2012; US EPA, 2012). Public Health England (2014) stated that the risks of water contamination are, however, generally low due to the regulatory protection of water supplies, although accidental spillages could still occur. PHE (2014) also highlight that private water supplies are more vulnerable to contamination than public water supplies as they are more localised and have limited resources thereby diminishing any benefits from dilution. Within the UK and Ireland, private water supplies are also subject to less stringent monitoring requirements. Very low levels of naturally occurring radioactive material (NORM) may also be encountered in drill cuttings and flowback fluid, or through the release of radon gas, which may affect how such wastes are handled and subsequently disposed of.

Public perception of the impacts of hydraulic fracturing can affect mental, physical and emotional wellbeing during all stages of the exploration and production lifecycle. This can exacerbate or trigger health effects caused by anxiety or changes in behaviour arising from people's perception of a project. Construction and preparation of the pad may also be used as a focus for anti-fracturing sentiment and may be subject to protest action from opposition groups and the local community. This could potentially increase the fear of crime such as vandalism and personal injury as a result of an influx of a large number of people into an area. In the UK, there have also been reports that protests against hydraulic fracturing have involved low levels of violence (The Telegraph, 2014).

As with any construction activity, there are health and safety risks for workers on site which require management.

4.5.3 Production development

Most of the activities associated with this stage of the UGEE lifecycle are expected to be largely similar to exploration. However, the scale, magnitude and duration of potential health impacts (and particularly those impacts relating to noise, emissions to air and water contamination) may be greater given the need to drill, complete and hydraulically fracture a greater number of wells per pad and more pads in a wellfield.

4.5.4 Production/operation/maintenance

Health impacts are likely to be limited at this stage. There will be limited levels of noise and vehicle movements. Health impacts from air pollutants and potential effects on drinking water may arise if a well is re-fractured.

4.5.5 Decommissioning and site restoration

Health and safety risks associated with the decommissioning process would be similar to those encountered on a conventional demolition site. The process may give rise to dust, noise and emissions which affect local receptors.

4.6 The Regulatory Framework

There is no legislative basis for standalone HIA at the European or national (Northern Ireland and Ireland) level. However, an existing regulatory framework is in place to manage health impacts arising from activities such as UGEE (although this framework is not specific to UGEE). The following sub-sections summarise the key components of this regulatory framework in the context of UGEE with a view to ascertaining the extent to which health impacts must already be assessed for UGEE projects/operations and identifying any potential regulatory gaps which might necessitate the consideration of HIA.

4.6.1 European legislation

The European Union's (EU) environmental legislation was developed at a time when high-volume hydraulic fracturing (HVHF) was not in use in Europe. The European Commission (EC) adopted Recommendation 2014/70/EU[33] in January 2014, which sets out minimum principles that may be used for Member States that are looking to develop the exploration and production of hydrocarbons using HVHF[34]. The principles aim to ensure that: activities can be carried out with appropriate and adequate safeguards for the public and the environment; that resources are used efficiently; and that the public is informed. They include a number of measures for Member States, regulators and operators that would be expected to help ensure the protection of human health during UGEE activities including in respect of the protection of water resources, pollution prevention and controls on seismicity.

The Recommendation of the EC relies on the "*acquis communautaire"* in the field of environmental protection, which is composed of numerous legislative instruments on the prevention of air pollution, water protection, protection of wildlife and flora, human health, treatment of wastes and protection of workers. The legislation of particular relevance to human health listed in the Recommendation includes:

- Health and Safety at Work Framework Directive (89/391/EEC);

33 On minimum principles for the exploration and production of hydrocarbons (such as shales gas) using high-volume hydraulic fracturing (HVHF).

34 Defined as injecting 1000 m^3 or more of water per fracturing stage or 10,000 m^3 or more of water during the entire fracturing process into a well.

- Mineral-Extracting Industries - Drilling Directive (92/91/EEC);
- Water Framework Directive (2000/60/EC);
- SEA Directive (2001/42/EC);
- Groundwater Directive (2006/118/EC);
- Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation (REACH);
- Mining Waste Directive (2006/21/EC); and
- EIA Directive (2014/52/EU).

The Recommendation does not include a requirement for HIA nor is there overarching EU legislation relating to, and/or requiring, assessments of health. However, the Recommendation sets out that, before granting licences for the exploration and/or the production of hydrocarbons which may lead to the use of HVHF, Member States should prepare a SEA in accordance with the SEA Directive (2001/42/EC) and that operators should then carry out an EIA on the basis of the EIA Directive (2014/52/EU) for specific projects.

The SEA Directive is a systematic, decision-support process, that aims to ensure that the likely significant environmental effects of plans and programmes are identified, described and evaluated. It is transposed into law in Northern Ireland through the Environmental Assessment of Plans and Programmes Regulations (Northern Ireland) 2004 (SI No 280) and, in Ireland, through SI No. 435 of 2004 (European Communities (Environmental Assessment of Certain Plans and Programmes) Regulations 2004 and SI No. 436 of 2004 (Planning and Development (Strategic Environmental Assessment) Regulations 2004 (as amended). The Directive requires the consideration of "*the likely significant effects on the environment, including on issues such as …, human health …"*, although there is no specific requirement or guidance in respect of what aspects of human health should be considered in any assessment. In the context of Northern Ireland and Ireland, onshore UGEE applications are made on a case-by-case basis and in consequence, health impacts associated with UGEE would not be currently considered at the plan level (as there is currently no "licensing plan" that requires SEA).

At the project level, the EIA Directive requires a description of the aspects of the environment likely to be significantly affected by a proposed project. UGEE is not specifically identified in Annex I of the EIA Directive which defines those projects for which EIA is mandatory although as an extractive industry, UGEE falls under Annex II and EIA may be required (subject to screening by the competent authority). The EIA Directive is transposed into law in Northern Ireland through The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2015 (SI 74) and in Ireland through the integration of its requirements into the land-use planning consent system and several other development consent regimes. Recent amendments to the Directive[35] require that impacts on health are considered although this requirement has yet to be transposed into national legislation in Northern Ireland and Ireland. Like SEA, there is also currently no specific requirement or guidance in respect of what aspects of human health should be considered in any EIA.

4.6.2 Northern Ireland legislation

There is a range of regulation in place in Northern Ireland relating specifically to occupational and public health and safety and which primarily extends from the Health and Safety at Work (Northern

35 See EIA Directive 2014/52/EU.

Ireland) Order 1978 (as amended).[36] With specific regard to the oil and gas sector, relevant legislation includes the Borehole Site and Operations Regulations (Northern Ireland) 1995 (No. 491), which are concerned with the health and safety management of oil and gas sites, and the Offshore Installations and Wells (Design and Construction, etc.) Regulations (Northern Ireland) 1996 (No. 228), which relate to the integrity of all wells drilled for petroleum extraction (including unconventional gas). The Construction (Design and Management) Regulations (Northern Ireland) 2007 (No. 291) are also in place to improve health and safety at construction sites, with legal duties placed on a range of parties, including designers, clients, contractors and workers. Other legislation in Northern Ireland that may be related to UGEE includes, inter alia, that relating to noise, pollution, water resources and air quality.

The UK has existing, well-developed regulation governing conventional oil and gas. UGEE will be regulated within this framework. These requirements comprise the licensing, permitting and permissions processes, which include: a requirement for Environmental Risk Assessment (where health impacts should be considered); the need for planning permission (and, where relevant, EIA); and other permits and consents (allied with the role of the Health and Safety Executive in overseeing working practices and public safety). Further information regarding the consenting process is provided in the Department for Energy and Climate Change's (DECC) Regulatory Roadmap for unconventional gas (DECC, 2013).

4.6.3 Ireland

The Safety, Health and Welfare Act 2005 (No. 10) is the primary legislation in Ireland relating to health. Regulations and orders made under the Act that are particularly relevant to UGEE include the Safety, Health and Welfare at Work (Construction) Regulations 2013 (SI 291), the Safety, Health and Welfare at Work (Control of Noise at Work) Regulations 2006 (SI 371) and the Safety, Health and Welfare at Work (Control of Vibration at Work) Regulations 2006 (SI 370). Other relevant regulation includes the Safety, Health and Welfare at Work (Extractive Industries) Regulations, 1997 (SI 467).

With specific regard to the oil and gas sector, relevant legislation include the Petroleum (Exploration and Extraction) Safety Acts 2010 and 2015 (amending the Electricity Regulation Act 1999). Other legislation in Ireland that may be related to UGEE includes, inter alia, that relating to noise, pollution, water resources and air quality such as the European Union (Industrial Emissions) Regulations 2013, (SI 138 of 2013).

4.6.4 Voluntary measures

Although experience of UGEE is limited in Europe, potential best practice/voluntary actions by unconventional gas operators are emerging, such as the UK Onshore Operators' Group *UK Onshore Shale Gas Well Guidelines. Exploration and Appraisal Stage* (UKOOG, 2015). This addresses a number of factors relevant to health including:

- Well design and construction;
- Fracturing/flowback operations;
- Environmental management (construction and operations);
- Fracturing fluids and water management;
- Minimising fugitive emissions to air; and

36 A comprehensive overview is provided by the Health & Safety Executive for Northern Ireland via http://www.hseni.gov.uk/resources/legislation.htm (accessed June 2015).

- Public disclosure of fracture fluids.

If implemented, these measures could help to minimise adverse health impacts associated with UGEE projects.

4.6.5 HIA, SEA and EIA

Whilst there is no statutory requirement for HIA, at the strategic level through SEA, and at the project level through EIA, mechanisms exist for assessing the health impacts of UGEE plans and projects. Although SEA and EIA may not be mandatory for all UGEE plans and projects, Recommendation 2014/70/EU and industry guidance in the UK together provide clear direction as to the role of SEA and EIA in this regard.

A common criticism of SEA and EIA has been the failure of the assessment processes to adequately consider the full range of health determinants. This may in part be because health in the context of SEA and EIA is not fully defined in the associated directives and their transposing regulations and is open to interpretation by the responsible authority (Fisher, 2013; Jha-Thakur *et al*., 2013). With specific regard to EIA, the requirement to consider health impacts has also only recently been introduced through amendments to the EIA Directive and has yet to be transposed into national legislation. Others have highlighted a lack of involvement of health stakeholders in the assessment processes and the potential for health issues to be overlooked or given less attention due to the wide range of topics/impact dimensions that tend be integrated into the SEA and EIA processes and also their focus on environmental impacts (WHO, 2009, 2014; Tajima and Fisher, 2013).

However, the scope of SEA and EIA and their legal basis have led some commentators to argue that they are the most appropriate tools to assess health impacts (e.g. Bhatia and Wernham, 2008). In its extensive review of HIA practice in Europe, the WHO (2014) highlights the benefits of integrating HIA with other forms of assessment as:

- There is obvious topical overlap between impact assessments;
- With current trends towards enlarging the scope of topics covered by specific impact assessments, this overlap can be expected to increase;
- Such topical overlap, at the very least, implies a certain duplication of efforts and an example of societal inefficiency;
- For a given action being assessed, contradictory statements may be made by different forms of impact assessment, which is bound to undermine their credibility with policy-makers, stakeholders, and the public at large; and
- Even short of such contradictions, the existence of multiple impact assessments conducted in parallel may wear out the goodwill and patience of all parties involved, contributing to impact assessment fatigue.

The WHO recommends that caution should be applied when considering whether or not to integrate assessments. They concluded that "*the need of, and justification for separate HIA cannot automatically be derived from the universally accepted significance of health; rather, it should be demonstrated whether and how HIA offers a comparative advantage in terms of societal benefits*".

Research undertaken in respect of the application of HIA in Ireland has identified both advantages and disadvantages to the assessment process. For example, Pursell and Kearns' (2007, 2012) evaluation of a HIA undertaken in respect of traffic and transport projects in Ballyferm found that the assessment generated a number of benefits, including:

- Encouraging partnership working between the community, local authority, the HSE, the voluntary sector, and other key service providers;
- Raising awareness of both obvious and more indirect issues regarding the impact of transport and traffic on health;
- Enabling the assessment of impacts on vulnerable groups; and
- Facilitating wide ranging community engagement and skills training in HIA.

However, they also highlight a number of important issues with respect to the HIA, including:

- A lack of transparency in the assessment process. Some stakeholders felt that they did not have the expertise to engage fully in the process;
- Difficulties in balancing and integrating quantitative and qualitative data into the assessment;
- Funding issues that led to the HIA being conducted retrospectively; its ability to inform decision-making was therefore greatly reduced;
- A perception that the HIA process was top-down; and
- The practice of HIA in public sector is largely absent, undermining its ability to influence decisions.

A study by the Environmental Protection Agency (de Souza *et al*., 2010) that sought to compare the health status of the populations of two regions of County Clare (Clarecastle and Ennistymon) with health status determined as part of an earlier, separate study also raises potential methodological limitations, including:

- Changes to baseline health characteristics can mean that health impacts can be difficult to assess and monitor over the long term;
- A lack of available environmental data in respect of, for example, emissions to air can undermine assessments; and
- Changes in data collection methodologies over time may mean that it is not always possible to compare data sets.

Houghton *et al.*'s (2003) review of an investigation into health concerns in the Askeaton area of Limerick, meanwhile, found that limitations in respect of computerised health information systems prevented in-depth assessment and resulted in significant delay in the ability of the health board to respond to community concerns regarding the concentration of heavy industry in the Shannon Estuary.

With specific regard to HIA in the context of UGEE projects, Public Health England (2014, 44) highlights that HIA may be considered as a useful tool but notes that:

> "The objectives of an HIA would differ on a case-by-case basis, depending on the definition of health used, the type of development, the scale of the operation, the availability of data and the specific health outcome or issue under consideration. Lack of data and information may make an HIA difficult. HIAs can often be time and resource intensive; depending on their scope they can take months or even years. The scale and size of the development under consideration are also key factors since an HIA around a single drill site may have limited

value. Therefore, the potential of HIA to assess shale gas activities remains to be determined and HIA may not be needed for all developments."

The research summarised above suggests that the need for separate HIA in the context of UGEE requires careful consideration in order to understand the additional benefits it may offer over other forms of assessment such as SEA and EIA. *Section 4.7* considers how HIA and other forms of assessment have been applied in the context of UGEE plans and projects in part to help determine the need for standalone HIA.

4.7 Case Study Analysis

This section presents the findings of a case study analysis of HIA and other forms of health assessment undertaken in respect of UGEE plans and projects. The review sought to: understand how the health impacts of UGEE plans and projects have been assessed elsewhere; to identify any particular scoping and methodological requirements in the context of UGEE; and to evaluate the potential role of HIA in decision making.

4.7.1 Approach

A total of seven case studies were considered as part of the analysis. Case studies were sought that draw on experiences in the US (where UGEE has advanced to the production stage and where health impacts have potentially been experienced, measured and reported) and the UK (where the industry is in its infancy) at the national, regional (i.e. basin level) and local (project) level. An overview of the case studies considered in the analysis, together with the rationale for their selection, is provided in Table 4.1.

The review identified only a limited number of UGEE HIAs. In consequence, it was necessary to expand the reach of the case study analysis to include other assessments of UGEE plans and projects that considered health impacts, but which were not formal HIAs (such as SEA, EIA and public health reviews).

Each case study was reviewed, and the findings of the analysis were recorded in a standard format shown in Table 4.2. The analysis was sourced from publically available documents and associated websites. Case study reviews are contained at *Appendix 2.*

Table 4.1. HIA case study overview

Case study[a]	Year	Commissioning body (author)	Scale	Assessment type (e.g. HIA, SEA or EIA)	Rationale for selection
1. Public Health England Review of the Potential Public Health Impacts of Exposures to Chemical and Radioactive Pollutants as a Result of the Shale Gas Extraction Process	2014	Public Health England	National	Public Health Review	This review is not a formal, comprehensive HIA but does provide an example of a review of health impacts undertaken at a national level. The review considers the potential public health impact of direct emissions of chemicals and radioactive material from the extraction of shale gas. Other considerations such as climate change and greenhouse gas emissions, sustainable use of water resources, nuisance issues such as noise and odour, traffic (apart from vehicle exhaust emissions), occupational health, and visual impact, are not considered in this review. Similarly, the review does not consider the socioeconomic benefits or impacts of shale gas extraction. The case study is cited in other assessments of health impacts in the UK.
2. Strategic Environmental Assessment (SEA) for Further Onshore Oil and Gas Licensing	2013	Department of Energy and Climate Change (DECC)/(AMEC Environment & Infrastructure UK Ltd)	National	SEA	An example of how health impacts are considered at the national/strategic scale and at the plan level as part of the SEA process.
3. Marcellus Shale Public Health Study	2014	Maryland Department of Health and Mental Hygiene	Regional	Public Health Study	An example of an assessment of health impacts undertaken at a regional level. The case study is widely cited in academic literature.
4. New York State Public Health Review	2014	New York State Department of Health	Regional	Public Health Review	An example of an assessment of health impacts undertaken at a regional level and widely cited in academic literature.
5. HIA of Proposed Shale Gas Exploration Sites in Lancashire	2014	Lancashire County Council	Local	HIA	A UK project level example of HIA undertaken by the consenting authority.
6. Roseacre Wood and Preston New Road	2014	Cuadrilla Resources	Local	EIA	Provides a UK example of how health impacts are

Case study[a]	Year	Commissioning body (author)	Scale	Assessment type (e.g. HIA, SEA or EIA)	Rationale for selection
EIAs		(Arup)			taken into account in EIA.
7. Battlement Mesa HIA (2nd Draft)	2011	Garfield County Board of County Commissioners (Colorado School of Public Health)	Local	HIA	A US example of HIA undertaken at a local level on behalf of a regulator.

[a]See Appendix 2 for details of the case studies.

4.7.2 Case study analysis summary

The findings of the case study analysis are summarised below with regard to the scope of the health assessments considered; methodology and approach; assessment findings; and outcomes and influence.

4.7.2.1 Assessment scope

As set out in Section 4.3.1, HIA involves the consideration of the impacts of proposals across a wide range of health determinants. Table 4.2 summarises the health issues considered by the case studies.

Table 4.2. Case study scopes

Case study	Air quality	Water/soils	NORM	Transport	Noise	Greenhouse gases	Seismicity	Lighting	Community facilities	Physical Activity	Economy/ emplovment	Social and mental health	Occupational health
1. Public Health England Review of the Potential Public Health Impacts of Exposures to Chemical and Radioactive Pollutants as a Result of the Shale Gas Extraction Process	Y	Y	Y	N	N	N	N	N	N	N	N	N	N
2. SEA for Further Onshore Oil and Gas Licensing	Y	Y	Y	N	Y	N	N	Y	N	N	N	Y	Y
3. Marcellus Shale Public Health Study	Y	Y	Y	Y	Y	N	Y	N	Y	N	N	Y	Y
4. New York State Public Health Review	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	N
5. HIA of Proposed Shale Gas Exploration Sites in Lancashire	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N
6. Roseacre Wood and Preston New Road EIAs	Y	Y	Y	N	Y	N	N	N	N	Y	N	Y	N
7. Battlement Mesa HIA (2nd Draft)	Y	Y	N	Y	Y	N	N	Y	Y	N	Y	Y	N

Broadly, the range of health issues assessed across the case studies reflect both the health determinants identified in *Section 4.5* and the range of health impacts that may arise from UGEE projects and operations. The most common health issues or hazards considered in the case studies included air quality, water (including NORM), noise and social and mental health. Those topics that were less frequently included in the scope of the assessments included, in particular, economic and employment impacts and physical activity.

The findings of the case study analysis suggest that the extent to which these determinants are considered for UGEE plans and projects depends on, in particular, the type of assessment undertaken (i.e. whether HIA, SEA or EIA). Assessments of health contained in the SEA for Further Onshore Oil and Gas Licensing and the Roseacre Wood and Preston New Road EIAs were not as broad ranging in terms of the health topics considered. This is perhaps unsurprising given the focus of SEA and EIA on the assessment of significant environmental (as opposed to socio-economic) impacts and reflects wider research that has reviewed the extent to which health is adequately assessed in SEA and EIA. However, it is important to note that many of the health issues were addressed in other topics contained in the SEA and EIAs.

In many cases, the temporal scope of the assessments (i.e. the stages of the UGEE lifecycle for which health impacts were considered) was not explicitly defined with the emphasis tending to be on hydraulic fracturing activities.

4.7.2.2 Methodology and approach

The approach to health assessment adopted in the two formal HIAs reviewed as part of the case study analysis (the HIA of proposed shale gas exploration sites in Lancashire undertaken by Lancashire County Council and Battlement Mesa HIA) reflected the six stages of HIA outlined in Figure 4.2 and comprised:

- Screening;
- Scoping;
- Appraisal;
- Reporting;
- Supporting decision-makers; and
- Monitoring and evaluation.

Whilst not a formal HIA, this approach was also adopted in the Marcellus Shale Public Health Study and a number of the other case studies included scoping, assessment and reporting phases. For SEA and EIA this approach is broadly consistent with the respectively regulatory requirements for these assessments, although the scoping stages tended to focus less on potential health impacts. In this regard, the inclusion of health as a standalone topic in the Environmental Statements prepared for Roseacre Wood and Preston New Road was in response to Lancashire County Council's EIA Scoping Opinion and concerns raised by PHE.

In the Battlement Mesa HIA and Marcellus Shale Public Health Study, health issues (or "stressors"/"hazards") were scoped to identify those of most concern including through community engagement, literature review and baseline analysis. These assessments then ranked the health issues identified in terms of their likely significance using a set of pre-defined criteria. In the case of the Battlement Mesa HIA, this criteria took into account: direction of potential health effects; the relationship of geography to health effects; the likelihood of health effects occurring as a result of

development proposals; the presence of people considered especially vulnerable to the effects of the stressor; the estimated duration of exposure; the frequency of exposure when it does occur; and severity of the potential health effect. The assessment of each stressor included a review of its general impact on physical, mental and/or social health as described in relevant literature, a compilation and analysis of existing environmental and health data describing current conditions in Battlement Mesa, the means by which the developer (Antero) planned for drilling might alter the current conditions, and finally a characterisation of the stressor's impact on health. Several physical health outcomes linked to potential exposures were also considered, including respiratory, cardiovascular, cancer, psychiatric, and injury/motor vehicle-related impacts on vulnerable and general populations in the community. Similarly, in the Marcellus Shale Public Health Study, impacts were ranked based on: vulnerable populations; geographic extent; duration of exposure; frequency of exposure; likelihood of health effects; magnitude of health effects; and effectiveness of the setback.

For the most part, the assessments of health impacts relied on existing literature and peer reviewed research/data alongside engagement with communities, public health bodies, regulators and developers/operators. As part of the Marcellus Shale Public Health Study, raw data was collated and analysed in some instances which included noise monitoring at homes and at compressor stations. The HIA of proposed shale gas exploration sites in Lancashire and the assessments of health impacts undertaken by the developer as part of the respective EIAs, meanwhile, were able to draw on detailed topic-specific assessments undertaken as part of the wider EIA process (including, for example, noise and air quality monitoring) enabling a more quantitative based assessment.

A number of common methodological limitations have been identified through the case study analysis and that should be considered in the context of assessments of health impacts in respect of UGEE on the island of Ireland. These limitations include:

- A lack of data and research focused specifically on potential health impacts arising from UGEE and in particular concerning the connections between factors such as air and water pollution and health outcomes;
- The need for well-designed studies that evaluate the overall effect of UGEE on public health pre, during and post UGEE activities;
- A lack of consistent methods that are universally accepted regarding HIA which makes it difficult to compare different HIAs, including the ranking of impacts;
- A lack of data on individual level exposure to physical and chemical hazards associated with UGEE projects;
- Quantitative and cumulative assessments are often beyond the resources allocated to projects; and
- A need to ensure that the most recently available scientific evidence on health impacts has formed the basis for any assessment of health impacts.

4.7.2.3 Assessment findings

The range of health impacts identified in the assessments considered in the case study analysis broadly reflect those identified in Section 4.5. The HIA of proposed shale gas exploration sites in Lancashire, for example, found the most important health issues to be lack of public trust and confidence, stress and anxiety from uncertainty that could lead to poor mental wellbeing and noise related health effects due to continuous drilling.

The Battlement Mesa HIA concluded that air quality impacts were likely to produce significant negative health impacts to residents. Other "stressors" that may produce health impacts were considered to include traffic and noise. Similarly, the Marcellus Shale Public Health Study identified those hazards with the most likelihood of negative health impacts to include air quality but also healthcare infrastructure (i.e. increased pressures on healthcare services and facilities from an influx of migrant workers) and social determinants of health (specifically impacts arising from industrial vehicle movements such as motor vehicle crashes, increases in violent crime, sexually transmitted diseases, mental health problems and substance abuse).

Health impacts associated with water and noise, meanwhile, were assessed as being of moderately high significance. This study also considered the combined effect of cumulative exposures, as well as the interactions between chemical and non-chemical stressors. It found that the combined effect of UGEE related hazards described in the report may be higher than the simple sum, and that the impact will be more pronounced in disadvantaged communities and disproportionately felt by vulnerable subpopulations such as property owners without mineral rights, the elderly, children, and individuals with pre-existing diseases.

4.7.2.4 Outcomes and influence

The case study analysis has found that the assessment of health impacts at the national, regional and local level can have an important role in the identification of measures to mitigate adverse health impacts and enhance benefits, as a tool for engaging key stakeholders and public health bodies and communities, and in informing the decision making process.

At the national level, for example, the Environmental Report concerning the SEA for further onshore oil and gas licensing in the UK identified a number of measures to be considered at the project level to mitigate potential health impacts and which licence applicants were invited to indicate, in their Statements of Environmental Awareness prepared in support of licence applications, how they intended to incorporate into their planning and operations.

At the regional level, following the publication of the New York State Department of Health Public Health Review, hydraulic fracturing was banned within the state of New York. This decision was in part based on the findings of the Public Health Review and which concluded:

> "While a guarantee of absolute safety is not possible, an assessment of the risk to public health must be supported by adequate scientific information to determine with confidence that the overall risk is sufficiently low to justify proceeding with HVHF in New York. The current scientific information is insufficient. Furthermore, it is clear from the existing literature and experience that HVHF activity has resulted in environmental impacts that are potentially adverse to public health. Until the science provides sufficient information to determine the level of risk to public health from HVHF and whether the risks can be adequately managed, HVHF should not proceed in New York State."

The Marcellus Shale Public Health Study made 52 recommendations relating to, for example, disclosure of well stimulation materials; air quality; water and soil quality. Some (but not all) of the recommendations arising from the study were taken forward in the wider Marcellus Shale Safe Drilling Initiative Study and which informed the state Proposed Oil and Gas Resources Regulations that were designed to establish new oil and gas exploration and production standards (Maryland Department of the Environment, 2001).

At the local level, the HIA of proposed shale gas exploration sites in Lancashire made 45 recommendations, 16 of which specifically sought to inform the determination of UGEE applications at Roseacre Wood and Preston New Road. The recommendations identified in the HIA included that the County Council should undertake further noise assessments to determine the significant of noise impacts on residential receptors in close proximity to the sites. The County Council subsequently appointed specialist noise consultants to review the applicant's noise assessments contained in the respective EIAs, and to also undertake background monitoring at night. Following this additional assessment work, the application at Preston New Road was rejected on the grounds that included unacceptable noise impacts, against the recommendation of officers. The Roseacre Wood application was rejected on traffic grounds and in accordance with officer recommendations.

4.7.2.5 The strengths and weaknesses of standalone HIA, SEA and EIA

As set out in Section 4.6, there is ongoing debate with regard to the potential benefits of undertaking HIA including in respect of its relative merits when compared to an approach that integrates health considerations into other assessments, notably SEA and EIA. Based on the findings of the case study analysis, Table 4.3 draws together the key strengths and weaknesses of undertaking a standalone HIA compared to an integrated impact assessment approach (i.e. one that combines HIA with SEA or EIA) in the context of UGEE projects.

Table 4.3. The key strengths and weaknesses of HIA versus Integrated Impact Assessments

	Health Impact Assessment	**Integrated Impact Assessment**
Key Strengths	Standalone HIA helps to ensure that the full range of health impacts associated with UGEE projects are identified, assessed and reported. HIA can inform debate and decisions in respect of UGEE projects. HIA can raise awareness of the health issues associated with UGEE projects, prompting their mitigation. HIA can be means of securing stakeholder engagement on health issues. Independent HIA undertaken by a regulator can usefully assess the robustness of any assessment of health impacts undertaken by the developer.	Integrated impact assessment (IIA) can be a useful tool for considering the health impacts of UGEE projects by drawing together assessments (including primary data) across a wide range of health determinants. EIA/SEA are well established and therefore IIA is expected to help inform debate and decisions in respect of UGEE projects. IIA (through EIA and SEA) provides a mechanism for considering cumulative effects of developments. EIA/SEA have a legal basis.

	Health Impact Assessment	Integrated Impact Assessment
Key Weaknesses	There are information gaps that will need to be addressed through studies that consider health impacts before, during and after the implementation of projects. HIAs can be resource intensive and extend over prolonged periods. There may be unnecessary overlap between HIA and other types of assessment such as EIA. The consideration of cumulative impacts with potential future activities is problematic, particularly at the project level. There is no legal requirement to undertake HIA	There is currently no legal requirement to consider health impacts arising from UGEE projects. The inclusion of health as an EIA topic is therefore subject to the outcome of scoping. There is a risk that the full range of key health determinants are not fully considered. EIA and SEA generally focus on significant environmental impacts and may be less well suited to consider the wider impacts of the proposed development on the health and wellbeing of the affected communities. IIA may not actively involve health professionals in the assessment process. There are information gaps that will need to be addressed through studies that consider health impacts before, during and after the implementation of projects.

The comparative analysis presented in Table 4.3 above serves to demonstrate that HIA can be a useful tool in helping to ensure that the full range of health impacts arising from UGEE projects are described, assessed and, importantly, communicated. This is particularly pertinent given the range of potential health impacts that could be associated with such development (see Section 4.5 and Project B) and the lack of familiarity with the technology used in the Island of Ireland.

Notwithstanding the benefits identified, HIA is a potentially resource intensive process and one which may duplicate the consideration of health impacts as part of, in particular, EIA. Further, unlike SEA and EIA, HIA does not have any legal basis which may undermine the weight given to the findings of assessments in decisions relating to UGEE plans and projects.

The case study analysis has revealed that SEA and EIA are likely to have a role in the assessment of health impacts arising from UGEE plans and projects. EIA in particular provides scope to draw on a range of assessments (for example, in relation to air quality, noise, transport and the economy) to provide a holistic health assessment of proposals. However, as evidenced by the scope of the Roseacre Wood and Preston New Road EIAs, there is a risk that the full range of key health determinants may not be fully considered.

4.7.2.6 Key lessons

Regardless of whether HIA is undertaken as a standalone or integrated assessment, the case study analysis has identified a number of important lessons that cut-across the case studies and that could be considered in an assessment of UGEE projects. These lessons are summarised in Box 4.1.

Box 4.1. Key Lessons Derived from the Case Study Analysis

- Effective and wide ranging stakeholder and community engagement in the assessment process is essential. Advisory groups can usefully support the assessment process.
- Scoping, informed by robust baseline information, can help to focus the assessment on those issues that are most prevalent to potentially affected communities.
- Assessments should reflect the most recently available information, research and data.
- Ranking systems and criteria can be used to usefully highlight the most significant risks to health.
- Ensuring that there is sufficient time and resources available to conduct a robust assessment is critical. HIA can become resource intensive and extend over a long time frame. If proposals are delayed there is a danger that any HIA may become outdated/not utilised effectively.
- There is a need to adopt a common approach to HIA so that findings can be compared objectively.
- Monitoring protocols, which focus on the need to monitor conditions before, during and after activities, may be necessary as part of the HIA process.
- It may be necessary to determine the extent to which baseline surveys are required to inform the assessment.

4.8 HIA Guidance Review

Should HIA be used as a tool to assess and mitigate the risk of adverse health impacts that may arise from UGEE projects in Ireland and Northern Ireland (either alone or as part of an integrated assessment), it is important to determine whether existing guidance on HIA provides a sufficiently robust framework to guide the assessment process. In this context, this section is a review of HIA guidance in Ireland and Northern Ireland as well as that specifically concerning oil and gas projects.

4.8.1 HIA guidance in Ireland and Northern Ireland

The IPHI (2009) *Health Impact Assessment Guidance*[37] is the principal guidance on HIA in both Ireland and Northern Ireland. Alongside a range on online tools[38], the guidance covers the key HIA stages of screening, scoping, appraisal, reporting and monitoring and is broadly consistent with UK and WHO guidance on HIA (e.g. WHO European Centre for Health Policy, 1999; Merseyside Health Impact Assessment Steering Group, 2001; Wales Health Impact Assessment Support Unit, 2012). It identifies a number of key methodological issues to consider when undertaking HIA, which are relevant to HIA in the context of UGEE plans and projects. These issues are summarised in Box 4.2.

37 Available online: http://www.publichealth.ie/ireland/hiaresources (accessed June 2015).
38 See http://www.publichealth.ie/hia (accessed June 2015).

Box 4.2. Issues to Consider in Undertaking HIA Identified in IPHI Guidance

Support

At the outset it is useful to identify the support that is likely to be available for HIA. This can be a critical factor in commencing or in determining the ease with which HIA can be conducted and recommendations implemented. This may include reviewing relevant government or political processes and the identification of resources available to conduct the HIA.

Ensuring a broad understanding of health and its determinants

Health in HIA is understood to encompass physical, mental and social wellbeing. It also emphasises the social, economic and environmental determinants of health. This perspective is essential in helping to decide where a HIA might be appropriate, the type of research needed and if any specialist assistance is required.

Timing

It is important to be clear about what stage the policy, programme or project is at when undertaking HIA. This will impact upon the level of influence the HIA recommendations may have. HIA may be undertaken prospectively, concurrently or retrospectively. Ideally HIA would be carried out prospectively, i.e. when the proposal is being developed, so that HIA recommendations have the potential to influence decisions being made.

Level

HIA can be conducted at different levels depending on a range of factors including:

- The status and complexity of the policy, programme or project
- Locally determined health priorities and targets
- The potential scale and severity of health impacts
- The quality of the evidence base and availability of data
- The support for HIA at regional and local level

The resources available to conduct HIA.

Source: Institute of Public Health Ireland (2009)

Overall, the IPHI guidance provides a good methodological basis for the HIA of UGEE plans and projects. However, it is generic and there is a lack of sector-specific guidance relating to the assessment of health impacts of UGEE plans and projects in Ireland and Northern Ireland. Further, there are no known examples of the application of the IPHI Guidance to the oil and gas sector through which its effectiveness in this context could be determined.

4.8.2 HIA Guidance in the oil and gas sector

There is limited guidance in relation to HIA in the oil and gas sector and this review has not identify any specific guidance concerning the application of HIA to UGEE. International Petroleum Industry

Environmental Conservation Association (IPIECA) and International Association of Oil & Gas Producers (OPG) (2005) provides the most comprehensive guidance on HIA in the oil and gas sector. This guidance: defines and outlines the purpose and value of HIAs within the oil and gas sector; describes the overall HIA process; and seeks to create a common understanding of the basic concerns, principles and practices of HIA that would be relevant across a diversity of projects.

Like the more generic HIA guidance produced by the IPHI and others, the IPIECA/OPG guidance provides advice in relation to when to undertake HIA, the type of HIA to be undertaken and the scope of HIA as well as the key stages in the HIA process. It also includes a set of guiding principles for HIA in the oil and gas sector and which are reproduced in Box 4.3.

Box 4.3. HIA Guiding Principles Identified in IPIECA and OPG Guidance

- Choose the overall HIA level, policy, project or both.
- Choose the appropriate type of HIA—rapid appraisal or comprehensive.
- Routinely integrate some level (rapid appraisal or comprehensive) of the HIA process into the overall project development process.
- Carefully consider and design the scope of the assessment so that it is realistic and achievable.
- Define and document appropriate baseline conditions.
- Stakeholder consultation and communication is critical and such a programme should be carefully planned and implemented where appropriate.
- A well-executed and documented qualitative or semi-quantitative ranking system is more realistic than an overly uncertain and theoretical attempt at quantification.
- Certain high profile diseases like malaria, tuberculosis and HIV/AIDS may require separate intensive evaluation and assessment.
- A realistic implementation plan should be developed that recognises host country capacity constraints but still clearly defines roles, responsibilities and accountability.
- For large and high profile projects that are likely to impact multiple communities, a well-designed surveillance and monitoring system is appropriate so that early awareness of novel or unexpected impacts is available.
- Senior management commitment to the process is critical.
- National and international sensitivities to certain topics addressed must be recognised. This includes recognising that the analysis may include potential issues that may adversely reflect on the existing conditions in certain cultures or communities.

Of note, the IPIECA/OPG guidance states that if environmental and/or social impact assessments are undertaken as part of a proposed project then a comprehensive HIA is also appropriate. It states that large oil field developments, pipelines, liquid natural gas (LNG) facilities, chemical plants and refineries are major capital investments that would be appropriate projects for a comprehensive HIA.

For the most part, the IPIECA/OPG guidance is generic rather than specific to a particular activity or type of oil and gas development, such as UGEE. Where the guidance is more sector specific, it is arguably tailored to less developed countries where HIA is not well established (for example, the guidance identifies a set of "critical health areas of concern" that appear to be applicable to projects in low Human Development Index settings such as sub-Saharan Africa). This implies that more tailored guidance is required detailing how the HIA process should be applied in the context of UGEE and covering, for example:

- Who should undertake HIA and when;
- What risks and health specific impacts should be assessed;
- Who should be involved in HIA;
- Information sources; and
- Example mitigation measures.

4.9 Conclusions

The potential range of health impacts associated with UGEE are broad and cut across many health determinants. Relative to many other types of development, UGEE projects are more complex and use technologies and involve activities that are novel in an Irish context and that are also the subject of public concern. There are also information gaps relating to the health impacts of UGEE projects. This suggests a lack of identification and assessment of potential health impacts of UGEE plans and projects.

There is a regulatory framework in place at the EU and national level that is expected to manage health impacts arising from UGEE projects. Through SEA and EIA there are existing mechanisms for assessing the potential health impacts. Nonetheless, there is uncertainty with regard to the extent to which SEA and EIA are the most appropriate tools to assess the full range of health impacts that could arise from UGEE plans and projects. In the context of Northern Ireland and Ireland, onshore UGEE licence applications are also made on a case-by-case basis and so, health impacts associated with UGEE would not be considered at the plan (SEA) level. This implies that there is a case for the application of HIA in the context of UGEE in the Island of Ireland.

The case study analysis contained in Appendix 2 and summarised in *Section 4.7* has demonstrated the important role that HIA could have in decisions relating to UGEE. In particular, HIA could:

- Raise awareness amongst decision makers, developers/operators, stakeholders and communities of the health implications of UGEE plans and projects;
- Aid transparency in the decision making process;
- Ensure that assessments of health impacts are evidence based;
- Act as a vehicle for community and stakeholder engagement on health issues; and
- Support the identification of measures for mitigating adverse health impacts and enhancing benefits associated with UGEE plans and projects.

Despite the benefits of HIA, this review has identified a number of potential disadvantages or challenges associated with this type of assessment. In particular, as there is no legal requirement to undertake HIA, any assessment would be carried out on a voluntary basis only (if at all) and the capacity of an assessment to influence decisions may be limited. Further, HIAs can be resource

intensive, extend over prolonged periods and may result in the duplication of assessment contained in EIAs. From an Ireland and Northern Ireland perspective, it is also important to note that the practice of HIA is limited and the process underdeveloped, which may undermine its robustness and effectiveness when applied to UGEE. In consequence, the need for separate HIA in the context of UGEE requires careful consideration and may not be appropriate in all circumstances.

Regardless of whether HIA is undertaken as a standalone or integrated assessment, there are a number of important methodological limitations that need to be addressed in order to ensure that any health assessment is effective. In particular, a lack of data availability (including environmental baseline information) and information in respect of health impacts arising from UGEE projects are critical issues which may only be addressed as projects come forward and schemes are monitored. In consequence, any health assessment will need to be proportionate to the data and information available.

The methodological limitations outlined above, allied with the complexities of UGEE and the range of potential health impacts that could occur, mean that there may be merit in developing specific guidance relating to the application of HIA in the context of UGEE. This guidance could be prepared with input from other regulatory, government and industry stakeholders and specifically seek to address issues relating to assessment scope, baseline data gathering and data availability, setting out a common approach to the identification of significant health impacts whether through a standalone HIA or integrated impact assessment.

Based on the evaluation of the role of HIA in respect of UGEE presented in this chapter, there are a number of possible approaches for taking forward health assessment in Ireland and Northern Ireland. These include:

1. *No additional requirement for HIA***.** HIA would not be a requirement for UGEE plans and projects. Instead, the assessment of health impacts would be undertaken through SEA (should licensing plans come forward) and EIA. Should this approach be taken forward, then it would be important that additional guidance on the assessment of health impacts arising from UGEE is prepared to ensure that assessments adequately consider health issues. This guidance should seek to ensure that HIA principles are incorporated into the SEA/EIA processes.

2. *Non-mandatory recommendation for HIA.* HIA would not be mandatory but guidance would make clear that HIA of both plans and projects is recommended and encouraged. Guidance could set out when HIA should be undertaken, taking into account the scale and location of proposals.

3. *Mandatory requirement for HIA***.** HIA would be a licence requirement. This approach may still require the preparation of specific guidance relating to HIA in the context of UGEE to ensure that a consistent approach is followed.

Taking into account the potential health impacts of UGEE projects identified in Section 4.5, the key lessons identified through the case study analysis in Section 4.7 and review of existing guidance on HIA (Section 4.8), a number of guiding principles have been identified (see Box 4.4), which may provide the basis for a protocol for any HIA in Ireland and Northern Ireland, whether standalone or integrated.

Box 4.4. Guiding Principles for HIA of UGEE in Ireland and Northern Ireland

At what scale should HIA be undertaken?

HIA can usefully be applied at the plan level or project stage. In the context of the Island of Ireland, this would be likely to include any future sub-regional or basin level assessments and individual project assessments.

When should HIA be undertaken?

Prospective HIA should be undertaken in all cases however, ongoing monitoring and assessment of health impacts during operation and at completion should be undertaken.

Who should be responsible for HIA?

The responsibility for HIA will be dependent on the plan or project. At the project stage there is value in HIA being undertaken by the developer/operator and, potentially, independently by the regulator (on a voluntary basis). For any HIA, it is important that the assessment is undertaken by a competent specialist.

Who should be involved in the HIA process?

HIA should proactively engage with key stakeholders including public health bodies, potentially affected communities, relevant regulators and operators/developers. Consideration should be given to the establishment of a steering or advisory group to guide the HIA process from the outset.

What impacts/issues should the HIA consider?

The topics to be considered in any HIA should be determined through a robust scoping process. This process should involve engagement with a range of stakeholders and potentially affected communities, a review of the most recently available evidence on UGEE health impacts and community profiles. The following topics are likely to be of particular relevance to UGEE plans and projects:

- Air quality impacts;
- Drinking water contamination and reduced availability;
- Surface water contamination and runoff;
- Noise;
- Mental health impacts;
- Climate change effects;
- Socio-economic impacts (such as jobs creation, pressure on services and facilities, crime and increased traffic);

- Occupational impacts; and
- Cumulative impacts.

HIA should consider health impacts across the principal stages of the UGEE lifecycle including:

- Exploration;
- Appraisal;
- Development and production;
- Decommissioning, restoration and aftercare.

It will be important to take into account resource availability and the timing of any assessment to ensure that the scope of the HIA is proportionate. A project management approach to undertaking the HIA will be essential.

What should be the approach to HIA?

In most cases, a comprehensive HIA will be the most appropriate type of HIA. The approach to HIA should follow the five key stages outlined in the IPHI Guidance, namely:

1. Screening
2. Scoping
3. Appraisal
4. Reporting
5. Supporting decision-makers
6. Monitoring and evaluation.

The assessment itself could seek to rank risks using pre-defined criteria to identify the most significant health impacts. The findings of the assessment including mitigation and enhancement measures should be widely disseminated to ensure transparency and subsequent monitoring undertaken.

What are the likely data requirements for HIA?

Assessments should be based upon the most recently available evidence including baseline information concerning the specific characteristics of potentially affected communities, existing research and academic literature concerning the health impacts of UGEE in other localities and, where possible, quantitative data drawn from, for example, EIA. Engagement can also be a useful information source. Where information gaps are identified, specific monitoring may be required.

5 Best Practice for UGEE Projects/Operations

5.1 Introduction

This section examines regulatory enforcement requirements and best operational practices for UGEE projects and operations.

5.2 Method

The assessment of regulatory enforcement requirements and best operational practices for UGEE was carried out through the following activities:

- Mapping and classification of enforcement requirements and best operational practice (collectively identified as measures) through links to Project B, Task 1 of Project C and by reference to a previous assessment by the European Commission (EC);
- Determination of whether these measures are definitely, or only may be, required by the existing regulatory framework;
- Determination of which measures may be applied either through regulation (e.g. permit requirements) or typical industry practice;
- Links to Best Available Technology (BAT) requirements under the Mining Waste Directive and others; and
- Links to the EPA's existing and possible future requirements for financial provision.

The work has made extensive use of earlier work by Amec Foster Wheeler for the European Commission (the EC study) (Amec Foster Wheeler, 2014). This work is particularly useful and authoritative because it:

- Identified a comprehensive list of measures that might be used to mitigate the risks from UGEE;
- Examined the regulatory framework for UGEE at a European level to determine which measures are definitely required and those that may be required by European legislation; and
- Examined which measures constitute typical practice by industry and their likely rate of uptake.

The work was undertaken by a group that included experts in European legislation and UGEE. It was subject to extensive review within the European Commission and by external peer reviewers before publication.

The results of the work have been mapped onto Island of Ireland regulations to consider whether these impose any additional requirements.

Good operational practice, set out in Project B, has also informed the analysis of best practice for UGEE operations. The range of mitigation measures identified in Project B has been compared to the mitigation measures from the EC review to ensure that they are all covered.

The regulation of UGEE on the Island of Ireland has been considered by reference to: the national legislation identified in Task 1; and to specific guidance on regulation for UGEE in Northern Ireland (DECC, 2013).

Additional guidance on the likely requirements of permits and authorisations has been taken from the approach set out on in the Environment Agency for England's 2013 "Onshore oil and gas exploratory operations: technical guidance" and the Scottish Environmental Protection Agency (SEPA) 2012 "Regulatory guidance: coal bed methane and shale gas." The Environment Agency guidance is in the form of a consultation draft and is likely to be revised following an extensive consultation process.

5.3 Results

5.3.1 Mapping and classification of enforcement requirements and best operational practice

To map and classify enforcement requirements, the EC study:

- Identified risks from UGEE;
- Identified measures that could mitigate those risks; and
- Reviewed the application of the acquis communautaire to establish whether or not measures are required by the current EU legal framework (i.e. are definitely stated as being required in the legislation).

The risks and measures identified in the EC study were based on an extensive review of literature including regulatory documents, best practice guidance, codes of practice and research reports to establish the available and applied requirements and practices combined with practical experience in UGEE operations. The measures cover a full spectrum of environmental impacts from UGEE. These measures have been compared to the work undertaken in Project B to ensure that there are no gaps.

Measures were classified into those measures definitely required by application of the *acquis*, which were identified as business as usual (BAU), and those measure not definitely required by the *acquis*, which were considered non-BAU.

Consideration of the project lifecycle and wide range of risks presented by UGEE identified 237 measures, which were subject to further scrutiny. The risks and measures were categorised into the following themes:

- Zoning. The risks posed by UGEE could be mitigated by zoning (land use planning) measures;
- Underground risks. Well drilling, hydraulic fracturing and production of unconventional gas pose risks related to: groundwater contamination; the integrity of rock formations; and the likelihood, scale and frequency of induced seismic activity. These risks are collectively referred to as underground risks;
- Chemical use. The primary risks of concern with chemicals used in UGEE relate to the potential release to the wider environment and subsequent exposure of people and contamination of water resources or other environmental media. This may occur through underground release pathways, releases at the surface resulting from spills and accidents or through presence in flowback water and subsequent release
- Water depletion. Fracturing requires supply of water. To supply this water, operators typically require either groundwater or surface water. Extraction of groundwater could lower water tables, dewater aquifers and possibly cause changes in water quality (e.g. chemical contamination from mineral exposure to an aerobic environment and bacterial growth due to lower a water table) during the stages of the life cycle involving fracturing. Extraction of surface water could have impacts on hydrology and hydrodynamics altering the flow regime and water quality. There are potential cumulative effects from a large numbers of operations,

particularly in drought and dry periods but also in wet regions where there are stresses within existing water supplies due to substantial demands or limited infrastructure.

- Surface water. Risks of pollution of surface water arise from leaks and spills of flowback and/or produced water prior to treatment and disposal, as well as of chemicals, fracturing fluid and mud and stemming from construction activities. Leakage and spillage could occur during storage (e.g. tank failure) and/or general operation (e.g. pipelines and treatment facilities). There is also risk of pollution due to well failure and induced fractures providing underground pathways to groundwater and subsequently surface water and from improperly treated flowback or produced water leading to pollution of surface water following discharge;

- Air Quality. Diesel engines that provide power for drilling and fracturing operations and vehicles used on the site and for haulage associated with the site may be required at a significant scale. These engines generate emissions of air pollutants (e.g. NOx, SOx and particulate matter (PM)) and greenhouse gases (e.g. CO_2). In addition, gas releases from flowback and produced water may be potentially significant due to the cumulative effect of many wells over long time periods. Fugitive methane and hydrogen sulphides or flared combustion gases released during drilling and well completion require management;

- Waste. Well drilling, hydraulic fracturing, production of unconventional gas and well plugging/testing generate a significant volume of waste, in particular in the form of flowback, produced water and drilling mud. Types of pollutants likely to be present in wastewater and indicators of water pollution include VOCs, metals, petroleum hydrocarbons, NORM, oil and grease, BTEX, SVOCs, TDS, pH, sulphates, H_2S, heavy metals, biocides, emulsion breakers and corrosion inhibitors;

- Post Closure. Following the closure of UGEE wells, there is a concern that there could be longer-term impacts on the environment. For example, the long timescales with which groundwater takes to flow in some cases means that contaminants could potentially appear in water supplies long after closure. Similarly, geological or seismic events after well closure could potentially lead to new exposure pathways for contaminants that remain underground following hydraulic fracturing to groundwater and surface water. There is also the potential for gas to escape due to well failure, leading to safety and environmental risks;

- Public acceptance. UGEE developments have, in certain instances, caused significant public concern and opposition. Public concern may be motivated by a range of issues, from opposition to UGEE wherever it occurs; concern over environmental damage; to localised concerns over property values, livelihoods; health and safety implications and noise and other disturbance; and

- Other. These are risk management measures not categorised elsewhere

The key risk mitigation measures identified by the EC study were:

- Zoning: A range of measures to prevent or mitigate impacts on specific, sensitive environments and land uses.

- Underground risks:

    - Establishment of a geological, hydrogeological and seismic data and conceptual baseline model of the area under exploration;

    - Modelling of the fracture programme in advance and a requirement for smaller pre-injection stimulations prior to main operations to enable induced seismicity response to be assessed and managed;

  - Requirements for well safety and integrity testing; and
  - Monitoring of underground conditions (e.g. groundwater, seismicity) during exploration, production and following well closure.

- Chemicals:
  - The assessment of chemicals to be used in hydraulic fracturing, with particular reference to their behaviour under hydraulic fracturing conditions and consideration of potential transformation products and mixtures in the underground context;
  - The selection of chemicals to: reduce potential impacts on the environment once released; which minimise flowback treatment requirements; or which result in only inert materials being used; and
  - The disclosure of chemical usage to competent authorities and the public.
- Water depletion:
  - A range of measures addressing: the development of demand profiles for water use; development of water management planning; and reuse of wastewater to minimise demand.
- Surface water quality:
  - Measures to provide pollution prevention through: provision of spill kits; site construction (e.g. bunding of pads, impervious liner under the site); equipment (bunded tanks, level alarms); and monitoring of surface water bodies.
- Air quality:
  - Measures to address emissions from on-site power generation through either fuel or power source substitution or emissions abatement; and
  - Reduced emissions completions to prevent/minimise releases from gas venting from the well and flowback and produced water through flaring and/or gas capture.
- Waste:
  - Measures focussed on monitoring flowback and produced water characteristics to enable appropriate treatment and to secure the appropriate treatment of the wastewaters.
- Post closure:
  - Abandonment surveys for various parameters; inspections and maintenance; and requirements for retention of ownership and liability for damage, the transfer of responsibilities and financial guarantees/contributions from operators to cover costs of monitoring and remedial actions.
- Public acceptance for both operators and Competent Authorities:
  - Key measures for operators centre on disclosure of information and engagement of the public. For Competent Authorities, measures focus on provision of information on licences/permits and other relevant information regarding unconventional gas.
- Other measures:

- This covers a range of aspects such as incident response (contingency planning emergency response), assurance and delivery (including development of the capacity of Member State competent authorities), noise management and mitigation, environmental permitting and assessment and transportation measures.

The full list of measures is provided in the EC study. Measures that are definitely required and measures that may be required are considered in following sections.

Project B has identified specific mitigation measures for some of the impacts of UGEE that are covered in a more general sense in the EC study. For example, Project B has suggested specific measures to extend each lateral wellbore as far as technically and legally possible to reduce the total number of wells required within a spacing unit. In the EC study, this is covered by a broader measure to maximise efficiency of operations.

5.3.2 Determination of whether the measures are definitely or only may be required by the existing regulatory framework

In the EC study measures were subject to analysis to consider whether the measures were either *definitely required* by EU legislation (BAU) or only *may be required* (non-BAU measures), i.e. there was uncertainty whether the measure would definitely be required by a permit or implementation of the Directive's objectives. For the current project, this analysis has been extended to consider whether regulation on the Island of Ireland would definitely require some of the measures that only "may be" required by EU legislation.

There are some areas where regulation on the Island of Ireland is likely to be more robust than at the EU level. The main areas are:

- Health and Safety (H&S) legislation in Northern Ireland and Ireland that is specific to oil and gas, including UGEE; and
- Mandatory requirement for EIA for UGEE projects involving deep drilling Ireland (Deep drilling - EU (EIA) (Planning and Development) Regulations 2014 SI 543/2014).

In Northern Ireland H&S legislation specific to oil and gas is implemented through the Offshore Installations and Wells (Design and Construction, etc.) Regulations (SI 1996/913) and the Borehole Sites and Operations Regulations (Northern Ireland) SR 1995/491. These have requirements for operators to:

- Demonstrate competency;
- Ensure that a well is designed, modified, commissioned, constructed, equipped, operated, maintained, suspended and abandoned so that risks are "as low as reasonably practicable" (ALARP);
- Conduct an assessment of conditions below ground before starting a well;
- Ensure that the design and construction of a well satisfactorily address subsequent suspension and abandonment;
- Promote competence in those who carry out well operations by ensuring they receive appropriate information, instruction, training and supervision; and
- Maintain well control through risk assessment, based on existing information, and ensuring that adequate equipment is in place.

In Ireland, a safety framework (the Framework) for offshore and onshore oil and gas operations is provided by the Electricity Regulation Act 1999 as amended by the Petroleum (Exploration and Extraction) Safety Act 2010 and The Petroleum (Exploration and Extraction) Safety Act 2015. The 2015 Act brings EU Directive 2013/30/EU[39] into force. The Commission for Energy Regulation (CER) is the competent authority for petroleum activities. The 2015 Act extends the scope of the Framework to cover the risk and potential consequences of major accidents including major offshore (but not onshore) environmental incidents. The Framework is a risk-based, objective orientated safety regime that requires that the risks associated with petroleum activities are reduced to a level that is "as low as reasonably possible" (ALARP). The CER provides guidance on the processes required to demonstrate that a process is ALARP (CER, 2013a). The Framework requires oil and gas operators to:

- Reduce all safety risks to workers and the public to ALARP;
- Submit a safety case to the CER, to obtain a safety permit; and
- Report incidents to the CER.

Details of the requirements for adherence to the petroleum safety framework are set out in CER guidance, rather than in legislation.

A safety permit is required from the CER to carry out designated petroleum activities, as listed in Petroleum Safety (Designation of Certain Classes of Petroleum Activity) Regulations 2013 SI 89 of 2013. Designated petroleum activities include, exploration, production and decommissioning. To obtain a safety permit from the CER, the ALARP demonstration within the safety case must be acceptable.

A petroleum activity is defined broadly as:

> "1. Any petroleum activity or discontinuance of a petroleum activity (whether permanently or temporarily) in relation to a well including: Digging, drilling, boring, or sinking of shafts for the purposes of raising petroleum; Testing and completion of wells; Well interventions and workovers; Re-injection of petroleum, water or any other material into a well; Plugging, blocking, capping, or abandonment of any well whether temporarily or permanently.
>
> 2. Production, excluding the conveyance of petroleum by means other than pipeline.
>
> 3. Decommissioning of petroleum infrastructure until such time as: In respect of a well, the well is abandoned; and In respect of petroleum infrastructure other than a well, any apparatus designed to contain or convey petroleum that comprises or forms part of such petroleum infrastructure is free of hydrocarbon." (CER, 2015)

From the EC study and Island of Ireland legislation measures were grouped into those that are:

- *Definitely required* by existing European or Island of Ireland legislation; and
- Those which only *may be required* by legislation.

The measures that are definitely required by EC Directives and Regulations are listed in Table 5.1.

39 Directive 2013/30/EU of the European Parliament and of the Council of 12 June 2013 on safety of offshore oil and gas operations and amending Directive 2004/35/EC.

Additional measures definitely required by regulation on the Island of Ireland are set out in Table 5.2.

Table 5.1. Business as usual measures required by EC Directives or Regulation (after Amec Foster Wheeler, 2014)

No.	Measure description	EC Directive or EC Regulation that requires this measure
Underground risks		
13a	Operators to draw up a plan for closure of a waste facility[a] (i.e. check that the waste facility ensures short and long term safe disposal; close the waste facility)	MWD
27f	Operators keep records of all waste management operations and make them available for inspection (e.g. of flowback, produced water management)	MWD & WSR
28c	Reporting of major accidents to a competent authority for Category A waste facilities covered under Mining Waste Directive	MWD
Chemical usage		
CAB1	REACH registration (for substances subject to registration), including chemical safety assessment for relevant substances to demonstrate safe use (by chemical manufacturer/importer)	REACH
CAB2	Downstream user (operator) complies with risk management measures in REACH registration (for substances subject to registration)	REACH
CAB3	Approval of biocidal active substance and authorisation of biocidal products for defined product types based on assessment of risks	BPR
CSB1	Avoid substances not registered under REACH for the relevant use (unless exempted from REACH registration)	REACH
CSB2	If use of substances subject to restriction (Annex XVII), comply with the conditions for restriction; if use of "substances of very high concern', comply with the conditions for authorisation (for substances on Annex XIV) of REACH	REACH
CSB3	Avoid biocidal active substances without approval and biocidal products without authorisation	BPR
CDB1	Identified (potential) uses of substances registered under REACH made available to public on ECHA website per substance	REACH
CDB2	Chemical suppliers provide safety data sheet to operator for relevant substances, including (eco)toxicological hazard and properties data, with exposure scenario and required risk management measures	REACH/CLP
CDB3	REACH competent authority can access data available on substances used by operator	REACH
Surface water		
33k	Technical development and training of staff for the management of waste facilities (e.g. pollution prevention training)	MWD
Waste		
10a	Characterisation of waste and wastewaters by operator prior to treatment	MWD & REACH & BPR

No.	Measure description	EC Directive or EC Regulation that requires this measure
30f	Traceability of hazardous waste from production to final destination	MWD
36d	Require wastewater treatment/processing: i) processing of flowback for recycling ii) treatment of flowback for discharge to surface water	MWD
36e	Duty of care/chain of custody arrangements for waste transfer between Member States or to third countries	WSR
Post closure		
29d	Site inspection and assessment prior to and after closure of waste facilities	MWD
43a	Land affected by a waste facility is rehabilitated	MWD
43b	Post closure waste facility monitoring	MWD
43d	Post closure waste facility maintenance	MWD
Other		
14a	Operators provide a financial guarantee or equivalent prior to waste management operations	MWD
42a	Environmental Impact Assessment for pipelines (above specified threshold)	EIAD
N14	Mandatory EIA for all projects involving extraction of over 500,000 m^3 gas per day. Assessment of whether deep drilling projects and surface industrial installations for gas extraction are likely to have significant effects on the environment regardless of amount extracted (screening)	EIAD

[a]Designated structures - whether natural or artificial - where extractive waste is intentionally accumulated or deposited, qualify as "waste facilities', under MWD. This covers underground structures designated by the operator as areas where residuals of fracturing fluids remain after the fracturing operations;

BPR Biocidal Products Regulations; CLP Regulation for Classification, Labelling and Packaging; EIAD Environmental Impact Assessment Directive; MWD Mining Waste Directive; REACH Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals; WSR Waste Shipment Regulations.

Table 5.2. Business as usual measures required by regulation on the island of Ireland

No.	Measure description	Regulation that requires this measure	
Other		**Northern Ireland**	**Ireland**
9a	Consideration of major hazards for all stages in the life cycle of the development and development of safety case demonstrating adequacy of the design, operations and safety management (including emergency response) for both safety and environmental major impacts	BSOR	PEESA HSA -
9b	Emergency response plan developed and put in place.	BSOR	PEESA -
Underground risks			
22a	Maintain well safety	OIWR & BSOR	PEESA -
29a	Good practice construction/deconstruction practices, including design for well	OIWR & BSOR	PEESA

No.	Measure description	Regulation that requires this measure	
	abandonment		
26d	Development of a conceptual model of the zone before work commences covering geology, groundwater flows, pathways, microseismicity and updating of the model as information becomes available	OIWR & BSOR	
26g	Implementation of remedial measures if well failure occurs	OIWR & BSOR	

OIWR, Offshore Installations and Wells (Design and Construction, etc.) Regulations (SI 1996/913).
BSOR, Borehole Sites and Operations Regulations (Northern Ireland) SR 1995/491.
PEESA, Electricity Regulation Act 1999 as amended by the Petroleum (Exploration and Extraction) Safety Act 2010.

5.3.3 Determination of which measures may be applied

Those measures that are not definitely required by EU or Island of Ireland legislation but may be required could be applied through:

- Land use planning;
- Petroleum authorisation or licensing conditions issued by DCENR (Ireland) and DETI (Northern Ireland) abbreviated to petroleum licence (PL) here; and
- Conditions set in EPA licences (Ireland) or environmental permits and licences (NI) collectively referred to as permits here covering: discharges to groundwater; water abstraction; waste management; pollution prevention; radioactive substances; and protection of conservation areas; and
- Typical practice by industry. Such measures are likely to be adopted by operators regardless of legislation, PL or permit requirements (e.g. due to standard industry practice, or to minimise financial risk of investments).

Measures that are likely to be applied by PL and permit conditions and those likely to be applied through typical industry practice regardless of legislative requirements have been considered as "may be applied'.

The results of this analysis is a list of measures that may be applied. The results are provided in Table 5.3 where the most likely route by which they could be applied on the Island of Ireland based on a brief review of the DECC roadmap, Irish legislation and by consideration of the approach taken in England and Scotland.

Other measures listed in the EC study but not included in Tables 5.1, 5.2 and 5.3 are considered unlikely to be applied. The exceptions were measures identified in Project B. A specific measure identified by Project B was a requirement for deep monitoring boreholes. This is likely to have specific applicability to the Island or Ireland where shale gas deposits are at relatively shallow depth and in relatively close proximity to aquifers.

Northern Ireland

For Northern Ireland, the review considered the requirements of PL and permits. PLs include requirements to:

- Generally, follow good practice;

- Have adequate operational and environmental management controls in place;
- Undertake an environmental risk assessment (ERA) at an early stage. This is an overview assessment of environmental risks, including risks to human health, covering the full cycle of the proposed operations, including well abandonment, with the participation of stakeholders, including local communities;
- Demonstrate of operator competency;
- Develop a conceptual model for the borehole; and
- Provide a hydraulic fracture plan to address seismicity and demonstrate how hydraulic fracturing will be undertaken to minimise seismic risks;

Good practice in the UK, including Northern Ireland, is set out in UK Onshore Operators' Group (UKOOG) "UK Onshore Shale Gas Well Guidelines. Exploration and Appraisal Stage" (UKOOG, 2015). These guidelines are likely to influence good practice in Ireland but do not appear to have been formally endorsed. In the UK, licence holders are required to follow good practice and so will need to have regard to these guidelines.

The UKOOG guidelines focus on the exploration and appraisal stages and do not extend to the production and closure stages. The approach of the guidelines is based on objective-setting rather than prescriptive requirements. It reflects the existing UK regulatory framework and addresses the following:

- Well design and construction;
- Fracturing/flowback operations;
- Environmental management (construction and operations);
- Fracturing fluids and water management;
- Minimising fugitive emissions to air; and
- A proposed format for the public disclosure of fracture fluids.

The UKOOG guidelines are a first attempt to set out and encourage the industry to operate to a consistent set of objectives (specific measures are not proposed) focussed on the early stages of development. The adoption of the objectives by industry is entirely voluntary, addressing the UK perspective.

Ireland

Safety requirements for the oil and gas industry are covered by the need to adhere to the petroleum safety framework (CER, 2013b), which includes: permissions, compliance assurance, incident investigation and enforcement. The framework applies to "petroleum undertakings[40]" for petroleum exploration and extraction activities, including decommissioning. It places a general obligation on all petroleum undertakings to reduce all safety risks to ALARP. It also requires petroleum activities to be conducted in accordance with approved safety cases and permits. Petroleum activities include drilling, testing, completion, interventions, plugging and abandonment, petroleum production and decommissioning of petroleum infrastructure.

40 Under The Petroleum Act 2015, which is scheduled to commence in 2016 the term "petroleum undertaking" will change to "operator or owner'.

The DCENR provides detailed guidance in the case of offshore oil and gas exploration and production activities in the form of a "Rules and Procedures Manual" (DCENR, undated). However, there is no onshore equivalent. This reflects the fact that exploration in Ireland to date has been focussed on the offshore environment.

The Health and Safety Authority (HSA), which reports to the Minister for Jobs, Enterprise and Innovation is the competent authority for REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) Regulation and the Seveso II Directive. For onshore petroleum activities the HSA requires submission of a suitable Emergency Response Procedures Manual; a Pre-construction Safety Report and an Operational Safety Report for operations classified as an Upper-Tier sites under the Seveso II Directive. More generally, the HSA enforces occupational health and safety law, promotes accident prevention and provides information and advice. A memorandum of understanding between the CER and HSA attempts to facilitate co-operation between regulators.

There are few specific environmental requirements relating to onshore exploration and exploitation of oil and gas. There are a number of requirements for offshore oil and gas that are likely to apply including through licence requirements to:

- Adhere to good industry practice; and
- Take all necessary steps to secure the health, safety and welfare of employees;
- Undertake operations with regard for the protection of the environment and protection of petroleum (or water) bearing strata;
- Control and remove pollutants and deal effectively with any threat of pollution; and
- Obtain approval for flaring, venting or reinjection of petroleum and the reinjection of water.

Under the 1960 Petroleum and Other Minerals Development Act, the Minister may impose conditions when granting a licence. All Petroleum Activities require screening under the EIA Directive or Habitats Directive before being granted permission to drill. It is likely that there will be a requirement to undertake an EIA for deep drilling under European Union (Environmental Impact Assessment) (Petroleum Exploration) Regulations 2013 (SI No. 134/2013).

Under the 2011 European Communities (Birds and Natural Habitats) Regulations 2011 (SI No. 477/2011) a screening for an Appropriate Assessment to determine implications for the site would be mandatory in any case where consent for drilling is applied for. It is likely that an Appropriate Assessment will be required if the site encroaches on a Natura 2000 site.

Other countries in the UK

The wider United Kingdom context is described in the Task 2 case study in Appendix 1. SEPA/Environment Agency guidelines suggest that permits may be needed to cover:

- Borehole construction (Scotland);
- Hydraulic fracturing is considered to be a groundwater activity (England) unless it can be demonstrated that there is: no significant groundwater or that the activity is so deep that it is outside hydrogeological active zones. In Scotland all hydraulic fracturing requires a permit;
- Water abstraction from the well, i.e. produced water (Scotland);
- Management of wastes, which are classified as extractive waste. This will include a waste management plan to that has objectives to: prevent or reduce the production of extractive

waste, and its harmfulness; encourage recovery of waste where possible; and ensure safe short- and long-term disposal;

- Radioactive waste management of naturally occurring radioactive material (NORM); and
- In England there is a requirement for approval of and full public disclosure of chemicals to be used. In Scotland, SEPA required disclosure to the regulatory but not public disclosure.

Table 5.3. Non-BAU measures that may be applied and potential drivers

Ref.[a]	Measure description[a]	Route by which non BAU measures may be applied				
		Typical practice	Land use planning	Environmental permit	Petroleum licence	H&S
Zoning						
1a	Prohibit operations within and underneath specified sites (e.g. Natura 2000, protected sites, coal mining areas, drinking water protection areas, water extraction areas for public drinking water supply, mineral spa protection zones karstic aquifers, flood prone zones and mineral water reserves, reforestation areas and areas known to be unfavourable - with regard to potential environmental impacts) or within certain distances to specified sites		X		X	
1b	Restrict operations within and underneath specified sites (e.g. Natura 2000, protected sites, coal mining areas, drinking water protection areas, water extraction areas for public drinking water supply, mineral spa protection zones karstic aquifers, flood prone zones and mineral water reserves, reforestation areas and areas known to be unfavourable - with regard to potential environmental impacts) or within certain distances to specified sites		X			
Underground risks						
N55	Conduct 2D seismic survey to identify faults and fractures	X			X	
3a iii	Site baseline Undertake sampling of groundwater		X	X		
3a x-a2	Site baseline Geological, hydrogeological and seismic conceptual model [2] Obtain geomechanical information on fractures, stress, rock strength, *in situ* fluid pressures	X		X	X	
3a x-a7	Site baseline Geological, hydrogeological and seismic conceptual model [7] Obtain data on area, thickness, capacity, porosity and permeability of formations.	X		X	X	
3a xi	Site baseline Establish the presence of methane in groundwater,			X		

Ref.[a]	Measure description[a]	Route by which non BAU measures may be applied				
		Typical practice	Land use planning	Environmental permit	Petroleum licence	H&S
	including drinking water					
3a xiii	Site baseline Undertake assessment of existing underground wells and structures	X	X	X	X	
3b iii	Monitoring Undertake monitoring of groundwater		X	X		
22a	Key elements to maintain well safety such as: • blowout preventers • pressure & temperature monitoring and shutdown systems • fire and gas detection • continuous monitoring for leaks and release of gas and liquids • modelling to aid well/HF design • isolate underground source of drinking water prior to drilling • ensure micro-annulus is not formed • casing centralizers to centre casing in hole • select corrosive resistant alloys and high strength steel • fish back casing • maintain appropriate bending radius • triple casing • casing and cementing designed to sustain high pressure and low magnitude seismicity • isolation of the well from aquifers • casings: minimum distance the surface casing extends below aquifer (e.g. 30 m below the deepest underground source of drinking water encountered while drilling the well, ref. Environment Agency 2012) and surface casing cemented before reaching depth of e.g. 75 m below underground drinking water (AEA, 2012). Production casing cemented up to at least 150 metres above the formation where hydraulic fracturing will be carried out (AEA 2012)	X		X		X
22b i	Integrity testing at key stages in well development e.g. before/during/after all HF events, including: i) wireline logging (calliper, cement bond, variable density)	X		X		X
22b ii	Integrity testing at key stages in well development e.g. before/during/after all HF events, including: ii) pressure (between 2.1 and 8.3 MPa based on setting times between 4 and 72 hours)/hydrostatic testing	X		X		X
22b iii	Integrity testing at key stages in well development e.g. before/during/after all HF events, including:	X		X		X

Ref.[a]	Measure description[a]	Route by which non BAU measures may be applied				
		Typical practice	Land use planning	Environmental permit	Petroleum licence	H&S
	iii) mechanical integrity testing of equipment (MIT)					
22b iv	Integrity testing at key stages in well development e.g. before/during/after all HF events, including: iv) casing inspection test and log	X		X		X
22d	Search for and document potential leakage pathways (e.g. other wells, faults, mines)	X		X	X	X
26g	Implementation of remedial measures if well failure occurs		X	X	X	X
Chemical use						
CDL2	Disclosure of information to public: list of chemicals potentially to be used in hydraulic fracturing by an Unconventional Gas company to be made available (e.g. via company website or centralised data dissemination portal). Per concession/play	X		X		
CDM1	Disclosure of information to Competent Authority: declaration of substance name, CAS number, concentrations, precise quantities and all physicochemical and (eco)toxicological data for the substances potentially to be used in hydraulic fracturing. Also potentially e.g. date of fracturing, total volume of fluids, type and amount of proppant; description of the precise additive purpose; concentration in the total volume. Per well. Prior to and after operations			X		
Water depletion						
3a vi	Site baseline Establish water source availability and test for suitability	X		X		
38b	Demand profile for water	X				
38c	Water management plan	X		X		
Surface water						
3b ii	Monitoring Undertake monitoring of surface water bodies in wet and dry periods		X	X		
29a	Good practice construction/deconstruction practices, including design for well abandonment	X	X			X
33a	Good site practice to prevention of leaks and spills	X	X			
33b	Use of tank level alarms	X	X	X		
33d	Spill kits available for use	X	X	X		
33f	Impervious site liner under pad with puncture proof underlay	X		X		
33g	Collection and control of surface runoff	X		X		
33i	Good site security	X		X		

Ref.[a]	Measure description[a]	Route by which non BAU measures may be applied				
		Typical practice	Land use planning	Environmental permit	Petroleum licence	H&S
Air quality						
3a i	Site baseline: Undertake sampling of air quality			X		
17c	Flares or incinerators to reduce emissions from fracturing fluid at exploration stage (where not connected to gas network)			X		
Waste						
3b xiv	Monitoring: Undertake monitoring of flowback water return rate and characterise	X		X		
3b xv	Monitoring: Undertake monitoring (volume and characterisation) of produced water volume and treatment solution			X		
27c i [41]	Injection of flowback and produced water into designated formations for disposal, provided specific conditions are in place: i) treated waste water			X		
30c	Use of closed loop system to contain drilling mud	X		X		
36c	Treatment requirements for wastewater and capability of treatment works to treat wastewater established		X	X		
Post closure[42]						
N22	Maintain records of well location and depth indefinitely				X	
12	Specific risk assessment, well plugging, inspection and monitoring requirements (e.g. for releases to air, well integrity, periodicity of inspections, wellhead monitoring every 90 days)				X	
13b i	Specific post closure well inspection, maintenance and monitoring/reporting programme: (i) following detection of possible pollution (low ambition)			X		
13b ii	Specific post closure well inspection, maintenance and monitoring/reporting programme: (ii) periodic inspection and monitoring (high ambition)			X		
13d ii	Abandonment survey: Undertake sampling of surface water bodies near the pad			X		
13d iii	Abandonment survey: Undertake sampling of groundwater near the pad			X		
13d iv	Abandonment survey: Obtain data on drinking water abstraction points (wells, boreholes, springs, surface water abstraction points)			X		
13d ix	Abandonment survey: Undertake assessment of ex-anti			X		

41 Under current EU legislation, direct discharges of pollutants into groundwater are prohibited under the Water Framework Directive (2000/60/EC) and the Mining Waste Directive (2006/21/EC) applies to the management of extractive waste both at the surface and in the underground.

42 The Mining Waste Directive includes provisions on closure and post-closure of waste facilities. Measures included under the options would include more specific provisions.

Ref.[a]	Measure description[a]		Route by which non BAU measures may be applied				
			Typical practice	Land use planning	Environmental permit	Petroleum licence	H&S
	underground wells and structures						
13d v	Abandonment survey: Undertake land condition (soil) survey around pad			X	X		
26g	Implementation of remedial measures if well failure occurs		X		X		
29a	Good practice construction/deconstruction practices, including design for well abandonment						X
Public acceptance							
15a i	Public consultation and engagement by operators: (i) at all stages (pre-permitting, permitting, exploration, testing, production and abandonment)				X		
15a ii	Public consultation and engagement by operators: (ii) for permitting			X	X		
Other measures							
29e	Management	Site reinstatement plan		X	X		
51e	Noise	Vehicle routes specified		X	X		
N08a	Incident	In the case of an incident/accident significantly affecting the environment, (a) operator informs competent authority immediately			X		X
N08b	Incident	In the case of an incident/accident significantly affecting the environment, (b) competent authority provides details of the circumstances of the incident and effects on the environment to a designated body at EU level who will make non-confidential information available to the public			X		X
N18	Equipment	Ensure equipment is compatible with composition of fracturing chemicals	X				X
N19	Equipment	Carry out thorough planning and testing of equipment prior to hydraulic fracturing operations	X				X
N31	Inspection	Inspections by Competent Authorities during all stages of development (e.g. of well completion reports and environmental risk management and controls)			X		X
3a iv	Baseline	Site baseline: Obtain data on drinking water abstraction points (wells, boreholes and springs)			X		
3a v	Transport	Site baseline: Undertake land condition (soil) survey around pad		X	X		

Ref.[a]	Measure description[a]		Route by which non BAU measures may be applied				
			Typical practice	Land use planning	Environmental permit	Petroleum licence	H&S
3a vii	Transport	Site baseline: Undertake transport and traffic study.		X	X		
3a xii	Baseline	Site baseline: Undertake assessment of land use, infrastructure and buildings		X	X		
3b iv	Monitoring	Monitoring: Undertake monitoring of drinking water abstraction points (wells, boreholes, springs, surface water)		X	X		
3b xix	Incident	Monitoring: Undertake monitoring of spills volume, nature, location and clean-up (including reporting)	X	X	X	X	
9a	Incident	Consideration of major hazards for all stages in the life cycle of the development (early design, through operations to post abandonment) and development of HSE case or similar demonstrating adequacy of the design, operations and HSE management (including emergency response) for both safety and environmental major impacts	X		X		X
9b	Incident	Emergency response plan developed and put in place covering: • leaks from the well to groundwater or surface water • releases of flammable gases from the well or pipelines • fires and floods • leaks and spillage of chemicals, flowback or produced water • releases during transportation	X		X		X
51a	Noise	Maximum noise levels specified		X	X		
51c	Noise	Noise screening installation: (i) screen drilling and fracturing rigs with noise barrier/enclosure; (ii) acoustic fencing around the site perimeter.		X	X		
59a	Transport	Traffic impact assessment including consideration of noise, emissions and other relevant impacts		X			
59b	Transport	Transport management plan (including consideration of available road, rail, waterway infrastructure)		X			

[a]Measures are from the Amec Foster Wheeler 2014 study for the EC. Measure references are from the EC study.

The need for additional regulatory requirements

The regulatory analysis (Project C Task 1 and here) and consideration of typical practice/voluntary agreements (Project B) indicates that many of the risks posed by UGEE at the surface maybe addressed through a combination of regulation and typical industry practice (although relying on typical industry practice does not provide a guarantee that a measure will be adopted in all cases). Task 1 found that there is an absence of a coherent and comprehensive approach, in particular, with regard to: strategic planning; environmental impact assessment; baseline monitoring and reporting requirements; capture of gases; well integrity; and public disclosure of chemicals used.

There is also a lack of clarity regarding the effectiveness of the existing EU legislative framework, notably with reference to mining waste (due to absence of BAT guidance covering UGEE), environmental impact assessment (whether this is required or not) and protection of air and water.

There are potential gaps in the European *acquis* and in national legislation with regard to underground risks because these have not previously been considered in detail. The EC Recommendation (2014/70/EU) published on 22 January 2014 (see Task 1) "on minimum principles for the exploration and production of hydrocarbons (such as shale gas) using high-volume hydraulic fracturing" (the "Recommendation') and emerging best practice (e.g. UKOOG guidance) attempts to address these gaps but these do not provide a guarantee that the proposed approaches will be adopted either in part or in full by all operators or required by regulators.

The EC Recommendation is not legally binding on Member States or operators, however, it lays down minimum principles to be applied as a common basis for hydrocarbons exploration and production activities in the EU that may involve the use of high-volume hydraulic fracturing (HVHF). The Recommendation's minimum requirements are complementary to existing EU legislation applicable in the field of environment and safety legislation.

Key measures identified by the Recommendations are:

- Strategic planning and EIA including public engagement to reduce impacts and restrict activities around sensitive sites;
- Co-ordination of regulation of permits and licences across regulators;
- The development of a conceptual understanding of the site and subsurface prior to drilling;
- Baseline monitoring;
- The prevention of leaks and spills from reaching the environment;
- Development of adequate infrastructure;
- The use of BAT and the development and implementation of operational management for the safe exploitation of UGEE and to minimise environmental impacts and to respond to incidents;
- The use of chemicals in HVHF is minimised and that treatment is considered in chemical selection;
- The need for monitoring during HVHF operations
- The need for financial provisions;
- Ensure administrative capacity within competent authorities

- The need for post-closure surveys;
- The need to disseminate information (public participation).

Relying on typical practice of industry is similar to a voluntary approach to environmental protection, albeit without an industry-wide commitment. Voluntary agreements could be in the form of industry commitments on a particular issue for an installation, corporate commitments by a company, commitments by a sector, or more formal agreements between a sector and government. Examples of voluntary agreements are those made with vehicle manufacturers and detergent manufacturers. For these sectors an industry representative organisation with which government could negotiate was available. With UGEE it is not clear that this is the case. The main issue with voluntary agreements, or relying on typical practice of industry (if typical practice can indeed be accurately defined) is that such approaches do not guarantee outcomes resulting in uncertainty and a lack of confidence whether environmental protection issues would be effectively and coherently addressed.

Many of the potential uncertainties in legislation could be covered through guidance that clearly identifies how legislation will be applied. Examples might include defining how monitoring would be required and requiring use of chemicals to be addressed through EIA. Such guidance has been issued by regulators in England and Scotland. The regulatory roadmap for Northern Ireland provides a useful guide to regulation at different stages in UGEE projects. In Ireland, the CER has produced a guide to the permissioning process for petroleum activities (CER, 2014), which could form the basis for a roadmap covering wider issues.

Also in Ireland, The Planning and Development Act 2000, as amended has provision for the issue of Ministerial Guidelines, which could be used to clarify how legislation is to be applied. Planning authorities and An Bord Pleanála are required to have regard to such guidelines.

5.3.4 Links to best available technology (BAT)

Under the IED and MWD BAT is used to set performance criteria for emissions and waste treatment. At a European level BAT is set out in BAT reference (BREF) documents. However, the current MWD BREF does not cover UGEE. It is therefore, not currently clear what constitutes BAT. The EC has commissioned work to develop a new hydrocarbons BREF that encompasses both UGEE and conventional oil and gas. Work to develop a BREF on hydrocarbon exploration and production process started on 01 June 2015 and the document is unlikely to be published for a number of years. Until the revised BREF is issued it will not be clear what constitutes BAT for UGEE. BAT is therefore likely to be subject to interpretation by regulators and operators. The hydrocarbons BREF is not linked to any particular directive.

There are few details on what will be covered by the hydrocarbons BREF. The EC state that "The hydrocarbons BREF will address the extractive oil and gas industry. It will focus on the installations linked to the actual well i.e. the development and operation of the offshore facility or onshore well pad (including directly related activities such as onsite storage prior to distribution), but excluding delivery infrastructure such as pipelines. In this context, the BREF will focus on BAT to manage impacts of releases of pollutants and best risk management techniques to manage risks of releases of substances as a result of incidents for the purpose of protecting human health and the environment.[i] "

In a "Call for expressions of interest for the selection of experts for the technical working group for the hydrocarbons BREF" (July 2015), the Commission states that the Hydrocarbons BREF should identify:

- 'BAT to manage the impacts (i.e. prevention or mitigation of releases of pollutants during normal operations of an installation);

- Best Available Risk Management Practices (e.g. for releases of substances to the environment as a result of unplanned incidents that are not part of normal operations or for seismic events). "

They also state that "The hydrocarbons BREF, will have the status of a non-binding reference document for the permitting of installations for the exploration and production of hydrocarbons.'

The Hydrocarbons BREF is likely to cover measures set out in the EC recommendation, including: governing:

- Planning;
- Development of a conceptual model;
- Risk assessment;
- Waste minimisation;
- Waste treatment;
- Emissions to air;
- Storage; and
- Disposal.

5.3.5 Links to financial provision

The purpose of financial provision is to ensure that adequate funds are available to manage environmental risks associated with both incidents at, and the closure of, permitted facilities.

At the European Community level, the Environmental Liability Directive[43] (ELD) recognises the importance of developing financial mechanisms to cover operators' responsibilities. Financial provision is not mandatory under the ELD. Member States are required to take measures to encourage the development of financial security instruments and markets with the aim of enabling operators to use financial guarantees to cover their responsibilities under the ELD.

Apart from the ELD, the only direct references to financial provision in EU Environmental Directives are the Mining Waste Directive[44] (MWD) and Landfill Directive[45]. The MWD obliges the competent authority to require a financial guarantee or equivalent prior to the commencement of operations to ensure that all obligations under the permit are discharged.

There is, however, reference within Directive 2013/30 on safety of offshore oil and gas operations to the need to ensure that operators have provided appropriate evidence that adequate provisions have been or are to be made to cover liabilities deriving from major accidents.

In Ireland, the EPA may require licensees under the Integrated Pollution Control (IPC) and waste licensing[46] regimes to make financial provisions. Such licences will typically require the licensee to:

43 Directive 2004/35/CE as amended on environmental liability with regard to the prevention and remedying of environmental damage.
44 Directive 2006/21/EC on the management of waste from the extractive industries.
45 Directive 1999/31/EC on the landfill of waste.
46 Section 53, Waste Management Act 1996 as amended; Section 83(6), Environmental Protection Agency Act 1992 as amended.

- Prepare an Environmental Liability Risk Assessment (ELRA) and a Closure and Decommissioning Management Plan (CDMP) and associated costings for approval by the EPA; and

- Make financial provision, agreed by the EPA, to cover the costs identified in the ELRA and CDMP.

EPA Guidance[47] identifies the following forms of financial instrument: secured fund; on demand performance bond; parent company guarantee; charge on property; and insurance.

The Guidance states that secured funds, bonds and charges on property are suitable types of financial provision to cover all liabilities i.e. both those arising from incidents at facilities and closure costs. Parent company guarantees and insurance are not considered suitable for closure costs but will be considered in the context of potential liability from incidents arising on sites subject to the conditions set out in the Guidance.

In Northern Ireland, financial provision (financial guarantee) under the MWD is required through the planning process[48]. The legislation does not state the form that such guarantees would take. NIEA guidance on financial provision for landfills does not specify the form that such provisions should take but indicates that they could take the form of Escrow accounts; bonds and renewable bonds, cash or Local Authority Deed Agreement (NIEA, 2016). Similar arrangements are likely to apply for UGEE operations.

5.4 Conclusions

Enforcement requirements and best operational practice for UGEE, which have been collectively identified as measures, have been established through links to Project B, Task 1 of Project C and by reference to a previous assessment by the European Commission (EC). Consideration has been given to which of these measure are *definitely* required and those that *may be* required by European and Island of Ireland legislation.

Those measures that are not definitely required by EU or Island of Ireland legislation but may be required for regulation of UGEE could be applied through:

- Land use planning;

- Petroleum authorisation or licensing conditions issued by DCENR (Ireland) and DETI (Northern Ireland);

- Conditions set in EPA licences (Ireland) or environmental permits and licences (NI) covering: discharges to groundwater; water abstraction; waste management; pollution prevention; radioactive substances; and protection of conservation areas; and

- Typical practice by industry. Measures that are likely to be adopted by operators regardless of legislation or regulatory requirements.

Many of the risks posed by UGEE at the surface can be addressed by a combination of regulation and typical industry practice. However, the analysis found an absence of a coherent and comprehensive approach to a number of UGEE issues.

There is also a lack of clarity regarding the effectiveness of some of the existing EU legislative framework, notably:

47 Guidance on Financial Provision for Environmental Liabilities (2015).
48 The Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2010.

- Mining waste because there is no BAT guidance covering UGEE. The existing MWD BREF does not cover UGEE, although work is in progress to revise the MWD BREF and also develop a new hydrocarbons BREF that encompasses both UGEE and conventional oil and gas. However, until the revised MWD BREF or hydrocarbons BREF are available, BAT is subject to interpretation by regulators and operators;
- Whether EIA is required or not; and
- Protection of air and water.

There are potential gaps in European and national legislation with regard to underground risks because these have not previously been considered in detail. The EC Recommendation (2014/70/EU) and emerging best practice attempt to cover these gaps but there is no guarantee that the proposed approaches will be required by regulators or adopted by industry resulting in uncertainty and a lack of confidence whether environmental protection issues would be effectively and coherently addressed. In addition, although the EC Recommendation lays down minimum principles as a common basis for UGEE in the EU it is not legally binding on Member States.

Many of the potential uncertainties in legislation could be covered through guidance that clearly identifies how legislation will be applied.

6 Case Studies of Public Engagement in UGEE

6.1 Introduction

This section presents and reviews case studies of public engagement processes carried out for UGEE projects to identify good practice and potential areas for enhancing engagement. It includes a description and comparison of the methods and processes employed by the case studies. In addition, the legislation relating to public consultation in the Island of Ireland is summarised.

6.2 Method

The task was delivered through the following activities:

- An initial review of 10 public engagement processes carried out in Europe and North America followed by discussion of the processes with the project board. Five case studies representing a range of project types and consultation approaches were short-listed for more detailed review and assessment;
- A detailed review and assessment of the short-listed case studies. Where possible, the coordinators of the consultation processes were contacted and interviewed to obtain further information and review the successes and failures of the processes to help define good practice;
- A review of the application of the Aarhus Convention and EIA and SEA Directives to proposed plans and projects involving UGEE was undertaken. This considered the stages in the planning and consent application process at which public information and participation are required and how these requirements can best be implemented in the context of the Irish national regulatory framework and the development of a public consultation strategy on the island of Ireland; and
- Comments on the draft report were accommodated as the report evolved to ensure that the requirements of the brief were met.

6.3 Results

6.3.1 Case studies

6.3.1.1 Case study selection

Ten case studies of consultation processes were identified as a long list of which five were selected by the project steering committee for more detailed review. The long-list and short-list case studies are presented in Table 6.1. The long-list included a range of processes of varying scope, geographic coverage and scale. The short-listed case studies included processes that encompassed voluntary and regulatory driven processes and national strategic and local site specific processes. These processes were carried out in Denmark, England, Germany and Scotland.

Table 6.1. Case study long list summary and short list selection

	Consultation	Summary	Key features	Selected
1	European Commission unconventional hydrocarbon consultation	2012/13 consultation by the European Commission. Part of "Environmental, Climate, and Energy Assessment Framework to Enable Safe and Secure Unconventional Hydrocarbon Extraction'.	EU scale. General scope	No
2	Hydrofracking Risk Assessment. Helmholtz Centre for Environmental Research – Germany	2011/12 extensive and public consultation process, combined with an independent risk assessment of hydraulic fracturing by technical stakeholders. German-wide	Technical & public consultation. Wide scope. Neutral	Yes
3	Sugar Creek, Ohio, USA	2012 local consultation regarding proposed development.	Small scale	No
4	Consultation on the SEA of the 14th gas licensing round	2013–2014 consultation on the SEA of the 14th gas licensing round. Combination of statutory and public consultation process.	Statutory process. Technical & public. Pre-licensing.	Yes
5	Cuadrilla – Roseacre Wood and Preston New Road, England	Regulatory driven (planning, EIA) of exploration site developments. Site and regional focus.	Site focussed. Regulatory driven	Yes
6	Dart Energy – Falkirk and Stirling, Scotland	Regulatory driven (planning) of exploration site developments for coal bed methane. Site and regional focus.	Site focussed. Regulatory driven. CBM	Yes
7	Oil and Gas task force, Colorado, USA	Consultation supporting recommendations to the Colorado legislature. State-wide focus.	Focus on developing legislation.	No
8	Östergötland and Öland in Sweden	Regulatory driven (minerals act) of exploration site developments. Site and regional focus.	Limited scale.	No
9	Nordsøfonden and Total, Nordjylland, Denmark	Regulatory driven (planning, EIA) of exploration site developments. Current, ongoing process. Site and regional focus.	Site focussed. Regulatory driven	Yes
10	New Brunswick, Canada	Consultation to solicit feedback on the government's proposed regulations for the shale gas industry.	Appears largely politically driven	No

6.3.1.2 Case study analysis

The five case studies short-listed for analysis had sufficient scope and detail with regard to public consultation processes in the context of UGEE projects and operations to provide a wide range of approaches and experience. The selected case studies are all based within the EU and subject to the same EU legislation. However, country specific legislation, such as the Town and Country Planning (Scotland) Act 1997 in Scotland and the Town and Country Planning Act 1990 in England, differ between the case studies. The Helmholtz Centre and DECC SEA case studies were supplemented by: a telephone interview of Dr. Dietrich Borchardt, the scientific director for the project; and a written response from Mr Ricki Kiff of DECC, respectively. Case study details can be found in Appendix **3.** A summary of the telephone interview with Dr Borchardt and copy of the written response from Mr Ricki Kiff are provided in Appendix 4. Cuadrilla, Dart Energy and Total were all

contacted to request information regarding evaluation of the engagement processes. Cuadrilla declined to participate, Dart Energy has been taken over by IGas since the consultation was carried out and no one was available with experience of the process to comment and Total did not respond following initial acknowledgement of the request to participate. The project-specific case studies (Cuadrilla, Dart Energy and Nordsøfonden and Total, Nordjylland) share some similarities with the current Irish context in that they were rural, not subject to previous UGEE activity, other than limited exploration, and the scale of the sites was similar. In addition, the regulatory framework based on EU Directives and Regulations, also apply on the island of Ireland. The processes and approach are, therefore, transferable to Ireland. A presentation and analysis of the processes is provided below.

Scope and duration

The Helmholtz Centre's research focused on health and environmental impacts of hydraulic fracturing whereas the DECC SEA assessed environmental and sustainability impacts and effects of a specific national plan and the EIA of Total's project assessed the environmental impacts. Cuadrilla and Dart Energy were project-specific applications which assessed a proposal against local planning policy and guidance. The Cuadrilla project was also subject to an EIA as part of the planning application process.

The duration of consultation was generally enforced by legislation and regulation e.g. 12 weeks consultation on DECC's SEA environmental report and planning regulations for UK based projects, or at least eight weeks for the Total project in Denmark, these time periods were regulatory requirements. SEA regulations regarding time periods for consultation do not state a finite time period, instead they require that consultation must be of such a length as will ensure an effective opportunity for consultation to ensure that the scope of consultation is related to the scale of the project or plan being consulted upon. This requirement was reflected in the SEA undertaken by DECC which extended the consultation period to reflect that it was held over a holiday period. The exception to these regulatory requirements was the Helmholtz Centre project in Germany which had no regulatory driver and hence no minimum requirement on the length of consultation, as the project was an independent research programme.

Stakeholders and consultees

All but one of the case studies were subject to regulations that set out which statutory bodies must be consulted. The processes governed by legislation and regulation specify statutory stakeholders to ensure that their interests with regard to the plan or programme are consulted upon. With regard to the SEA, EIA and planning application processes, statutory and non-statutory consultees from national to local scale were engaged. DECC consulted with the statutory SEA bodies for England, Scotland and Wales but also with non-statutory bodies seeking involvement in the process. These non-statutory bodies included Public Health England (PHE), Local Authorities, Non-Government Organisations (NGOs) and campaign groups. Total consulted with stakeholders involved in the EIA procedure, which included the local municipality, national and local stakeholders.

Cuadrilla engaged statutory (e.g. the Environment Agency, Natural England) and non-statutory stakeholders (e.g. Council for the Protection of Rural England (CPRE), Lancashire and the Ministry of Defence), in the planning application process as well as in the technical EIA work streams. The range of stakeholders involved included the local community and national stakeholders as well as technical and non-technical stakeholders.

As a regulatory requirement, Dart Energy consulted local authorities (Falkirk and Stirling Councils) and held a public meeting but in addition held a further four public meetings over an extensive period of engagement with interested parties.

The Helmholtz Centre's project involved stakeholders, including municipalities, public and private companies amongst others, with the aim of ensuring the study focused on practical issues reflected the concerns of people in the regions potentially affected. Dr Borchardt noted that it was important to use experienced professionals in consultation and moderation to plan and deliver the process and that those managing the process needed to be accepted by all as advocates of the process rather than the proposal. It was also indicated that:

- Different stakeholder groups had different roles in the process (e.g. landowners, water supply companies) and it was important to include representatives across the governance hierarchy; and
- There is a need to balance the share of stakeholders across different themes, e.g. environment, technical, authorities, public, landowners.

The Helmholtz Centre case study found that statutory stakeholders were not necessarily required as part of the process to ensure effective engagement. They also found that being outside of regulation helped the case study ensure that one group of stakeholders, statutory or otherwise, were not prioritised over another. Dr Borchardt highlighted the importance of maintaining a good mix of stakeholders, not only the visible/vocal minority but also the "silent" majority who may become more vocal through the process as their understanding increases. The engagement of this silent majority was considered crucial to ensure a balanced approach. In addition, the relationships, hidden agendas and history between stakeholders was established in the project year-long pre-study that was carried out. This was important to help avoid conflicts based on past experiences and existing relationships and to avoid the subject becoming a surrogate for disagreements resulting from historical conflicts.

Process design and delivery

The duration of the consultation for regulation-driven engagement processes ranged from a minimum of eight weeks for Total to 12 weeks for DECC, Cuadrilla and Dart Energy. This duration relates to consultation on the plan or programme once it has been developed. Consultation earlier in the timeframe of the plan or programme may have additional benefits to the entire process. The timing and duration of the consultation considered the availability of the consultees to effectively respond to the plan or programme. The consultation processes used by each case study are presented in Table 6.2.

Table 6.2. Consultation techniques used by the case studies

Consultation	Pre-study/ application consultation	Statement of community intent/ proposal of application notice	Peer review	Work-shops	Public exhibitions	Website
Cuadrilla – Roseacre Wood and Preston New Road, England	Y	Y		Y	Y	Y
Dart Energy – Falkirk and Stirling, Scotland	Y	Y			Y	Y

Consultation	Pre-study/ application consultation	Statement of community intent/ proposal of application notice	Peer review	Work-shops	Public exhibitions	Website
Consultation on the SEA of the 14th gas licensing round	Y			Y		Y
Hydrofracking Risk Assessment. Helmholtz Centre for Environmental Research – Germany	Y		Y	Y		
Nordsøfonden and Total, Norjylland, Denmark					Y	Y

DECC first consulted publicly on the assessment methods to be used, before then consulting on the outcome of the assessment. Cuadrilla engaged in public consultation when developing the design for the two planning applications whilst simultaneously informing interested parties about the development. This allowed those affected by the development to influence the project before planning applications were submitted. At the inception of their study the Helmholtz Centre compiled questions from citizens, public and private companies during a year-long pre-study consultation process. This pre-study consultation stage enabled the issues of concern to be identified and allowed stakeholders to gain ownership over, and commitment to the process. It also enabled trust to be established and for stakeholders to determine their own roles in the process.

The year-long pre-study consultation process used an information-dialogue basis to enable genuine issues of interest to be established and stakeholder understanding to be developed. This was a necessary first step before evaluation of the issues was undertaken. As a result, a common understanding of issues was developed e.g. risks relative to other industries and activities, and the basis of information was established, and hence it was possible to debate and rate the pros and cons effectively.

The SEA led by DECC and the Helmholtz Centre's research project had a similar geographical scale with regard to the project and consultation. Both projects investigated UGEE on a national scale in the UK and Germany respectively, and also at a regional level: five regional level areas in the UK; and the North East of Germany, focusing on Lower Saxony and North Rhine Westphalia. DECC noted that although the report did refer to regional areas, consultees were only engaged at a national level. Both projects assessed the principle of UGEE development, as opposed to a location-specific development. These case studies considered the potential effects of development that would result from a UGEE activity.

The Cuadrilla, Dart Energy and Total case studies had a local, site-specific geographic focus on the application site of an UGEE activity. This was reflected in the scope of the plan or project which was subject to local policy and guidance and the scale of consultation undertaken with a focus on consultation methods, topics considered, issues assessed and feedback from stakeholders. Consultation held by Total was carried out during the EIA and to inform local residents and stakeholders about the ongoing development.

As part of their respective planning applications, Cuadrilla and Dart Energy were also subject to pre-application consultation as a regulatory requirement. Cuadrilla were required to prepare a Statement of Community Involvement. This described the engagement and wider consultation they intended to undertake. Dart Energy were required to submit a Proposal of Application Notice at least 12 weeks before their planning application and also carry out Pre-Application Consultation (PAC).

Pre-consultation fed back into the design of the consultation process in some of the case studies. The Helmholtz Centre began its work by compiling questions from German citizens, public and private bodies, which were used to shape the project. Dr Borchardt noted that the wider context for the process was important. The exact format was demand driven, hence sizes were flexible and responsive to stakeholder needs. The first year of the study and consultation focussed on information, i.e. what did consultees want to know? What are the technical and environment aspects? The second year focussed on evaluation. The Helmholtz Centre considered that discussions with stakeholders throughout the process promoted further discussion relevant to the study which resulted in additional feedback. Dr Borchardt also noted that a particularly successful process was an "open stage peer review" event over two days which examined the science and advisory groups' work. A global audience took part, featuring 300 participants in open debates and breakout groups addressing specific themes (e.g. ecotoxicology). The result of this exercise was that technical evidence that was subsequently developed was generally accepted by stakeholders as the basis for the following evaluation stage.

As part of their consultation, Cuadrilla established a Community Liaison Group (CLG) which included local residents and other interested stakeholders. The CLG was independent of Cuadrilla and provided an opportunity for dialogue between the company and the local community. Although the CLG did not have any decision-making powers, it made recommendations to Cuadrilla. The CLG provided a formal and structured link for consultation between interested stakeholders and Cuadrilla which allowed Cuadrilla to understand the views of the local community as the proposal progressed.

DECC consulted with statutory and non-statutory consultees at the scoping stage of the project on the proposed approach to the assessment, which resulted in some amendments. DECC also held a series of workshops during the consultation period to discuss the findings of the Environmental Report and supported consultees in providing feedback. All contributors were invited to make written responses to provide an accurate record of the message the consultee wished to convey. This was considered to be an unrushed processing of their contribution with regard to audit trail purposes and the most appropriate way of receiving contributions. DECC considered that the workshops and the consultation on the scoping report provided a useful opportunity to explain the context of the licensing plan and the proposed approach to the SEA and also to understand the views of different stakeholder groups.

The Helmholtz Centre, DECC, Cuadrilla and Dart Energy case studies all used early engagement with interested stakeholders, either as a voluntary process or to meet regulatory requirements. The Helmholtz Centre and DECC both provided an opportunity to assess the latest information regarding the principle of UGEE development in their respective nations rather than a project, or location, specific development. The advantages of early, pre-consultation engagement that can result in changes to the plan or programme, is that it provides a transparent and auditable process and improves public confidence in the process. Pre-application consultation by Cuadrilla and Dart Energy allowed this to take place in a way that consultation on the final development plan would not have done. The Helmholtz Centre and DECC projects were both publicly transparent, although questions were initially raised about The Helmholtz Centre's work due to its funding by ExxonMobil and its possible influence on the project. Total developed a project-specific website to provide news and updates. Cuadrilla engaged in a wide range of consultation methods across the scope of its plan including a CLG workshops, meetings, and dedicated telephone lines. DECC and Dart Energy used meetings, websites, and a report to engage with consultees.

The SEA Directive requires that timeframes for consultations allow sufficient time for consultees to have an effective opportunity to engage. This is a principle across public engagement that helps to ensure consultation is of a relevant scale to the plan or project being assessed. Consultation during the development of a plan or programme can have additional benefits, as could the timing and duration of consultation which should be considered with regard to the intended stakeholders. The year-long pre-study consultation process and the two years taken for the Helmholtz Centre project are a good example of the benefits of a long consultation period integrating ongoing evaluation and review. Dr Borchardt noted that the process could not have been any faster as proper communication was required plus investment in learning for stakeholders to enable a minimum quality of discussion to take place. All but one of the case studies were subject to regulations specifying statutory stakeholders. Stakeholders, whether statutory or otherwise, should vary in scale and cover a broad range of topics so to provide material feedback.

The DECC case study highlights the use of information updates during the consultation process so as to inform interested stakeholders. DECC also sought consultation on the assessment method before consulting on the outcome of the assessment. Dart Energy had to consult with the all the municipalities whose area was within or adjoined the application site (Falkirk and Stirling Councils) to ensure that they could respond jointly response to the consultation and avoid cross-boundary differences. Following recommendations from the Helmholtz Centre, ExxonMobil intended to continue consultation once hydraulic fracturing activities commence to provide assurance that issues raised during consultation had been addressed and to and provide transparency. However, the moratorium on further activities in Germany has meant that this has yet to occur.

The use of a CLG integrated a process of engagement into the project as a formal and structured link between the public and Cuadrilla during the planning stage.

Evaluation of processes

Evaluation of the effectiveness of consultation processes is good practice. Lessons learnt from evaluating processes can be used to inform future consultations and contribute to the further development of good practice in engagement. Evaluation can be achieved through a combination of methods throughout the process including questionnaires for stakeholders (e.g. regarding clarity of information, ability to access information and comment, techniques used for engagement) and evaluation assessments against engagement process performance criteria. In examining the case studies, no evidence was found that formal process evaluations were carried out and made publically available. However, in the response provided by DECC regarding the consultation on the SEA, the following process evaluation comments regarding the consultation process were noted as learning points:

- There is a need to ensure that consultation is wide-reaching and transparent and careful consideration should be given with regard to who to engage, how and when;
- UGEE projects/operations and associated impacts may not be well understood by some stakeholders and the public. There is the potential for misinformation. Careful consideration should be given to how information is presented so that it is easily accessible and understandable;
- Summarising the findings of any detailed and extensive assessment in short and accessible documents can help widen understanding and take up by stakeholders and the media;
- On-line web based questionnaires are a useful tool to collate responses to any identified key questions;

- Meetings and workshops are a useful tool to help explore in detail stakeholder concerns, gather evidence, address any misconceptions and gain consensus and
- Feeding back the outcomes of the consultation process is important.

The above observations hold true as general principles of consultation, particularly where the subject matter has the potential for controversy.

6.3.2 The law relating to public participation

The UN Convention on access environmental information, public participation and access to justice (made at Aarhus, Denmark, in 1998) "Aarhus Convention" sets the framework for EU law relating to public participation. It is as relevant to UGEE as it is to any other activity which is likely to effect the environment. The Aarhus Convention confers rights directly upon citizens under three "pillars':

1. Right of access to information relating to the environment (which would include information relating to UGEE and effects on the environment);
2. Right to participate in environmental decision-making (including decisions relating to UGEE plans, programmes, projects and activities);
3. Right of access to justice, including an effective review procedure to appeal/challenge the validity of environmental decisions (including decisions in relation to access to UGEE information and decisions to grant consent for UGEE activities).

These three pillars of the Aarhus Convention have been incorporated into various EU Directives, including the PAEID, the SEAD, the EIAD and the IED (previously IPPCD).

Ireland ratified the Aarhus Convention in 2012 however there have been questions regarding transposition of the Conventions in Ireland, particularly regarding access to Justice. Under Article 29.6 of the Irish Constitution and in the absence of domestic legislation to implement the Convention, the Convention does not form part of Irish domestic law. This has been indicated in the judgments of Hogan J. in NO2GM Ltd vs. EPA and O'Connor vs. EPA which noted that under general principles of statutory interpretation it is arguable that judicial notice[49] has to be taken of the Convention. However, the Convention has been relied upon successfully by a number of parties in establishing a right of access to justice to challenge decisions of An Bord Pleanála and other decision-makers. In one notable case Sandymount and Merrion Residents Association vs. An Bord Pleanála and Dublin City Council, the Aarhus Convention was relied upon to establish a right of review by an unincorporated local residents association, a type of organisation not previously recognised by the Courts as having legal capacity to initiate proceedings.

Aarhus has been part of EU law since 2005 and Ireland is already required to give domestic legal affect to many of the rights guaranteed by the Convention, but only insofar as such rights are enforceable under EU law, specifically the SEAD, EIAD and IED. For example, under the EU (Access to Review of Decisions for Certain Bodies or Organisations promoting Environmental Protection) Regulations 2014, certain NGOs are deemed automatically to have sufficient interest if they seek a judicial review of a decision based on SEAD, EIAD and IED. Furthermore, the Environment (Miscellaneous Provisions) Act 2011 and Planning and Development (Amendment) Act 2010 have established special costs rules to facilitate access to justice for persons seeking to establish and enforce rights under EU Directives including the EIAD, SEAD and IED. The absence of domestic legislation implementing the Convention in full could be viewed as a short-coming in implementation,

49 i.e. that a fact may be introduced as evidence if the fact is so well established, or authoritatively attested, that it cannot reasonably be doubted.

particularly with respect to parties seeking to directly enforce environmental protections and rights not explicitly covered by EU law.

6.3.2.1 Access to environmental information

The Aarhus Convention and associated United Nations Guidelines confirm that members of the public concerned with the environment must have access to relevant information in order to effectively exercise their right to participate in environmental decision-making. Equally, an effective right of participation must be underpinned by a right of access to justice, to effectively challenge the validity of environmental decisions.

Environmental information will only be accessible from private entities to the extent that they hold such information for or on behalf of public authorities, or that such information is relevant to a consent decision under EIAD, IED etc., For this reason, environmental information held by a private UGEE operator may not be accessible to the public under the PAEID and relevant domestic legislation unless it forms part of an application for consent or unless it is held for or on behalf of a public authority.

6.3.2.2 Public participation

Members of the public and NGOs are entitled to an early and effective opportunity to participate in environmental decision-making under the SEAD, EIAD and IED.

SEAD relates to certain public plans and programmes which set the framework for future development consent, including plans and programmes in the energy sector. For example, if the DCENR (Ireland) plans to undertake a licensing round under the Petroleum and Other Minerals Development Act 1960, as amended, for the award of options, petroleum exploration or production licences, such a plan or programme should be subject to a prior SEA incorporating an early and effective public participation process, while there is still an opportunity to influence the decision-making process. In the absence of a relevant public plan or programme, there is no obligation to carry out SEA or engage with the public.

EIAD provides for public participation at an early stage in the development of a proposed project coming within the scope of the EIAD. The project developer is encouraged, under the Aarhus Convention and the EIAD, to engage with members of the public in advance of submission of an application for project consent under the EIAD if possible. The project developer is in any event obliged to provide members of the public with information on the proposed development (including the EIS) as soon as possible following submission of the application for consent. Domestic planning and licensing legislation provides an appropriate period for submissions and observations to be made in relation to the proposed development. If any material new information is provided by the developer or relied upon by the competent authority, members of the public must be provided with an opportunity to consider and make comments on the further information before any decision is reached. A competent authority is obliged to have regard to the outcome of the public participation process, and to publish its decision to grant or refuse consent together with its reasons and considerations and any other information relevant to the decision-making process. The EIAD incorporates further provisions for transboundary public participation, where applicable.

There are no generally applicable public participation guidelines or strategies for UGEE, although industry charters and commitments regarding community engagement have been developed[50]. More broadly, the National Economic and Social Research Council (NESC) has published studies on

50 For example, e.g. the UKOOG's community engagement charter for oil and gas from unconventional reservoirs, which sets out principles for its members with the aim of ensuring open and transparent communications between industry, stakeholder groups and communities.

building community engagement and social support for wind energy in Ireland. These documents contain recommendations which may be applied to other sectors and activities, including UGEE. In addition, various organisations such as the Royal Town Planning Institute (RTPI) in the UK, the Economic and Social Research Council (UK) and the European Commission DG Health & Consumers have issued guides on public participation and engagement (RTPI, 2005; ESRC, 2015; European Commission, 2015). The DG Health & Consumers guidance provides a useful summary of benchmarks for consultations; which can be summarised as follows:

- Plan consultations early in the process and publish a consultation plan;
- Explain why the consultation is happening and how stakeholders' views will be taken into account;
- Involve the widest spectrum of stakeholders in consultations, including underrepresented and hard-to-reach groups;
- Organise consultations in ways which are convenient and accessible to the people whose views are being sought;
- Analyse the input and data received from consultations and distinguish between evidence and opinions. Assess if respondents were representative;
- Provide feedback to stakeholders that participated in the consultation in a way that clarifies how decisions and outcomes were reached;
- Report back on the next steps in the process and their possible timeline;
- Communicate the consultations and their results clearly and directly, with a focus on relevance and using plain language;
- Act on the findings to improve policies, programmes, projects or proposals; and
- Evaluate consultations and review processes to inform future consultations and contribute to good practice.

6.3.2.3 Access to justice

The EIAD, WD and IED incorporate access to justice provisions, providing members of the public concerned and environmental NGOs with a right of access to an impartial tribunal or other judicial process to appeal or review environmental decision-making.

The right of access to justice must be at a cost that is not prohibitively expensive.

These provisions are implemented in Ireland generally in relation to judicial review through the Planning and Development Act 2000, as amended, and the Environmental (Miscellaneous Provisions) Act 2011. Various judicial determinations since 2010 have expanded the scope of these provisions, such that it is clear that special costs rules will generally apply where the proceedings raise issues under EU environmental law. The principal objective is to ensure that any person bringing a legal challenge to a proposed public plan or programme, or public or private project or activity, is protected against the risk of an adverse costs order being made against them if the proceedings are unsuccessful. In certain circumstances a protective costs order may be obtained, limiting the party's potential exposure to costs.

In 2014 the DCELG (Ireland) commenced a consultation process with a view to exploring potential alternative means of achieving access to justice in accordance with the Aarhus Convention. Options

under consideration included: (i) expansion of legal aid regime; (ii) creation of regulatory court; (iii) creation of planning/environmental division of High Court; (iv) establishment of an alternative judicial tribunal or body with relevant statutory powers; or (v) do nothing.

In the meantime, the DCELG has commenced an independent review of An Bord Pleanála to consider, amongst other things, its role and functions in relation to environmental decision-making and various means for reducing the cost, impact and frequency of judicial review proceedings.

In Northern Ireland the right of access to justice is through the Costs Protection (Aarhus Convention) Regulations (Northern Ireland) 2013. Article 3(2) of these regulations provides that an applicant in proceedings shall not be liable for more than £5000 in costs where he or she is an individual and £10,000 in costs where the Applicant is a legal person or an individual applying in the name of a legal entity or unincorporated association e.g. an NGO.

In January 2016, the Department of Justice (DOJ) in Northern Ireland commenced a consultation process seeking views on proposals to revise the costs capping scheme of the Cost Protection Regulations. The DOJ recently extended this consultation period with same due to close on the 17th February 2016.

6.4 Conclusions

Good practice has been drawn out from each of the case studies through evaluation and comparison.

The regulatory requirement for public engagement in four out of the five case studies strongly influenced the structure and parameters of public consultation but best practice can be found in those processes that went beyond the regulatory requirements. The case study not subject to regulation (Helmholtz Centre) provides an example of a consultation outside of the parameters of regulatory requirements in which it appears that stakeholders were free to engage and allowed for a much longer consultation period, including a one year pre-study consultation period.

6.4.1 Scope

The case studies demonstrate that the geographic scope of consultation should be relevant to the scale of the plan or programme being consulted upon and may need to include stakeholders across administrative boundaries where the plans approach those boundaries.

6.4.2 Duration and timing

The consultation should be of a sufficient duration so to allow effective engagement with stakeholders. Regulations provide a minimum duration but longer consultation periods may provide benefit by allowing time to address initial questions and to refine the scope of the consultation.

However, the consultation processes also need to be efficient and effective in conveying information to and from stakeholders whilst also being transparent and supported by robust and impartial evidence.

The specification of regulatory requirements regarding time period for consultation is required for practical reasons but consultation should be of such a length that allows an effective opportunity for consultation.

The length and scale of consultation should be related to the scale of the plan or project subject to consultation.

Due to the variation of the topics and impacts being assessed, the terms of reference and scope of the consultation should be formulated with input from stakeholders at the start of the process rather than being imposed upon them.

6.4.3 Stakeholders and consultees

Stakeholders, whether statutory or otherwise, should;

- Vary in scale, from local to national;
- Be a mixed and balanced group of stakeholders should be maintained;
- Cover a broad range of subject matter, both objective and subjective; and
- Provide consultation responses that are material to the plan or programme.

Different stakeholders and groups are likely to have different roles in the consultation process and so the share of stakeholders should be balanced across the different themes. Those managing the consultation process, and therefore engaging with stakeholders, should be;

- Experienced in consultation and moderation with regards to planning and delivering the process;
- Accepted by the stakeholders; and
- Advocates of the consultation and engagement process rather than of the subject matter or of specific points of view.

Stakeholders should be assessed to establish relationships, hidden agendas or history between stakeholders. Assessment of stakeholders will help to avoid conflicts during consultation on topics and issues not pertinent to the subject and process.

6.4.4 Process design and delivery

The timing and duration of the consultation should consider the availability of consultees to effectively respond. The format of the consultation should be driven by the stakeholders and consultees and be responsive to their needs.

Consultation should be sought as early as possible so that the outcomes can provide influence and guidance as the plan or project progresses. It should identify issues of concern and provide robust and impartial evidence before the evaluation of such issues is undertaken. The process should give stakeholders ownership of the process as this will build trust and commitment to the process. It should also be used to inform the context of the process as well as understanding the view of stakeholders.

Continued consultation throughout the process will promote further discussion and additional feedback.

It is advisable that, before granting any licensing option or exploration licence (particularly where such grant is part of a broader licensing round) the DCENR (Ireland) should first carry out SEA of the proposed licensing programme and engage in early and effective public participation as part of this process [51]. SEA at this stage ensures compliance with the public participation requirements under the Aarhus Convention and SEAD. In Northern Ireland the absence of a licensing round means that SEA is unlikely.

51 For example, see SEA by Petroleum Affairs Division of DCENR for offshore exploration.

Under domestic legislation, DCENR (Ireland) may grant an exploration licence to an operator without first ensuring public participation and assessment in accordance with the EIAD [52]. EIA is triggered when the operator submits a request to carry out specified activities including well work and drilling. In certain circumstances, however, the grant of an exploration licence may be subject to the operator committing to a certain level of exploration activity under the licence. The environmental implications of such commitments should be assessed as part of the SEA process prior to the granting of individual exploration licences.

6.4.5 Process evaluation

Evaluation of a consultation process needs to be an integral part of the whole process. Evaluation should commence at the beginning of the process, run through delivery at appropriate points and be performed and reported on at the conclusion. Adjustments to the process should be made in response to such ongoing evaluation to optimise the process for all parties.

The evaluation should establish if the correct consultation techniques are being used and review their efficacy. Effectiveness of consultation processes includes whether both the consulting organisation is achieving the overall aim of the consultation and also whether stakeholders' consultation process-related aspirations are met. Such aims and aspirations are consultation *process* related and should not be confused with whether stakeholders are for or against a proposal; for example, was it clear why the consultation was happening and how stakeholders' views would be taken into account, were all relevant stakeholders involved, including hard-to-reach groups, and was there feedback to stakeholders that clarified how decisions and outcomes were reached.

Process evaluation outcomes should be made available to stakeholders and will provide information to improve the process as it progresses and also future processes.

52 For example, EC (EIA) (Petroleum Exploration) Regulations 2013.

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Glossary and Abbreviations

Acquis communautaire/ "acquis"	The rights and obligations that EU countries share. Includes all EU' treaties and laws, declarations and resolutions, international agreements on EU affairs and the judgments given by the Court of Justice. Candidate countries have to accept the "acquis" before they can join the EU, and make EU law part of their own national legislation
ALARP	As low as reasonably possible
AQD	Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe (OJ L 152, 11.6.2008, p. 1–44)
BAT/BREFs	BREF or BAT (Best Available Techniques) reference document means a document, resulting from the exchange of information organised pursuant to Article 13 of the Industrial Emissions Directive. BREFs are drawn up for defined activities within a particular sector and describe, in particular, applied techniques, present emissions and consumption levels, techniques considered for the determination of best available techniques as well as BAT conclusions and any emerging techniques
BPR	Biocidal products regulations. Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products (OJ L 167, 27.6.2012, p. 1–123)
BTEX	Benzene, toluene, ethyl benzene, and xylene chemicals used mainly in producing petroleum products
CER	Commission for Energy Regulation
CLG	Community Liaison Group
DCCAE	Department of Communications, Climate Action and Environment
DCENR	Department of Communications, Energy and Natural Resources – Ireland
DCLG	UK Department for Communities and Local Government
DECC	UK Department of Energy and Climate Change
DETI	UK Department of Enterprise, Trade and Investment
DfE	Department for the Economy
Drilling fluids/drilling mud	Fluid or lubricant added to the wellbore to facilitate the drilling process by suspending cuttings or controlling pressure for example

EA	Environment Agency for England
EC	European Commission
ECHA	European Chemicals Agency
EIAD	Environmental Impact Assessment Directive. Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (OJ L 26, 28.1.2012, p. 1–21). As recently amended by Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014
ELD	Environmental Liabilities Directive. Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage (OJ L 143, 30.4.2004, p. 56–75)
END	Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise - Declaration by the Commission in the Conciliation Committee on the Directive relating to the assessment and management of environmental noise (OJ L 189, 18.7.2002, p. 12–25)
EPA	Environmental Protection Agency - Ireland
Flowback water	Water and excess proppant typically mixed with residuals of chemicals and naturally occurring material (e.g. heavy metals, naturally occurring radioactive material depending on the geology) that flowback up to the surface after the hydraulic fracturing procedure is complete
GWD	The Groundwater Directive. Directive 2006/118/*EC on the protection of groundwater against pollution and deterioration*
H_2S	*Hydrogen sulphide* (a colourless, toxic, highly flammable gas)
H&S	Health and safety
HD	Habitats Directive. Directive 1992/43/EC on the conservation of natural habitats and of wild fauna and flora and Directive 2009/147/EC on the conservation of wild birds
HGV	Heavy Goods Vehicle
HLD	Hydrocarbon licensing Directive. Directive 94/22/EC of the European Parliament and of the Council of 30 May 1994 on the conditions for granting and using authorisations for the prospection, exploration and production of hydrocarbons (OJ L 164, 30.6.1994, p. 3–8)

HSE	Health & Safety Executive. UK regulator for work-related health, safety and illness
HVHF	High Volume Hydraulic Fracturing
IED	Industrial Emissions Directive. Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control)
Induced seismicity	Earthquake and tremor activity caused by human activity
IPHI	Institute of Public Health Ireland
IPPCD	Integrated Pollution Prevention and Control Directive. Directive 2008/1/EC concerning integrated pollution prevention and control
MCENR	Minister of Communications, Energy and Natural Resources - Ireland
MWD	Mining Waste Directive. Directive 2006/21/EC on the management of waste from extractive industries and amending Directive 2004/35/EC
NGO	Non-governmental organisation
NIEA	Northern Ireland Environment Agency
NORM	Natural Occurring Radioactive Material
NOx	The generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts
NRMMD	Non road mobile machinery directive. Directive 97/68/EC of the European Parliament and of the Council of 16 December 1997 on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery (OJ L 59, 27.2.1998, p. 1–86)
OMND	Outdoor machinery noise directive. Directive 2000/14/EC of the European Parliament and of the Council of 8 May 2000 on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors (OJ L 162, 3.7.2000, p. 1–78)
PAEID	Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information and repealing Council Directive 90/313/EEC (OJ L 41, 14.2.2003, p. 26–32)
PEDL	UK Petroleum Exploration and Development Licences; the name of onshore oil and gas production licences which are generally offered within Licensing Rounds in the UK

PHE	Public Health England
Produced water	Fluids that return from the well along with the natural gas after fracturing has taken place. Such fluids can contain substances that are found in the formation, and may include dissolved solids (e.g. salt), gases (e.g. methane, ethane), trace metals, naturally occurring radioactive elements (e.g. radium, uranium), and organic compounds, as well as residual fracturing fluid
Proppant	Solid material, typically treated sand or man-made ceramic materials, designed to keep an induced hydraulic fracture open
REACH	Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC (OJ L 396, 30.12.2006, p. 1–849)
SEA	Strategic Environmental Assessment
SEAD	Strategic Environmental Impact Assessment Directive. Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment
SEVESO II	Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances (OJ L 10, 14.1.1997, p. 13–33)
SEVESO III	Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (OJ L 197, 24.7.2012, p. 1–37)
SHPWEI	Council Directive 92/91/EEC of 3 November 1992 concerning the minimum requirements for improving the safety and health protection of workers in the mineral- extracting industries through drilling (eleventh individual Directive within the meaning of Article 16 (1) of Directive 89/391/EEC) (OJ L 348, 28.11.1992, p. 9–24)
SO2	Sulphur Dioxide (a toxic and odorous gas)
SOOGO	Directive 2013/30/EU of the European Parliament and of the Council of 12 June 2013 on safety of offshore oil and gas operations and amending Directive 2004/35/EC
(S)VOCs,	(Semi) Volatile organic compounds

TDS	Total dissolved solids
UKOOG	United Kingdom Onshore Operators Group, the representative body for the UK onshore oil and gas industry
WD	Waste Directive. - Directive 2008/98/EC on Waste (WD)
WFD	Water Framework Directive. Directive 2000/60/EC establishing a framework for Community action in the field of water policy
WHO	World Health Organisation
Wireline logging	Continuous measurement of formation properties with electrically powered instruments to infer properties and make decisions about drilling and production
WSR	Regulation (EC) N° 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190, 12.7.2006, p. 1–98)

Appendix 1 Country and State Case Studies

Germany

Pre-development: Germany

Issue	Regulatory approach: Germany
Exploration	Permits need to be obtained (licences). There are several types of licence: “Erlaubnis” for exploration only, “Bewilligung”, which are production licences, “Bergwekseigentum” (mining proprietorship) and “alte Rechte” or old rights that remain from previous legislation and are still valid. Anyone who aims to start exploration activities (any resource, not exclusive of unconventional hydrocarbons) needs to obtain a licence. The same applies to the production stage. The licence area covers a specified area of land above ground (x km2) but does not have a depth limit. Applications must meet specific criteria that are included in the legislation. The licences are issued for hydrocarbon exploitation and not for a certain type, which means that any licence that covers conventional gas also extends to cover unconventional gas. As a result, each stage of the lifecycle of these activities needs to have a licence. However, this is only the legal right to explore/produce in the area, the activity itself cannot be undertaken without an authorisation, which implies further requirements (explained below).
Exploration + production	Companies that aim to start exploration activities need to draft an operation plan, as the licence does not automatically lead to authorisation for exploration. The plan contains details of the impacts (e.g. seismicity, drilling). A further operation plan is necessary to obtain authorisation for production. The plans describe the risks and monitoring procedures for the lifespan of the projects and are necessary to obtain the required permits. This is not specific to unconventional gas. As a result, apart from a licence for each stage, an operational plan and separate permits are also required for each stage.
Exploration + production	There are four types of operational plans: principal operational plan, framework operational plan, special operational plan and mine closure operational plan. Principal: valid for two years. Drafted for districts, several oil and gas fields. The exact content is not standardised by law. They are prepared by operators and have to be approved by the authorities provided that they comply with certain requirements. A licence has been issued, they have to include information on liability and precautionary measures against hazards for life, health and physical assets; measures for the protection of the surface, other mineral resources as well as waste storage and precautionary measures for the restoration once the activity has finished. Plans are approved unless they are in conflict with spatial planning, air pollution control and environmental and soil protection legislation. Framework: for mining activities expected to take longer. Drafted for single wells belonging to one project. It involves authorities and stakeholders. It is based on the principal operational plan and is valid for 10–25 years. Mandatory for the projects that are subject to an EIA. However, an EIA is only required for projects of more than 25ha and when production is higher than 500,000 m^3 per day. The principal operational plan still needs to be approved in all cases and in each stage, regardless of the fact that a framework operating plan may have been approved for several years.
	Special operation plan: some activities are subject to this requirement but it is up to the Länder (Federal States) to decide if this is required for shale

Issue	Regulatory approach: Germany
	gas activities. In Lower-Saxony, this is required to obtain a licence for borehole completion, test drilling, drilling activity, and casing. Hydraulic fracturing is also subject to the authorisation of this special plan in this "Land". It is envisaged that most Länder will require this.
Closure	A closure operational plan and an operational plan for waste activities are required for all activities regulated by this law (including but not limited to UGEE).
Operational plans	All operational plans have to be approved by the competent mining authority. The requirements for this approval are specified in the regulations. This includes: • Having a licence for the activity they present the plan for (or mining proprietorship). • Information on liability. • Precautionary measures (protection of the environment, humans and other mineral resources). • Evidence that waste management will be carried out according to the law.
Requirements for installations and facilities	The Deep Drilling Regulations specify the requirements for installations and facilities (on how to install and operate them). These requirements apply to cementing, caving, waste storage, among others.
Issue of licences by competent authorities	The competent authorities for the enforcement of the Mining Law in most Länder are the mining authorities, represented by the Ministry of Economic Affairs of each Land in most cases. However, in two Länder (Hesse and Württemberg-Baden), the mining authority is the Ministry of Environment of the Land. The representatives of the State Mining Authorities in each Land act as authorising and supervising bodies.
Public participation	The degree of participation depends on whether the project needs EIA. Only in the case of EIA, does a project require integrated public participation. However, the licence requirements state that authorities take into account public interests when authorising or rejecting the licence. The competent authority is obliged to consult other public authorities. This should also include all municipalities within the licence area if urban development interests are concerned. However, this has not always happened and in some cases other public authorities were only informed but not consulted. However, the Mining Law does not have a requirement of consulting the relevant landowners, environmental associations or the general public. When the EIA is in place, other authorities may be consulted such as water authorities. As a result, it can be concluded that Germany does not require public and stakeholder participation apart from urban development authorities and municipalities in the exploration and/or production licensing processes or when approving operational plans, unless in the case of an EIA.
Financial guarantees	Germany establishes a financial guarantee to ensure the activities and restoration described in the operational plans can be undertaken. Also, the law requires the introduction of a fund to cover this in case of insolvency. Applicants to exploration permits must demonstrate their financial capability to be able to commence and complete the activities. The coverage of this financial capability is not specified and is modified on a case by case basis.
EIA	EIA for the commercial exploitation of gas where the amount exceeds 500,000 m^3 and involves an area of more than 25ha. Some

Issue	Regulatory approach: Germany
	unconventional activities could be excluded. However, the new hydraulic fracturing regulations proposed by the Government aim to include a compulsory full EIA for all hydraulic fracturing activities. In any case, a moratorium has been put in place with regard to this technology when it is applied to explore shale gas. As described above, the draft (at November 2014) legislation states that hydraulic fracturing for commercial purposes will continue to be prohibited above 3000 m deep but permitted below that depth and after careful consideration and once a committee of experts has been consulted (but always after 2018). As it has been stated, an EIA requires a mandatory framework operational plan. This will involve public, stakeholders and other authorities. Data to include in this plan are: type and quantity of expected emissions and waste materials, especially regarding air pollution, type and volume of wastewater, other significant effects to people, the environment, the environment and climate. A Strategic Environmental Assessment has to be carried out before the approval of the spatial plan. The basis would be a large-scale plan of the operator for exploration and production of the entire reserves in the licence area.
Strategies to avoid disruptions to land use, biodiversity, community and water stress	No special provisions related to this activity. The general provisions are included in the Spatial Planning legislation and the Federal Nature Protection Act.
Zoning restrictions and minimum well spacing requirements	No special provisions exist related to hydraulic fracturing. Minimum restrictions would apply but only linked to indirect legislation (noise, distance from protected areas, populated areas, etc.). For example, the general industry standards require that production sites have to be a minimum of 200 m away from populated areas. However, these requirements are on discretion of the competent authority when issuing the licence.
Filling of wells and preparation of sites	The Seismic Mining Ordinance requires that drilling wells should not have direct contact with the surface and fluid/gas leaks into other rock layers must be avoided. The drilling site should be restored after the activity. This is not specific of unconventional gas.
Vehicles and mobile working machines	There are rules about these in the Seismic Mining Ordinance that are general to all activities regulated by the law and not specific to unconventional hydrocarbons. It is stated that all vehicles and machinery used has to be suitable for the intended use. Regulations include specific tests and inspections for vehicles and machinery (to be done on an annual basis).
Geological characterisation including risks of geological faults, manmade structures, characteristics of the cap rock	Provisions applicable to the execution of works creating induced seismicity are laid down in the Seismic Mining Ordinance, for all relevant activities included in the Ordinance (not exclusive to unconventional hydrocarbon exploitation). Activities have to be announced to the public in advance.
Baseline monitoring prior to drilling or fracturing	General provisions under the Federal Mining Act state that the competent authority may ask the operator to conduct measurements in areas where damage to the surface by mining operations may happen or in the case where these measurements are important for the prevention of damage. However, this is left for the interpretation of the competent authority. No specific requirements are applicable to groundwater quality monitoring prior to drilling or fracturing under the Federal Water Act. There are general requirements in the national law and also any specific requirements under each Land's regulations are applied.

Issue	Regulatory approach: Germany
	Although these provisions are not specific to hydraulic fracturing, it has the necessary elements to regulate it, and it provides discretion for the competent authority, which can be interpreted in several ways. This includes for instance inclusion of the safety management system specific for hydraulic fracturing, including a 3rd party monitoring system. This is not enforced under the mining legislation but through administrative orders.
Risk assessment requirements prior to development	Risk assessment requirements covering individual and/or cumulative risks are within the discretion of the individual permitting authorities, hence there is no standardised method and frequency established and the authorities decide on a case by case basis.

Exploration/Appraisal/Production: Germany

Issue	Regulatory approach: Germany
Noise and fumes	Some general requirements on the use of machines and vehicles in the Seismic Mining Ordinance. Also, other pieces of legislation (Federal Emission Control Act and the Ordinance of Emission Control) implement the Outdoor Machinery Noise Directive, and will apply to noise levels for machines used in drilling and hydraulic fracturing.
Groundwater distance from drilling (above ground)	Requirements that could be applicable to UGEE are included in general water legislation that does not refer to this activity in particular. Moreover, there are special rules on competence of water authorities within mining activities. Therefore, the operator needs a permit to use a water body. The Federal Water Act and the Federal Mining Act are equally relevant in terms of protecting water. For example, the operational plan required under mining legislation can only be approved in accordance with water legislation. Some activities related to unconventional gas development are subject to permits as per the Federal Water Act. This covers abstraction, withdrawal, introduction and discharge of substances into surface waters, removing, extracting and channelling groundwater as well as discharging substances into groundwater. The Federal Water Act requires a permit for any measures that could permanently or severely affect water quality. This may include fracturing fluids, water mixed with sand and (toxic) chemicals, getting into deep water aquifers or shallow groundwater, even if it has not been scientifically proven. The legislation shall apply to both shallow and deep groundwater. This is particularly relevant for unconventional gas exploitation but has not been drafted as a consequence of it nor has the law been modified to include this activity. At some point the German authorities may discuss whether deeper saline groundwater requires protection and whether graded requirements are needed. The new draft legislation includes the prohibition of hydraulic fracturing in the first 3000 m (depth) and in protection areas, drinking water reservoirs and water protection zones. However, it may be permitted after 2018 below 3000 m, in certain circumstances (more details below). Finally, if artesian water resources are found during the drilling operations, the activity has to be stopped immediately and authorities need to be reported. The operational plan has to be modified or an administrative order issued before the activity is resumed. The competent authority decides on the permit, which will be rejected if the predicted changes of the affected water bodies may imply harmful unavoidable or non-compensable changes in water quality.
Well integrity above ground and linked	The construction of the borehole as well as the drilling well casing falls under the Federal Water Act and is subject to permitting. This is not

Issue	Regulatory approach: Germany
infrastructure	specific of UGEE. The construction of linked infrastructure is subject to the provisions of the deep drilling regulations. The regulations lay down general requirements for pipes such as material, pressure control mechanisms, shut-off mechanisms and other requirements that are common to all deep drilling activities (including unconventional fossil fuels extraction). A monitoring plan needs to be made specifying how and when pipeline monitoring is conducted. Venting and flaring are included in the voluntary technical regulations and standards of the German Industry Association of Oil and Gas Extraction and in the Technical Instructions on Air Quality Control. The German Industry Association of Oil and Gas Extraction issued a guidance document on casing calculation for the tightness and pressure of the holes with regard to the inserted pipe tours and cementation in terms of fracturing pressures. However, these guidance documents do not cover unconventional hydrocarbons specifically. The Deep Drilling Regulations specify that in the event of gas leakages, these gases have to be dissipated into the open without causing danger to human health and the environment. If necessary, the gas released during the leakages needs to be washed, filtered and burned.
Monitoring of induced seismicity/fracturing	Requirements on potential risks of induced seismicity specifically related to the fracturing do not exist in Germany. Specific deep geothermal projects have led to the implementation of guidelines and specific limit values for seismic effects. According to the guidelines related to the general risks of induced seismicity indicates that all steps should be accompanied by seismic monitoring even if no seismic events have occurred in the area before.
Well integrity (below ground)	There are requirements on the design, casing and cementing of wells for all deep drilling activities, which apply to unconventional hydrocarbons. These requirements include standpipes and casing for all drilling wells as well as the installation of the core tube ride before the drilling reaches the rock strata containing the oil/gas. The design has to take into account the strength of the rock and the pressure. The case has to be completed by cementation and the lining tube must be cemented entirely. Aquifers and unused oil or gas rock layers needs to be sealed as well. Well heads need to be equipped with shut-off devices that are used to ensure well completion and conclusion of an annular space in case of a spill. The core tube must be deposed in a way that the shut-off mechanism can be installed and the next lining tube can be installed solidly. The borehole has to be monitored and measured several times during the drilling process each time a rock layer with (potentially) oil and gas may be reached and after the final depth has been reached. Well integrity measurements (e.g. direction and inclination) need to be undertaken in intervals (determined by the operator). The borehole will be measured as well if there is indication of horizontal deviations. Samples of all the layers affected needs to be kept until the end of the drilling activity. Also, these layers need to be geologically identified. After each drilling activity, a drilling report has to be issued with certain information regarding the depth, type and thickness of rock layers, diameter, depth and location of casing and information on other mineral deposits. Also, the report must contain information on salt, springs and water levels, as well as on the inclination and direction measurements. Also, aquifers and water deposits cannot be affected by the drilling. This implies further measurements of the quality and usability of mineral deposits.
Emergency safety plan	The deep drilling ordinance includes provisions on safety and prevention measures in the case of spills and well collapse during exploration. If it is

Issue	Regulatory approach: Germany
	known that a spill is likely to occur, the person in charge has to take all the preventives measures. If the spill cannot be avoided, the necessary mitigation and control measures shall be taken. Workers need to leave the installations and the area should be sealed off. Facilities that may pose a risk (in case of disruption or damage) to the surroundings have to be built with sufficient distance from buildings, public transport facilities, etc.
Monitoring: production	Well pressure needs to be monitored during the cementation phase. During the drilling process, the borehole needs to be monitored several times (Whenever a layer that could potentially contain gas/oil is reached). As for the effects of fracturing operations, there are no specific requirements for hydraulic fracturing. General monitoring requirements on production wells arise from the Deep Drilling Regulations. The underground conditions have to be monitored according to a plan prepared by the operator. Also, the operating pressure as well as production and withdrawal quantities and composition of the injected substances need to be assessed at regular intervals. Data has to be recorded A production book is required for each well. This must contain a diagram of the well, an infrastructure plan, a list of all major equipment and timing, nature and scope of the work performed at the bore. The deep drilling regulations specify the constant monitoring of the hydraulic pressure of wells. In the event of signs suggesting that the permissible operating pressure may be exceeded the pressure has to be shut off immediately.
Hydraulic fracturing	Germany introduced a proposal of law on hydraulic fracturing which included a full EIA for all hydraulic fracturing and prohibition in drinking water protection areas in February 2013. However, public opposition and the pressure of opposition political parties resulted in the German Government delaying the proposal and a moratorium was put in place. In July 2014, the German Government stated that it would work on draft guidelines intended to regulate hydraulic fracturing for shale gas purposes. According to proposals, hydraulic fracturing would be completely prohibited until 2021, except from test drilling for scientific purposes. Finally the new draft law for the regulation of hydraulic fracturing (announced at the end of November 2014) includes a general ban above 3000 m depth for an indefinite period, but that hydraulic fracturing for commercial purposes could be allowed after 2018 in exceptional cases and after successful test drilling and the approval of a special committee. The German Government has stated that groundwater will be protected with the total prohibition within the first 3000 m and that the ban will still apply for drinking water protection zones and groundwater catchment areas regardless of depth. The draft law does not include an explicit prohibition of deep injection of flowback. The obligations of the operator with regard to hydraulic fracturing and flowback material management are included in the Deep Drilling Regulations. However, these are not specific of this activity within the framework of unconventional fossil fuels but general provisions related to the injection of substances in deep drilling activities. This applies effectively to both the fracturing process itself and to the flowback water, but there is nothing drafted specifically for unconventional hydrocarbon exploitation. The main provision states that “prior to the introduction of solid, liquid or gaseous substances in the production wells, the use of these substances associated dangers and hazards are to be assessed and, where appropriate, necessary safety measures have to be determined”. This implies that special requirements apply to all fracturing involving the injection of substances, being the main areas the stimulation, corrosion protection and cleaning of the borehole as well as the risk assessment of

Issue	Regulatory approach: Germany
	using these fluids. Specific requirements applicable to hydraulic fracturing include a shut-off device for wells. If a particularly corrosive substance is injected, the annulus and production string have to be shut and filled fully with a protective medium. The wellhead has to close tightly and must be designed in a manner to withstand the maximum expected pressure in the head. Finally, it has to be stated that fracturing is considered as a secondary or tertiary production measure and can also be considered an injection drilling. Special precautionary measures have to be taken for this kind of injection drilling to prevent that the injected substances migrate to other rock layers.
Monitoring: Water supply	There are no specific requirements on monitoring, reporting and verification of water abstraction and use for the hydraulic fracturing phase itself. A permit is needed for surface and groundwater (as described above), so authorities can pose specific obligations on a case by case basis.
Monitoring: Noise	The Federal Emission Control Act has emission control standards for assessing noise. This is general for all industrial activities.
Waste management requirements	The General Mining Ordinance includes provisions for the disposal of "Mineral waste", including the draft of a Waste Management Plan where the waste is characterised (in line with European legislation). If the flowback has been treated, its discharge to surface or its deep underground injection might affect groundwater and needs a permit. This will only be granted if water quality is not affected (or not expected to be affected). Although the interpretation of two articles of the Federal Water Act and the Water Framework Directive may allow for interpretation that re-injection of the flowback water is possible, it seems that this is not possible because harm to groundwater cannot be excluded. On the other hand, experts in the German Environment Agency state that this would not be an issue for deep groundwater that is not suitable for present and future use and is not part of the ecosystem. This is unclear, especially with the new draft legislation, as it does not explicitly forbid reinjection. No special EIA exists for the pipes that transport flowback water, although the Deep Drilling Regulations specify that the pipes need to be ready for the expected exposure. Drilling cuttings are not considered liquid waste and can be disposed of at landfill sites outside of the drilling area (as per the Mining Waste Directive). There are provisions in the General Mining Ordinance regarding the handling and storage of flammable liquids that can be applied to fracturing fluids. These must have a storage capacity of less than 10,000 litres and have to be constructed in a way that leaks are easily identified. Spills that can enter surface water or seep into the ground have to be prevented at all times. Waste management facilities need to be built and operated at a site which is suitable geologically, hydrologically and geotechnically. The General Mining Ordinance includes specific requirements for the construction, operation and decommissioning of these facilities. Also, an operational plan for waste management facilities needs to be prepared. As a result, the waste impacts are considered during the planning stage. As for the waste management plan, it has to contain the composition, expected total amount of mining waste, how it arises and how they are treated.
Disclosure of the composition of chemical additives	No specific provision has been drafted for the hydraulic fracturing fluids in the scope of unconventional fossil fuels extraction. All the manufacturers and importers of substances that are produced or

Issue	Regulatory approach: Germany
	imported into the EU in a quantity equal or higher to 1 tonne/year have to register these substances. The characteristics of the substance as well as the risks arising from its use have to be included in the registration of these substances. This requirement arises from the REACH Regulation, and has been transposed into German legislation. As a result, if the substance is manufactured or imported in quantities lower than 1 tonne, the registration would not be needed. The access of information clause of REACH does not apply to the chemicals used in the fracturing activity and this has not been changed in the German regulations. In Germany, the use of chemicals within the fracturing process is subject to both Chemicals and Mining laws. The latter contains more specific regulations for hazardous materials. The requirements under this legislation focus on health and safety issues for workers handling these materials. If these two laws do not include regulations for a given case, the Hazardous Substances Ordinance applies. This Ordinance includes a substitution test that needs to be documented before commencing the operations, including if an alternative is possible and whether a waiver is required (appropriately justified). If the outcome of this test suggests that the substance that is used can be replaced by a less hazardous alternative, the operator has the obligation to do this. The German Länder Committee for Mining published best practice examples on drilling which included specific operating plans for certain substances that are used in mining and drilling activities, but that are no specific requirements for hydraulic fracturing activities. This requests the operator to provide the exact name, quantity and concentration of certain chemical substances, as well as possible alternatives for them. It is worth noting that these requirements are only based on health and safety requirements (i.e. environmental requirements such as groundwater protection are disregarded). The substitute test requirement mentioned above applies if the hydraulic fluids are: inorganic acids (except hydrochloric acids and phosphoric acids) such as hydrofluoric acids, fluoride hypochlorite peracids and inorganic “breakers” such as hypochlorite/chlorite, peroxides, persulfates, perborates bromates and gasoline-condensates, radioactive material, biogenic substances. As a result, it seems that the German legislation does not require the disclosure of the exact substances used for the fracturing fluids.

Decommissioning/Closure/Post-closure: Germany

Issue	Regulatory approach: Germany
Requirements for temporary abandonment/well idle time	Requirements for the temporary abandonment/well idle time are addressed in the management plan and are site specific and therefore decided on a case-by-case basis. These plans are described in the Federal Mining Act and the Federal General Mining Ordinance (Operational plans) as stated above.
Integrity of well	The Deep Drilling Regulations oblige to maintain the integrity of the well after closure. ISO norms are used to specify what is necessary (e.g. ISO 10426–1:2009 on cement and materials for well cementing).
Dismantling of installations	The Federal Mining Act includes provisions on the dismantling of installations and the obligation (stated above) of land restoration. Nothing specific for unconventional gas has been drafted. The Mine closure operational plan has to include, among other things: Name of the contractor, name of mineral resources extracted, heating

	value, description of other encountered minerals, information about the disruptions, technical and operating conditions, details of the day of start of operations and reasons for closure, description of the storage area, list of stocks of natural resources and capacity, representation of treatment plants, representation of the traffic and transport situation.
Liability and responsibility	This is regulated in the Federal Mining Act. However, nothing specific is set out specifically for unconventional fossil fuel extraction.

Denmark

Pre-development: Denmark

Issue	Regulatory approach: Denmark
Exploration and production	Permits need to be obtained (licences). The Subsoil Act distinguishes between two licence types: a preliminary investigation licence and a combined exploration and production licence. The Parliamentary Committee on Energy Policy needs to be informed before licences are granted. Denmark has a single set of Model Licence terms for onshore and offshore operations. These have standard terms that are negotiated, although certain issues need to be specified on a case by case basis (e.g. area, duration of exploitation period, work obligations). The first licence authorises initial research such as seismic and geological surveys so that companies are able to estimate if hydrocarbons are present. This licence does not give exclusive rights nor ensure preferential rights for the company if the area results to have enough reserves for the company (or other companies) to request an exploration and production licence. The combined exploration and production (E&P) licence authorises exploration and production. This licence provides exclusive rights, although the licence does not grant automatic authorisation for the commencement of production. This requires further licences. The combined E&P licences are valid for six years and may be extended for up to 30 years if production proceeds. The licence reflects the exploration period, which can be increased, and when this period is about to end the area of interest is reduced to what will be exploited. In Denmark, there is no legal difference between concession, licence, permission, or permit. All are public administrative decisions and the exact term is chosen as appropriate. The layout of production installations and pipelines, as well as the organisation of production needs to be drafted in a plan, which has to be approved by the Danish Energy Agency. A work programme is also required to start exploration (attached as appendix to the licence). The plan is exclusive of the exploration phase. If the plan is not met, the company has to pay a fine equivalent to the quantity it would have spent if it had met those requirements. Each work programme is different in each licence. Each of the activities contained in it will normally need a permit prior to its commencement. The exploration period is normally set for six years and it will then be followed by their respective development and production phases, once the exploration phase has been successful and the licence holder has obtained all the permits. The exploration phase is divided into three phases: At the end of Phase 1, the licence holder needs to decide whether additional exploratory work is necessary or whether it relinquishes the licence. Phase 2 will continue exploring to decide the suitable location of exploration wells, and Phase 3 will include drilling in an exploration well (or request a permit to do so within the last six months of duration of the licence) or relinquishment of the licence. The municipality of Frederikshavn has granted the first drilling permit to

Issue	Regulatory approach: Denmark
	licence 1/10 (Frederikshavn, awarded to Total E&P Denmark B.V.) and will now explore to assess the potentiality of the area. However, hydraulic fracturing will not be allowed for the scope of this permit. Companies are subject to a parent company guarantee or bank guarantee and a draft Guarantee Model has been prepared and published by the Energy Agency.
Requirement of local plan	A land use planning system as well as a rural zone permit system is required in Denmark. These shall not be in conflict with national legislation/plans. These plans shall contain information and guidelines on construction of technical installations, as well as guidelines for the protection of assets such as nature, landscape, cultural heritage, agricultural land, among others. A local plan is required for new activities that could lead to significant changes in the environment, whatever these are (i.e. not exclusive of hydrocarbon exploration). They are legally binding. The rural zone permit system is similar but exclusive for activities in rural zones. These requirements are envisaged to enable public participation extensively throughout the process.
Requirement of EIA	The EIA rules for land-based activities establish which activities require a compulsory EIA and which may require an EIA, subject to an initial screening. This screening procedure has to be done by the municipality. Shale gas exploration well drilling without hydraulic fracturing requires an initial screening that will determine whether a full EIA is necessary. The criteria to be used in this screening are also described in the legislation and are in line with the EIA Directive. There is no public participation in the screening process but its results have to be published. This publication must contain detailed material that is available to the public. If hydraulic fracturing is used, a full EIA is required without exception. This is a modification of the law that regulates EIAs in 2012. However, no SEA was carried out as the SEA Directive entered into force in 2001, 4 years after the Open Door procedure for granting the 2 onshore licences that have been granted so far started. The EIA shall include size and characteristics, land requirement, production processes, type an amount of materials, emissions and other environmental impacts in terms of noise, vibration, lighting, water, air and land pollution etc., various alternatives and the reasoning for the final choice including locations, impacts on the environment and surrounding areas in the short and long term in terms of habitants, flora, fauna, air, soil, water; the extent of transportation and descriptions of options to avoid and limit the impacts. This EIA shall analyse each situation on a case by case basis and the extent to which groundwater, residential areas, flood-prone areas and seismic-prone areas are protected depend on what is established in this assessment. The competent authority publishes a statement with the final assessment including the options and alternatives presented by the developer and the results. For activities relevant to licence 1/10 in Frederikshavn, an EIA was not recommended by the Municipal Committee for Planning and the Environment. However, the Council decided that an EIA would be required. The report was published in February 2014 and went for consultation during eight weeks. The EIA only covered the establishment of an exploration well that does not include hydraulic fracturing. If this is intended at a new and full EIA will be required if fracturing is to be carried out (as stated above).
Strategies to avoid disruptions to land use, biodiversity, community	Danish law protects nature and species through the Nature Protection Act. Certain habitats (wetlands, meadows) as well as internationally protected areas are especially protected and there is prohibition to

Issue	Regulatory approach: Denmark
and water stress	change them. This will be covered in the EIA for the activities that require it. Environmental permits are required for certain activities that are considered hazardous and/or involve using natural resources. An assessment is required to determine whether the permit can be granted. Also, the Environmental Protection Act establishes the principles of "Polluter pays" and "Pollution Prevention Measures". This act also establishes that the municipalities are the competent authorities to enforce the legislation, and a general decentralisation of competences with regard to environmental protection. Operators must apply for a number of permits to commence drilling activities including permits for the abstraction of water, drilling water wells, discharge in surface water, construction of waste water tanks, change of road access, construction of diesel tanks, control of waste discharge etc. Local municipalities are responsible for granting these permits. Groundwater supply is protected by the Water Supply Act. If groundwater is used for unconventional hydrocarbon extraction and production, then a general permit is required according to this law. For the specific case of licence 1/10, the local authority has granted a permit for a maximum water withdrawal of 3000 m^3 per year, with continuous monitoring and reporting. For the licence 1/10 Total has, following the advice of the authorities, agreed on gathering data to analyse and control groundwater quality before, during and after drilling to ensure any impact or contamination can be ascertained.
Zoning restrictions	There are no provisions on well spacing, however, before production and measures aimed at production are initiated, a plan for the production activities, including the organisation of production and the layout of production installations and any pipelines (production measures, etc.), requires approval by the Minister for Climate and Energy. Well spacing and whether the wells are sufficiently away from where they could cause an issue are assessed. As for depth, no specific restrictions for hydraulic fracturing activities apply in Denmark, but this is to be assessed on a case by case basis (considering geology, exact characteristics of the activity, particular issues of the area in question, etc.).
Vehicles and mobile working machines	It is envisaged that the EIA and permits contain information about this. This is not specific to unconventional hydrocarbons.
Geological characterisation including risks of geological faults, manmade structures, characteristics of the cap rock	The operator must prepare a "drilling programme', which needs to be approved by the Danish Energy Agency. This plan should provide information on the depth, the various geological horizons that would be affected including stratigraphic columns, a description of the lithology, where the casing points are envisaged to be located, and the seismic sections near the planned wells. The operator shall submit samples and other information free of charge as required by the law, including geological and 3D surveys of the affected areas, gravity and magnetic measurements, reports, maps, etc. Samples have to be submitted as soon as they are available. These include cuttings (dry and wet samples), drilling and formation fluids, and sidewall cores (including UV image). Daily reporting is compulsory during drilling operations. Reports, maps and data about the well sites, subsoil and soil surveys require submission. For each production test, a summary report needs to be submitted with: • An account of the production tests. • Measurement data and values obtained in production tests. • Any parameters that are not derived from direct measurements.

Issue	Regulatory approach: Denmark
	• All master curves and plots used in the analysis of production tests. • Conclusions on the results and their interpretation. A final report of the conclusions and all information about the drilling operation has to be submitted no later than six months after its termination. This must include: • An outline of the measurement data for each well (coordinates, drilling rig, water depth, contractor, date and time of operation, number of hours spent, total depth). • Summary of drilling operations (with indication of any technical problems and possible reasons, geological information). • Information and results of casing and cementing. • Description of the drilling mud used. • Detailed description, including a chart showing the well status upon completion of the work. • A composite log of the measurements made in the well, indicating core and test production intervals, casing and cementation, plugs, lithology, selected logs and analysis of the drilling fluid. The core material requires submission to the Geological Survey of Denmark and Greenland. Additionally, this authority and/or the Danish Energy Authority may demand the submission of more data or samples.
Baseline monitoring prior to drilling or fracturing	The Danish Energy Agency requests the operator to provide information on water and air quality, seismicity. Daily monitoring and reporting: • Measurements in the well (including information about the performance of the production tests, computed values obtained in these tests (radius of influence, permeability, flow efficiency), detailed conclusions with regard to the interpretation of results). • Directional measurements (submitted as soon as they are available). • Seismic measurements. • Qualitative and quantitative analysis of the formation water produced. • Pressure, volume and temperature. Sampling: types of samples required described above. Reports from the analysis of these samples require also submission. Reports: • Geological surveys. • Core description and photographs. Results of measurements and analysis of core materials. • Qualitative and quantitative analysis of formation water. • Reports on raw data (pressure, temperature, size of orifice, production rates and others). • A final report within six months of termination of the drilling operation (described above).
Risk assessment requirements prior to development	EIA covers this. Danish Authorities have stated that the risk assessment procedures in place are based on Best Available Techniques (BAT) for the exploration and production of unconventional hydrocarbons as well as considers possible changes to the geological formation, man-made structures and existing wells as a result of the use of hydraulic fracturing. However, this risk assessment process does not have a specific minimum vertical separation between the area to be fractured and groundwater, as this is analysed on a case by case basis.

Issue	Regulatory approach: Denmark
Public participation requirements	• Grant of the licence: the Parliamentary Committee on Energy Policy needs to be informed before any licence is granted. This Committee may raise questions that have to be answered by the Minister. Also, the relevant authorities (e.g. municipalities) are informed and requested for comments. • Investigation phase: the consent of the landowner has to be obtained 30 days prior to the start of the seismicity and geochemical properties investigation. These investigations do also need to be carried out with the least inconvenience as possible to landowners and other people. Also, the general public from the likely affected regions must be informed at least 30 days before the start of the investigations, normally through an announcement in local newspapers that shall include location and schedule. Also, contact information should be provided. The Energy Agency and the Geological Survey of Denmark and Greenland have to be notified as well. • Public participation in the scope of EIA: EIA reports need to be consulted by the public for at least eight weeks. In the 1/10 licence, an EIA was required and the public consultation was held from Wednesday, 5th March to Monday, to 5th May 2014(eight weeks). Prior to that, a consultation of four weeks was put in place as part of the EIA screening and scoping process. • Public participation in the rural zone permit: To obtain this permit, a neighbourhood hearing process needs to be implemented. Permits cannot be granted before two weeks after informing the neighbourhood about the project (written). For licence 1/10, the municipality (Frederikshavn) held a public meeting on the activities, in which the authorities and the developer could present their views/information on the project. All the relevant material was made available online. • The public has to be informed of incidents/accidents; results of inspection; non-compliances and sanctions. The results of inspections have to be notified up to 4 months after the inspection date. These information disclosures do not imply public participation.
Financial guarantee	The licensee must obtain a parent company or bank guarantee. The guaranteeing body must cover the licensee irrevocably and without any time limit for all current and future obligations and liabilities caused under the licence activities towards the Danish State. Also, liabilities related to pollution or environmental damage (irrespective of which party suffers the damage). The licensee will have to pay for any damage caused by its activities even if the damage is caused accidentally. Liability is strict and unlimited and includes personal injury and damage to property. It has to be noted that for a licences that are held jointly by several companies, even if activities are conducted by an “operator’, all the companies that hold the licence are strictly liable. The liability must be covered by an insurance, which should cover employees, and any injury to a third party, potential pollution damages.

Exploration/Appraisal/Production: Denmark

Issue	Regulatory approach: Denmark
Noise and fumes (drilling)	The Danish Environment Agency has published recommended noise limits for most types of environmental noise and this is the basis for the authorities’ assessment of noise impact. Any environmental permit (of a given new activity) will take this into account and will have a maximum

Issue	Regulatory approach: Denmark
	noise level. When the environmental authorities grant an environmental permit to a plant, they use the recommended noise limits, as well as a description of the noise level that can be obtained by use of the best available technology, as a basis for the specific noise limits in the conditions of the permit.
Gas venting	Venting is forbidden and flaring is only accepted under specific conditions, which are set out in the drilling permit.
Drilling requirements: groundwater	The Danish Energy Agency is responsible for the protection of drinking water. A drilling programme has to be approved. This must contain information on groundwater resources. The programme includes a description of what is the necessary cementing and casing to protect drinking water in the vicinity. This drilling programme should be drafted in a way that includes prevention measures to prevent explosions, pollution or any other damage to drinking water (e.g. it must include a description of the installation of cemented casings to protect drinking water). Safety related equipment shall be installed as drilling operations progress. All relevant logs and the test programme has to be submitted for approval to the Danish Energy Agency before test production is carried out. Operations shall preferably take place at daylight. Test production shall not take place in adverse wind and weather conditions. Other general requirements of oil and gas operations (experience of staff, fire precautions) are also in place.
Monitoring induced seismicity	No general requirements to manage the risk. Seismicity should be monitored daily and any changes should be communicated. Equipment for the detection and monitoring of induced seismicity should be in place. This requirement is especially relevant to hydraulic fracturing, where daily monitoring of possible induced seismicity is compulsory.
Well integrity: casing and cementing	According to the Drilling Guidelines to exploration and appraisal wells for hydrocarbons and other minerals (not exclusive of UGEE), operators must prepare a programme describing the positioning and casing of wells and describing the diameter of the drilled hole, casing dimension, weight and quality of casing, depth, strategy for centring of casing, demonstration of the well strength, precautions to be taken if the formation strength is not obtained, procedure and minimum requirements with regard to formation strength tests. No specific provisions on this matter exist for wells where hydraulic fracturing is practised. Before a permit is granted, the operators must determine foundation and stability conditions and an evaluation has to be done before the location of a well is allowed. The maximum internal pressure has to be tested in the well so as to ensure that casing is adequate and do not leak. This is common for all drilling practices, not specifically of UGEE. A production test programme has to be approved by the Danish Energy Agency. All production test logs have to be submitted as well. Valves, lines and vessels have to be tested.
Well integrity: tests before, during and after drilling	The acceptability of the platform/rig for the specific operation and location must be documented. After casing and cementing, pressure shall be tested. This is to ensure that the casings installed are not leaking. As stated above, before test production of a well can be carried out, logs and a test programme shall be approved by the Danish Energy Agency. Fire precautions shall be taken. A drilling fluid programme (detailed description of the types of drilling fluids that will be used, their density and composition and monitoring programme for the volumes) must be prepared.

Issue	Regulatory approach: Denmark
	The integrity of other man-made structures is not clearly protected as the Danish authorities need to evaluate the specific structures that would fall under this term. Well casing shoes must be set at depths that are sufficient to ensure complete control of the well at all times. An evaluation programme must be approved if hydrocarbons are discovered. In view of its results, the licence can be extended for 30 years. The operator must ensure that operations stop and remedial action is taken (if necessary) if there is a loss of well integrity.
Hydraulic fracturing	As stated above, the guidelines establish daily reporting to the Danish Energy Agency. This information should include: performed hydraulic and chemical treatment. The operator is also requested to perform surface monitoring of seismicity of fracturing. Authorities require the operator to submit a specific programme describing the fracturing activity, which has to be approved.
Waste management requirements	Waste resulting from these activities is considered as “mining waste” and classified as “waste from the exploration for shale gas”, regardless of whether this waste arises from exploration or production. If the waste is treated in a dedicated waste treatment plant, a special permit must be obtained. However, this waste treatment facility will not always be required, so the waste would be managed as described by the law that transposes the Mining Waste Directive. As of March 2013, there was no new legislation expected to be enacted with regard to this issue in the near future.
Monitoring: water supply	General water legislation applies. This has been described above.
Monitoring: Air emissions	Operators shall monitor their air emissions, especially methane and other volatile organic compounds (VOC). This will be established during the EIA process and follows general industry best practice.
Disclosure of the composition of chemical additives	The guidelines for drilling explorations state that drilling fluids need to be described in detail including type, density, rheological properties, composition, relevant standard followed. Also, details should be given on the equipment used and monitoring of the volumes used and volumes that need to be stored in the facilities. A manual with all the hazardous substances used shall also be prepared. All the chemicals that will be used for fracturing have to be described in the fracturing programme. This programme has to be approved by the Danish Energy Agency before commencement of operations. According to the Danish Energy Agency, all chemicals being used for fracturing have to be described in the programme for this activity being performed in a well. The programme has to be approved by the Danish Energy Agency before commencement of operations. At the moment, there are no obligations with regard to the publication of these data, but the operator of the two onshore licences granted so far (Total E&P Denmark BV) has the willing to do so.

Decommissioning/Closure/Post-closure: Denmark

Issue	Regulatory approach: Denmark
Requirements for temporary abandonment/well idle	Temporary abandonment of a well that is not plugged permanently shall be permitted in special circumstances following an application that the operator needs to submit to authorities. This application has to describe who is responsible and how the temporary abandonment will be

time	monitored.
Integrity of well	The well has to be plugged prior to the abandonment of any well, as described by the Danish Energy Agency. For this, an application for permission to stop operations and to plug and abandon a well must be submitted prior to commencement of the abandonment activities (at least 24 hours earlier). The licence holders need to justify the planned abandonment and specify how this will be done. Elaborated details of how the plugging should be done are available in the Drilling Guidelines. A cement plug of 100 m long has to be placed near the surface. Reporting requirements and details on the submission of samples are also included. When a well is abandoned the original state of the well site shall be re-established. This will be monitored by the authorities. All the relevant obtained documentation shall be submitted to the Danish Energy Agency.
Dismantling of installations	According to the Subsoil Act, licences should include detailed rules concerning which steps are necessary once the licence has terminated. The steps shall include how the installations that have been used will be handled in the closure/post-closure periods. The Government is entitled to take over all or part of any installations intended for a long term use in the licence area once the licence is terminated, and without any compensation. Because of this, the operator is obliged to ensure that facilities are handed over in an appropriate condition. Licence holders must compensate when they are not capable of fulfilling this requirement. If the installation will be abandoned and no longer used, the licence holder needs to dismantle the installations according to a schedule. A plan describing this is included in the licence and has to be submitted and approved by the Energy Agency. In general terms, operators shall ensure that previous areas of operation are remediated to achieve the best environmental status that is possible, but without necessarily focusing on achieving the environmental status prior to the operations, as this status could have been affected by other factors. The company has to compensate the State if a third party claims for compensation to the State from any event resulting from a negligence or wrong procedure related to the dismantling of installations.
Liability and responsibility	There is no sanction regime specific to unconventional gas extraction. It is the general regime in the energy and environmental legislation that would be applicable.

United Kingdom

This Appendix describes the Regulations regarding UGEE applicable to the United Kingdom. Due to the particular status of this EU Member State, the UK Parliament has gradually devolved certain powers to the Scottish Parliament, the National Assembly for Wales, and the Northern Ireland Assembly. As a result, there are certain aspects that are different in each of the UK countries, or are applied differently depending on the country. Generally, the requirements in this section refer to England (but apply to all four countries). The environmental authority is also generally referred to as “The Environment Agency” in this section to avoid repetition, even though the environmental authority denomination is different in each of the four countries (Scottish Environment Protection Agency, SEPA for Scotland; Natural Resources Wales, NRW for Wales; and Northern Ireland Environment Agency, NIEA for Northern Ireland). Country specific aspects and exceptions for Scotland, Wales and Northern Ireland are described where relevant. Finally, the term “the Government” refers to the UK Government unless otherwise stated.

Scotland: Update (January 2015)

On 28th January 2015, the Scottish Government announced a moratorium on all planning consents for unconventional oil and gas, including those involving hydraulic fracturing. The Scottish Energy Minister, Fergus Ewing, indicated that this moratorium will allow Scotland to run a full public consultation on hydraulic fracturing, as well as to conduct a full public health impact assessment.

It is also expected that the Scottish Government will strengthen environmental regulations and improve planning guidance.

Therefore, the Regulations outlined below would apply to Scotland only if this moratorium was lifted. However, it should also be noted that new Regulations may come into force in Scotland during this time.

Wales: Update (February 2015)

The Welsh government indicated that it will try to block hydraulic fracturing in Wales until its safety is proven. For this, a moratorium on fracturing in Wales was announced in February 2015. Although the Welsh Government states that it has a solid legal argument to enact this moratorium, it is unclear that this could actually occur as the UK Government has the legal authority of issuing exploration and production licences.

The UK Government published its plans over a devolution of powers to Wales with regard to this in February 2015 in "Powers for a Purpose: Towards a Lasting Devolution Settlement For Wales'[53] which states "3.11 The political discussions demonstrated strong consensus for the same powers to be devolved to Wales. The UK Government agrees with the consensus that the licensing of onshore oil and gas extraction in Wales should be devolved. These powers would complement the Assembly's existing planning powers, and would allow the Welsh Ministers to take strategic view of future licensing in Wales.

More specific information will be made public following the outcome of these plans, along with the legal advice that the Welsh Assembly has sought to evaluate its possibilities.

As with Scotland, the Regulations outlined below apply to Wales only if the moratorium plans do not go ahead. If that is the case, new legislation may also come into force in Wales during the time the moratorium applies.

Pre-development: UK

Issue	Regulatory approach: UK
Planning exploration + production	Oil and gas licensing in England, Wales and Scotland is governed by the Petroleum Act 1998, the Petroleum Regulations 1995 and the Hydrocarbon Licensing Directive Regulations 1995 (transposing Directive 94/22/EC on the conditions for granting and using authorisations for the prospection, exploration and production of hydrocarbons). This legislation regulates "all oil or relative hydrocarbon and natural gas existing in strata but not including coal or bituminous shales or other stratified deposits from which oil can be extracted by destructive distillation." The Government holds the right and ownership of petroleum resources and shall grant licences for the exploration and production rights. There are different types of licence with their separate regulations for offshore

53 See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/408587/47683_CM9020_ENGLISH.pdf

Issue	Regulatory approach: UK
	and onshore activities. For onshore areas, the licence is called a Petroleum Exploration and Development Licence (PEDL). A PEDL confers the right to search for, bore for and obtain hydrocarbons. A PEDL grants exclusivity to an operator for a licence area but does not provide the consent for drilling or any other operations. It is awarded by the Department of Energy and Climate Change (DECC). The Exploration and Production (E&P) Regulations 2004 set out model clauses in relation to PEDLs granted from the 12th licensing round onwards. DECC consulted on a Strategic Environmental Assessment (SEA) prior to the invitation for the 14th round of onshore licences (covering England, Scotland and Wales). The consultation ended in March 2014 and the bidding process started in July 2014, with applications to be submitted by October 2014. The invitation to apply was published in the Official Journal of the European Union on 20th June 2014 (notice (2014/C 188/04). According to the SEA, licences cover the exploration and production of shale gas. Following the consultation, DECC expressed its satisfaction with the current consideration of environmental issues in the Licensing Plan. In the SEA post adoption statement, DECC states that a monitoring programme has been proposed to enable future consideration of additional mitigation or intervention measures where significant effects or uncertainty have been identified. PEDLs cover three stages, called Initial Term (Work Programme required), Second Term (Development Programme required) and Third Term (Production Phase). Licence holders are required to obtain specific permits for drilling and production (process described below). In particular, operators require planning permission, appropriate permits from the relevant environmental regulator, and must meet HSE's standards. PEDL applications include an analysis of the geology of the area, a work programme for evaluating the potential petroleum production from the area, evidence of the technical and financial capacity of applicants as well as how the work programme expects to consider the results from the mentioned geological analysis. Applicants are judged according to the financial viability of the applicant and its capacity to carry out the activities, the technical capability of the applicant, the procedures that will be followed to carry out the activities permitted in the licence. DECC takes into account previous licences that may have been granted to the same applicant under the Petroleum Act 1998 and how activities have been carried out. DECC has confirmed that applicants need to demonstrate awareness of the environmental issues and regulatory requirements related to the activities that will be carried out. As a result, the PEDL application must include an Environmental Awareness Statement explaining how the applicant understands of the onshore environmental legislation that is relevant to the exploration, development and production stages of the project. Also, the applicant must specify how the sensitivities associated with the activities are considered (e.g. special areas of conservation, special protection areas, marine protected areas, etc.). Applicants are also required to explain their pollution mitigation arrangements; as well as details of any failure to comply with environmental standards in the previous five years (and any penalty of conviction derived from this). PEDLs include obligations, specifications on commencement, abandonment and plugging of wells, distance of wells from the boundaries of a given licensed area, provision of ancillary infrastructure (e.g. pipelines). PEDLs do not include site specific conditions. Licence holders will also need individual landowners to consent. A recent ruling of the Supreme Court has confirmed however that where

Issue	Regulatory approach: UK
	a landowner "unreasonably refuses to agree access, where he demands unreasonable terms, or where the fragmentation of land ownership means a licensee cannot agree terms with everyone" then the Mines (Working Facilities and Support) Act 1996, as modified by the Petroleum Act 1998, can be used in order for the licensee to obtain access rights. There are no specific requirements relating to public participation and consultation or access to information with the legislation covering the grant of licences in the UK. However, PEDLs as well as consents are publicly accessible on the DECC website, and each licensing round commences following a SEA, in which public consultation is allowed. Also, although licences do not require public consultation, this is required as part of an EIA that is likely to be necessary to obtain planning permission. Moreover, the planning process will enable public participation even when an EIA is not required. As for the required environmental permits, the Environment Agency for England (EA) (or its equivalent in Wales and Scotland) will first consult on the initial application on its website during 28 days. The EA bases its decision on the documents requested to the applicant as well as the results of the consultation (details in the relevant sections below) and publishes a draft decision. A second consultation to collect the views of the public regarding the draft decision is also available on the EA website for another 28 days. For instance, the EA initially granted a permit to Cuadrilla Ltd for its application for several environmental permits regarding its activities at Preston New Road in Lancashire. The final approval is pending this second consultation, which will be available for comments on the EA's website from 10th November 2014 to 08th December 2014. Apart from DECC and the EA, the Government has created an Office for Unconventional Gas and Oil. Northern Ireland: Petroleum Licences are issued by the Department of Enterprise, Trade and Investment DETINI under the Petroleum (Production) Act (Northern Ireland) 1964 and various subsequent regulations (DETINI 2010). There are no licensing rounds, and DETINI assesses the licence applications one by one. DETINI assesses the technical competence, environmental awareness, financial viability and capacity of licence applicants before making a decision on granting a licence, and will reassess these when a Licensee makes a firm decision to drill on a "drill or drop" work programme. This decision has to be taken in three years.
EIA requirements	A PEDL does not (per se) allow for all exploration and production activities. To proceed, the company needs to apply for drilling and development consents, planning permission, as well as comply with the access requirements and HSE requirements. As part of the SEA for the 14th Round of Onshore Licensing, an Environmental Assessment was carried out. This included an environmental report, with a high level description of the possible impacts. Items included in this report were: • Outline of the environmental characteristics of the affected areas and how these would evolve if the activities are carried out. • Likely significant effects on the environment in the short/medium/long term, whether these effects are potentially temporary or permanent, and whether these may be primary/secondary/cumulative/synergic. • Existing environmental problems, especially relating to the areas of particular environmental importance such as areas protected under the Birds Directive and/or Habitats Directive. A more detailed assessment (by the licence holder) is performed when

Issue	Regulatory approach: UK
	planning permission is applied for (if an EIA is required). Once a PEDL is obtained, the operator needs planning permission before exploration is permitted. An application for planning permission has to be submitted and granted for each phase (exploration, appraisal and production). The local planning authority has to decide whether an EIA is required. According to the law, in the case of extraction of petroleum and natural gas for commercial purposes, an EIA would be required where the amount extracted exceeds 500,000 m^3 per day in the case of gas and 500 tonnes per day in the case of petroleum. If groundwater requires to be abstracted for injection into the well, it may also require compulsory EIA (if it exceeds 10 million m^3). If these two conditions are not met, a compulsory EIA would still apply if the pipelines that are required have a diameter of 800 mm or more and a length of more than 40 km; and/or if the storage facilities have a capacity of more than 200,000 tonnes. As a result, UGEE exploration may not involve these quantities and would not automatically be subject to EIA. UGEE would likely be within a group of activities in which the requirement of EIA is evaluated (Annex II activities), considering whether there are likely to be significant effects to the environment. DECC requires an Environmental Risk Assessment for operators. In this document, operators will need to undertake an assessment of environmental risks over the full life-cycle of the proposed operations, including abandonment. This ERA will require consultation with stakeholders (including local communities). DECC published guidelines on how to prepare this document in April 2014. In addition, under the Pipelines Act 1962 and the Pipe-line Works (Environmental Impact Assessment) Regulations 2000, an Environmental Statement is required where the development relates to pipelines of over 16 km in length. The requirement for EIA is also important in terms of access to information, public participation and consultation requirements. More details in the relevant section. Northern Ireland: No licensing rounds exist and the DETINI evaluates each application independently. DETINI conducts screening of impacts of the activities requested to be authorised in the licence as well as which may need more detailed assessment on a case by case basis and when the application is submitted. The same criteria for the inclusion of the activities in Annex I (compulsory EIA) and Annex II (screening needed to determine if an EIA is required) would also apply in NI. For the developments that do not meet the criteria for being included in Annex II in terms of thresholds, the Department of Environment may still decide that an EIA is necessary. A current example of how a licence does not imply the granting of an exploration permit in Northern Ireland is Tamboran activities in County Fermanagh. The company received a licence in 2011 and had three years to inform DETINI of their “drill or drop” decision. The company received an extension (up to September 2014) to complete the first part of their working plan, which included drilling a borehole to take rock samples and carry out a preliminary environmental review. Tamboran applied for a permit to drill a 750 m deep borehole but the Minister of Environment rejected it in August 2014 stating that a full planning application with its Environmental Statement should be submitted as drilling could have severe effects on the environment. DETINI decided to terminate the licence when the extension up to September 2014 expired. In October 2014, Tamboran stated that it was seeking leave to apply for

Issue	Regulatory approach: UK
	a judicial review against the rejection of another extension.
Financial guarantees/requirements	England, Wales and Scotland require a financial guarantee as part of the environmental permit according to Article 14 of the Mining Waste Directive, which was adopted by Defra in its Mining Waste Directive guidelines, given that hazardous waste is managed at UGEE facilities. Also, candidates of the onshore licensing rounds are judged according to (among other things), the financial capacity of applicants to perform the activities that are permitted in the licence. Also, a more detailed evaluation of the financial capacity of the applicant is conducted upon an application for well consent or field development once the licence has been granted. In Northern Ireland, applicants must also have the necessary financial capacity before a licence is granted. Companies are required to hold insurance to cover exploration activities, and may require a parent company guarantee. DETINI reviews the level of insurance in place where a company is to proceed to the drilling phase, and may increase the required level of insurance.
Public participation	In principle, there is no consultation or public participation envisaged for the process in which licences are granted. The planning process is the first instance where the public can express their views. For those cases where an EIA is required, there will be public participation as part of required due process. For Annex II activities (a screening process is required to determine the need of an EIA), the Local Planning Authority or the Secretary of State must make the information that is considered relevant available to the public. When a Planning application with environmental statement is received, the Authority communicates with any person that is likely to be affected or could be interested in the development as a stakeholder but is unlikely to be aware of it by means of local announcements or other publicly available information. Any consultation body that has not been notified by the applicant shall be contacted by the authorities. Details of the environmental statement are published in a local newspaper and notice given for any person that wants to make representation. In the cases where an EIA application is determined by a local planning authority, the authority informs the public of the decision by local advertisement or any other reasonable way and makes a statement available for the public with: • The content of the decision and conditions relevant to it, if any. • Main reasons on which the decision has been made. • Description of the measures to avoid, reduce and offset the major adverse effects of the development. • Information about how to challenge the decision. The Environmental Regulators in each country are statutory consultees and are consulted on the scope of the environmental statement and on the environmental statement submitted with the planning application. They may also provide advice to operators prior to the application, if requested. LPAs have to consider whether a project will affect protected areas. Within this context, authorities may consult the general public if it is deemed relevant.
Strategies to avoid disruption to land use, biodiversity, community and water stress	These issues are dealt with during the EIA process, if the given activity meets the criteria to be eligible for compulsory EIA or EIA decided after a screening process. The inclusion of specific conditions is considered in the scope of planning permissions, which are granted by the Local Planning Authority

Issue	Regulatory approach: UK
	(e.g. requirement to install impermeable lining to prevent spills). These specific conditions may be included in the planning permission as a result of the EIA. If there are conditions related to land use, these are dealt with in the planning permission process. Requirements related to impacts on water are dealt with in other processes (environmental permitting), although the planning permission may refer to them, or even make the planning permission conditional to obtaining the environmental permit related to water. For example, the planning permission granted in relation to operations at land at Annas Road, Westby, Blackpool included several planning conditions related to the ecology and protection of watercourses and drainage. One of the conditions states that no development shall start until there are measures in place to protect ecological interests (e.g. overwintering birds), including seasonal restrictions and that all operations including restoration should end within 18 months of commencement of operations. Conditions relating to water included the need to obtain a water abstraction permit and the need to include measures to prevent the transfer of fluids between different geological formations. In February 2014, the operator (Cuadrilla Ltd) applied for a modification of the planning permission. After partial abandonment of a well due to drilling problems, the operator no longer wished to continue drilling and the Local Planning Authority approved the modification that gave the operator additional time for restoration purposes. According to the Conservation of Habitats and Species Regulations in England & Wales and the equivalent Regulations in Scotland and Northern Ireland, Local Planning Authorities are required to carry out "an appropriate assessment" of the environmental implications of a given project, if the project is likely to have significant effects on a European site or European offshore marine site. This "appropriate assessment" includes consultation with nature conservation bodies and if considered appropriate, take the opinion of the general public.
Planning: Zoning restrictions	The model clauses for PEDLs and NI petroleum licences indicate that "no well shall [...] be drilled or made so that any part thereof is less than 125 m from any of the boundaries of the licensed area." The only exception would be the existence of consent in writing of the Minister. Requirements relating to setbacks, zoning restrictions and minimum well spacing requirements are addressed through the inclusion of specific conditions within any planning permission ultimately granted by the Local Planning Authority. It should be noted that where coal seams could be affected by the proposed development, consent will also be required from the Coal Authority.
Planning: Vehicles and mobile working machines	The Planning Permission shall include specific conditions on issues such as hours of operation, road improvement works or dust control. For example, in the planning permission for the operations in Annas Road, Westby, Blackpool (referred to above); include such provisions. As a requirement of the licence, the licensee has to avoid harmful methods of working and apply the good practice of the oil and gas industry, including methods and machinery. The infrastructure and appliances have to be in good condition and be repaired when needed.
Geological characterisation including risks of geological faults, manmade structures, characteristics of the cap rock	As part of the application for a PEDL, a geological analysis with the petroleum prospects and technical data is required. A work programme for evaluating the potential petroleum production from the area to which the application relates should also be provided and an explanation of the way in which the work programme takes account of the analysis of the geology. The licence holder is required to provide DECC at least 21 days written

Issue	Regulatory approach: UK
	notice of any proposed seismic survey. This notice will indicate the nature of the survey as well as evidence of consultation to the relevant authorities of the area that needs to be surveyed. If the survey requires Planning Permission, evidence that this has been granted is necessary. The LPA shall consult the British Geological Survey (BGS) regarding suitable locations of wells. If EIA is required, a chapter is required regarding geological characteristics. New controls to mitigate the risk of seismicity require the operator to carry out prior geological analysis to identify faults, submit a fracturing plan and conduct background monitoring of seismicity prior to the commencement of operations. DECC will not authorise the development of a well until it has considered that the plan is satisfactory.
Baseline monitoring prior to drilling or fracturing	As stated above, the initial term of PEDLs require a Work Programme, which may include the monitoring of seismicity. Requirements for baseline monitoring of water quality and air quality may be addressed through the inclusion of specific conditions within the planning permission. Companies will also be requested to conduct site monitoring and publish their results, as recommended by the Government in its response to Royal Academy of Engineering and Royal Society report on Shale Gas Extraction in the UK. If the EA or SEPA identifies a risk to groundwater, then groundwater monitoring will be required before and during shale gas operations. Scotland: Boreholes of over 200 m depth require a specific licence under the Water Environment Regulations. The licence may include baseline monitoring of water quality prior to and after drilling.

Exploration/Appraisal/Production: UK

Issue	Regulatory approach: UK
Monitoring: noise and fumes	Any requirements relating to noise and fumes from engines used for drilling will be covered by the inclusion of specific conditions within the planning permission. For instance, the planning permission of the operations at Annas Road, Westby, Blackpool (referred to in several occasions above), establishes that noise in the site shall not exceed 55 dB LAeq[54] (1 hour) in general. The limit is reduced to 42 dB after 18.30 hours on working days, after 13.00 hours on Saturdays and during the whole day on Sundays. There is another provision for the compulsory silencing equipment in all the machinery used onsite.
Buffer distance from drilling (water and groundwater)	As in the case of noise, requirements related to water and groundwater will be covered by including specific conditions within the planning permission. Also, any environmental permit required shall also cover this. As a way of example, the planning permission for operations at Annas Road, Westby, Blackpool sets out that a water abstraction permit or environmental permit from the EA has to be requested. Additionally, there are provisions to protect groundwater, prevent the transfer of fluids between different geological formations and to prevent uncontrolled discharge of groundwater to surface during drilling.
Monitoring: induced seismicity	As explained above, the initial term of PEDLs require the licence holder to establish the scheme of geological surveys as well as the test drilling

54 LAeq stands for "equivalent continuous sound level" and refers to a given noise level expressed in dB, using an "A" correction algorithm to reflect human hearing and "eq" being *equivalent*. The time period "1 hour" is the one over which the sound level is averaged.

Issue	Regulatory approach: UK
	programme (Work Programme). The additional controls introduced by DECC require operators to submit a hydraulic fracturing plan prior to the granting of well consent. DECC has to be satisfied with this plan, which includes seismicity monitoring. The plan should follow the precautionary approach and therefore envisage that only small amount of fluid is injected at the beginning, and only proceed further after analysing the results of these first tests. A flowback period will also be required after each stage of injection to ensure that pressure is re-balanced. The development of the fracture has to be monitored (by the operator) to ensure that it is developing according to its design. DECC will also give consent to wells equipped with a "traffic light system" so that operations can stop immediately if there is seismic activity. According to this system, as soon as the seismic activity goes above a certain level, activities shall be halted immediately and remedial action taken (e.g. pressure reduction). The limit is set to a magnitude of 0.5 (0.5 on the Richter scale), but this value is subject to review and may change. Northern Ireland: DETINI has similar requirements than DECC, except those additional requirements that DECC introduced from December 2012 onwards. It is expected that following the approach from DECC, DETINI will adopt additional measures related to seismic risk mitigation and hydraulic fracturing plans.
Well integrity	The Offshore Installation and Wells (Design & Construction etc.) Regulations 1996, also applicable to on-shore operations, state that wells must be designed, modified, commissioned, constructed, equipped, operated, maintained, suspended and abandoned as good as it is reasonably practicable, so that there is no unplanned escape of fluids from the well. The Northern Ireland equivalent is the Offshore Installation and wells (Design & Construction etc.) Regulations (Northern Ireland) 1996. Licence holders must maintain all wells (not abandoned) and machinery in good condition. While the well is being designed, the operator needs to assess the conditions below ground through which the well will pass. These conditions shall also be monitored while the well is being drilled. All operators are required to keep records of the drilling, deepening, plugging, or abandonment of all wells and any alterations of the casing. They also have to deliver accurate geological plans and maps to DECC when requested. Conditions of samples taken have been stated above. All this information is treated as confidential, and no requirements to inform the public. Northern Ireland: Northern Ireland differs in the provision of information to the public, as DETINI or the Geological Survey of Northern Ireland may publish any data of geological, scientific or technical nature after four years or after so long as DETINI considers necessary after considering representations made to this by the licence holder.
Well requirements: linked infrastructure	The PEDLs model clauses require licence holders to use best practice with regard to tanks, pipelines, pipes, etc. Operators have the responsibility to demonstrate that they comply with these industry standards.
Well requirements: gas leakage and air pollution (venting and flaring)	The PEDL model clauses state that flaring is prohibited, except with the consent of DECC and in accordance with the conditions imposed in this consent. However, if there is an unexpected and unforeseen event, that cannot be dealt with in any other way than flaring, this will be allowed without the need of consent if it prevents or reduces the risk of injury to persons in the vicinity of the well. In the latter case, the licence holder shall inform DECC

Issue	Regulatory approach: UK
	and stop flaring if requested. The licence holder will also have to give notice to DECC of any event causing escape of or waste of petroleum or damage to petroleum bearing strata. Even though the mentioned consent process is in place, DECC expects that the applicants will keep flaring or venting to the minimum. It is expected that most companies will seek permission for an extended well test, which allows production for a sufficient time (often 90 days) to establish flow rates. In the likely absence of production facilities, gas will need to be flared or vented. DECC will not normally consent venting unless flaring is not technically feasible. Methane flaring must also be reduced to the economic minimum. This term does not seem to be clearly defined and may be subject to variable interpretations (e.g. depending on gas prices or depending on how *economically possible* it is for the company). According to PELDs, the gas produced in the exploration phase cannot be commercially exploited. These and any gases in the flowback fluid need to be discarded and have been given the status of extractive waste, subject to a mining waste management plan and permit from the EA. Applicants to this permit shall in turn submit a waste management plan. These waste management plans are incorporated in the permit and reviewed every five years. If the activities cause pollution, the EA will require the operator to revise the plan. Local authorities are also responsible for inspecting sites for odour and noise associated with the venting or flaring of gas; as well as for measuring air quality to ensure the activities do not breach local air quality standards.
Hydraulic fracturing	As stated above, the controls put in place in the UK to mitigate the risk of seismicity after the Ministerial statement of December 2012 state that operators should submit a fracturing plan that has to be accepted by DECC to obtain well consent. This plan shall include prior analysis of fault patterns, background monitoring of seismicity (before the start of operations) and an ongoing monitoring scheme during operations. Hydraulic fracturing requires a permit according to the environmental/water regulations that apply to each of the countries that form the UK, if fracturing fluids containing potential pollutants (i.e. the chemical additives made to fracturing fluids) are injected in formations that contain groundwater or when there is a risk that the fracturing activities mobilise natural substances that may cause pollution. The EA (or SEPA and NIEA for Scotland and Northern Ireland respectively) shall assess each site. It is prohibited to operate a regulated facility without a permit as well as to cause or knowingly permit a water discharge activity or groundwater activity without a permit or to an extent that is not authorised by the permit. Groundwater activities are those where pollutants are discharged directly or indirectly to groundwater; or where any other discharge might lead to the indirect or direct input of a pollutant to groundwater. Given the emerging nature of the industry, it is likely that where a permit is required, this will be tailored to needs and drafted on a case by case basis. The current system implies that any well pad may require a number of separate permits under the Regulations (mining waste, radioactive substances and groundwater activities). The environmental regulator is likely to integrate the number of permits required per site. If hydraulic fracturing takes place in a borehole that passes through groundwater, it will be regarded as groundwater activity. A permit will be required if the EA considers that groundwater is at risk. For example, the EA did not require an environmental permit for one of

Issue	Regulatory approach: UK
	the operations currently (June 2015) in the process of obtaining a number of permits (operated by Cuadrilla). The EA considered that the only groundwater at risk was a saline aquifer and that this would not be used as drinking water source. In the document containing the draft decision, the EA states that shales at depths of between 1100 m to 2100 m, below ground level are not considered to contain "groundwater'. In cases where there is a major aquifer or source protection zone, an environmental permit will be necessary. However, if the risk is too high, the EA may even prohibit the activity. The EA states that in cases where the shale layer does not contain groundwater, the discharge will not result in a risk to groundwater and a permit will not be needed if other mitigation measures are in place. However, if there is groundwater, it could be possible that a direct discharge will not be permitted, or a permit may be required; although the decision will ultimately lie with the EA. Regarding management of flowback fluid, the English and Welsh authorities have stated that the reuse of flowback fluid, where practicable, is considered to be the preferred and most sustainable option to minimise the overall quantity of waste requiring off-site recovery or disposal. Therefore, they will expect that Waste Management plans include this element when practicable. Scotland: The Regulations state that no person shall carry on (or permit that others do so) any regulated activity that includes or may cause direct or indirect discharges of any hazardous substance or other pollutant, except when it is authorised. A permit will always be needed in this case. Other activities that are subject to authorisation in Scotland are: Borehole construction. Injection of fracturing fluid. Abstraction of water for injection. Abstraction of flowback Management of abstracted fluids. If more than one activity is carried out in the same site, a single permit will be issued covering them. As for the injection of fracturing fluids, SEPA states that this will be allowed (subject to the obtaining a permit) as per an exception under the Water Framework Directive However, the guidance that explains this does not specify which exemption it is, but it is likely to be the one that states that the injection of water containing substances from the exploration and extraction of hydrocarbons or mining activities and injection of water for technical reasons into geological formations which hydrocarbons have been extracted or into geological formations which for natural reasons are permanently unsuitable for other purposes. Such injections shall not contain substances other than those resulting from the operations. This exemption is subject to interpretation and SEPA has considered that the injection of fluids, while not resulting from the operation, is totally necessary for the exploration and extraction of hydrocarbons with this technology. Northern Ireland: Any direct discharge of poisonous, noxious or polluting material is an offence. The specific consent of the NI EA is required for any discharge to any waterway or groundwater. The consent is given as a licence granted through a complex process that includes all operations onsite that may put any waterway at risk.
Hydraulic fracturing: waste management	The EA considers flowback fluids and waste gases as mining waste, and therefore, their management is considered a mining waste operation according to the EA. These activities require a permit, which in turn requires a waste management plan to be submitted along with the application. If the permit is granted, these plans need to be reviewed

Issue	Regulatory approach: UK
	every five years. If the plan fails and there is pollution resulting from them, the EA may oblige the operator to revise the plan and implement it. In previous applications, the EA has requested information to operators on the flowback composition as well as groundwater analyses. Additionally, technical staff from the EA conducted their own analyses on groundwater and flowback compositions to verify results. The treatment and disposal of wastewater would require an environmental permit prior to discharge into a disposal well. Also, the English and Welsh Environmental Regulators expect that flowback re-injection is included in Waste Management plans, and would find this as a sustainable way of minimising the quantity of flowback fluid that needs to be disposed. As for the construction of the borehole, any waste arising from that activity would be treated as mining waste. No permit is needed if this waste is non-hazardous. The operator is required to meet the requirements in the Mining Waste Directive (e.g. Mining Waste Management plan). Spent drilling muds and cuttings have to be disposed of at a permitted facility. If wastewater contains naturally occurring radioactive material (NORM), a permit will be needed if the concentration exceeds certain limits. The EA will evaluate in application separately and if flowback fluids contain NORM above a certain level, it will request separate applications for environmental permits for radioactive waste. The operator will include the monitoring regime and standards in the plan, which has to be approved by the EA, which will assess whether the monitoring meets its requirement.
Monitoring: water abstraction and use in hydraulic fracturing	As stated above, operators need to obtain a permit from the EA when the water abstracted exceeds 20 m^3 per day. There are further controls where there are discharges into controlled waters, as the obligation to notify the intention to drill as set out in the Water Resources Act 1991. The EA is required to ensure that the well has been built according to the requirements and that it is designed and constructed to meet the highest standards.
Movement of vehicles	Specific conditions will be included in the planning permission granted by the LPA.
Disclosure of the composition of chemical additives	The EA has the power to demand the disclosure of the composition of the fracturing fluids. The EA needs this information to assess whether permits are needed or whether a discharge has to be prohibited. The details will normally be available to the public, but the specific composition may not be disclosed due to commercial confidentiality agreements.

Decommissioning/Closure/Post-closure: UK

Issue	Regulatory approach: UK
Requirements for temporary abandonment/well idle time	DECC/DETINI require operators to submit an abandonment plan and obtain consent before the operations can be abandoned. If the well has been temporarily abandoned, operators will not resume operations without the consent in writing of DECC/DETINI. DECC/DETINI may relieve operators from the obligation of plugging and sealing a well provided that a notice is given at least one month before licence expiry. This notice may also be given for a well from which the operator has not extracted oil/gas during the previous month. If this occurs, the operator shall leave the well in good condition and fit for further working. The consent for the abandonment of a well may be granted unconditionally or subject to conditions. Where conditions are imposed, DECC/DETINI may impose that the well and records are examined periodically, the cost of which will be borne by the operator. Abandonment plans shall meet good industry practice (guidelines on the abandonment of wells developed by Oil and Gas UK) as in conventional oil and gas activities. DECC/DETINI will also provide requirements on the plugging and sealing of wells. The environmental permits granted by the EA (or equivalent) will cover the abandonment of the well.
Integrity of well	Plugging and sealing requirements as above. Scotland: Licences cover decommissioning.
Dismantling of installations	Plugging and sealing requirements are as above. Also, the planning permission will include specific conditions on the restoration of sites after abandonment. For instance, the planning permission granted for the operations at Annas Road, Westby, Blackpool set out that all plants, buildings, etc. have to be removed and that a specific depth of subsoil has to be replaced before putting a topsoil layer in. Also, the after-care measures shall be in place for five years, and the operator will have to submit an after-care scheme within three months of completion of the restoration.
Liability and responsibility	Operators have an open-ended liability to remediate any ineffective abandonment operations. However, Parliament[55] has recommended that, as described in a report by the Royal Academy of Engineering, a Common Liability Fund is established to bear the costs of the restoration needed for a well failure after abandonment, if the operator can no longer be identified. Operators will also be obliged to take remedial measures where there is an imminent threat of environmental damage or if their activities have caused environmental damage. No monitoring or actions are envisaged after abandonment unless the abandonment has not been satisfactory.

55 http://www.publications.parliament.uk/pa/ld201314/ldselect/ldeconaf/172/17211.htm

Colorado (USA)

Pre-development: Colorado (USA)

Issue	Regulatory approach: Colorado (USA)
Exploration and production	Operators are encouraged to prepare a Comprehensive Drilling Plan (valid for six years), but these are voluntary. They are described and regulated in Colorado General Rules emanated from the Oil and Gas Conservation Act of the State of Colorado. Comprehensive Drilling Plans shall cover more than one proposed oil and gas location within a geological basin, although it may only cover one if there are specific issues in a particular location. Operators who prepare a plan shall send as much information as possible, but the specific data to be included is decided by the operator. These may include: • An official 1:24,000 topographic map showing the proposed locations including proposed access roads. • Current aerial photo showing the locations[56] (Same scale). • Overlay maps showing the information above plus drainage, stream crossings, existing and proposed buildings, roads, utility lines, pipelines, other wells and proposed wells, water wells and riparian areas. • Proposed facilities and the timing of installation. • Waste Management Plan. • Reference areas[57] (for reclamation) • Description of wildlife resources of each oil and gas location. Also, wildlife information deemed necessary after consultation with the Colorado Parks & Wildlife. • Land uses of the area in the previous 10 years. • Proposed best management practices or mitigation to minimise adverse impacts to air, water, air or wildlife. • List of participants in the drafting of the plan. Before preparing the Plan, operators are encouraged to discuss with Colorado's Oil and Gas Conservation Commission's (COGCC) Director as well as with the Colorado Department of Health and Environment and Colorado Parks and Wildlife about the content, scope, timescales and public participation opportunities envisaged for the plan. Plans accepted by COGCC have to be published on the Commission's webpage (although confidential information will be withheld). There are variances of the general rules that may be incorporated to the plan as agreed with the surface landowner. These can include specific requirements to include as conditions of approval in any of the permits that are required in Colorado. Incentives for the submission of this voluntary plan include: • Acceptance of the plan as a way to fulfil other requirements (Form 2A described below) if the information does not change. • Modification of the requirements with regard to the submission of Form 2A to include information that has been provided by the operator in the Comprehensive Drilling Plan.

56 According to the Rules, an oil and gas location is defined as "definable area where an operator has disturbed or intends to disturb the land surface in order to locate an oil and gas facility".

57 According to the Rules, a "Reference area" is defined as "an area either (1) on a portion of the site that will not be disturbed by oil and gas operations, if that is the desired final reclamation; or (2) another location that is undisturbed by oil and gas operations and proximate and similar to a proposed oil and gas location in terms of vegetative potential and management, owned by a person who agrees to allow periodic access to it by the Director and the operator for the purpose of providing baseline information for reclamation standards, and intended to reflect the desired final reclamation".

Issue	Regulatory approach: Colorado (USA)
	• If a specific location was included in an approved Comprehensive Drilling Plan and no substantial changes have taken place, the COGCC will give priority to this location and will decide on the approval or denial of any other (compulsory) permit application within 30 days. A Comprehensive Drilling Plan can be modified following the same process. Form 1 (Registration For Oil And Gas Operations): Mandatory for all producers, operators, transporters, refiners, gasoline or other extraction plant operators, and initial purchasers who are conducting operations regulated by the O&G Conservation Act. It needs to be approved by the COGCC. Also, any person providing financial assurance for O&G operators in Colorado shall file a form 1. Form 1A (Designation of Agent): Operator employees approved to submit documents have to submit a form 1A. A company/individual other than the operator can be a Designated Agent and its representatives will be listed on a form 1A. All changes to this have to be reported immediately on another form 1A. Form 2 (Permit to drill, deepen, re-enter, recomplete, operate): The following operations with heavy equipment must be approved by the COGCC Director: • Drilling a well. • Deepening an existing well. • Re-entering a plugged well (except when a well abandonment report is needed). • Recompleting and operating an existing well. • Drilling a side-track from a well. This form is binding with respect to any provision of a local government permit or land use approval that is in operational conflict with the permit to drill. Form 2 requires the following information: • Distance between the nearest building and the centre of the proposed well. • Details of the proposed work and wellbore diagram. • A drawing of the well containing the location, dimensions of the well and adjacent sections, dimension of irregular, partial or truncated sections; elevation, monuments found nearby, data of the landownership, data on the land legal status. • Deviated drilling plan, if required (if the well is to be horizontal or deviated) Form 2A (Oil and Gas Location Assessment): Approval is mandatory for all new locations as well as modifications or expansions that may disturb the surface in existing locations and additions of wells to existing locations. Exceptions: emergency wells and operations that have been accepted in a Comprehensive Drilling Plan, provided that the information submitted was equivalent to the one that has to be submitted with the form. Also seismic operations, pipelines and roads are exempt. Information required: • Distance to the nearest building, road, rail road, property line, utility or designated Outside Activity Area. • Four colour photographs (minimum), one per cardinal direction. • A list of major components to be used, apart from the drilling equipment (e.g. tanks, pipelines). • Location drawing, including all improvements (buildings, roads, fences, utility lines, other wells) and water streams within 500 ft.

Issue	Regulatory approach: Colorado (USA)

	(152 m) from the well.
	• Hydrological map (within 1000 ft. [305 m] of the well).
	• Access roadmap.
	• Current land use and landowners. Basis for reclamation standards. If the final use includes rangeland, forestry, recreation or wildlife habitat then an area shall be selected for reclamation and additional information shall be submitted:
	  • Map with location of the site and the reference area.
	  • Four colour photographs of the reference area.
	• Soil map unit description.
	• Construction layout drawing. If activities are to occur on lands with a slope 10% or greater, then a location cross-section plot.
	• If the location is < 1000 ft. from a building, the following will be provided:
	  • Facility Layout Drawing (existing and proposed).
	  • Waste Management Plan.
	  • Evidence that the given building's owners received pre-application notice.
	• If the proposed location is within an Urban Mitigation Area, evidence that the local government received a pre-application notice.
	• Multi-Well plan (if the location is for multiple wells).
	• Best Management Practices (according to the applicant).
	• If the location is covered by an approved Comprehensive Drilling Plan, a list of any conditions of approval.
	• Information of whether the location is within sensitive habitat or a restricted surface occupancy area.
	• Information relative to possible water streams nearby (water protection buffer zone, information in the section below).
	• It should indicate if the location is in a wetland.
	• Any other aspects that the COGCC believes it is reasonable to request.
	After approval, the operator must notify the surface owner, the owners of buildings within the Exception Zone Setback, and owners of surface property within 500 ft. (152 m). In this notification, the operator has to include whether it will apply hydraulic fracturing and in which wells this will take place. The entities notified are invited to meet the operator and communicate their views.
	Special circumstances that enable the COGCC Director to issue a permit without consultation or notice: The operator has the right or obligation under the terms of an existing contract to drill a well; and the owner or operator has a leasehold estate which will be terminated unless the operator is permitted to immediately commence the drilling of the said well OR exigent circumstances like economic hardship or change in geological interpretation.
	Also, a permit can be withheld if there are claims by the local Government or if the Director believes there are reasons for doing so.
	Pre-application notifications: Urban Mitigation Area Notice to Local Government, Exception Zone and Buffer Zone Setback Notice to the Surface Owner and building owners. Within 30 days of submission of form 2A.

Strategies to avoid disruptions to land use, biodiversity, community and water stress	The operator shall take precautions to prevent significant adverse environmental impacts to air, water, soil, or biological resources to the extent necessary to protect public health, safety and welfare, including the environment and wildlife resources, taking into consideration cost-

Issue	Regulatory approach: Colorado (USA)
	effectiveness and technical feasibility to prevent the unauthorised discharge or disposal of oil, gas, E&P waste, or chemical substances. No injection is authorised if they can result in groundwater pollution (if such groundwater is or could be used as a drinking water source). The criteria to establish whether this groundwater could be used are if it contains fewer than 10,000 mg/L of total dissolved solids; and if the aquifer is not exempt. Exempted aquifers: These are considered unable to be used as a drinking water source because it is mineral, hydrocarbon or geothermal energy producing or can be used for these purposes; or it is situated at a depth where it is unfeasible to obtain drinking water or it is so contaminated that it is unfeasible to recover it. Also, if the total dissolved solids are between 3000–10,000 mg/L and it is not reasonably expected to use the aquifer as public water system. There are public notifications and public consultation when the COGCC intends to consider an aquifer exempt. After 30 days, if no one submits a request to avoid this or if the COGCC considers that claims are not justified, the exemption will be approved. Underground disposal of water: Written authorisation by the COGCC is needed. Public notice is required and the public can express its views. Protection of habitats and wildlife: The operator has to review the Sensitive Wildlife Habitat Map and the Restricted Surface Occupancy map in the COGCC website prior to drafting a Form 2A or preparing a Comprehensive Drilling Plan. If operations are finally permitted in these sensitive areas, the following operating requirements apply: • Installation of wildlife crossovers and escape ramps during pipeline construction. • Information and education for employees. • Consolidate new facilities to minimise impact. • Minimise rig mobilisation and demobilisation. • Consolidate corridors for pipelines and roads to minimise impacts. • Boring instead of trenching across perennial streams considered critical fish habitat. • Treat waste water pits so they do not become a medium for breeding mosquitoes with Bti (*bacillus thuringiensis serotype israelensis*, a type of bacteria that kills mosquito larvae) or viruses that may infect wildlife. • Leave roots intact. • Speed limits and caution signs (If accepted by surface owner). • Wildlife appropriate fencing (if accepted by surface owner). • Use remote monitoring of well production. • Reduce traffic. In general, (not only sensitive areas), the following applies: • Black bear habitat: Bear-proof dumpsters and rubbish receptacles for food waste. • Designated Cutthroat Trout habitat: Operators shall disinfect water suction hoses and water transportation tanks withdrawing from or discharging into surface waters. Planning ahead is recommended for minimising surface disturbance when designing facilities and transportation networks.
Buffer zones and setbacks	Setbacks: 200 ft. (61 m) from buildings, public roads, major utility lines above ground, or railways. 150 ft. (46 m) from a surface property line (unless allowed by the owner or an exception is granted).

Issue	Regulatory approach: Colorado (USA)
	Exception Zone: No well or production facility is to be located within 500 ft. (152 m) of buildings, unless the following is done: A "Notice of Comment Period", which shall be provided by postcard to building owners within this zone (500 ft. (152 m) from the development). Once approved, the operator must give a notification of the activities at least 30 days before commencement to building owners within 1000 ft. (305 m, also known as Buffer Zone). In this notification, the operator must include data on the location, name, and codes of the wells as well as the date in which the drilling operations are expected to start. Also, they need to comply with the consultation requirements outlined below (Public participation section). The same consultation is required for developing facilities in the Buffer Zone (1000 ft. (305 m) from the proposed development). Designated Outside Activity Areas: No well or production facility shall be located 350 ft. (106.68 m) from them. Mitigation measures will be required for oil and gas operations within 1000 ft. (305 m) of these areas. All wells drilled for oil or gas to a common source of supply shall have the following setbacks with regard to depth: • Wells ≥ 2500 ft. in depth (762 m): At least 600 ft. (182.88 m) from any lease line, and shall be located at least 1200 ft. (366 m) from any other producible or drilling oil or gas well when drilling to the same common source of supply, unless authorised by the COGCC. • Wells <2500 ft. (762 m) in depth: At least 200 ft. (61 m) from any lease line and 300 ft. (91 m) from any other producible oil and gas well unless exceptions apply. • Exceptions: COGCC may grant an exception because of geologic, environmental, topographic or archaeological conditions, irregular sections, a surface owner request, or for other good cause shown provided that a waiver or consent signed by the lease owner.
Vehicles, mobile working machines and ancillary infrastructure	There are safety requirements for safety valves, pressure control, and waste management equipment. Also, there are specific rules for pipelines (Installation and reclamation: materials, design, cover, excavation, backfill, reclamation, pressure testing of flowlines, operations, maintenance, and repair: maintenance, repair, markings, one call participation, emergency response, abandonment)
Baseline monitoring prior to drilling or fracturing	Baseline monitoring samples shall be collected from an Available Water Source. Initial sampling shall be conducted within 12 months prior to setting a conductor pipe in an oil and gas well or the first well on a Multi-Well Site, or commencement of drilling a dedicated injection well. One subsequent sampling event shall be conducted at the initial sample location between 6 and 12 months following completion of the well or dedicated injection well, or the last well on a Multi-Well Site. Wells that are drilled and abandoned without ever producing hydrocarbons are exempt from subsequent monitoring sampling. If free gas or a dissolved methane concentration greater than 1.0 mg/L is detected in a water sample, gas compositional analysis and stable isotope analysis of the methane shall be performed to determine gas type. The operator shall notify the Director and the owner of the water well immediately if: • The test results indicated thermogenic or a mixture of thermogenic and biogenic gas; • The methane concentration increases by more than 5 mg/L between sampling periods; or • Methane concentration is detected at or above 10 mg/L.

Issue	Regulatory approach: Colorado (USA)
	Also, the operator shall notify the COGCC immediately if BTEX (benzene, toluene, ethylbenzene, and xylenes) or TPH (total polyaromatic hydrocarbons) are found.
Risk assessment requirements prior to development	Nothing specific seems to be in place
Public participation requirements	In general, a public hearing is required before the COGCC does any change, exemption, amendment, etc. of the Regulations. Normally, 50 days are allowed between the application and the public hearing. The rules include several specifications that change depending on the issue (e.g. if the applications affect drilling units, setbacks, etc.). Subjects like the increase in well density may lead to the organisation of a local public forum, at the COGCC's discretion, or if requested by a citizen of the affected county (ies). Normally the following issues are raised: • Impact to local infrastructure; • Impact to the environment; • Impact to wildlife resources; • Impact to ground water resources; • Potential reclamation impact; and • Other impact to public health, safety, and welfare Operators need to issue an Oil and Gas Location Assessment Notice to the surface owner, owners of buildings within the Exception Zone Setback, owners of surface property within 500 ft. (152 m) of the proposed locations, local authority, Department of Health and Colorado Parks and Wildlife. The Director shall not approve a Form 2A, or any associated Form 2, for a proposed Well or Production Facility for twenty days from posting, and shall accept and immediately post on the Commission's website any comments received from the public, the Local Governmental Designee, the Colorado Department of Public Health and Environment, or Colorado Parks and Wildlife regarding the proposed Oil and Gas Location. This period can be extended 30 more days if requested by the local authority, the Department of Health, Colorado Parks and Wildlife, the surface owner or the owner of any surface that was included in the notice. Approved Comprehensive Drilling plans need to be published on the COGCC webpage. Before commencement of operations, operators need to consult with: • Surface Owner. They can waive their right to be consulted. • Local Government: Within 14 days they have to communicate whether they think the Colorado Department of Public Health and Environment should be consulted. • Colorado Parks and Wildlife (on form 2A): They can issue recommendations or request conditions for the approval of these forms. They have to be consulted if there is going to be a change in well density to more than 1 well per 40 acres (~16 ha). • Colorado Department of Public Health and Environment: If Local Governments request it as indicated above. Also, if the operator seeks a variance of or if a consultation is required for the rules on Public Water Protection, Underground Disposal of Water, odour, waste management, and others. The Department may also require conditions of approval. In the cases of possible damage to health and the environment, the consultation may include the review of public comments on the issue. Also if the operator requests a well density change to more than 1 well per 40 acres. • Building owners within a buffer setback or Urban Mitigation

Issue	Regulatory approach: Colorado (USA)
	Areas. They can waive this right. • Tenants: Operators shall have no obligation to consult with tenant farmers, lessees, or any other party that may own or have an interest in any crops or surface improvements that could be affected by the proposed operation unless the Surface Owner appoints such person as its agent for such purposes. Consultation is also required if the COGCC proposes an aquifer to be considered exempt from protection. Consultation is required if the COGCC receives an application for the underground disposal of water.
Financial guarantee	Operators must have a financial guarantee: • Surface owner protection: $2000 (€1830) per well for non-irrigated land, or $5000 (€4570) per well for irrigated land. Instead, operators may submit blanket financial assurance of $25,000 (€22,830). • Centralised Waste Management facility: The quantity that is deemed necessary. • Seismic operations: $25,000 (€22,830). • Soil protection and plugging and abandonment: $10,000 (€9130) per well for wells <3000 ft. of depth (914 m). For a greater depth, the financial guarantee has to be of $20,000 (€18,270) per well. If not, they can provide a guarantee of $60,000 (€54,800) for operations of <100 wells or $100,000 (€91,340) for operations with >100 wells. • Inactive wells have a specific financial guarantee. • General Liability Insurance: $1 m (€0.9 m) per occurrence. • Oil and Gas Conservation and Environmental Response Fund. • Natural gas gathering, processing and underground storage: $50,000 (€45,670) • Underground injection: $50,000 (€45,670)

Exploration/Appraisal/Production: Colorado (USA)

Issue	Regulatory approach: Colorado (USA)
Drilling requirements: Reporting	To be submitted to the COGCC. Preliminary Drilling Completion Report: To be submitted within 90 days of the suspension of commenced drilling activities prior to reaching total depth on a well. The form shall include the date drilling activity was suspended, the reason for the suspension, the anticipated date and method of resumption of drilling, and the details of all work performed to date (including a cement job summary). Final Drilling Completion Report: To be submitted within 60 days of rig release after drilling or deepening a well to total depth. If there are multiple wells configured as sequential drilling, the form will be submitted for all the wells within 60 days of rig release for the last well drilled on the pad. Completed interval report: To be submitted within 30 days after a formation has been completed, successful or not. Monthly report: To be submitted within 45 days after the end of each month. Operators must provide all existing oil and gas wells that are not plugged and abandoned. A well must be reported every month from the month that it is spud[58] until it has been reported for one month as

58 "Spud" refers to the actual start of drilling of an unconventional well. A well may be considered to be a spud when the drilling bit penetrates the surface of the land.

Issue	Regulatory approach: Colorado (USA)
	abandoned. All information required by the form shall be reported, including all fluids produced during the initial testing and completion of the well. Also, the volume of produced fluids injected each month (e.g. produced water; used drilling fluids; used workover fluids; used stimulation fluids; and used fluids from circulation during cementing operations recovered from production, injection, and exploratory wells). These reports can remain confidential during 6 months if required by the operator.
Well integrity: Wellhead, pressure and mechanical integrity tests	Operators must perform wellhead tests and submit a report within 10 days of completion. Also, a wellbore diagram must be submitted. Additionally, operators may have to conduct subsurface pressure measurements. Mechanical Integrity tests are required. Results of mechanical integrity tests of injection wells, shut-in wells, or temporarily abandoned wells shall be submitted within 30 days after the test.
Field operations notice	Operators must give written notice to the COGCC 48 hours prior to any of the following: • Hydraulic Fracturing Treatment. • Spud. • Construction or major change. • Bradenhead test. • Pit Liner installation. 24 hours prior to: • Run and cement casing. • Formation Integrity Test. • Blowout preventer test. • Significant lost circulation. • High Bradenhead pressure during stimulation. 10 days prior to: • Mechanical Integrity Test. Operators have to provide notice of completion of Form 2/2A permit conditions (if required). Also, they have to provide notice of any inspection corrective actions performed.
Drilling requirements: Blowout prevention	Blowout prevention equipment is mandatory when required by the COGCC.
Well integrity: Casing and cementing	The casing for each well must protect any potential oil or gas bearing horizons penetrated during drilling from infiltration of injurious waters from other sources, and prevent oil, gas or water from migrating from one horizon to another. The COGCC must approve any cementing operations and a Drilling Completion Report, daily operations summary, cement verification reports from the contractor, and if required as a condition of the repair approval, cement bond log(s), shall be submitted within 30 days after completion of operations. In areas where pressure and formations are unknown, sufficient surface casing shall be run to reach a depth below all known or reasonably estimated usable domestic fresh water. In areas where fresh water aquifers are of such depth as to make it impractical or uneconomical to set the full amount of surface casing necessary to comply fully with the requirement to cover or isolate all fresh water aquifers, the owner may, at its option, comply with this requirement by stage cementing the intermediate and/or production string so as to accomplish the required result. The operators must ensure that materials used for cementing and casing are of the highest quality and suitable for the purpose. Wells used for injection of fluids shall be cased with safe and adequate casing or tubing so as to prevent leakage.

Issue	Regulatory approach: Colorado (USA)
	In the event drilling operations are suspended before production, the COGCC shall be notified immediately and the operator shall take adequate and proper precautions to assure that no alien water enters oil or gas strata, nor potential fresh water aquifers during such suspension period or periods. If alien water is found to be entering the production stratum or to be causing significant adverse environmental impact to fresh water aquifers during completion testing or after the well has been put on production, the condition shall be promptly remedied.
Mitigation measures	• Noise and visual impact. There are specific rules on noise, odour and visual impact. For noise, there are specific dB limits for residential/agricultural/rural; commercial; light industrial and industrial areas. These are different from 7 am to 7 pm than from 7 pm to 7 am. • Closed loop drilling systems: Required within the Buffer Zone (1000 ft. (305 m) from the operations). Pits are not allowed within the Buffer Zone Setback except fresh water storage pits, reserve pits to drill surface casing and emergency pits. Fresh water pits within the Exception Zone shall require prior approval. In the buffer zone, a 30-day notification is needed. • Uncontrolled venting is prohibited. • Equipment to handle 1.5 times the largest flowback volume of gas experienced in a 10 mile radius. Valves to divert gas to temporary equipment or to flaring equipment. • Traffic plan: if required by the local government. • Multi-well pad: If feasible and economically viable, operators shall consolidate wells to create multi-well pads (including shared locations with other operators). These facilities must be as far as possible from buildings. Pads should have noise mitigation if required. • Leak Detection Plan. • Berm construction. To be built in designated setback locations around crude oil, condensate and produced water storage tanks. • If blowout preventer equipment is required, there are specifications about which devices should be installed (as a minimum). It has to be tested once a month. • Pit level indicators. • Fencing to restrict access by unauthorised persons. • Control measures for fire hazards. • All loadlines shall be bullplugged or capped. • Special measures to control dust arising from handling sand used in hydraulic fracturing operations. • Surface waste to be removed in a legal manner. • Tank specifications set out in the rules for the prevention of leaks, fire. • All roads shall accommodate local emergency vehicle access requirements and be maintained. • Abandoned wells must be identified. • Where possible, operators shall provide for the development of multiple reservoirs by drilling on existing pads. • Site-specific measures identified in the consultation with stakeholders, Department of Health and Environment, Colorado Parks and Wildlife. • Exception Zone: All the above plus: More stringent indications of how berms should be constructed, indications of how secondary containment areas for tanks should be constructed, and

Issue	Regulatory approach: Colorado (USA)
	indications of the number of tanks to be located within a single berm.
Gas flaring and venting	Flaring is allowed when gas escapes from the well. Local authorities shall be notified.
Drilling requirements: groundwater	See the "Cementing and casing" as well as the "Strategies to avoid disruptions to land use, biodiversity, community and water stress" sections above.

Drilling requirements: Public Water Systems protection (buffer zone above ground)	There is an appendix in the General Rules with a list of Public Water Systems under protection. There must be a buffer distance between surface operations and these Systems:
	• Internal Buffer: 0–300 ft. (0–91 m). Operations forbidden unless the COGCC grants it explicitly (e.g. because it considers that the operator applies best available techniques (BAT). Also, it may be authorised if it is considered that the disturbances, environmental or health risks are higher if the operations are not conducted there or if it is unfeasible for the operator to exercise its mineral rights otherwise.
	• Intermediate Buffer: 301–500 ft. (92–152 m). Operations allowed but certain conditions apply:
	  • Pitless drilling systems;
	  • Flowback and stimulation fluids contained within tanks that are placed on a well pad or in an area with down gradient perimeter berm;
	  • Berms or other containment devices shall be constructed;
	  • Collection of baseline surface water data and three months after conclusion of operations (pH, alkalinity, specific conductance, major cations/anions, total dissolved solids, BTEX/GRO (gasoline range organics)/DRO (diesel range organics, TPH (total petroleum hydrocarbons), PAHs; and metals (arsenic, barium, calcium, chromium, iron, magnesium, selenium).
	  • Notification of potentially impacted Public Water;
	  • An emergency spill[59] response programme (and apply it in the event of a spill or release); and
	  • If a spill or release impacts or threatens to impact a Public Water System, the operator shall notify the affected or potentially affected Public Water System(s) immediately.
	• External Buffer: 501–2640 ft. (153–805 m). Pitless drilling systems or containment of all drilling flowback and stimulation fluids are required. Then, the sample analysis and emergency spill programme outlined above are also required.

Monitoring: Produced and injected water	Volumes have to be measured and reported. The injection of water needs to be authorised.
Requirements related to seismic works	Seismic operations require approval. A copy of the application shall be submitted to the local government Any change of plans or line locations may be implemented without COGCC approval provided that notification is given within five days. A map shall be included with the notice, providing the location of the proposed seismic lines, including source and receiver line locations. The Notice of Intent to Conduct Seismic Operations shall be in effect for six months from the date of approval. An extension of time may be granted upon written request submitted prior to the expiration date.

59 The rules specify that a "spill" includes the chemicals used in hydraulic fracturing operations.

<table>
<tr><th>Issue</th><th>Regulatory approach: Colorado (USA)</th></tr>
<tr><td></td><td>A good faith effort shall be made to consult surface owners of the affected areas.
The Regulations provide blasting safety setbacks:
<table>
<tr><th>Charges in kg</th><th>Minimum setback distance (metres)</th></tr>
<tr><td>0–0.9</td><td>61</td></tr>
<tr><td>0.91–2.3</td><td>91</td></tr>
<tr><td>2.3–2.7</td><td>110</td></tr>
<tr><td>3.2–3.6</td><td>146</td></tr>
<tr><td>3.6–4.1</td><td>165</td></tr>
<tr><td>4.1–4.5</td><td>183</td></tr>
<tr><td>4.5–5.0</td><td>198</td></tr>
<tr><td>5.0–5.4</td><td>212</td></tr>
<tr><td>5.4–5.9</td><td>226</td></tr>
<tr><td>5.9–6.4</td><td>239</td></tr>
<tr><td>6.4–6.8</td><td>251</td></tr>
<tr><td>6.8–7.3</td><td>263</td></tr>
<tr><td>7.3–7.7</td><td>275</td></tr>
<tr><td>7.7–8.2</td><td>285</td></tr>
<tr><td>8.2–8.6</td><td>295</td></tr>
<tr><td>8.6–9.1</td><td>305</td></tr>
<tr><td>>9.1</td><td>402</td></tr>
</table>
Drilling and plugging. The following guidelines shall be used to plug shotholes:
• Any slurry, drilling fluids, or cuttings which are deposited on the surface around the seismic hole shall be raked or otherwise spread out to at least within 1 inch of the surface, such that the growth of the natural grasses or foliage shall not be impaired.
• All shotholes shall be preplugged or anchored to prevent public access if not immediately shot.
• The hole shall be filled to a depth of approximately 3 ft. (1 m) below ground level by returning the cuttings to the hole and tamping the returned cuttings to ensure the hole is not bridged.
• When non-artesian water is encountered while drilling seismic shotholes, the holes shall be filled from the bottom up with a high grade coarse ground bentonite to 10 ft. (3 m) above the static water level or 3 ft. (1 m) from the surface.
• If artesian flow (water rising above the depth at which encountered) is encountered in the drilling of any seismic hole, cement or high grade coarse ground bentonite shall be used to seal off the water flow.
• A completion report has to be submitted after completion of the works. Also, the area has to be remediated as much as possible.</td></tr>
<tr><td>Hydraulic fracturing</td><td>Information included in the relevant chapters. There are requirements for the disclosure of chemicals used, as well as of notification of the use of the technology, both in the planning stage and 48 hours before conducting the operations.</td></tr>
<tr><td>Groundwater and soil</td><td>Further to what has been stated above, there is no additional groundwater</td></tr>
</table>

Issue	Regulatory approach: Colorado (USA)
Monitoring	and soil monitoring provided it is not suspected that groundwater or soil could have been contaminated or that pollutants may be present in concentrations that are higher than that established in the Rules (Table 910–1 of the Rules contains the maximum concentration levels for organic and inorganic compounds as well as metals).
Waste management requirements	For the injection of non-produced fluids into a dedicated Class II Underground Injection Control well; a separate approval is needed. The request shall include the nature, composition, source, and date of intended commencement of injection of the chemicals. Dedicated monthly reports with the details have to be submitted. Pits used for exploration and production of oil and gas shall be constructed and operated to protect public health, safety, and welfare and the environment, including soil, waters of the state, and wildlife, from significant adverse environmental, public health, or welfare impacts from exploration and production waste. Any accumulation of oil or condensate in a pit shall be removed within 24 hours of discovery. The following pits constructed on or after 1st April 2009 shall be lined: • Drilling pits designed for use with fluids containing hydrocarbon concentrations exceeding 10,000 ppm TPH or chloride concentrations at total well depth exceeding 15,000 ppm. • Production pits unless the operator demonstrates satisfaction that the quality of the produced water is equivalent to or better than that of the underlying groundwater. • Special purpose pits, except emergency pits constructed during initial emergency response to spills/releases, or flare pits where there is no risk of condensate accumulation. • Skim pits. • Multi-well pits used to contain produced water, drilling fluids, or completion fluids that will be recycled or reused, except where reuse consists only of moving drilling fluids from one oil and gas location to another such location for reuse there. • Pits at centralised exploration and production waste management facilities. • In Sensitive Areas, the COGCC may require a leak detection system for the pit or other equivalent protective measures. • Pits not used exclusively for drilling operations, buried or partially buried produced water vessels, and emergency pits shall be closed in accordance with an approved Site Investigation and Remediation Workplan. This Workplan shall be submitted for approval and shall include a description of the proposed investigation and remediation activities. Emergency pits shall be closed and remediated as soon as the initial phase of emergency response operations is complete or process upset conditions are controlled. Spills and Releases: Operators are obliged to control them upon discovery. They need to report the event to the COGCC within 24h for: any spill with risk of affecting water, the environment or health; a spill of one barrel or more of produced fluids or exploration and production waste if it is released outside of berms; and any spill over five barrels regardless of whether it is contained. The COGCC may require additional information. Operators are obliged to notify the local government, surface owner, Environmental Authorities within 24 h after discovery in the conditions stated above. Chemical spills or releases shall be reported according to Federal Laws. Management of exploration and production waste: Exploration and

Issue	Regulatory approach: Colorado (USA)
	production waste must be properly stored, handled, transported, treated, recycled, or disposed to prevent impacts to the environment. Reuse and recycling: To encourage and promote waste minimisation, operators may propose plans for managing waste through beneficial use, reuse, and recycling by submitting a written management plan to the COGCC for approval Such plans shall describe, at a minimum, the types of waste, the proposed use of the waste, method of waste treatment, and product quality assurance. Waste transportation. COGCC shall authorise the facilities to which waste is transported offsite within Colorado. Outside Colorado, the equivalent authority shall approve it. Waste generators of exploration and production waste shall maintain copies of each invoice, bill, or ticket for at least five years. Documentation must include date, data of generator and transporter, pickup location, type and volume, location of destination site. Produced water: • Treatment: It must be treated prior to placement in a production pit. • Disposal: The following are permitted methods for the disposal of produced water: Injection into a Class II well (complying with the rules), evaporation/percolation in a properly permitted pit, disposal at permitted commercial facilities, spread on lease roads outside sensitive water (for produced waters with less than 3500 mg/L total dissolved solids, when authorised by the surface owner and without impacts), discharge into state waters but complying with the Water Quality Control Act, evaporation in a lined pit at a centralised exploration and production waste management facility. Produced water reuse and recycling: It may be reused for enhanced recovery, drilling, and other approved uses in a manner consistent with existing water rights and in consideration of water quality standards. Mitigation: Can be used as an alternative domestic water supply but only to surface owners within the oil and gas field, without selling or trading. Drilling fluids: • Recycling and reuse: Drilling pit contents may be recycled to another drilling pit for reuse. • Treatment and disposal: Injection into Class II well (complying with the rules), land treatment at centralised exploration and production waste management facility. • Additional authorised disposal of water-based bentonitic drilling fluids: Drying and burial in pits on non-crop land, or land application for lease road maintenance or production facility maintenance. Surface owners must approve this. Operators have to maintain a record of the source, volume, location where the fluids were applied. If the COGCC requests this information, the operator has to provide it within five days. If the operator intends to reuse water-based bentonitic drilling fluids as soil amendment, an approval of the COGCC will not be required. Oily waste: Disposal at commercial solid waste disposal facility, land treatment onsite or land treatment at centralised E&P waste management facility. Other exploration and production waste (workover fluids, tank bottoms, pigging wastes, natural gas gathering, processing, and storage wastes): Disposal at commercial solid waste disposal facility, treatment at centralised E&P waste management facility, injection into Class I injection well, or any other method that is approved by the COGCC. Non-commercial centralised E&P waste management facilities: Operators may establish them for the treatment, recycling or reuse of their E&P waste. The operator must not act as waste management provider for any

Issue	Regulatory approach: Colorado (USA)
	other party (non-commercial use of the facility). Before its construction, the operator shall seek permission from the COGCC. Design and engineering of the facilities: The following data is required: • Geologic data (type of soils, local and regional geologic structures) • Hydrologic information (depth to aquifers, surface water within one mile, and others). • Engineering data such as location, dimensions, and access roads. Operating plan with detailed information of treatments, controls, inspection, sampling, record keeping, site security, hours of operation, noise and odour mitigation and final disposition of waste. Non-E&P waste: They need to be classified. If hazardous, they require storage, treatment, and disposal practices in accordance with general hazardous waste regulations in Colorado. If non-hazardous, the relevant non-hazardous solid waste regulations apply.
Disclosure of the composition of chemical additives	A service provider who performs any part of a hydraulic fracturing treatment and a vendor who provides hydraulic fracturing additives directly to the operator shall, unless it is a trade secret, provide the operator with all the necessary information to be able to disclose the information mandated by the Regulations (below). Operators must provide within 60 days after the conclusion of an hydraulic fracturing treatment and in any case 120 days of the start of a hydraulic fracturing process disclose: • Date. • Location and number of the well. • Vertical depth. • Total volume of water used and, if applicable, volume of base fluid used. • Each additive used and trade name, vendor, description. • Chemicals name and concentration. • As stated above, this does not apply if there is trade secret. This information (if it is not deemed a trade secret) is public and everyone will be able to search and sort the data by geographic area, ingredient, chemical, time period and operator. Vendors are not responsible if a third party provided them with inaccurate information. Operators are not responsible for inaccurate information given to them by vendors or service providers. Trade secret chemicals may be disclosed to health professionals is requested to do so. A confidentiality agreement and statement of why this information is needed will be signed by the health professional. This information should not be published. Also, COGCC staff may be able to know specific information that is necessary in case of a spill. Vendors, service providers or operators are not required to disclose information of chemicals that have not been intentionally added or chemicals accidentally added or the incidental result of a chemical reaction.

Decommissioning/Closure/Post-closure: Colorado (USA)

Issue	Regulatory approach: Colorado (USA)
Well abandonment requirements	Any dry or abandoned well, seismic, core, or other exploratory hole, must be plugged in such a manner that oil, gas, water, or other substance shall be confined to the reservoir in which it originally occurred. When the well, seismic, core, or other exploratory hole to be plugged may safely be used as a fresh water well, and such use is desired by the landowner, the well need not be filled above the required sealing plug set below fresh water; provided that written authority for such use is secured from the landowner and that he/she assumes the responsibility to plug it when he/she does not desire to use it as a water well anymore. Temporarily abandoned well: A well may be temporarily abandoned after passing a successful mechanical integrity test if approved by the COGCC, for a period not to exceed 6 months provided the hole is cased properly to avoid leaks/spills. Liability: The owner and operator of any well drilled for oil or gas production or injection purposes, or any seismic, core, or other exploratory holes, whether cased or uncased, shall be liable and responsible for the plugging regardless of the costs.
Well abandonment report	To be submitted to the COGCC prior to the abandonment of a well. It must describe all the proposed abandonment operations, including the proposed depths of mechanical plugs and casing cuts; the proposed depths and volumes of all cement plugs; the amount, size and depth of casing and other materials or items to be left in the well; the volume, weight, and type of fluid to be left in the wellbore between cement or mechanical plugs; and the nature and quantities of any other materials to be used in the plugging. The well needs to be plugged within six months of approval of the abandonment report. Within 30 days after abandonment, a second report has to be submitted to the COGCC explaining the actual abandonment details.
Closure plans (Waste Management Facilities)	Two closure plans are required. One is preliminary, and the second is more detailed and is submitted 60 days prior to closure of the waste management facility. There, the remediation and decommissioning strategies, pit closure procedures and post-closure monitoring will be described. Within 30 days of completion of the remediation works, the operator shall notify the COGCC and they will proceed to release the financial assurance once it is checked that the site has been remediated properly.
Reclamation	There are rules that give specifications on the restoration and re-vegetation (all disturbed areas, crop lands, non-crop lands, reseeding and types, timing, notice forms, etc.) and weed control. The rules also describe the final reclamation of well sites and associated production facilities: timing/completion (crop and non-drop lands), pit closure, reclamation threshold for release of financial assurance, weed control. The surface owner can grant a waiver for part of these requirements.
Dismantling of installations	Nothing specific
Liability and responsibility	There is no sanction regime specific to unconventional gas extraction. It is the general regime in the energy and environmental legislation that would be applicable.

Pennsylvania (USA)

Pre-development: Pennsylvania (USA)

Issue	Regulatory approach: Pennsylvania (USA)

Licences and permits	Permit
	• No well can be drilled or altered without a permit from the Department of Environmental Protection (DEP). Application shall be accompanied by a permit fee and takes 45 days for approval unless it denies it for one of the six reasons set out in Act 13 (3211) e).1In particular, DEP may not issue a permit if a company is violating an environmental law elsewhere in the state.
	• The main part of the permit application consists of a map – drawn to scale, showing the divisions of a piece of land – called a plat prepared by an engineer or surveyor. Among other things it includes (3211(b)):
	  • The location of the proposed well
	  • The name of the surface landowner of record and lessor
	  • All surface landowners and water purveyors whose water supplies for unconventional wells are within 3000 feet (2750 m) from the vertical well bore
	  • The acreage of the tract to be drilled
	  • The angle and direction of the well if it will not be vertical
	  • Description of any workable coal seams underlying the area to be drilled
	• The operator must start drilling within one year of issuance, unless the permit is renewed. The landowner, local municipality, and DEP are to receive 24-hours' notice before drilling begins. Once the well has been drilled, the permit is valid until the well is plugged. The DEP also receives 24-hours' notice before certain critical activities take place on the well, such as cementing of casing strings.
	• Each application for a well permit shall be accompanied by a permit fee, established by the Environmental Quality Board. The DEP can issue enforcement orders, suspend or revoke a well permit, and issue orders requiring immediate cessation of drilling operations. Cease orders may only be issued by the secretary of DEP.
	Well fee
	• Local authorities are entitled to impose a fee on the unconventional gas produced from wells within its borders if the county passes the ordinance 60 days after the effective date of Act 13 (until April 14, 2012).
	• Act 13 contains certain provisions to encourage county governments to adopt a fee, which is applied also to existing wells (any gas produced in the year prior to imposition of the fee). Failure to comply with the fee can entail permit suspension or withholding by DEP.
	• The fee is assessed annually for fifteen years, and is determined on the basis of several elements including the average annual price of natural gas, consumer price index, years of operation and whether the well is horizontal or vertical. Overall, the fee begins at between $40,000 and $60,000 (€37,000–€55,000) per well in year one, and decreases annually over time until final payments are between $5000 and $10,000 (€4600– €9000) in years 11 to 15.

Issue	Regulatory approach: Pennsylvania (USA)
	• There are several reporting obligations to DEP and the PUC (Pennsylvania Public Utility Commission) tied to this fee, but these are to be kept confidential. • The total fees collected are deposited in a fund known as the Unconventional Gas Well Fund.
Strategies to avoid disruptions to land use, biodiversity, community and water stress	Water and the environment: • Every operator must prepare a water management plan for approval by DEP that must show that the operators' withdrawals from streams and wells will not harm these sources. It must also include a reuse plan for fluids that will be used to hydraulically fracture wells. • In reviewing a plan, the DEP must consider the impact of the withdrawal both on the specific water body at issue and on the watershed as a whole. When approved, a water management plan is made a part of the well permit. • Best practices as determined by DEP to ensure the protection of the waters must be utilised for the storage and handling of all water, chemicals, fuels, hazardous materials or solid waste on a well site located in a floodplain. The well site operator may be requested to submit a plan and may be imposed conditions to protect the environment, public health and safety. Social elements: • Act 13 encourages producers to contract to the "maximum" extent "practicable," local businesses, but there appears to be no enforcement mechanism or penalty (only a requirement for the Department of General Services to assess the success of this aspect).

Planning/spatial aspects (including buffer zones/set-back distances)	• Setbacks:
	  • 500 feet (460 m) from private water supplies and buildings.
	  • 1000 feet (900 m) from a public water supply intake.
	  • For perennial streams, 300 feet (275 m) from the well or 100 feet (90 m) from the edge of the well site, whichever greater; plus, 100 feet (90 m) from the edge of any disturbed area.
	  • 300 feet (275 m) from wetlands > 1 acre (0.4 hectares)
	  • Floodplains: A well or well pad may not be built in a floodplain if the well site will contain a pit or impoundment for drilling wastes. Wells and well pads may be built in a floodplain if wastes will be stored in tanks that are not located within the floodway section of the floodplain.
	• Setback waivers:
	  • Setback requirements can be waived for privately owned structures and water supplies if their owners agree. Even where an owner does not agree to a waiver, the DEP may grant a waiver if an operator shows that a setback requirement would deprive the operator of its rights in oil and gas resources.
	  • Waivers are also required regarding a stream and wetland if the applicant submits a plan that contains additional measures, facilities or practices to be employed during well site construction, drilling and operations necessary to protect the waters. However, this waiving possibility was overturned in the Supreme Court decision of 19 December 2013.

Issue	Regulatory approach: Pennsylvania (USA)
	• Regarding flood plains, the DEP may, but is not required to, waive the setback requirements if an operator submits a plan with additional protective measures. • Other considerations: • Aside from the setback requirements, DEP must consider the impact of the proposed well on other "public resources", including: (1) Public parks, forests, game lands and wildlife areas; (2) National or State scenic rivers; (3) National natural landmarks; (4) Habitats of rare and endangered plants and animals and "other critical communities"; (5) Federal and state historical and archaeological sites; and (6) Public drinking water supply sources. • DEP may establish additional protective measures for storage of hazardous chemicals and materials on an unconventional well drilling site within 750 feet (700 m) of perennial streams. • Zoning • Act 13 requires that all oil and gas operations other than surface impoundments, processing plants and compressor stations shall be allowed in all zoning districts, including residential districts. Impoundments and compressor stations must be allowed in residential districts as a conditional use. Only processing plants do not need to be allowed in a residential district. • Under Act 13, state-wide land use rules would be established and local authorities will not be able to regulate zoning. However, this was overturned in the Supreme Court decision of 19 December 2013.
Geological characterisation including risks of geological faults, manmade structures, characteristics of the cap rock	• Upon notification by DEP prior to commencement of drilling, the well operator shall collect any additional data specified by the department, including representative drill cuttings and samples from cores taken and any other geological information that the operator reasonably can compile (3222).
Baseline monitoring prior to drilling or fracturing	• Permit applicants are not required to perform pre-drill tests of water supplies near the proposed gas well, but it is in their interest in view of how the rebuttable presumption of liability operates, which covers water supplies within 2500 feet (2300 m) of an unconventional gas well (see point on liability below). The survey shall be conducted by an independent certified laboratory.
Risk assessment requirements prior to development	Nothing specific seems to be in place
Public participation requirements	Permit application • The applicant must mail a copy of the plat that is part of the application to the surface landowner where the well will be located, as well as the municipality (and any municipality within 3000 feet (2750 m) of the well), any surface owners and persons that operate public water supplies within 3000 feet (2750 m) of the proposed well, and the owner and lessee of any coal seams beneath the well. 3211(b)(2). Among other things, the notice must indicate that it is in the owner's interest to perform his/her own independent assessment of drinking water quality before drilling begins. 3211(b.1). • Act 13 establishes a process for surface landowners to object to

Issue	Regulatory approach: Pennsylvania (USA)
	a permit either because the well location violates one of the buffer zone restrictions in the law, or because information in the application is not true. Municipalities can comment on permit applications pending before the DEP but do not have the right to challenge DEP decisions to issue well permits within their borders. However, this was overturned in the Supreme Court decision of 19 December 2013.
Financial guarantee	After permit application, the operator must place a bond for the well that will be released when the well is properly plugged or transferred. Bonds may be declared forfeited and collected in full if the owner fails to properly plug the well, or comply with the law: • For wells that are less than 6000 feet (5500 m) in length, the bond rates range from $4000 to $250,000 (€3600–€230,000) depending on how many wells are operated – from one to more than 250 wells. • For wells more than 6000 feet (5500 m) in length, the rate ranges from $10,000 to $600,000 (€9000–€550,000) – from one to more than 150 wells.

Exploration/Appraisal/Production: Pennsylvania (USA)

Issue	Regulatory approach: Pennsylvania (USA)
Well design	• The operator shall equip the well with one or more strings of casing of sufficient cemented length and strength to attach proper well control equipment and prevent blowouts, explosions, fires and casing failures during installation, completion and operation (Ch. 78) • To prevent pollution of fresh groundwater from migration of gas or fluids, strings of “casing” (i.e., metal tubing) must be run through the fresh groundwater zone and any coal bearing zone, and then “permanently” cemented up the outside of the casing strings to isolate production fluids and gas bearing zones from the fresh groundwater zone.
Well integrity	The operator shall inspect each operating well at least quarterly to ensure it is in compliance with the well construction and operating requirements of chapter 78 and the act. The results of the inspections shall be recorded and retained by the operator for at least five years and be available for review by the Department. At a minimum, inspections must determine: (1) The well-head pressure or water level measurement; (2) The open flow on the annulus of the production casing or the annulus pressure if the annulus is shut in; (3) If there is evidence of gas escaping from the well and the amount escaping, using measurement or best estimate of quantity; (4) If there is evidence of progressive corrosion, rusting or other signs of equipment deterioration.
Operational plans	• Containment plan • To prevent spills from contaminating on-site soil and prevent off-site pollution needs to be approved (referred to as a Pollution Prevention and Control or PPC Plan). This plan must describe containment practices to be utilised and the area of the well site where containment systems will be employed. Containment practices must be in place during both drilling and hydraulic fracturing operations and must be sufficiently impervious and able to contain spilled materials, and be compatible with the

Issue	Regulatory approach: Pennsylvania (USA)
	waste material or waste stored within the containment. Containment plans must be submitted to the department and describe any equipment that is to be kept onsite to prevent a spill from leaving the well pad. • Containment systems shall be used wherever any of the following are stored: (1) Drilling mud; (2) Hydraulic oil; (3) Diesel fuel; (4) Drilling mud additives; (5) Hydraulic fracturing additives; and (6) Hydraulic fracturing flowback. Containment areas must be sufficient to hold the volume of the largest container stored in the area plus ten per cent. • Erosion and sediment control • During and after earthmoving or soil disturbing activities the operator shall design, implement and maintain best management practices in accordance with Chapter 102 (relating to erosion and sediment control) and an erosion and sediment control plan prepared under that chapter.
Monitoring in the production stage	• Emissions of air pollutants from operations at unconventional wells including development, production, transmission, and processing must be monitored and annually reported to DEP by March 1. The annual reports to DEP must explain how air pollutants emitted were calculated by the operator. Specific reporting requirements apply to the emission of nitrogen oxides and volatile organic compounds.
Water supply	• A water management plan needs to be approved to use any water for drilling. • When DEP is notified about a spill, the agency must contact the operators of any public water supply that may be harmed by the spill.
Requirements on vehicle movements	Nothing specific seems to be in place
Fracturing and induced seismicity	Nothing specific seems to be in place
Noise and vibration	Nothing specific seems to be in place
Gas venting/flaring	• Excess gas encountered during drilling, completion or stimulation shall be flared, captured or diverted away from the drilling rig in a manner that does not create a hazard to the public health or safety (Ch78.73). • The venting of gas to the atmosphere from a well is prohibited when the venting produces a hazard to the public health and safety.
Waste management	• Control and disposal planning: Prior to generation of waste, the well operator shall prepare and implement a plan for the control and disposal of fluids, residual waste and drill cuttings, including tophole water, brines, drilling fluids, additives, drilling muds, stimulation fluids, well servicing fluids, oil, production fluids and drill cuttings from the drilling, alteration, production, plugging or other activity associated with oil and gas wells. The plan must also include a pressure barrier policy that identifies barriers to be used during identified operations. A copy of the plan shall be provided to DEP upon request and shall be made available on the site. • The operator shall contain polluting substances and wastes other than gases in a pit, tank or series of pits and tanks. The operator

Issue	Regulatory approach: Pennsylvania (USA)
	shall install or construct and maintain these in accordance with the requirements specified in Ch78.56/57. • The owner and operator may not discharge tophole water or water in a pit as a result of precipitation by land application unless the discharge is in accordance with the requirements established in Ch78.60. • Transportation records regarding wastewater fluids must be kept by the operator for five years and provided to DEP upon request. These records must include information on the amount of wastewater generated during drilling and hydraulic fracturing, the company that transported the wastewater fluids off-site, their final location, the quantity of waste disposed, and the disposal method. This means that only those records requested by DEP, on a site by site basis, will be available to the public for review.

Disclosure of information (e.g. chemicals used)	• Operators of an unconventional well shall file with the DEP a semiannual report specifying the amount of production on the most well-specific basis available and the status of each well.
	• Operators have to submit a significant amount of technical data to the DEP about each well. For example, the driller must collect data while drilling the well that would include any observations of difficulties or anomalies that occurred. A well completion report must be submitted to the DEP within 30 days after completion of the well. Other technical information will be provided on request (e.g. copy of any electrical, radioactive or other standard industry logs which have been run).
	• The well completion report must contain the operator's stimulation record, which must include:
	  • A descriptive list of the chemical additives used, including the trade name, vendor, and intended use of each chemical additive.
	  • A list of chemicals used and the per cent by mass of each chemical used
	  • The total volume of the base fluid
	  • List of water sources
	  • Pump rates, pressures, total volume used to stimulate a well
	  • Total volume of recycled water used
	  • However, certain information can be kept secret under certain circumstances (Trade Secret or "confidential proprietary information").
	• The well record shall identify all of the following: (i) Whether methane was encountered in other than a target formation; (ii) The country of origin and manufacture of tubular steel products used in the construction of the well.
	• In addition to the well completion reports, the law creates a public online and searchable registry of chemicals used by companies during hydraulic fracturing. The company is to upload this data 60 days after fracturing (stimulation) has commenced on a particular well. However, the disclosure can be limited if a chemical or concentration is a trade secret or for confidentiality reasons.
	• Emergency personnel and other health professionals can get access to the chemicals and additives claimed to be a Trade Secret or "confidential proprietary information" under certain circumstances (e.g. when "medical emergency exists").

Emergency safety	• The operator of an unconventional well shall develop and

Issue	Regulatory approach: Pennsylvania (USA)
plans	implement an emergency response plan that provides for equipment, procedures, training and documentation to properly respond to emergencies that threaten human health and safety for each well site (Chapter 78.55). • DEP may enter into contracts with well control specialists in order to provide adequate emergency response services in the event of a well control emergency.

Decommissioning/Closure/Post-closure: Pennsylvania (USA)

Issue	Regulatory approach: Pennsylvania (USA)
Closure plans and closure requirements	The well owner or operator must notify the DEP when the well ceases production, and plug the well in the manner prescribed by regulation of the department within 30 days to ensure that no fluid or gas will continue moving upwards through the well casings.
Well site restoration/Dismantling of installations	Well sites must be restored, including removal or filling any pits used for produced fluids or industrial wastes, within nine months after drilling is completed. Any remaining facilities used for production and storage must be removed nine months after the well has been plugged. The ultimate purpose of restoration is to restore the site to approximate original contours and allow the support of the uses of the land that existed pre-drilling.
Post closure monitoring	Nothing specific seems to be in place
Liability and responsibility	• A well operator who affects a public or private water supply by pollution or diminution shall restore or replace the affected supply with an alternate source of water adequate in quantity or quality for the purposes served by the supply. Upon being notified of a claim, DEP has 10 days to investigate the claim and 45 days to make a decision. • "Rebuttable presumption" of liability: responsibility of the well operator is presumed for any water pollution 2500 feet (2300 m) from the unconventional gas well when it occurred within 12 months after the drilling, stimulation or other alteration. The rebuttable presumption can be overcome if any of the defences established in 3218(d) can be proved. • Unlawful conduct under the law is prosecuted criminally and civil penalties can be assessed. The DEP is required to post inspect reports for violations on its website.

Appendix 2 HIA case study reviews

Table A2.1. Case Study 1: Review of the potential public health impacts of exposures to chemical and radioactive pollutants as a result of the shale gas extraction process: UK

	Area	Review: Public Health England, UK
1	Project summary	Public Health England (PHE) is an executive agency of the Department of Health in England. In response to emerging public concern regarding the process of hydraulic fracturing for shale gas extraction, and requests for advice from national and local agencies, the PHE Centre for Radiations, Chemical and Environmental Hazards (CRCE) reviewed the potential public health impact of direct emissions of chemicals and radioactive material from the extraction of shale gas. Shale gas extraction is at an early exploratory stage in the UK with very limited drilling having actually occurred. Despite such limited activity to date, shale gas extraction raised concerns with the general public.
2	Overview of the Review of Potential Public Health Impacts	The PHE review focused on the potential public health impacts of exposures to chemical and radiological pollutants as a result of shale gas extraction in the UK, based on the examination of literature and data from countries which already have commercial-scale gas extraction operations. Caution was required when extrapolating experiences in other countries to the UK since the mode of operation, underlying geology and regulatory environment are likely to be different.
3	The requirement for the review	There were no regulatory drivers behind this review, although it was prepared in response to public concern regarding the process of hydraulic fracturing for shale gas extraction, and requests for advice from national and local agencies.
4	Approach	A search of published or peer reviewed scientific literature was undertaken until January 2014. The search strategy initially aimed to capture the widest number of publications as possible, which returned 1276 references but following screening this was reduced to 303. These were then subject to further review focusing on the English language and human health impacts. Further literature was identified from internet searches and key government websites in the UK, European Union, US and Canada. Contacts were also made in the UK with a range of stakeholders including the Environment Agency, British Geological Survey and the Department of Energy and Climate Change (DECC). All the references were assessed by a working group of the report authors, with the greatest weighting given to reports and papers published in the scientific literature especially peer reviewed papers. The final report considered 229 papers or reports, of which 110 were directly cited. The report focused exclusively on the direct health impact of releases into the environment due to emissions from the production of shale gas (and some liquid hydrocarbons) from shale formations with hydraulic fracturing in either vertical or horizontal wells. The following areas were considered within the report: air pollution including from stationary on-site sources, and radon; water pollution including the use of hydraulic fracturing fluids, flowback water, presence of natural substances, e.g. heavy metals and NORM, and the risk to the watercourse or aquifers; and land/waste issues including disposal and treatment of wastewater, muds, etc. The following areas were outside the scope of this report: occupational health issues; water usage and water sustainability issues; energy policy and security; nuisance issues including, noise and odour; seismicity; wider impacts of shale gas extraction on local employment and the local economy; and detailed consideration of the longer-term impact of shale gas extraction on climate change. It was recognised that community concerns can extend to broader issues (e.g. socioeconomic impacts, visual amenity and noise). It was also recognised that some of the observations and recommendations in the report could be extended

	Area	**Review: Public Health England, UK**
		to other oil and gas operations. However, the assessment focused solely on issues related to local emissions arising from shale gas extraction and any potential direct health impacts. The impacts on climate change were not addressed in this review; however, climate change remains an area of concern for public health and must be considered in any strategic decisions related to the energy industry.
5	Findings	The PHE review highlights that the UK has an established onshore oil and gas industry and, although shale gas extraction is a relatively new process and there is limited experience of its use in the UK, the potential emissions and many of the associated industrial processes (such as horizontal drilling or the use, transport and processing of chemicals) are not new and their risks are relatively well characterised. Hazards to health from shale gas extraction activities identified in the review include potential emissions to air of primary pollutants such as oxides of nitrogen (NOx) or particulate matter (PM) and the precursors of secondary pollutants such as O3 and volatile organic compounds. Shale gas extraction activities may also impact on surface water and groundwater through accidents and spillages. Most evidence suggests that contamination of groundwater as a result of borehole leakage through poor well design, construction and integrity is an area of concern, but that contamination of groundwater from the underground hydraulic fracturing process itself is unlikely. There is also a need to adequately manage the chemicals used in hydraulic fracturing fluids as well as the process residues and waste containing chemicals and naturally occurring radioactive materials (NORM). The review found that the risks from small-scale exploratory drilling (e.g. single wells) are different from commercial-scale operations. The potential health impact from single wells is likely to be very small, but the cumulative impacts of many wells in various phases of development in relatively small areas are potentially greater and will need careful scrutiny during the planning process. It would be appropriate to determine the initial radon concentrations in natural gas from hydraulic fracturing sources as well as the radiological activity concentrations in the NORM-containing waste materials to provide adequate reassurance. Baseline environmental monitoring data for emissions to air and water are required before drilling to establish background levels. Any monitoring programme will need to continue throughout the lifetime of the well, including the decommissioning of the well pad. Analytical methods may need to be developed that are capable of detecting chemicals associated with shale gas extraction and related activities. Agencies in the UK will need to agree criteria for correct disposal of wastewater after treatment via regulation and permitting regimes. Experiences from countries with commercial-scale operations, particularly the US, demonstrate that good on-site management and appropriate regulation of all aspects of the operations, from exploratory drilling to gas capture and well abandonment, as well as the use or storage of hydraulic fracturing fluid and the treatment of any wastes, are essential to minimise the risk to the environment and public health. Problems in the US appear to be attributable to operational failures and inadequacies in the regulatory environment. The geology, topography, mode of operation and, most importantly, the regulatory environment will be significantly different in the UK.
6	Outcomes	The review sets out the following recommendations: • PHE needs to continue to work with regulators to ensure all aspects of shale gas extraction and related activities are properly risk assessed as part of the planning and permitting process. • Baseline environmental monitoring is needed to facilitate the assessment of the impact of shale gas extraction on the environment and public health. There should also be consideration of the development of emission inventories as part of the regulatory regime.

	Area	**Review: Public Health England, UK**
		• Effective environmental monitoring in the vicinity of shale gas extraction sites is needed throughout the lifetime of development, production and post-production. • It is important to ensure that broader public health and socioeconomic impacts such as increased traffic, impacts on local infrastructure and worker migration are considered. • Chemicals used in hydraulic fracturing fluid should be publicly disclosed and risk assessed prior to use. It is useful to note that any potential risk to public health and the environment from hydraulic fracturing chemicals will be dependent on the route of exposure, total amount and concentration, and eventual fate of any such chemicals. It is expected that these aspects will be considered as part of the regulatory environmental permitting process. • The type and composition of the gas extracted is likely to vary depending on the underlying geology and this necessitates each site to be assessed on a case-by-case basis. • Evidence from the US suggests that the maintenance of well integrity, including post-operations, and appropriate storage and management of hydraulic fracturing fluids and wastes are important factors in controlling risks and appropriate regulatory control is needed. • Characterisation of potentially mobilised natural contaminants is needed including naturally occurring radioactive materials (NORM) and dissolved minerals. The findings of the PHE review have been used in other assessment work undertaken at the national level (the SEA for Further Onshore Oil and Gas Licensing undertaken by the Department of Energy and Climate Change (DECC) and at the local level (see, for example, EIAs undertaken in respect of proposals by Cuadrilla at Roseacre Wood and Preston New Road, Lancashire). However, the review has been subject to criticism from opposition groups stating that it does not consider the most recently available research.
7	Key lessons	A number of lessons can be derived from this case study. These include: • national level assessments can help to inform debate around the health impacts of UGEE; • the importance of stakeholder engagement in the assessment process; • the need for further work to better define the potential health impact of shale gas extraction in the UK; • the need to ensure that HIAs reflect the most recently available information, research and data; and • the drilling of exploratory wells should allow the collection of a comprehensive set of data on shale gas extraction and related activities.
8	References	PHE (2014) Review of the Potential Public Health Impacts of Exposures to Chemical and Radioactive Pollutants as a Result of the Shale Gas Extraction Process. Available online: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/332837/PHE-CRCE-009_3-7-14.pdf (accessed June 2015).

Table A2.2. Case Study 2: Strategic Environmental Assessment (SEA) for further onshore oil and gas licensing: DECC, UK

	Area	Review: DECC, UK
1	Project summary	The UK Government's Department of Energy and Climate Change (DECC) is responsible for administering the oil and gas licensing system in the UK. The licences give exclusive rights to explore for, and exploit, hydrocarbons within a specific area and could cover: conventional oil and gas exploration and production; unconventional oil and gas exploration and production; and natural gas storage in hydrocarbon reservoirs. DECC carried out Strategic Environment Assessment (SEA) for further onshore oil and gas licensing for unlicensed areas in parts of England, Scotland and Wales (hereafter referred to as "the Licensing Plan') between 2009 and 2014. The purposes of the SEA of the Licensing Plan were to: • identify and quantify the potentially significant environmental effects of the Licensing Plan including alternatives; • help identify appropriate measures to avoid, reduce or manage adverse effects and to enhance beneficial effects associated with the implementation of the Licensing Plan wherever possible; • give the statutory SEA bodies, stakeholders and the wider public the ability to see and comment upon the effects that the Licensing Plan may have on them, their communities and their interests, and encourage them to make responses and suggest improvements to the Licensing Plan; and • inform the UK Government's decisions on the Licensing Plan.
2	Overview of the Health Impact Assessment (HIA)	The SEA of the draft Licensing Plan was undertaken by assessing those potential activities that could follow on from the licensing round and which may have environmental effects. The SEA did not include a formal HIA but health impacts were considered. The main output of the SEA of the draft Licensing Plan was the revised Environmental Report which was issued 16th December 2013.
3	The requirement for HIA	SEA became a statutory requirement following the adoption of European Union Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment and is incorporated into UK law in The Environmental Assessment of Plans and Programmes Regulations 2004 (the SEA Regulations). The objective of SEA, as defined in Directive 2001/42/EC is: "To provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to contributing to sustainable development." Case law has established that oil and gas licensing rounds are plans or projects for the purpose of the SEA Directive. The SEA Directive specifically requires the consideration of "the likely significant effects on the environment, including on issues such as …, human health …". However, health is not defined in this context.
4	Approach	The SEA of the Licensing Plan was undertaken in accordance with the SEA Directive and its transposing regulations and followed established Government guidance. This included the following key stages: • Scoping the assessment (Stage A) • Developing and refining alternatives and assessing effects (Stage B) • Preparing the Environmental Report (Stage C) • Consulting on the Environmental Report (Stage D) • Post adoption statement and monitoring (Stage E)

	Area	Review: DECC, UK
		The assessment of the draft Licensing Plan (Stage B above) considered, for conventional oil and gas, shale gas and oil, virgin coalbed methane and gas storage in-turn, the effects associated with six exploration and production stages. This included the assessment of effects against the 10 topic areas identified below: • Biodiversity & Nature Conservation; • Population including demographics, socio-economics; • Health; • Land Use, Geology & Soils; • Water & Flood Risk; • Air Quality; • Climate Change; • Waste & Resource Use; • Cultural Heritage including architectural and archaeological heritage; and • Landscape. SEA objectives and guide questions were used to guide the assessment which sought to predict the significant environmental effects of the draft Licensing Plan. In undertaking the assessment, consideration was given to: baseline information including existing environmental problems and their evolution; the likely activities and potential sources of impact associated with oil and gas exploration and production; the regulatory framework; the evidence base regarding the relative risks and potential for significant effects from activities that may potentially arise following the licensing round; and consultation with statutory consultees and other stakeholders. With specific regard to the health topic, the SEA focused in particular on noise, air and amenity impacts arising from construction, drilling/hydraulic fracturing and HGV movements as well as NORM, water quality/resources and stress/anxiety. The assessment was informed by baseline environmental information collated at the scoping stage and peer reviewed literature including, in particular, the PHE (2014) Review of the Potential Public Health Impacts of Exposures to Chemical and Radioactive Pollutants as a Result of Shale Gas Extraction.
5	Findings	The SEA found that exploration and production activities have the potential to adversely affect health due, in particular, to the potential for generation of noise, vibrations, dust and other emissions to the air through, for example, HGV movements or pad preparation activities. However, taking into account existing regulatory controls, effects were considered to be minor but with the potential for significant, local impacts. The risks of contaminating drinking water were considered to be remote provided that wells are well designed, the casing of each well is of adequate depth and there is adequate separation between wells and aquifers. The Environmental Report made a number of recommendations for consideration at the project level, many of which related to the mitigation of potential health impacts.
6	Outcomes	The recommendations of the Environmental Report have been taken forward by DECC and in particular, licence applicants will be invited to indicate, in the Statements of Environmental Awareness which are already required as part of their applications, how they intend to incorporate these measures into their planning and operations. There was an unusually high level of media interest in the assessment (reflecting in part the public concerns in respect of UGEE projects/operations) and at the end of the consultation period on the revised Environmental Report, a total of

	Area	Review: DECC, UK
		2419 responses were received. The majority of respondents disagreed with the findings of the Environmental Report. With specific regard to health impacts, PHE stated that "In our opinion the Report does not address all of the potentially • significant negative environmental and subsequent health impacts that shale gas extraction could have on groundwater if operations are not • properly run and regulated. These include the potential for contamination of groundwater with injected fracturing chemicals and flowback water (e.g. leakage through • the vertical borehole), surface spills and accidents above ground (e.g. waste fluids, chemical additives in concentrated form, blowout or flowback water)". Following consultation on the SEA Environmental Report between December 2013 and March 2014, the licence bidding process commenced in July 2014. The bidding process closed in late October 2014 and DECC are now assessing licence applications.
7	Key lessons	A number of lessons can be derived from this case study. These include: • SEA is, by its very nature, a high level assessment which means that effects on individual communities are difficult to predict, although it can usefully inform regulation and guidance; • SEA relies on existing literature and evidence to inform professional judgements as opposed to primary research; • there is considerable overlap in terms of the range of health issues considered in SEA and HIA although SEA may not cover the full range of health determinants (and in particular socio-economic effects) and may not actively involve health professional in the assessment process; and • UGEE projects/operations are controversial and any assessment of health impacts is therefore likely to attract widespread public (including media) interest.
8	References	DECC (2014) Environmental report for further onshore oil and gas licensing. Available online: https://www.gov.uk/government/consultations/environmental-report-for-further-onshore-oil-and-gas-licensing (accessed June 2015).

Table A2.3. Case Study 3: Maryland Marcellus Shale public health study: Maryland, USA

	Area	Review: Maryland, USA
1	Project summary	The Marcellus Shale lies in the northern Appalachian Basin, including New York, Pennsylvania, Ohio, West Virginia, and Maryland. The Marcellus Shale is one of the largest shale regions in the United States and covers over 9 square miles. It is 4000–8000 feet deep and contains more than 410 trillion cubic feet of natural gas. In June 2011, Executive Order (E.O.) 01.01.2011.11 established the Marcellus Shale Safe Drilling Initiative. The purpose of the Initiative is to assist regulators in determining whether and how gas production from the Marcellus Shale and other shale formations in Maryland can be accomplished without unacceptable risks of adverse impacts to public health, safety, the environment, and natural resources. The purpose of the Marcellus Shale Public Health Study (PHS) was to evaluate the potential public health impacts associated with UGEE in the Marcellus Shale in Maryland. The project lead for the PHS was the Maryland Department of Health and Mental Hygiene (DHMH) and the assessment was carried out by the Maryland Institute for Applied Environmental Health (MIAEH),

	Area	Review: Maryland, USA
		School of Public Health, University of Maryland, College Park. The assessment was initiated on 18 October 2013 and the final report was submitted on 15 September 2014. The geographic scope was the state of Maryland.
2	Overview of the Health Impact Assessment (HIA)	The PHS was not a HIA per se although it did incorporate several elements of the HIA process. The memorandum of understanding (MoU) between the Maryland DHMH and the MIAEH specified that the "project is designed to provide a baseline assessment of current regional population health, an assessment of potential public health impacts, and possible adaptive and public health mitigation strategies in the event that natural gas extraction takes place within Maryland's Marcellus Shale resources". The assessment of potential health impacts was not intended to predict whether such effects will necessarily occur in Maryland. Instead, the PHS sought to identify impacts that could occur and that need to be addressed by preventative public health measures if and when UGEE is allowed. In this regard, the PHS was not designed to make recommendations about whether or when to allow UGEE projects in Maryland. Rather this study was designed to inform decisions by clearly describing the risks and potential public health responses. The PHS focused on populations in Allegany and Garrett Counties living and working near shale gas development sites. The study notes that the findings may have relevance for individuals in surrounding counties and other shale deposits in the state of Maryland. The PHS was initiated on 18 October 2013. Consultation closed to the public at the final report stage.
3	The requirement for HIA	The requirement was established in the Marcellus Shale Safe Drilling Initiative. The Initiative itself was established in E.O 01.01.2011.11 which required the Maryland Department of the Environment (MDE) and the Department of Natural Resources (DNR), in consultation with an advisory commission made up of a broad array of stakeholders, to undertake a study of UGEE from the Marcellus Shale in Western Maryland. The PHS was conducted to inform the Marcellus Shale Safe Drilling Initiative Advisory Commission, State legislators and the Governor about potential health impacts associated with UGEE activities to allow them to make an informed decision that takes into account the health and well-being of Marylanders.
4	Approach	In order to assess the baseline health of Allegany and Garrett County residents, the PHS considered the following indicators: • demographics; • potential vulnerable populations; • a wide range of health indicators; • environmental health; • social determinants of health; and • healthcare infrastructure. The assessment identified eight UGEE-related hazards that were of most concern to the community members in western Maryland: • air quality; • flowback and production water related (including water quality, soil quality and naturally occurring radioactive materials (NORM)); • noise; • earthquakes; • social determinants of health (including sexually transmitted infections; traffic; and crime); • healthcare infrastructure; • occupational health; and

	Area	Review: Maryland, USA
		• cumulative exposure/risk. The assessment did not consider economic benefits or climate change impacts. The scope of the PHS, with regard to the range of health issues considered and receptors identified, estimated the baseline health of the relevant communities by examining a wide range of health indicators including vulnerable populations, chronic and non-chronic disease, major causes of morbidity and mortality, environmental health, social determinants of health, and healthcare infrastructure. Other factors considered in the baseline assessment were age, genetics, behaviour, educational attainment, family income, poverty status, access to quality healthcare, proximity to hazards and environmental exposures can influence individual health status. The PHS assessed the period from well construction through to well completion. The assessment process focused on four key stages: • Detailed scoping – which included creating a timetable for the remaining deliverables, methods to be used and the scope and scale of public input to determine the study objectives; • A baseline assessment of contemporary regional population health indicators, including demographics, causes of morbidity and mortality, local health priorities, vulnerable populations, local healthcare provision and social service infrastructure; • Objective assessment of the impact of the potential exposures related with UGEE, including hazards and known health impacts directly and indirectly associated with hydraulic fracturing, an assessment of current exposures and their severity and data gaps prior to the onset of hydraulic fracturing; and • The final report including the study's findings, monitoring and assessment recommendations and public health response and mitigation strategies. Cumulative risk and/or exposure was a specific hazard identified and assessed within the HIA. The risk/exposure included a combination of chemical, physical, and psychosocial stressors which can lead to effects that are cumulative involving potentially additive or multiplicative interactions amongst the exposures. Hazards were ranked using a set of pre-established criteria: vulnerable populations; geographic extent; duration of exposure; frequency of exposure; likelihood of health effects; magnitude of health effects; and effectiveness of the setback. Overall scores were then used to rank each hazard into three broad categories using a colour-coded scheme (from high, medium and low likelihood). The PHS used County level and census tract level statistics for the baseline health assessment. Where possible, data for Allegany and Garrett counties was compared to the health data of the region and the state of Maryland for an overall baseline health profile. The PHS was primarily based on a review of existing literature. Reports and articles submitted to MIAEH from the community, industry groups and environmental advocacy organisations were also considered. Baseline and post-UGEE monitoring data on air and water quality were gleaned from peer-reviewed literature and reports from state, local and non-governmental organisations. Whenever available, raw data was used to come to a conclusion instead of relying on the original authors' interpretation of the data. Noise monitoring at homes and at compressor stations was undertaken. The scoping process sought input from a wide range of stakeholders through public meetings and publication of a draft detailed scoping document. The final report was also made available for public comment. The final assessment findings were presented in a report available from a dedicated website. The report was also summarised and presented to the Marcellus Shale Advisory Commission.

	Area	**Review: Maryland, USA**
5	Findings	The main health impacts identified in the report are summarised below with regard to the likelihood of negative public health impact: • Air quality: high; • Healthcare infrastructure: high; • Occupational health: high; • Social determinants of health: high; • Cumulative exposures/risks: moderately high; • Flowback and production water related: moderately high; • Noise: moderately high; and • Earthquakes: low. The PHS considered the combined effect of cumulative exposures, as well as the interactions between chemical and non-chemical stressors. It found that the combined effect of UGEE related hazards described in the report may be higher than the simple sum, and that the impact will be more pronounced in disadvantaged communities and will be disproportionately felt by vulnerable subpopulations such as property owners without mineral rights, elderly, children, and individuals with pre-existing diseases. The report concluded that there is a moderately high likelihood that UGEE related activities will have a net negative impact with regard to cumulative exposure/risk. The PHS identified a range of mitigation measures and recommendations relating to: the contents of Comprehensive Gas Development Plans (CGDP); disclosure of well stimulation materials; air quality; water and soil quality; NORM; noise; earthquakes; traffic safety; empowering communities; healthcare infrastructure; cumulative exposure/risk; and occupational health.
6	Outcomes	The focus of the PHS recommendations were based on answering the question: "Given the baseline population health, vulnerabilities, and potential impacts of UNGDP, how can Maryland best protect public health if and when UNGDP foes forward?" In this context, the PHS identified 52 recommendations relating to: the contents of Comprehensive Gas Development Plans (CGDP); disclosure of well stimulation materials; air quality; water and soil quality; NORM; noise; earthquakes; traffic safety; empowering communities; healthcare infrastructure; cumulative exposure/risk; and occupational health. Some (but not all) of the recommendations of the PHS were taken forward in the wider Marcellus Shale Safe Drilling Initiative Study and which subsequently informed the Proposed Oil and Gas Resources Regulations designed to establish new oil and gas exploration and production standards. The PHS was met with mixed responses from the public and stakeholders. Of particular note was a letter sent by Concerned Health Professionals of Maryland (CHPMD) to the governor highlighting two studies demonstrating the risks of hydraulic fracturing and also pointing to the shortcomings in the PHS which it notes did not incorporate recently released studies exploring the health effects of hydraulic fracturing. Following publication of the PHS, the "Protect our health and communities" Act was introduced by Maryland delegate David Fraser-Hildalgo, Senator Karen Montgomery and others as a bill to enact a long term, state-wide moratorium on hydraulic fracturing. The bill came into force on 30 May 2015 and the legislation barred the state from issuing permits for hydraulic fracturing until October 2017. It also requires Maryland's Department of the Environment to adopt regulations for the practice by October 2016. The PHS itself identified a number of methodological limitations, some of which are related to the assessment process, while others are related to a lack of available data. The limitations identified included a broad range of issues such as: • a lack of consistent methods that are universally accepted regarding

	Area	Review: Maryland, USA
		HIA and which makes it difficult to compare HIAs, including the ranking of hazards; • a lack of monitoring data available in the literature that has evaluated the impact of UGEE projects on air and water quality pre, during and post UGEE related activities; • a lack of data on individual level exposure to physical and chemical hazards associated with UGEE projects. HIA specific limitations included that quantitative health risk assessment and cumulative risk assessment were beyond the data and time resources allocated to the project. As such, the only primary data collected was noise monitoring in one UGEE impacted community. All other evaluations were based on existing data from the literature review. Additionally, the PHS did not address economic benefits associated with UGEE.
7	Key lessons	A number of lessons can be derived from this case study. These include: • recommendations arising from HIA can usefully inform debate, regulation and guidance; • scoping, informed by robust baseline information, can help to focus the HIA on those issues that are most prevalent to potentially affected communities; • the need to involve key stakeholders and communities throughout the HIA process; • ensuring that HIAs reflect the most recently available information, research and data; • ranking systems and criteria can be used to highlight the most significant risks; • ensuring that there is sufficient time and resources available to conduct a robust assessment; • the need to adopt a common approach to HIA so that findings can be compared objectively; • the need to consider cumulative impacts; • the need to ensure that monitoring protocols are established as part of the HIA process and which focus on the need to monitor conditions before, during and after activities; and • the need to determine the extent to which baseline surveys are required to inform the HIA.
8	References	Maryland Department of Health and Mental Hygiene (2014) Marcellus Shale and Public Health. Available online: http://phpa.dhmh.maryland.gov/OEHFP/EH/SitePages/MarcellusShale.aspx (accessed June 2015). Maryland Department of Health and Mental Hygiene (2014) Marcellus Shale and Public Health Marcellus Shale Safe Drilling Initiative. Available online: http://www.mde.state.md.us/programs/land/mining/marcellus/pages/index.aspx (accessed June 2015). University of Maryland School of Public Health (2014) Potential Public Health Impacts of Natural Gas Development and Production in the Marcellus Shale in Western Maryland. Prepared for the Maryland Department of the Environment and the Maryland Department of Health and Mental Hygiene. Available online: http://www.marcellushealth.org/uploads/2/4/0/8/24086586/final_report_08.15.2014.pdf (accessed June 2015). University of Maryland School of Public Health (2014) Maryland Marcellus Shale Public Health Study. Available online: http://www.marcellushealth.org/ (accessed June 2015).

	Area	Review: Maryland, USA
		Maryland Department of the Environment and Maryland Department of Natural Resources (2014) Marcellus Shale Safe Drilling Initiative Study. Available online: http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Final_Marcellus_Shale_Report.pdf (accessed June 2015).

Table A2.4. Case Study 4: New York State Department of Health Public Health Review: New York, USA

	Area	Review: New York, USA
1	Project summary	This case study concerns a review of public health impacts from high volume hydraulic fracturing (HVHF) activities undertaken by New York State Department of Health (NYDOH) to determine whether the available scientific and technical information provides an adequate basis to understand the likelihood and magnitude of risks for adverse public health impacts from HVHF activities in New York State. The Public Health Review (PHR) was commenced in 2012 and the final report published December 2014.
2	Overview of the Health Impact Assessment (HIA)	The overall purpose of the PHR was to investigate and assess whether public health would be adequately protected from HVHF in New York State, although it was not a formal HIA.
3	The requirement for HIA	There was no statutory or regulatory requirement to carry out the PHR. In 2012, the New York State Department of Environmental Conservation (NYDEC) requested that NYDOH review and assess NYDEC's analysis of potential health impacts contained in NYDEC's draft supplemental generic environmental impact statement (SGEIS) for HVHF. In response NYDOH initiated the PHR.
4	Approach	Scope NYDOH reviewed how HVHF activities could result in human exposure to: • contaminants in air or water; • naturally radiological materials that result from HVHF activities; and • the effects of HVHF operations such as truck traffic, noise and social changes on communities. NYDOH also reviewed whether those exposures may result in adverse public health outcomes. The report does not refer to a stage of HVHF in particular, rather a holistic approach and review of the potential activity within New York state. The first stage of the PHR focused on understanding how public health concerns were addressed in the draft SGEIS. To assist with this process, three experts participated as consultants reviewed elements of the draft SGEIS and documentation developed by NYDOH. Following this review and broader consultation, it became clear to NYDEC that NYDOH's Public Health Review needed to extend beyond its initial assessment to consider more broadly the current state of science regarding HVHF and public health risks. The broader consultation included site visits and discussions with health and environmental authorities in states with HVHF activities and discussions with multiple local, state, federal, international, academic, environmental and public health stakeholders. NYDEC advised that this would also require an analysis of whether such information was sufficient to determine the extent of potential public health impact of HVHF activities in New York state and whether existing mitigation measures

	Area	**Review: New York, USA**
		implemented in other states are effectively reducing the risk for adverse public health impacts. Further to this, additional literature was reviewed and considered supplemental to the main PHR. More than 20 NYDOH senior Research Scientists, Public Health Specialists and Radiological Health Specialists contributed to the review. The entire PHR process involved more than 4500 hours of combined effort. In addition to evaluating published scientific literature, multiple discussions and meetings were held with public health and environmental authorities in several states to understand their experience with HVHF. They also engaged in a number of discussions and meetings with researchers from academic institutions and government agencies to learn more about planned and ongoing studies and assessments of the public health implications of HVHF.
5	Findings	The outcomes and impacts identified in the PHR were limited to activities associated with HVHF and to the impact of HVHF on the State of New York and its population in particular. The environmental impacts and health outcomes potentially associated with HVHF activities identified in the PHR included: • air impacts that could affect respiratory health due to increased levels of particulate matter, diesel exhaust, or volatile organic chemicals; • climate change impacts due to methane and other volatile organic chemical releases to the atmosphere; • drinking water impacts from underground migration of methane and/or hydraulic fracturing chemicals associated with faulty well construction; • surface spills potentially resulting in soil and water contamination; • surface-water contamination resulting from inadequate wastewater treatment; • earthquakes induced during fracturing; and • community impacts associated with boom-town economic effects such as increased vehicle traffic, road damage, noise, odour complaints, increased demand for housing and medical care, and stress. Health impacts that have been reported to be potentially associated with exposure to HVHF activities identified in the PHR include a variety of acute or self-limiting signs and symptoms such as skin rash or irritation, nausea or vomiting, abdominal pain, breathing difficulties or cough, nosebleeds, anxiety/stress, headache, dizziness, eye irritation, and throat irritation. Other outcomes that have been reported as potentially associated with HVHF exposure include low birth weight and some congenital defects. The PHR found that well-designed, long-term health studies assessing the effect of HVHF activity on health outcomes have not been completed, although there is published health literature that examines health outcomes in relation to residential proximity to HVHF well pads. The PHR demonstrates that there are significant uncertainties about the kinds of adverse health outcomes that may be associated with HVHF (e.g. the effectiveness of some of the mitigation measures in reducing or preventing environmental impacts which could adversely affect public health). In consequence, the PHR concludes: “While a guarantee of absolute safety is not possible, an assessment of the risk to public health must be supported by adequate scientific information to determine with confidence that the overall risk is sufficiently low to justify proceeding with HVHF in New York. The current scientific information is insufficient. Furthermore, it is clear from the existing literature and experience that HVHF activity has resulted in environmental impacts that are potentially adverse to public health. Until the science provides sufficient information to determine the level of risk to public health from HVHF and whether the risks can be adequately managed, HVHF should not proceed in New York State.”

	Area	Review: New York, USA
6	Outcomes	Following the publication of the PHR, New York's Governor banned hydraulic fracturing within the State of New York. It should be noted that the PHR was used in the decision making process. The PHR and subsequent ban was met with a mixed response from natural gas groups and environmental organisations, amongst others. The former argued that the state is denying its citizens economic growth while the latter argue that the financial benefits of exploration have been overstated. Significant methodological issues identified in the PHR included: • The science surrounding HVHF activity is limited, only just beginning to emerge, and largely suggests only hypotheses about potential public health impacts that need further evaluation. • An evaluation of the studies reveals critical information gaps. These need to be filled to more fully understand the connections between risk factors, such as air and water pollution, and public health outcomes among populations living in proximity to HVHF shale gas operations. • Well-designed, prospective, longitudinal studies that evaluate the overall effect of HVHF shale-gas development on public health outcomes are lacking. • The existing science investigating associations between HVHF activities and observable adverse health outcomes is very sparse and the studies that have been published have significant scientific limitations. • Nevertheless, studies are suggestive of potential public health risks related to HVHF activity that warrant further careful evaluation. • Additional population-based research and surveillance, and more studies involving field investigations in locations with active HVHF shale-gas development, would be valuable.
7	Key lessons	A number of lessons can be derived from this case study. These include • HIA can inform debate and decisions in respect of, in the first instance, whether to proceed with UGEE; and • there is a need to address information gaps including through well-designed, prospective, longitudinal studies that evaluate the overall effect of shale-gas development on public health.
8	References	New York State Department of Health (20140 A Public Health Review of High Volume Hydraulic Fracturing for Shale Gas Development. December 2014. Available online: http://www.health.ny.gov/press/reports/docs/high_volume_hydraulic_fracturing.pdf (accessed July 2015).

Table A2.5. Case Study 5: Lancashire County Council: HIA of proposed shale gas exploration sites: Lancashire, UK

	Area	Review: Lancashire, UK
1	Project summary	In Lancashire, England planning applications for temporary exploratory drilling, hydraulic fracturing and flow testing at two sites (Preston New Road near Little Plumpton and Roseacre Wood near Roseacre) were submitted by Cuadrilla to Lancashire County Council (LCC) in May 2014 and June 2014 respectively. LCC's Cabinet agreed that the Director of Public Health (DPH) would undertake a HIA of these proposals.
2	Overview of	The primary aim of the HIA was to inform the planning, environmental permitting

	Area	Review: Lancashire, UK
	the Health Impact Assessment (HIA)	and consenting process by LCC and the regulatory roles of the Environment Agency (EA), DECC and HSE respectively. The HIA was initiated on 8th May 2014 and published on 6th November 2014. The proposals in question were at the planning, environmental permitting and consenting stage when the HIA was carried out.
3	The requirement for HIA	HIA is not a statutory requirement under the onshore oil and gas planning and regulatory regime. However, health issues are generally considered as part of an environmental impact assessment (EIA), which can be required through the planning and environmental permitting processes (the EIAs undertaken by the developer in this case considered health impacts). In addition, there is also an opportunity to consider risks to human health as part of the environment risk assessment that is required by DECC before petroleum exploration and development licenses (PEDL) are issued. Under the Health and Social Care Act 2012, the County Council became responsible to protect and improve the public health and wellbeing of Lancashire residents. The role of the DPH is to provide expert advice and support to the County Council, the public and any other relevant body, with the aim of protecting and improving the health and wellbeing of the population. In this context, the DPH was requested by the Council's Cabinet to undertake a HIA of Cuadrilla's proposals.
4	Approach	The HIA followed the stages set out in The Merseyside Guidelines for Health Impact Assessment. These stages included: • Screening; • Scoping; • Appraisal; • Reporting; • Supporting decision-makers; and • Monitoring and evaluation. Screening was completed when LCC Cabinet decided to undertake a HIA of the two proposed sites initially. It was also agreed that this work would be supported by a Health Advisory Group (HAG), led by the DPH. Specialist, external consultant support was also sourced. In terms of the range of health issues considered and the receptors identified for this HIA, these included the human health impacts of the following topics: • Air quality; • Greenhouse gases; • Hydrogeology and gas; • Induced Seismicity; • Waste; • Transport; • Noise; • Water; and • Lighting. The HIA was completed by desktop review of existing information in addition to engagement with local residents and elected members.
5	Findings	The DPH concluded that the key risks to the health and wellbeing of the residents who live near the two proposed sites in Lancashire included: • lack of public trust and confidence, stress and anxiety from uncertainty that could lead to poor mental wellbeing;

	Area	Review: Lancashire, UK
		• noise related health effects due to continuous drilling, and • issues related to capacity for flowback waste water treatment and disposal. The findings from the HIA also suggested that whilst there might be benefits of shale gas exploration to the economy, there are also risks. The HIA made 45 recommendations to a broad range of agencies, suggesting actions before, during and after any permissions or permits are granted. 16 recommendations specifically sought to inform the determination of the planning applications. The HIA also noted that long term monitoring of environmental and health conditions was required in order to reassure communities and to understand cumulative and long term effects.
6	Outcomes	The HIA identified that risks are particularly prominent for residents living near the proposed sites due noise impacts. It recommended that the County Council undertook further noise assessment and in response, the County Council appointed specialist noise consultants to review the applicant's noise assessment, and to also undertake some background noise monitoring at night time. The Roseacre Wood application was subsequently rejected on the grounds that an increase in traffic would result in "an unacceptable impact" on rural roads and reduce road safety. Preston New Road, meanwhile, was rejected on the grounds of visual impact and unacceptable noise, although this was against the recommendation of the planning officer. The HIA identified that a limitation of the assessment was that it did not include a systematic review and a meta-analysis of all the emerging evidence. This was due to the time constraints in making the recommendations available within the period for the determination of the planning applications and environmental permits. One consultation response to the planning applications also claimed that the HIA was incomplete due to its limited focus on eight exploratory wells and stated that it should have included an assessment of projected county-wide industrial-scale activity.
7	Key lessons	A number of lessons can be derived from this case study. These include: • recommendations arising from HIA can usefully inform debate and decisions; • the need to involve key stakeholders and communities throughout the HIA process; • advisory groups can support the assessment process; • the need to ensure that HIAs reflect the most recently available information, research and data; • the need to ensure that there is sufficient time and resources available to complete a robust HIA; • independent HIA undertaken by a regulator can usefully assess the robustness of any assessment of health impacts undertaken by the developer; • the consideration of cumulative impacts with potential future activities is problematic, particularly at the project level; and • the need to ensure that monitoring protocols are established as part of the HIA process and which focus on the need to monitor conditions before, during and after activities;
8	References	Lancashire County Council (2014) Potential Health Impacts of the Proposed Shale Gas Exploration Sites in Lancashire. Available online: http://council.lancashire.gov.uk/documents/b11435/Potential%20Health%20Impacts%20of%20the%20Proposed%20Shale%20Gas%20Exploration%20Sites%20in%2

	Area	Review: Lancashire, UK
		0Lancashire%2006th-Nov-2014%2014.pdf?T=9 (accessed July 2015).

Table A2.6. Case Study 6: Cuadrilla Roseacre Wood and Preston New Road EIA: Lancashire, UK

	Area	Review: Lancashire, UK
1	Project summary	In Lancashire, England planning applications for temporary exploratory drilling, hydraulic fracturing and flow testing at two sites (Preston New Road near Little Plumpton and Roseacre Wood near Roseacre) were submitted by Cuadrilla to Lancashire County Council in May 2014 and June 2014 respectively. Both applications were subject to Environmental Impact Assessment (EIA) with the accompanying Environmental Statements (ES) considering effects in respect of the following topics: • Air quality; • Archaeology and cultural heritage; • Greenhouse gas emissions; • Community and socio-economics; • Ecology; • Hydrogeology and ground gas; • Induced seismicity; • Land use; • Landscape and visual amenity; • Lighting; • Noise; • Resources and waste; • Transport; • Water resources; and • Public health.
2	Overview of the Health Impact Assessment (HIA)	Cuadrilla commissioned Ove Arup and Partners Ltd (Arup) to undertake the EIAs and prepare the Environmental Statements (ESs) for both proposals. Whilst formal HIA was not undertaken by the developer (HIA was undertaken by the County Council), public health impacts were assessed within dedicated chapters contained in the ESs.
3	The requirement for HIA	The planning applications in respect of both proposals were submitted under the Town and Country Planning Act (1990) and the EIA was undertaken in accordance with the provisions of The Town & Country Planning (Environmental Impact Assessment) Regulations 2011 (EIA Regulations). The EIA regulations apply to two distinct and separate types of project: • Schedule 1 projects, for which EIA is required in every case; and • Schedule 2 projects, for which EIA is required only if the particular project is likely to give rise to significant environmental effects and meets the threshold criteria set out in planning practice guidance The proposed developments did not fall under the types of project described in Schedule 1, however, as they included deep drilling and surface facilities associated with gas extraction, they were classified as EIA development under schedule 2 paragraph 2(d) or Schedule 2 paragraph 2(e) of the EIA Regulations. The ESs were subsequently prepared in accordance with the EIA Regulations (which transpose the EIA Directive). In undertaking the EIA, relevant guidance was

	Area	**Review: Lancashire, UK**
		also followed including Department for Communities and Local Government (DCLG) (2006) Planning Practice Guidelines for Environmental Impact Assessment, Environmental Impact Assessment: A Guide to Procedures, IEMA (2004) Guidelines for Environmental Impact Assessment, Planning practice guidance for onshore oil and gas and guidance received from LCC and other published sources. The EIAs were undertaken under the provision of Part 2; 4(2) of the EIA Regulations. Although no formal screening opinion was sought by the developer, an EIA was carried out to ensure that the subsequent planning applications were compliant with the EIA Regulations and to ensure that decision makers had sufficient, robust environmental information on which to base their decisions.
4	Approach	The EIAs comprised the following key stages: • Scoping; • Collation and analysis of baseline data; • Assessment of effects; • Identification of mitigation and enhancement measures; • Identification of residual effects; • Assessment of cumulative effects; and • Production of an Environmental Statement and Non-Technical Summary. The purpose of the scoping stage was for the applicant to engage with the local planning authority and other consultees in seeking agreement on the scope of the EIA, and the approach to be adopted for the assessment of those topics included in the EIA. This was undertaken through consultation on a Scoping Report. A wide range of baseline data and information sources on the environmental conditions of the areas was subsequently gathered including from field survey information, data from statutory and non-statutory consultees, and published and unpublished literature. In accordance with the EIA Regulations, effects were then assessed on a topic-by-topic basis. The assessments considered the following principal project components/activities: • Installation and operation of seismic arrays and groundwater and ground gas monitoring wells; • Construction of well pad and access tracks; • Construction of fencing, drainage ditches, earth bunds and utility connections; • Drilling; • Hydraulic fracturing; • Initial flow testing; • Construction of equipment and pipeline connections to the gas grid; and • Decommissioning of the wells and restoration of the well pad. With specific regard to the assessment of health impacts, public health was not included as a specific topic in the Scoping Reports. However, the County Council's subsequent Scoping Opinions suggested that the ES includes a section that provides a signposts to all of the sections in the ES where health impacts have been assessed. This reflected PHE's response to consultation on the Scoping Reports which raised the following points: • Identification of where within the ES receptors that could be affected by health impacts are identified; • Highlighting where, within the ES, the impacts from construction and decommissioning have been assessed; • How potential health impacts relating to emissions to air and water have been assessed and where in the ES these are documented; • Specific issues concerning emissions to air;

	Area	**Review: Lancashire, UK**
		• Specific issues concerning emissions to water; • How potential health issues relating to land quality and contamination have been assessed; • How potential health issues relating to waste management have been assessed; • Other health related issues have been taken into account; • The organisations that have been consulted regarding health related issues during the EIA process. A specific appendix was included in the ESs signposting where (in the ESs) the points above were addressed. Additionally, a specific chapter of the ESs considered public health impacts. This included a community profile (identifying demographics, deprivation and health baselines) and assessment of health issues for the following topics: • Noise; • Water; • Perception effects; • Effects on community facilities and social networks; and • Physical activity. The assessments were principally informed by the detailed topic-specific assessments contained in other ES chapters. It should be noted that Roseacre Wood and Preston New Road were amongst the first onshore deep shale gas exploration sites in England to be subject to an EIA. Consequently, the level of detail within the baseline and the assessment of likely significant effects was perhaps greater than which might typically be produced for a temporary hydrocarbon exploration project. The scope of future EIAs is likely to be refined and the volume of information contained in the ES may be reduced.
5	Findings	The principal conclusions of the assessments in respect of health impacts are summarised below. Noise • The projects will not have significant noise effects on the nearest residential properties. Air quality • It was concluded that there is a negligible risk of contaminated dust being generated during construction. • There is a negligible to low risk of dust being generated during construction. • Emissions from site do not present a significant source of air pollution. • The levels of NORM (Naturally Occurring Radioactive Materials) emitted to the atmosphere by the projects do no present significant risk to health. • The levels of NO2 and benzene are well within the regulatory limits and therefore do not present significant risk to health. • The assessment for dust, NO2, PM10, PM2.5, benzene and NORM will not be significant. Surface water and groundwater • The risk of a pollutant linkage being created that could then impact on human health is negligible. Effects on community facilities, social networks and physical activity were scoped out of the assessments. A range of mitigation measures were identified in the ESs across the topic chapters that relate to human health.

	Area	Review: Lancashire, UK
6	Outcomes	A number of statutory consultees and other bodies referenced potential health impacts in their responses to the consultations on the planning applications. Specific criticism of the approach adopted by the EIAs included the need to consider and review the most recently available scientific evidence on health impacts. The Roseacre Wood application was rejected on the grounds that an increase in traffic would result in "an unacceptable impact" on rural roads and reduce road safety. Preston New Road, meanwhile, was rejected on the grounds of visual impact and unacceptable noise, although this was against the recommendation of the planning officer.
7	Key lessons	A number of lessons can be derived from this case study. These include: • EIA can be a useful tool for considering the health impacts of UGEE projects by drawing together assessments across a wide range of health determinants. However, this is dependent on health being scoped in as a specific topic; • nonetheless, there remains a risk that the full range of key health determinants are not fully considered - EIA generally focuses on significant environmental impacts and may be less well suited to consider the wider impacts of the proposed development on the health and wellbeing of the affected communities; • there is a need to scope any assessment of health including through consultation with health bodies, regulators and communities; • there is a need to consider all stages of the UGEE lifecycle in any assessment of health impacts; • assessment needs to take into account the most recently available scientific research concerning health impacts; and • there will be a need for longer term monitoring of health impacts.
8	References	Arup (2014) Temporary Shale Gas Exploration, Preston New Road, Lancashire: Environmental Statement. Available online: http://planningregister.lancashire.gov.uk/PlanAppDisp.aspx?recno=6586 (accessed June 2015). Arup (2014) Temporary Shale Gas Exploration, Roseacre Wood, Lancashire: Environmental Statement. Available online: http://planningregister.lancashire.gov.uk/PlanAppDisp.aspx?recno=6591 (accessed June 2015).

Table A2.7. Case Study 7: Battlement Mesa HIA (2nd Draft): Colorado, USA

	Area	Review: Colorado, USA
1	Project summary	In 2009, Antero announced plans to develop natural gas within the Battlement Mesa Planned Unit Development (PUD) including 9 well pads within the PUD as well as 3 other pads outside the PUD and a water storage and management system and pipelines. After Antero announced its intentions to drill within the Battlement Mesa PUD, community members expressed concern regarding potential environmental, health, and safety impacts. Citizen concerns included (inter-alia): • the proximity of drilling and gas production to homes, recreational areas, and schools; • the presence of "vulnerable" populations with diminished immune capacity;

	Area	Review: Colorado, USA
		• exposure to airborne volatile organic compounds (VOCs), diesel emissions, particulate matter (PM), and other air contaminants; • exposure to fluids used in the hydraulic fracturing process, hydrocarbons, and VOCs through soil or water exposure routes; • potential increased risk of fires, explosions and/or motor vehicle crashes; and • changes in community "livability". In November 2009, the Battlement Mesa Concerned Citizens (BCC) group submitted a petition to the Garfield County Board of County Commissioners (BOCC) requesting that BOCC require Antero to address health concerns before drilling for natural gas within the Battlement Mesa PUD. Alongside a range of actions taken by both the BOCC and Antero in response to community concerns (including community meetings, air quality monitoring and a study of water quality and hydrology), in May 2010 the BOCC engaged the Colorado School of Public Health (CSPH) to perform a HIA.
2	Overview of the Health Impact Assessment (HIA)	The CSPH worked closely with Garfield County Public Health (GCPH) to ensure that the scope of the HIA addressed the concerns outlined by the citizens in their letter to the BOCC as well as those voiced in public meetings. In addition to the GCPH, the CSPH also met with the Colorado Oil and Gas Conservation Commission (COGCC), the Colorado Department of Public Health and Environment (CDPHE), Antero, and the Colorado Hospital Association to ensure that all stakeholders with pertinent data and information had an opportunity to be involved in the HIA process. The BOCC expressed a desire for the HIA to be conducted by CSPH expeditiously, so that results could be available prior to permitting decisions. At the time, it was anticipated that Antero would submit the Major Land Use Impact Review (MLUIR) and Comprehensive Drilling Plan in late spring 2010 and that these documents would be available as part of the basis for the HIA. At the time of the HIA being published however, Antero had not submitted either document. Therefore, the CSPH used public meeting minutes, the Surface Use Agreement with the surface owners Battlement Mesa Company (BMC) and other information provided by Antero as sources for the report.
3	The requirement for HIA	There was no statutory requirement to undertake the HIA. The assessment was undertaken to address health concerns in advance of development activities.
4	Approach	The approach to the HIA was based upon guidelines provided by the Pew Health Impact Project, as well as those found in the Merseyside Guidelines for HIA and comprised seven stages: • scoping; • screening; • assessment; • recommendations; • implementation; • reporting; and • evaluation. The HIA was screened and scoped using information from a literature review, concerns raised by citizens, an earlier HIA as well as input from the BOCC, GCPH, CDPHE, COGCC and Antero. As a result, the HIA focused on eight areas of health concern (stressors): • air emissions; • water and soil contaminants;

	Area	Review: Colorado, USA
		• truck traffic; • noise/light/vibration; • health infrastructure; • accidents and malfunctions; • community wellness; and • economics/employment. The assessment of the stressors listed above was undertaken by identifying and defining seven attributes relevant to the importance of potential health effects: direction of potential health effects; the relationship of geography to health effects; the likelihood of health effects occurring as a result of Antero development plans; the presence of people considered especially vulnerable to the effects of the stressor; the estimated duration of exposure; the frequency of exposure when it does occur; and severity of the potential health effect. The assessment of each stressor included a review of its general impact on physical, mental and/or social health as described in relevant literature, a compilation and analysis of existing environmental and health data describing current conditions in Battlement Mesa, the means by which Antero plans for drilling might alter the current conditions, and finally a characterisation of the stressor's impact on health. Several physical health outcomes linked to potential exposures were considered, including respiratory, cardiovascular, cancer, psychiatric, and injury/motor vehicle-related impacts on vulnerable and general populations in the community. The HIA provided a relative rank for each stressor to help emphasise where the most important impacts may occur.
5	Findings	The HIA concluded that the health of the Battlement Mesa residents will most likely be affected by chemical exposures, accidents or emergencies resulting from industry operations and stress-related community changes. It found that: • chemical exposures would occur primarily through air emissions during well development activities; • increased truck traffic would be a safety risk to Battlement Mesa residents, contribute to increased air and noise pollution; and impact quality of life; • increased noise may be a problem for some residents, but mitigation efforts by Antero to bring noise levels below COGCC permissible levels would decrease the risk of health impacts; • the impacts to community wellness will in part be determined by the success of mitigation of other concerns, such as air emissions, traffic and noise; • it was unlikely that primary water supply for Battlement Mesa would be contaminated although efforts to monitor and protect the secondary drinking water supply are needed. Industrial accidents and malfunctions occur in the industry and are likely to occur in Battlement Mesa, although most are expected to be minor incidents; • opportunities for recreation could decrease; • decreased social cohesion and quality of life; • likely decline in property values; • the Antero project would provide benefits for some Battlement Mesa citizens including jobs, increased economic activity for local businesses, including health clinics. By ranking the stressors, CSPH concluded that air quality impacts were likely to produce significant negative health impacts to residents throughout the community. Other stressors that may produce relatively significant health impacts included traffic and noise. The compromise of water supplies could produce significant effects to health but were considered not likely to occur.

	Area	**Review: Colorado, USA**
		The HIA made 70 recommendations to the BOCC to help it address and mitigate some of the impacts of the Antero plan, though it was not deemed possible to mitigate all of the impacts identified.
6	Outcomes	The HIA highlights that there are numerous gaps in information that limited the evaluation and may limit future evaluations of health in Battlement Mesa. Recommendations intended to address some of these gaps were provided in the HIA with the intention being that some of these gaps would be addressed in an environmental health monitoring study (EHMS) to be developed by CSPH investigators. This long term study during the lifecycle of the Antero project was intended to: • further characterise air emissions associated with natural gas production; • characterise air emission exposure levels for persons living in close proximity to natural gas production; • further characterise emission sources during development and production phases; • develop methods to characterise surface and ground drinking water contamination; • conduct health surveillance of residents in areas impacted by natural gas and in similar comparison populations not affected by natural gas development and production; • conduct social and community health surveillance of areas impacted by natural gas development and production; and • conduct studies to investigate health effects of ambient air quality on the general population. However, it is understood that the CSPH contract was terminated before the HIA was completed (the current status of the longer term EHMS is not known), a decision met with a mixed response from residents and the developer. Antero never drilled within the PUD and eventually sold their Piceance Basin natural gas assets to Ursa in 2012. In the summer of 2015, Ursa filed a proposal with Garfield County to drill 53 wells from two pads in the residential community near Parachute. It is not currently known what role, if any, the HIA/EHMS will play in this context.
7	Key lessons	A number of lessons can be derived from this case study. These include: • scoping, informed by robust baseline information, can help to focus the HIA on those issues that are most prevalent to potentially affected communities; • assessment should draw on, where possible, information provided by developers in addition to monitoring at existing sites; • there is a need to involve a wide range of stakeholders in the HIA process including developers, communities and health bodies; • ranking systems and criteria can be used to highlight the most significant risks; • information gaps are likely to require ongoing health monitoring and assessment during UGEE activities; • HIA can become resource intensive and extend over a long time frame; • if proposals are delayed there is a danger that any HIA may become outdated/not utilised effectively.
8	References	Colorado School of Public Health (2011) Draft Battlement Mesa HIA (2nd Draft). Available online: http://www.garfield-county.com/environmental-health/battlement-mesa-health-impact-assessment-draft2.aspx (accessed June 2015). The Aspen Times (2011) Garfield County commissioners terminate Battlement

	Area	Review: Colorado, USA
		health assessment. Available online: http://www.aspentimes.com/article/20110503/NEWS/110509946 (accessed June 2015). Western Colorado Congress (2015) Ursa plans drilling within Battlement Mesa. Available online: http://wccongress.org/wcc/2015/07/02/ursa-plans-drilling-within-battlement-mesa/ (accessed July 2015).

Appendix 3 Public Participation Case Study Reviews

Table A3.1. Case Study 1: ExxonMobil, Germany

	Area	Review: **ExxonMobil, Germany**
1	Project summary	ExxonMobil commissioned a panel of scientists to prepare a review into the environmental and public health implications of hydraulic fracturing in Germany. The engagement process was in response to public concern about the process of hydraulic fracturing with the intention of alleviating those concerns through thorough scientific investigation and reasoning. The process involved consultation with a wide range of stakeholders on a national basis although scenarios were focused around North-West Germany. The two year, scientific process was carried out so to inform the process of hydraulic fracturing as a subject rather than a development specific consultation.
2	Geographic and temporal scale of consultation	Hydraulic fracturing is widely practised in various regions of the USA, but media reports concerning earthquakes, contaminated waterbodies and groundwater, and flammable methane in drinking water wells raised concerns among German citizens, politicians, and water companies that hydraulic fracturing may be harmful to natural resources and in particular drinking water. These developments prompted ExxonMobil to instruct a panel of external experts (mainly academics) to conduct a scientific analysis and assessment (from April 2011 to April 2012) within the framework of ExxonMobil's hydraulic fracturing dialogue and information dissemination process to investigate health and environmental aspects of hydraulic fracturing as used for natural gas production from unconventional natural gas reservoirs. The process was held on a national scale, although ExxonMobil's hydraulic fracturing activities centred on the North-West regions of Lower Saxony and North Rhine-Westphalia. The investigations centred on whether, and under which circumstances, hydraulic fracturing is compatible with the needs of public health and environmental safety.
3	Target consultees	The consultation project was led by Prof. Dr. Dietrich Borchardt from the Helmholtz Centre for Environmental Research and facilitated by Dr. Christoph Ewen of Darmstadt University and consultant Ruth Hammerbacher. The study brought together a core group of eight scientists, as well as 35 other scientists at various stages of the study. The study experts were tasked with assessing the safety and environmental risks and effects of hydraulic fracturing. The results of the study were covered a number of potential risks of hydraulic fracturing examined including emission output, groundwater contamination and seismic events. The panel began their work by compiling numerous questions that German citizens, municipalities and water companies had asked on the subject of hydraulic fracturing and natural gas. Simultaneously they compiled and evaluated current knowledge on the subject and also added their own publications. The panel travelled to the USA to see the potential effects of hydraulic fracturing and talk to the people affected and the relevant, competent authorities. As a final step, the panel asked recognised German and foreign experts to assess the study design and the scientific quality of the work they had carried out thus far. On numerous occasions, the panel discussed their methodology and interim results with stakeholder working groups whose members were representatives of water companies, municipalities amongst others. These meetings aimed to ensure that the study focused on practical issues and on the concerns of people in the region affected. Without this process, it was felt that the issues that they focused on would have been different and some matters of concern may only have been explored at a superficial level. The dialogical process promoted debate on the matters addressed in this study and ensured that it was based on solid scientific foundations. The engagement process found that when hydraulic fracturing demonstration and exploration activities are carried out, the relevant local groups and political figures should be invited to participate in the process in the interest of transparency and to ensure that concerned citizens' desire to keep the noise, traffic, lights and vibrations associated with hydraulic fracturing to a minimum be addressed.
4	Project context	A significant share of domestic gas production comes from hydraulic fractured wells (including many of ExxonMobil's), and, as the state's mining authority has previously noted, environmental damage has never been recorded. Initially hydraulic fracturing was a technology only discussed in specialist circles – with some exceptions. In 2006, ExxonMobil

	Area	Review: **ExxonMobil, Germany**
		opened a new gas reservoir through hydraulic fracturing, ExxonMobil received a high-profile "Germany – Land of Ideas" award for this project. It has been estimated that there is between 700–2300 billion cubic metres of shale gas in plays in Germany which will require hydraulic fracturing to retrieve it. Development of this resource will create much involve much greater volumes use of hydraulic fracturing than currently experienced. In early 2011, ExxonMobil initiated an information and dialogue process on the potential risks and environmental impact of unconventional gas production, as a response to widespread public opposition to its exploration activities in North-Western Germany. An extended summary version of the "Risikostudie Fracking" (study of hydraulic fracturing risks) was presented during the final conference on April 25, 2012, in Osnabrück, Germany.
5	Purpose of consultation	ExxonMobil committed substantial resources to an extensive and openly publicised participatory stakeholder consultation process, combined with a "neutral" risk assessment study of hydraulic fracturing. ExxonMobil intended to develop ideas to provide a higher level of transparency, working with information and argumentation to educate the public, and make concessions to the greater political demand for responsible operations. ExxonMobil committed to educational efforts and to be open and communicative about public acceptance problems. It was incumbent upon the process, as well as the competent regulatory authorities, to ensure that key information was provided during all participatory processes. A key component of the consultation project was the concept of an independent and neutral panel of experts from different disciplines, who were formed to investigate potential risks of hydraulic fracturing for inclusion in a final report. For objectivity, the experts selected had not worked for ExxonMobil or in the natural gas industry before. ExxonMobil representatives observed the process but, for the most part stood out of the way. Some company engineers and scientists answered specific questions at the opening and end of the process, but overall ExxonMobil kept a low profile. Certain passages of the report explicitly explored the following question: What changes would be produced in, say, a 200 square kilometre area if hydraulic fracturing were being carried out throughout that area by the year 2030? The information and dialogue process was led by a panel of eight leading experts from German research organisations who worked on a broad spectrum of questions related to the environmental and health risks of hydraulic fracturing. The experts were selected very carefully on the basis scientific expertise, independence from the natural gas industry and from ExxonMobil. The investigation process helped inform regional discussion forums (e.g. one each for shale gas and coal-bed methane), that were focused on the following: • avoiding uncontrolled spatial industrial development; • the regional impact of hydraulic fracturing on the economy; • water use; • wastewater disposal; and • the protection of groundwater, thermal springs, and mineral water resources. The monitoring investigation recommendations took account of short term impacts and long term management. In terms of the latter, it was recommended that, gas companies, government authorities, and the relevant stakeholder groups should establish an arbitration panel, modelled on the type used in Germany's coal mining industry, that would be empowered to rule on disputes concerning environmental damage, property damage and other untoward effects of hydraulic fracturing. In addition, the monitoring process should be designed, defined, accompanied and evaluated via a social dialogue on the aspects of hydraulic fracturing including, but not limited to: seismic events; groundwater quality; methane emissions; flowback water; hydraulic fracturing fluids; water resource management; chemical pathway analyses; gas well and gas pipeline integrity; and the structural integrity of buildings located in the environs of hydraulic fracturing sites.
6	Regulatory requirements	The case study was undertaken on a voluntary basis and therefore did not have to meet any regulatory requirements. As part of the process a review of general regulations was undertaken which encompassed multiple German authorities and applicable laws, such as the federal mining law, state mining regulations, and various environmental regulations.

	Area	Review: **ExxonMobil, Germany**
7	Consultation method	ExxonMobil developed ideas regarding consultation on hydraulic fracturing with the intention of providing a higher level of transparency, using information to educate stakeholders and consultees and make concessions to the greater political demand for responsible operations. The relationship between the panel and ExxonMobil was noted for the openness to investigation and discussion of the risks in one of its key business areas. The panel were impressed by how thoughtfully and seriously ExxonMobil reacted to questions about hydraulic fracturing, which also opened up new perspectives for the company. The project was split into three sections; "knowledge and science', "speaking and influencing" and "questioning and commenting'. The project lasted a year with further correspondence and debate continuing once the final report was published. The analysis focused on worst-case scenarios, i.e. events that are extremely unlikely to occur, for example: continuous underground fault zones that neutralise the compression effect of geological barriers; critical underground tectonic stress that could potentially damage a hydraulic fracturing well; accidents; technical failures; and human error. Numerous dialogue meetings with stakeholder groups were held regarding how generally applicable assertions can be arrived at and specific locations can be assessed. In their final analysis, assessments and calculations were carried out for real-world locations and scenarios. One of the project objectives was to elaborate criteria and procedures that are applicable for the greatest possible number of locations. As part of this objective, they developed models based on the geological conditions in North Rhine-Westphalia and Lower Saxony, in the North East of Germany, and factored into these models a range of possible effects using characteristic scenarios. The project was subject to scientific peer review. The work was publicised and observed with a critical eye from a working group consisting of various social actors including community leaders, water utility representatives, farmers' associations, citizen groups and clerics and religious community representatives. They worked with the experts, collecting and formulating questions which the scientists would try to answer and later debate with the other stakeholders.
8	Evaluation of consultation	The evaluation was based on a telephone interview with the project lead, Dr Borchardt. He made the following points: • It was important to use experienced professionals in consultation and moderation to plan and deliver the process and to manage stakeholders. They needed to be accepted by all and needed to be advocates of the process rather than the subject matter or specific points of view. Industry and public authorities do not always have these skills. • Stakeholders were mapped across all areas. In addition, the relationships and any hidden agendas and history between stakeholders was established. This was important to enable avoidance of conflicts based on past experiences/existing relationships. It was important to avoid the subject becoming a surrogate for historical conflicts. • One group of stakeholders cannot be prioritised over another to ensure a balanced approach. • It was important to agree on the issues as a first step before their evaluation was carried out. • Pre-consultation was important as it enabled issues of concern to be identified and stakeholders to gain ownership over, and commitment to the process. • The timescale of two years was about right. Year one focussed on information, i.e. what do you want to know, what are the technical and environmental aspects. Year two focussed on evaluation. • All processes used were good. Used small groups for debate. The exact format used was demand driven, hence group sizes were flexible and responsive to stakeholder needs. • An open stage peer review event was particularly useful. This examined the science and advisory groups' work and allowed debate on the technical evidence. • It is estimated that 90% of the recommendation made are now in the draft law which is currently in development at Federal level (unconventional gas extraction law) that should be determined in autumn 2015.

	Area	Review: **ExxonMobil, Germany**
9	Key references	Hydrofracking Risk Assessment (ExxonMobil report) – http://dialog-erdgasundfrac.de/sites/dialog-erdgasundfrac.de/files/Ex_HydrofrackingRiskAssessment_120611.pdf Journal of European Management and Public Affairs Studies – https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=9&ved=0CFsQFjAI&url=https%3A%2F%2Fopus4.kobv.de%2Fopus4-th-wildau%2Ffiles%2F281%2F23-137-1-PB.pdf&ei=O-qHVf6_FMy3sQHXi4CoCQ&usg=AFQjCNHQ_h2Z7GMqOww00dmUOFjTke95-A&bvm=bv.96339352,d.bGg Hydraulic Fracturing (ExxonMobil website) – http://corporate.exxonmobil.com/en/technology/hydraulic-fracturing

Table A3.2. Case Study 2: Consultation of the Strategic Environmental Assessment (SEA) of the 14th gas licensing round: UK

	Area	Review: SEA, UK
1	Project summary	The UK Government's Department of Energy and Climate Change (DECC) is responsible for administering the oil and gas licensing system in the UK. The licences give exclusive rights to explore for, and exploit, hydrocarbons within a specific area (block). Applications for licences are invited in rounds, when a large number of blocks are released and bids invited. Licences allow developers to seek conventional oil and gas exploration and production; unconventional oil and gas exploration and production; and natural gas storage in hydrocarbon reservoirs. DECC carried out SEA for further onshore oil and gas licensing for unlicensed areas in parts of England, Scotland and Wales (hereafter referred to as "the Licensing Plan') between 2009 and 2014. The purposes of the SEA of the Licensing Plan were to: • identify and quantify the potentially significant environmental effects of the Licensing Plan including alternatives; • help identify appropriate measures to avoid, reduce or manage adverse effects and to enhance beneficial effects associated with the implementation of the Licensing Plan wherever possible; • give the statutory SEA bodies, stakeholders and the wider public the ability to see and comment upon the effects that the Licensing Plan may have on them, their communities and their interests, and encourage them to make responses and suggest improvements to the Licensing Plan; and • inform the UK Government's decisions on the Licensing Plan. Following consultation on a revised SEA Environmental Report between December 2013 and March 2014, the licence bidding process commenced in July 2014. The bidding process closed in late October 2014 and DECC are now assessing licence applications.
2	Geographic and temporal scale of consultation	A formal SEA scoping exercise was conducted by DECC in September 2009 and an additional phase of scoping was initiated in April 2010 in order to consider additional blocks for inclusion in the SEA. DECC published an initial Environmental Report in July 2010 and consulted on it for a period of 12 weeks. However, following two seismic events in Lancashire in 2011, caused by hydraulic fracturing for shale gas at Preese Hall near Blackpool, DECC suspended all hydraulic fracturing operations for shale gas pending an investigation. Work on the SEA was also suspended. As part of the announcement by the then Secretary of State for Energy and Climate Change ending the suspension, it was confirmed that work on the SEA would be recommenced. This included revision of the Environmental Report to ensure it reflected the latest information on potential effects, including learning from the events in 2011; and a fresh public consultation. • Following resumption of the SEA process, consultation on a revised Scoping Report was undertaken over a 6 week period between July and August 2013. This was followed by public consultation on a revised Environmental Report between December 2013 and March 2014 (a consultation period of fourteen weeks). A Post Adoption Statement was published in July 2014 alongside the Government's

	Area	Review: SEA, UK
		announcement of the start of the bidding process.
3	Target consultees	At the initial (2009/2010) scoping stage, consultation was undertaken with statutory consultees for England, Scotland and Wales – Natural England, the Environment Agency, English Heritage (now Historic England), Countryside Council for Wales and Environment Agency Wales (now Natural Resources Wales), Cadw, Scottish Natural Heritage, Historic Scotland and the Scottish Environment Protection Agency. A wider public consultation was subsequently undertaken on the initial (2010) Environmental Report. Following resumption of the SEA process, consultation was again undertaken with UK statutory consultees (as above but also including the Welsh Government, Scottish Government and Department of the Environment's "Environment and Heritage Service', Northern Ireland) as well as other bodies who submitted a specific request to the Secretary of State seeking involvement in the SEA process (Royal Society for the Protection of Birds, Friends of the Earth, World Wide Fund for Nature and Greenpeace). Public consultation was subsequently undertaken on the revised (2013) Environmental Report.
4	Project context	The main objectives of the Licensing Plan are to enable a further contribution towards the comprehensive exploration and appraisal of UK oil and gas resources and the economic development of identified reserves, together with enabling further gas storage capacity in hydrocarbon reservoirs, without compromising the biodiversity, ecosystem functioning and the interests of nature and heritage conservation, and other material assets and users. SEA is a statutory requirement under the European Union Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment and is incorporated into UK law in The Environmental Assessment of Plans and Programmes Regulations 2004 (the SEA Regulations). The objective of SEA, as defined in Directive 2001/42/EC is: "*To provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to contributing to sustainable development*." Case law has established that oil and gas licensing rounds are plans or projects for the purpose of the SEA Directive. Unusually (in the context of SEA), there was no formal Licensing Plan that could be assessed or issued for consultation (the Licensing Plan is in effect the plan to hold a landward licensing round, inviting applications for oil and gas licences in certain areas of England, Scotland and Wales, so far as not already licensed). The SEA of the Licensing Plan was, therefore, undertaken by assessing those potential activities that could follow on from the licensing round and which may have environmental effects. Specifically, the assessment considered, for conventional oil and gas, shale gas and oil, virgin coalbed methane and gas storage in-turn, the effects associated with the key stages in the exploration and production lifecycle using low and high activity scenarios. As there was no formal plan or document that was subject to consultation (unlike, for example, consultation on land use plans), the SEA became the principal consultation vehicle/document.
5	Purpose of consultation	Consultation undertaken at the scoping stage principally sought views on the proposed approach to the assessment as well as baseline information, key environmental issues and a review of other relevant plans and programmes. The findings of the consultation were taken into account in amending the approach to the assessment and in undertaking the assessment of the Licensing Plan contained in the Environmental Report. Consultation on the Environmental Report sought in particular responses to the following questions: • Whether the Environmental Report identified the significant environmental effects of the activities that could follow the licensing round. If not, what other significant effects were identified for inclusion. • Whether consultees agreed with the conclusions of the Environmental Report and the recommendations for avoiding, reducing or off-setting significant effects of the activities that could follow the licensing round. Whether consultees agreed with the proposed arrangements for monitoring the significant effects of the activities that could follow the licensing round, as detailed in the Environmental Report.
6	Regulatory	Regulation 12 of the SEA Regulations requires that consultation is undertaken with the

	Area	Review: SEA, UK
	requirements	statutory SEA bodies on the scope of the SEA for a period of 5 weeks. This consultation is normally undertaken by way of the preparation of a Scoping Report, although this is not a specific requirement. Regulation 13 requires that the draft plan or programme to which the SEA relates and the Environmental Report are made available to the statutory SEA bodies, other stakeholders and the public for comment. Regulation 13(3) requires that the consultation must be of such length as will ensure that the consultation bodies and the public consultees are given an effective opportunity to express their opinion on the relevant documents. Following consultation on the draft plan and Environmental Report, and as soon as reasonably practicable after the adoption of a plan or programme, Regulation 16 requires that the responsible authority prepares a Post Adoption Statement setting out (inter-alia) how consultation responses have been taken into account.
7	Consultation method	Consultation on the revised scope of the SEA was undertaken on a Scoping Report that was issued to the statutory consultees and other bodies for comment. A meeting was also held during the consultation to which all consultees were invited to discuss the approach to scoping. In support of consultation on the revised Environmental Report, DECC used a specific consultation website (as part of the wider GOV.UK website) that included an online survey comprising the key consultation questions which enabled DECC to monitor responses as they were received as well as the Environmental Report, a Non-Technical Summary (as required by the SEA Regulations) and, additionally, a two page synopsis which provided a brief overview of the key findings of the assessment. During the consultation period, four workshops were held with consultees to discuss the findings of the revised Environmental Report and support consultees in making responses to the consultation questions. Those consultees who attended the workshops included industry representative (UK Onshore Operators Group, eCorp, Celitque, Reach CSG, Egdon, Cuadrilla), the statutory SEA bodies (Natural England, English Heritage and the Environment Agency), NGOs and campaign groups (National Trust, Royal Society for the Protection of Birds, Countryside Alliance and the Campaign to Protect Rural England), local authorities (Bath and North East Somerset Council, Lancashire County Council, Somerset County Council and South Downs National Park) and other Government departments (Department for Environment, Food and Rural Affairs, Department for Communities and Local Government and the Health and Safety Executive). To launch the consultation, a press release was published and a national press/media briefing held which received widespread coverage. At the commencement of the licensing round, a further press release was issued alongside the official invitation in the Official Journal of the European Union and publication of the Post Adoption Statement on DECC's website. In accordance with SEA Regulations, those consulted on the Environmental Report were also notified of the Licensing Plan's adoption.
8	Evaluation of consultation	Detailed responses to the revised scoping consultation were received from 11 consultees. These were used to inform the approach to the assessment of the Licensing Plan and ensure buy-in to the assessment process. In this regard, the meeting with consultees during the scoping consultation period was considered to be a useful opportunity to explain the context to the Licensing Plan and the proposed approach to the SEA. In particular, the meeting facilitated discussion in respect of the approach to the SEA, helping to address concerns/issues early and gain agreement where possible on a revised approach. However, the United Kingdom Onshore Operators Group expressed disappointment that industry representatives were not involved at the scoping stage. The four workshops held with consultees to discuss the findings of the revised Environmental Report also provided a useful opportunity to discuss early and in detail the findings of the SEA and to understand the views of different stakeholder groups, enabling consultees to make informed responses. Similarly, the public briefing and publication of the two page synopsis helped to distil the key messages of what was a report in excess of 1000 pages and avoid, to an extent, misinterpretation.

	Area	Review: SEA, UK
		There was an unusually high level of media interest in the assessment (reflecting in part the public concerns in respect of UGEE projects/operations) and at the end of the consultation period on the revised Environmental Report, a total of 2419 responses were received. This suggests a high degree of engagement and interest in the assessment. Of the responses received, 2367 were from individuals including one MP, with the remaining 52 being submitted from organisations in the following categories: • Statutory SEA bodies • Other Government bodies • Local authorities • Industry • NGOs and campaign groups A total of 1342 direct email responses to the Department reflected an organised campaign by an NGO to oppose any further onshore unconventional oil and gas activity. These responses were essentially identical and did not address the questions posed in the consultation. The views from these respondents were clear that they did not want any further licensing activity to take place. A further 1029 responses included two separate campaign group responses (one comprised of 346 duplicate responses and the other 49 duplicate responses). The majority of respondents disagreed with the findings of the Environmental Report, but the consultation helped to raise wider awareness of the issues associated with UGEE operations and projects and of the potential measures that can be used to minimise negative effects and enhance positive effects. In this regard, responses from industry suggest that it intends to explore further some of the measures identified in the SEA. Key learning points arising from the case study are: • UGEE projects/operations are controversial and are likely to attract widespread public (including media) interest. • There is a need to ensure that consultation is wide-reaching and transparent and careful consideration should be given with regard to who to engage, how and when. • UGEE projects/operations and associated impacts may not be well understood by some stakeholders and the public. There is the potential for misinformation. Careful consideration should be given to how information is presented so that it is easily accessible and understandable. • Summarising the findings of any detailed and extensive assessment in short and accessible documents can help widen understanding and take up by stakeholders and the media. • On-line web based questionnaires are a useful tool to collate responses to any identified key questions. • Meetings and workshops are a useful tool to help explore in detail stakeholder concerns, gather evidence, address any misconceptions and gain consensus. Feeding back the outcomes of the consultation process is important.
9	Key references	Amec Environment and Infrastructure UK Ltd (2013) Strategic Environmental Assessment for Further Onshore Oil and Gas Licensing: Environmental Report. Available online: https://www.gov.uk/government/consultations/environmental-report-for-further-onshore-oil-and-gas-licensing (accessed June 2015). Amec Environment and Infrastructure UK Ltd (2013) Strategic Environmental Assessment for Further Onshore Oil and Gas Licensing: Post Adoption Statement. Available online: https://www.gov.uk/government/consultations/environmental-report-for-further-onshore-oil-and-gas-licensing (accessed June 2015). DECC (2010) Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds: Environmental Report. Available online: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66721/onshore-er.pdf (accessed June 2015). DECC (2014) Oil and gas: Licensing rounds. Available online: https://www.gov.uk/oil-and-

	Area	Review: SEA, UK
		gas-licensing-rounds#th-landward-licensing-round (accessed June 2015).

Table A3.3. Case Study 3: Cuadrilla – Roseacre Wood and Preston New Road: Lancashire, UK

	Area	Review: Roseacre Wood and Preston New Road, Lancashire, UK
1	Project summary	Cuadrilla have two proposals in the UK currently; Roseacre Wood and Preston New Road, Lancashire. Before they were submitted to the Local Planning Authority (LPA), both of these proposals were consulted upon, using a variety of consultation methods as the project developed. The Environment Agency announced on 16th January & 6th February 2015 that it had granted Cuadrilla the environmental permits for the proposed shale gas exploration site at Preston New Road and Roseacre Wood respectively. A decision on the planning application was made in June 2015, when permission was refused.
2	Geographic and temporal scale of consultation	Public consultation was separated into four stages to influence the development of the planning application. These stages include: • an overview of exploration and an introduction to Environmental Risk Assessment; • update on project progress and Environmental Risk Assessment; • the announcement of exploration sites and outline of planning and Environmental Impact Assessment process; and • presentation of emerging findings from the Environmental Impact Assessment for the exploration site. It was proposed that consultation and engagement would be on-going with stakeholders and the local community through the decision making process and should planning permission be granted, through construction, operation and site restoration. This will involve further meetings with the community liaison group and other initiatives such as the community information line, enquiries email address and proposals to trial residents' surgeries. Cuadrilla committed to on-going written communications, newsletters and website updates. The consultation period and time to determine was enforced by planning regulations.
3	Target consultees	During the pre-applications consultation process, Cuadrilla consulted with a range of stakeholders including the local community, Parish Councils, other local representatives and several national and technical stakeholders including the Environment Agency. This engagement included statutory and non-statutory consultees and discussions were in relation to the planning applications, the exploration works and monitoring works. As well as hosting the stakeholder workshops as part of the on-going consultation process, additional engagement was also undertaken with specific stakeholders as part of the technical EIA work streams.
4	Project context	The project was set within the regulatory requirements of the English planning application process. This process facilitated public consultation around hydraulic fracturing in a structured and regulated framework which allowed open discussion and consultation with a wide range of statutory and non-statutory stakeholders. Hydraulic fracturing is a new technology and process in the UK. The consultation process offered a structured process for interested parties to voice their concerns.
5	Purpose of consultation	Consultation was carried out to influence the design of the proposal. Cuadrilla sought to engage consultees in developing the design of the two projects whilst also informing interested parties about the development. For both applications, a Statement of Community Involvement (SCI) and appendices for the Environmental Statement (ES) were produced and information on the planning application and the response to consultation was published. Any feedback received as part of the pre-application consultation was assessed and reported within the Statement of Community Involvement that was submitted as part of the planning applications. Early involvement in the consultation process with those affected by the development allowed opportunities and issues to feedback into the project. Consultation ensured the public understood the implications of the project, which enabled misunderstandings to be resolved, in addition to obtaining information regarding potential impacts from consultees and potential mitigating measures to be considered.

	Area	Review: Roseacre Wood and Preston New Road, Lancashire, UK
		The purpose of the pre-application consultation programmes was to: • engage with the local community about the planning applications, the proposed processes to be undertaken and the timescales for these, and to help inform the planning applications, Environmental Impact Assessment (EIA) and Environmental Risk Assessment (ERA) • address any issues or concerns that may be raised by the local community or stakeholders regarding the applications and answer their questions.
6	Regulatory requirements	Consultation and stakeholder engagement were required for the planning application and the EIA. The Planning and Compulsory Purchase Act 2004 required each local planning authority to prepare a SCI. The SCI set out how the community and other stakeholders should be involved in shaping policies and the determination of planning applications and ensure all sections of the community and stakeholders play an active role in influencing the long-term spatial vision and objectives for the LPA. The SCI describes the engagement that has been undertaken in connection with the sites and wider consultation associated with the shale gas exploration programme, which was undertaken prior to this date. Cuadrilla's pre-application consultation process was undertaken in accordance with best practice and Government guidance. Extensive consultation was undertaken with a large number of stakeholders and the local community. This engagement has sought to encourage dialogue through an open and transparent process. The feedback received influenced the approach to the design of the site, technical work, assessments and the mitigation proposed. The SCI encouraged open and constructive pre-application discussion as an opportunity for LPAs and the developer to work together in order to establish the information required for proper consideration of the application. These discussions also provided an opportunity to identify key issues that the applicants' proposal should take into account.
7	Consultation method	Consultation activities included; workshop events; parish council meetings; dedicated phone line; newsletters; brochure; engagement with key bodies; day event and exhibition; physical model; animations; and online information. These activities were used throughout the project development stage leading to the planning application submission. From early 2011, Cuadrilla undertook a significant amount of stakeholder and community engagement. All of the aforementioned activities were accompanied by a thorough and continuing programme of community engagement. Cuadrilla's consultation plan consisted of the following headers and related actions: • identify – Site specific stakeholder mapping to ensure all relevant affected community stakeholders are identified and engaged through the consultation process; • sign off – A consultation strategy developed in discussion with LCC planning officers and appropriate local political stakeholders; • notify and inform – Clear communication tools for engaging with community stakeholders identified and used to inform those affected about the consultation process and how they can respond; • consult – a detailed consultation programme/timeline developed which identifies the various consultation tools and events that will be used • measure – defining the means by which people can feedback their views to Cuadrilla during the consultation process and the questions they will be asked. This will determine how the response to the consultation process is measured; • respond – a protocol agreed for responding to comments received during and after the consultation process with agreed methods of communication; and • report and publish – consultation reports prepared and submitted to LCC to accompany each planning application. All reports will be published and a programme agreed for communicating outcomes of the consultation process to local stakeholders. As part of their consultation, Cuadrilla established a Community Liaison Group (CLG) for the proposed exploration site at Preston New Road and Roseacre Wood. They invited local people to take part in a CLG to provide a link between Cuadrilla and interested

	Area	Review: Roseacre Wood and Preston New Road, Lancashire, UK
		parties. The membership includes elected representatives, local residents, business people and third-party stakeholder groups. Members of the CLG decided how the group met and worked and agreed that minutes of their meetings along with their membership, would be published online. The CLG is independent of Cuadrilla and provided an opportunity for dialogue between the company and the local community. Meetings encouraged discussion and allowed members to raise issues with Cuadrilla, obtain feedback and understand the views of the local community as the proposal progressed. The CLG provided a forum for Cuadrilla to inform interested parties about various aspects of the proposal including: the public engagement and consultation programme; the refinement of the proposal; its progress through the planning system; ultimately, should planning permission be granted, the operation of the site; and forum for the local community to describe or explain issues, questions or concerns and access or secure swift and specific responses. While the CLG did not have any decision-making powers, it could make recommendations to Cuadrilla for its consideration. The CLG looked to secure maximum mutual benefit to the company and the community through: better understanding the views of local communities in a structured way; finding opportunities to develop the CLG's understanding of Cuadrilla's operations through presentations from third parties and site visits; ensuring there is a mechanism to address the comments and concerns raised by the CLG; and freely feeding back the CLG's discussions and conclusions to the local community.
8	Evaluation of consultation	The timing and scale of consultation employed by Cuadrilla followed the legislation and regulation relating to the planning application process and the Environmental Impact Assessment they carried out for both of the sites. This suggests minimum standards were employed by Cuadrilla with regard to consultation but they did expand upon these requirements with extended consultation periods and on-going engagement – it was proposed that consultation would continue through to construction if they were granted planning permission. Cuadrilla engaged with both statutory and non-statutory stakeholders during their consultation process through meetings and workshops. Consultation was structured by the relevant regulations although the use of alternative structures, such as the CLG, highlights the importance of stakeholders to Cuadrilla in this process. No evaluation of the process was located. Cuadrilla declined to participate on a discussion of process evaluation when contacted.
9	Key references	Roseacre Wood webpage http://www.cuadrillaresources.com/our-sites/locations/roseacre-wood/ Preston New Road http://www.cuadrillaresources.com/our-sites/locations/preston-new-road/ Lancashire Council's planning register (LCC/2014/0096, LCC/2014/0097, LCC/2014/0101 & LCC/2014/0102) http://planningregister.lancashire.gov.uk

Table A3.4. Case Study 4: Dart Energy, Falkirk and Stirling, Scotland, UK

	Area	Review Dart Energy, Falkirk and Stirling, Scotland, UK
1	Project summary	Dart Energy are a developer based in Scotland that is looking to extract coal bed methane (CBM). The process involves drilling into and along coal seams, which initially releases water and then natural gas. This process does not require hydraulic fracturing but CBM is considered an unconventional gas. Dart Energy has planning permission for the exploration and pilot test wells for coal bed methane in Falkirk, Scotland. The operator extracts methane by abstracting groundwater from coal measures thereby releasing methane gas. The pilot test wells are showing early signs of small volumes of gas production, currently generating electricity which feeds into the national grid. On 28th January 2015, the Scottish Energy Minister announced that there is to be a moratorium on granting consents for unconventional oil and gas developments in Scotland whilst further research and public consultation is carried out.
2	Geographic and temporal	Consultation was carried out at a local scale to the development site. Dart Energy undertook a series of public exhibitions in order to provide the residents of the local and

	Area	Review Dart Energy, Falkirk and Stirling, Scotland, UK
	scale of consultation	wider area with an opportunity to share and shape the development proposals. The venues, dates and times of the public exhibitions were designed to provide members of the public with sufficient opportunity to attend and give their views on the proposed development. The exhibitions were advertised in local papers and on community council notice boards. The consultation period and time to determine was enforced by planning regulations. The exhibitions illustrated Dart Energy's plans - seven exhibition boards were displayed providing details of the proposal including information on who the applicant is; current operations; the proposed application; the drilling process and gas production; drill sites, rigs and production sites; aquifers and well mechanics; and rock formations and targeted coals.
3	Target consultees	The applicant had to consult every community council, any part of whose area is within or adjoins the land where the proposed development is situated. The applicant also provided the relevant community councils with a copy of the Proposal of Application Notice (PAN). Dart Energy undertook an extensive period of public consultation during June/July 2012 prior to the submission of their planning application, with exhibitions held in communities surrounding the application site (Airth, Letham, Cowie, Larbert and Fallin), advertisements in the Falkirk Herald and Stirling Observer, notification to Community Councils in which the proposals are located and advertising on local notice boards. Dart Energy held consultation with interested parties including community councils, residents' associations, local businesses and also directly with residents.
4	Project context	The project was set within the regulatory requirements of the Scottish planning application process. This process facilitated public consultation around coal bed methane in a structured and regulated framework which allowed open discussion and consultation with a wide range of statutory and non-statutory stakeholders. Coal bed methane is a relatively new technology in the UK. The consultation process offered a structured process for interested parties to voice their concerns
5	Purpose of consultation	Consultation was carried out with the intention of informing interested parties about the proposed development. The objective was for communities to be better informed about the development proposals and to have an opportunity to contribute their views before a formal planning application was submitted to the planning authority. The public exhibition provided local residents and the wider community with the opportunity to view and comment on the proposal. All visitors were able to meet with Dart management and technical staff who answered specific questions and explained the proposals in detail. Those who attended the exhibitions were able to view and comment on the proposals and understand the benefits the proposed development will bring, whilst the events also provided the applicant with a valuable opportunity to meet local residents and the wider community.
6	Regulatory requirements	All applications for planning permission for major developments must undertake pre-application consultation between the applicant and communities under the legislative requirements of the Town and Country Planning Development Management Procedure (Scotland) Regulations 2008. The applicant is required to hold at least one public event for members of the public where they can make comments to the applicant on the proposed development. This public event must be advertised at least seven days in advance in a newspaper circulating in the locality to enable members of the community councils, representative groups and other members of the public to attend the event. Dart Energy elected to hold five public exhibitions in order to raise widespread awareness of the proposed development and ensure that the pre-application consultation was both effective and meaningful. At least 12 weeks prior to the submission of the planning application, the applicant must provide to the planning authority a PAN. The PAN must include the following information: • a description in general term of the development to be carried out; • a plan showing the outline of the site at which the development is to be carried out and sufficient to identify the site; • detail as to how the prospective applicant may be contacted and corresponded with; and • an account of what consultation the applicant proposes to undertake, when such consultation is to take place, with whom and what form it will take. Through the public event(s), the applicant must explain fully the nature of Pre-Application

	Area	Review Dart Energy, Falkirk and Stirling, Scotland, UK
		Consultation (PAC) i.e. that it does not replace the application process whereby representations can be made to the planning authority. The applicant must prepare a report as to what has been done during the pre-application phase to comply with the statutory requirements for PAC and any requirements set out in the planning authority's response to the PAN. The legislation does not specify the content of the report beyond that it should set out what had been done to effect compliance with the aforementioned requirements. In its response to the PAN, the planning authority may specify any additional notification or consultation it wishes to see undertaken beyond the statutory minimum.
7	Consultation method	Public exhibitions provide a valuable method of presenting information and obtaining feedback from members of the public. The Applicant undertook a series of public exhibitions in order to provide the residents of the local area and the wider area with a genuine opportunity to shape the development proposals. The five public exhibitions provided both the local and wider community with the opportunity to engage with the Applicant at an early stage and for comments and views to be obtained before a formal planning application was submitted. Since submission of the Planning Application in August 2012 and conclusion of the pre application consultation period in-line with statutory planning requirements, Dart has continued extensive consultation activities with communities, community councils and local authorities. Dart set up an in-house exhibition at their Headquarters in Stirling at the start of December 2012 in addition to the five public exhibitions. The purpose of this exhibition is to further inform members of the public about Dart's proposal and provide an extended opportunity for the community to view and discuss the proposed development in further detail. Dart has also provided comprehensive additional consultation information as part of follow up and ongoing correspondence with the community and community councils. This included answers to a list of 112 questions passed to Dart by MSP Angus MacDonald in December 2012. We have also undertaken a series of telephone conversations discussing the proposals and providing further information. Dart also continues to actively engage with local communities and council officials via meetings and providing further written consultation information where appropriate.
8	Evaluation of consultation	No evaluation of the process was located. Dart Energy has been taken over by IGas since the process was run and no one with knowledge of the process was available for interview to discuss process evaluation.
9	Key references	Dart Energy webpage (since removed) Falkirk Council planning register (P/12/0521/FUL) – (archived) Stirling Council planning register (12/00576/FUL) Available online: http://pabs.stirling.gov.uk/online-applications/applicationDetails.do?activeTab=relatedCases&keyVal=M9I9CCPIDX000

Table A3.5. Case Study 5: Nordsøfonden and Total: Nordjylland and Nordsjælland, Denmark

	Area	Review: Nordsøfonden and Total, Nordjylland and Nordsjælland, Denmark
1	Project summary	To increase domestic gas supply, the Danish State – represented by Nordsøfonden – and Total E&P Denmark started joint activities to investigate whether natural gas is present in shale formations onshore in Denmark and whether it can be produced in an environmentally and commercially acceptable manner. In 2010, Nordsøfonden and Total were granted two onshore licences to explore for oil and gas in Denmark. The two licences were granted in Nordjylland, the northern most part of Denmark, and Nordsjælland, an area north and west of Copenhagen. The licences run from 2010 to 2016, with work being carried out at present on the first of three exploration phases. The full exploration process is due for completion in 2016. Drilling on site has been delayed until the spring of 2015 due to manufacturing delays with the drilling rig. As public debate in Denmark slowly picks up speed on the question of hydraulic fracturing, it can be expected that such arguments, promoted by the influential environmental groups in the country and the growing protest movement, will be considered accordingly.

	Area	**Review**: **Nordsøfonden and Total, Nordjylland and Nordsjælland, Denmark**
2	Geographic and temporal scale of consultation	Consultation by Nordsøfonden and Total was prepared with regard to the second stage of the licence which relates to drilling on site. Total organised a number of public meetings with locals and other stakeholders in a town near to the drilling site, Dybvad Kro. The aim of the meetings was to inform stakeholders on the progress of work and answer any questions they may have e.g. traffic, noise and safety. Some of the consultees were non-governmental organisations, including Greenpeace Denmark, WWF Denmark, the Danish Society for Nature Conversation and "Skifergas – Nej Tak". Frederikshavn City Council advised that an EIA (VVM in Denmark) was required for the proposed project of exploration drilling for shale gas. As part of the planning and EIA process, public consultation was opened for the period from 12th June to 10th July 2013 (four weeks).
3	Target consultees	Nordsøfonden and Total are committed to consulting all stakeholders involved in the EIA procedure including, inter alia: • the relevant municipalities; • the Environmental Protection Agency (DEPA); • The Nature Agency; • The Heritage Agency of Denmark; • NGOs; • the Danish Energy Agency; • Nature and Environment Board of Appeals; • elected representatives; • local businesses; and • surrounding communities.
4	Project context	The project was driven by the Danish government to find new domestic gas reserves onshore. The public/private partnership looked into the availability of shale gas within Denmark.
5	Purpose of consultation	Consultation on this project was carried out by Nordsøfonden and Total with regard to informing local people and stakeholders about the progress of the project with updates and consultation relating to the second phase of the licence, the drilling phase of the project. Trust and strong relations are greatly valued and all key stakeholders were expected to be involved at an early stage of the project, especially with regard to the local communities' issues.
6	Regulatory requirements	There is a requirement to inform the Parliamentary Committee on Energy Policy of all exploration licences before they are granted. Where an EIA is required, the EIA report must be subject to public consultation for at least 8 weeks before the final approval or rejection of the project and subsequent to the review and response to any objections received. The EIA procedure must be completed before starting any activities subjected by the EU directive on EIA. The EIA procedure is performed by the relevant municipality and public involvement is an important part of decision making. The purpose of an EIA is to ensure an assessment of the environmental impact as the basis for the decision to grant or refuse permission to activities that potentially can affect the environment significantly. This ensures that the municipality has a good basis for making environmentally informed decisions. Drilling for gas is covered by Annex 2, which means a screening of the project is necessary in order for the municipality to determine whether the project requires a full EIA, or whether a screening is sufficient. Activities covered by the EIA Directive Annex 1 or 2 that could have an effect on the environment must be assessed according to the EIA provisions of this order before they are allowed to be established
7	Consultation method	Details regarding consultation can be found on the project in Nordjylland specifically. The consultation methods employed so far include public meetings, presentations and a business exhibition in a local town, Dybvad Kro, near to the drilling site. Since December 2012, Total have published a dedicated website, "Skifergas i Danmark" (skifergas.dk) in Danish and English with background information and news about its two projects. The site also explains the economic prospects for shale gas for Denmark and internationally. With regard to this proposal the municipality of Frederikshavn proposed that a public orientation meeting on the activities connected to shale gas should take place on 10th January 2013 involving the authorities and the developer as speakers. Moreover, the municipality has given access to the public to all the relevant material (minutes of

	Area	**Review**: **Nordsøfonden and Total, Nordjylland and Nordsjælland, Denmark**
		meetings, draft permits etc.) via the internet.
8	Evaluation of consultation	No evaluation of the process was located. Total was contacted and responded initially but did not respond to follow up contact to discuss the consultation process.
9	Key references	Total (Nordjylland) webpage – http://en.skifergas.dk/nordjylland.aspx (archived) Journal of European Management & Public Affairs Study – http://jempas.th-wildau.de/index.php/Jempas

Appendix 4 Consultation Responses

Notes of telephone interview with Dietrich Borchardt

16th July 2015

Background to the project

Tight gas operations had been operated and accepted for some years in Germany with no perceived problems. Gas was seen as a contribution to the energy mix. Developments in the US altered this perception. The prospect of large-scale tight gas and/or shale gas developments raised a number of questions from the public. Public authorities did not respond well and were not prepared for the questions. ExxonMobil and other companies had existing exploration rights and given this, authorities had to decide whether or not to permit further exploration. ExxonMobil decided to proceed with the consultation in 2010/11.

Scope

The scope was OK. There were no issues. This is a result of the pre-consultation process (see below under process).

Stakeholders

It was important to use experienced professionals in consultation and moderation to plan and deliver the process and to manage stakeholders. Those managing the process needed to be accepted by all and needed to be advocates of the process rather than the subject matter or specific points of view. Industry and public authorities do not always have these skills.

Stakeholders were mapped across all areas. In addition the relationships and any hidden agendas and history between stakeholders was established. This was important to enable avoidance of conflicts based on past experiences/existing relationships. This was important to avoid the subject becoming a surrogate for disagreements from historical conflicts.

No stakeholders left the process

Cannot prioritise stakeholders. Must maintain a good mix, not only the visible minority but also the silent majority the second of which may become more vocal through the process as understanding increases. This is crucial to ensure a balanced approach.

Different stakeholder groups had different roles in the process (e.g. landowners, water supply companies). It was important to include representatives across the governance hierarchy.

There is a need to balance the share of stakeholders across different themes, e.g. environment, technical, authorities, public, landowners.

Process

The process was based on an information-dialogue basis to enable fact to be separated from fiction. This was definitely needed as a first step before evaluation of issues was carried out. As a result, a common understanding of issues was developed e.g. of risks relative to other industries and activities. Once the basis of information was established, it was possible to debate and rate the pros and cons.

A crucial aspect of the project was a pre-consultation process engaging with representation from around 30 stakeholder groups. This stage enabled the issues of concern to be identified and stakeholders to gain ownership over, and commitment to the process. It also enabled trust to be engendered and for stakeholders to establish and determine their own roles in the process. This was a participatory approach used to avoid losing groups at the beginning.

The timescale of two years was about right. Could not have been any faster as proper communication is required plus investment in learning for stakeholders to enable a minimum quality of discussion to be facilitated.

Geographically, the process focused on Lower Saxony and Westphalia to provide a context of active conventional and unconventional (tight gas and coal bed methane) hydrocarbon exploration and production.

The wider context for the process was very important. During the process the Fukushima nuclear accident happened which influenced German energy policy (i.e. the closing of nuclear power plants and transition to renewables-based energy mix requiring a transition strategy of gas and coal). Energy security and addressing transition developed increased importance and influenced how stakeholders valued the potential for gas production and balanced issues.

All processes used were good. Used small groups for debate. The exact format used was demand driven, hence group sizes were flexible and responsive to stakeholder needs. Year one focussed on information, i.e. what do you want to know, what are the technical and environmental aspects. Year two focussed on evaluation.

Particularly successful was the “open stage peer review” event in Berlin. This examined the science and advisory groups’ work. A global audience was used. 300 participants over two days. Included breakout groups addressing specific themes (e.g. ecotoxicology). The result was that technical evidence was not the subject of debate and questioning in the following evaluation stage.

Evaluation of the process

Post project there were two small conferences. The first focussed on how to develop regulations and the second on how Exxon should address issues. As a result, Exxon set up internal reviews to address all recommendations.

Estimate that 90% of the recommendation made are now in the draft law which is currently in development at Federal level (unconventional gas extraction law) that should be determined in autumn 2015.

What would you change?

Role of ExxonMobil was very good, it responded well. Public administrations were passive and did not want to take on responsibility, they were not innovative enough; they were very constrained in what they could say and do due to narrow mandates.

For a question of national relevance, this was a perfect approach to engagement.

DECC Response to Written Questions (22 July 2015)

Scope

Were the terms of reference for the consultation adequate? Were their aspects, e.g. time, methods, structure, and content, not covered that would have been useful to include?

> We judged at the time and after the event that we got the terms of reference right. In large part was determined by the governing regulations. Additionally we received no successful legal challenge to say that we got it wrong.

What, additional aspects if any, were built into the consultation process for regulatory driven processes – over and above statutory requirements E.g. scope, timescale, promotion, consultation approach, stakeholders, etc. What perceived benefits were derived from these actions?

> Some of the answers to these questions are set out below but certainly by our efforts to reach out to non-statutory stakeholders when not required to do so this may well have helped avert more hostile reactions and contributions and potentially legal challenge.

Stakeholders and consultees:

How did you identify, monitor and regulate the stakeholders/consultees involved?

> The governing legislation for an SEA provided us with the Statutory Consultees and the requirement to consult the general public. We then used our Press Office experience and contacts to identify other organisations who we should make aware that the consultation had started.

Which stakeholders provided most/least value or input and why? Please identify in priority order (e.g. engineers, scientists, geologists, social scientists, economists, local/wider community, landowners, farmers, interested parties, local authorities, residents, statutory consultees, non-statutory consultees)

> It would perhaps be unwise for me to rank the contributions made by parties which may seem to diminish some parties contributions over others. However good contributions were made by the range of consultees and well considered ones by parties such as the Environment Agency, Scottish Natural Heritage and Scottish Environmental Protection Agency.

What other stakeholders would have been beneficial to include and why?

> It did not become evident after the consultation exercise was completed that we had missed a valuable contribution by not directly seeking a view from another party that we had not included.

Process design/delivery

Was the time period sufficient to deliver the consultation? How have you reached your conclusion?

The timeframe was perfectly adequate to comply Cabinet Office guidelines on a full public consultation (12 weeks) and we in fact added extra time to reflect the fact the consultation was over the Christmas period.

Was there a specific geographical focus to the issues discussed? Did the geography of the study have any influence on the consultation and its outcomes? If so please explain how?

The Environmental Report that was consulted on did break down implications on a regional basis (The 5 SEA areas) as well as being on a UK wide basis. However the consultation did not attempt to force or receive responses only in relation to a particular SEA area.

Were stakeholders involved in the design of the consultation process? If yes, how were they involved and what influence did they have? (e.g. the Cuadrilla CLG)

Yes, the governing regulations identify statutory consultees all of whom were invited to contribute in a scoping exercise of the Report. We also involved (after Ministerial approval) other non-statutory consultees who had environmental protection objectives. The views of both groups helped with the shaping of the final report.

What methods of consultation worked well? E.g. workshops, small/large groups, written responses, other. Please explain why.

All contributions were invited to be made only in written form through one method or another. This allowed for an accurate receipt of the message they wished to convey, considered unrushed processing of that contribution and for audit trail purposes. Therefore this was the most appropriate way of receiving the contributions.

Evaluation

Did you carry out any monitoring or evaluation of the effectiveness of the consultation? If yes, is this available? If no, what are the reasons for not undertaking monitoring or evaluation?

No specific review of the consultation process and method was undertaken. But an internal informal and unwritten assessment of whether it had achieved its aim for us was taken.

If you were to run the process again, what would you do/not do or change with hindsight to improve the process? (timing, ToR, stakeholders involved, techniques used, evaluation)

We are about to undertake a new consultation exercise on a “Habitat Regulations Assessment of 14th Round Onshore Oil and Gas Licence Applications”. Our approach, at least initially, is to take exactly the same approach again. However, if we feel that the numbers of responses are going to be larger than we might easily manage we may contract an organisation that is well resourced to deal with such numbers that we had not employed in the SEA consultation.4

i http://ec.europa.eu/environment/integration/energy/hc_bref_en.htm (accessed 16 September 2015).

Final Report 5: Regulatory Framework for Environmental Protection

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Unconventional gas exploration and extraction (UGEE) involves hydraulic fracturing ("fracking") of low permeability rock to permit the extraction of natural gas on a commercial scale from unconventional sources, such as shale gas deposits, coal seams and tight sandstone.

The UGEE Joint Research Programme (JRP) (**www.ugeeresearch.ie**) is composed of five interlinked projects and involves field studies (baseline monitoring of water and seismicity), as well as an extensive desk-based literature review of UGEE practices and regulations worldwide. The UGEE JRP was designed to provide the scientific basis that will assist regulators - in both Northern Ireland and Ireland - to make informed decisions about whether or not it is environmentally safe to permit UGEE projects/operations involving fracking. As well as research in Ireland, the UGEE URP looks at and collates evidence from other countries.

The JRP is funded by the Department of Communications, Climate Action and Environment, DCCAE (formerly the Department of Communications, Energy and Natural Resources (DCENR) and the Environment Division of the Department of Environment, Community and Local Government (DECLG)) and the Northern Ireland Environment Agency (NIEA). The research programme was managed by a steering committee comprising the EPA, representatives from DCCAE, the Geological Survey of Ireland, Commission for Energy Regulation, An Bord Pleanála, NIEA, the Geological Survey of Northern Ireland and the Health Service Executive.

List of Outputs:

- Final Report 1: Baseline Characterisation of Groundwater, Surface Water and Aquatic Ecosystems
- Summary Report 1: Baseline Characterisation of Groundwater, Surface Water and Aquatic Ecosystems
- Final Report 2: Baseline Characterisation of Seismicity
- Summary Report 2: Baseline Characterisation of Seismicity
- Final Report 3: Baseline Characterisation of Air Quality
- Summary Report 3: Baseline Characterisation of Air Quality
- Final Report 4: Impacts & Mitigation Measures
- Summary Report 4: Impacts & Mitigation Measures
- Final Report 5: Regulatory Framework for Environmental Protection
- Summary Report 5: Regulatory Framework for Environmental Protection
- UGEE Joint Research Programme Integrated Synthesis Report

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