Cuadrilla Bowland Ltd

Temporary Shale Gas Exploration

Preston New Road, Lancashire

Environmental Risk Assessment

PNR_ERA

May 2014

Cuadrilla

ARUP

Contents

Appendices

1 Introduction

The purpose of this document is to summarise and report on the outcome of the high level Environmental Risk Assessment (ERA) process carried out for the proposed shale gas project at the Preston New Road site, Lancashire (the "Project"). The document aims to provide assurance to the Department for Energy and Climate Change (DECC), that an appropriate risk management structure is in place, and that environmental risks have been identified and will be managed appropriately or controlled. This process allows issues to be documented and demonstrates how the Project has addressed or will address them where relevant.

The proposed Project will be undertaken by Cuadrilla Bowland Limited ("Cuadrilla") under the Petroleum Exploration and Development licence number 165 (PEDL 165). There are two sites that are currently proposed for exploration. These are Preston New Road (this site) and another site at Roseacre Wood.

This report includes the following:

- A description of the scope of the assessment, including what is and isn't covered by the ERA, and how it relates to other key documents (Section 2);
- An overview of Cuadrilla's organisational structure for the management of health, safety, security and environmental risks and impacts (Section 3);
- An overview of the relevant legislation and regulation which underpins the risk mitigation measures (also Section 3).
- The risk assessment framework (Section 4);
- A brief summary of the project presenting the key information relevant to the risk assessment (Section 5)
- A description of steps taken to ensure that members of the local community and other stakeholders have had the opportunity to be involved in the identification of risks relating to the proposed activities (Section 6).
- A summary of key risks raised and assessed as a result of the risk identification process (Section 7).

Appendix A presents a long list of all the risks, issues and concerns identified during stakeholder engagement and technical workshops.

While many risks are common across all shale gas and other similar operations, their assessment, in terms of their *likelihood*, *consequence* and hence the *magnitude of the risk*, are specific to this particular site.

1.1 Risks vs. Impacts

A risk assessment deals with uncertain or unplanned outcomes from activities, where an identified hazard[1] and its consequence (impact) are not certain to occur

[1] "A situation or biological, chemical or physical agent that may lead to harm or cause adverse effects" (DEFRA, 2011 (5))

i.e. there is a probability measure associated with the impact occurring. As explained further below, the focus of this risk assessment is on identifying and assessing the unplanned outcomes from the proposed activities. Planned outcomes will be considered in detail in the Environmental Statement.

1.2 Related documentation

This ERA report precedes the submission of a planning application for the proposed activities, which will include an Environmental Statement (ES), presenting the full findings of the Environmental Impact Assessment (EIA).

The ES will consider in detail the impacts related to both planned outcomes (impacts) and unplanned events (risks). Mitigation strategies will be developed, and presented in the ES for both impacts and risks. The high level Environmental Risk Assessment presented in this report has been used to inform the scope of the detailed assessment of risks presented in the forthcoming ES.

As is routine in operational permitting, environmental risk assessments will also form part of future operational environmental permit applications.

2 Scope of Assessment

The objective of an Environmental Risk Assessment (ERA) is to **identify** and **assess** risks to the environment and human health resulting from the development, construction, operation and restoration of the proposed shale gas Exploration Project, and identify appropriate **actions to manage** those risks.

The purpose of this report is to summarise and report on the outcome of the high level ERA process, and to document the risk management structure which is place, for the benefit of all stakeholders, and to show how potential environmental risks have been identified and will be managed appropriately or controlled. The Department for Energy and Climate Change (DECC) is responsible for energy development and licensing, and has requested the compilation of a pre-planning ERA which includes public stakeholder engagement input for each proposed hydraulic fracturing site[2]. The detail of DECC's requirements[2] is:

"*An environmental risk assessment (ERA) is required for all shale gas operations involving hydraulic fracturing, as a matter of good practice. It should involve the participation of stakeholders including local communities at the earliest possible opportunity. The ERA should be undertaken as early as practicable and in any case before application for planning consent.*

The ERA should assess risks across the entire life cycle of the planned shale gas activities, including the disposal of wastes and well abandonment, and risks of induced seismicity.

The ERA can subsequently inform other assessments, such as the environmental impact assessment (EIA), where this is required following screening by the relevant planning authority."

DECC published their guidance to industry on the preparation of an environmental risk assessment[3] on 24 April 2014, i.e. subsequent to the preparation of this report. DECC require that operators "should make use of this draft guidance in all new projects, and seek to apply its principles so far as practicable to projects in which early engagement with stakeholders is already in hand."

An advantage of undertaking an ERA is that it considers all potential risk events in a consistent manner which allows comparison and prioritisation of the key risks.

2.1 Scope

This high-level ERA addresses potentially significant environmental and human health risks that are associated with the lifecycle of four wells, drilled for the purposes of exploring for shale gas at the Preston New Road site, including all

[2] DECC (December, 2013) "Onshore oil and gas exploration in the UK; regulation and best practice"
[3] DECC (April 2014) "Guidance on the preparation of an environmental risk assessment of shale gas operations in Great Britain involving the use of hydraulic fracturing"

directly associated infrastructure and processes. The scope includes connected activities such as transportation to and from the site.

This ERA does not explicitly cover the following, which are outside the scope of the ERA, or beyond the Project scope:

- Risks related to any production stages. These will be assessed at the appropriate time, following exploration, if production is planned for the site. This exploration stage ERA should inform any future production stage ERA at the site.
- Wider policy issues related to the use of fossil fuels and climate change.
- Commercial (cost and programme) or reputational risks to Cuadrilla.
- Local concerns which do not present a significant risk to the environment or human health, such as a perceived impact on local property prices (see Appendix A for concerns raised during stakeholder engagement).

2.2 Guidance and relevant documentation

The key guidance documents relating to ERA requirements in the UK and specific requirements for shale gas operations include:

- DEFRA (2011) Green Leaves III[4];
- Environment Agency (2013)[5]; and
- The Royal Society and the Royal Academy of Engineering (2012)[6].

Further mention of the ERA is presented by DECC (2013)[2].

2.3 Terminology

The following terminology, from DEFRA (2011)[4] is relevant to this report:

- **Hazard** A situation or biological, chemical or physical agent that may lead to harm or cause adverse effects
- **Risk** The potential consequence(s) of a hazard combined with their likelihoods/probabilities
- **Risk assessment** The formal process of evaluating the consequence(s) of a hazard and their likelihoods/probabilities.
- **Risk management** The process of appraising options for responding to risk and deciding which to implement.
- **Stakeholders** Individuals who are interested in, or affected by, an issue or situation.

[4] DEFRA and Cranfield University (2011) "Guidelines for Environmental Risk Assessment and Management: Green Leaves III"
[5] Environment Agency (2013) "An Environmental Risk Assessment for shale gas exploratory operations in England"
[6] Royal Society and Royal Academy of Engineering (2012) "Shale Gas Extraction in the UK: A review of hydraulic fracturing"

- **Uncertainty** Limitations in knowledge about environmental impacts and the factors that influence them.

2.4 Related activities

This ERA Report does not form part of the statutory process of applying for planning permission or environmental permits for the Project.

Related documentation on the planning consent application comprises the following:

1. Environmental Impact Assessment Scoping report (issued to Lancashire County Council on 4th February 2014)
2. LCC Scoping Opinion report (11th March 2014)
3. Emerging Findings brochure (26th March 2014)
4. Planning consent application including Environmental Statement and Statement of Community Involvement (in preparation)
5. Applications for environmental permits (in preparation)

There will be a formal consultation process on the planning application, managed by Lancashire County Council, and on environmental permits managed by the Environment Agency.

3 Corporate risk management framework

The Cuadrilla Health, Safety, Security and Environment (HSSE) Risk Management Framework underpins Cuadrilla's standards in risk management for Health, Safety, Security & Environment.

The governance of this framework is shown in Figure 1.

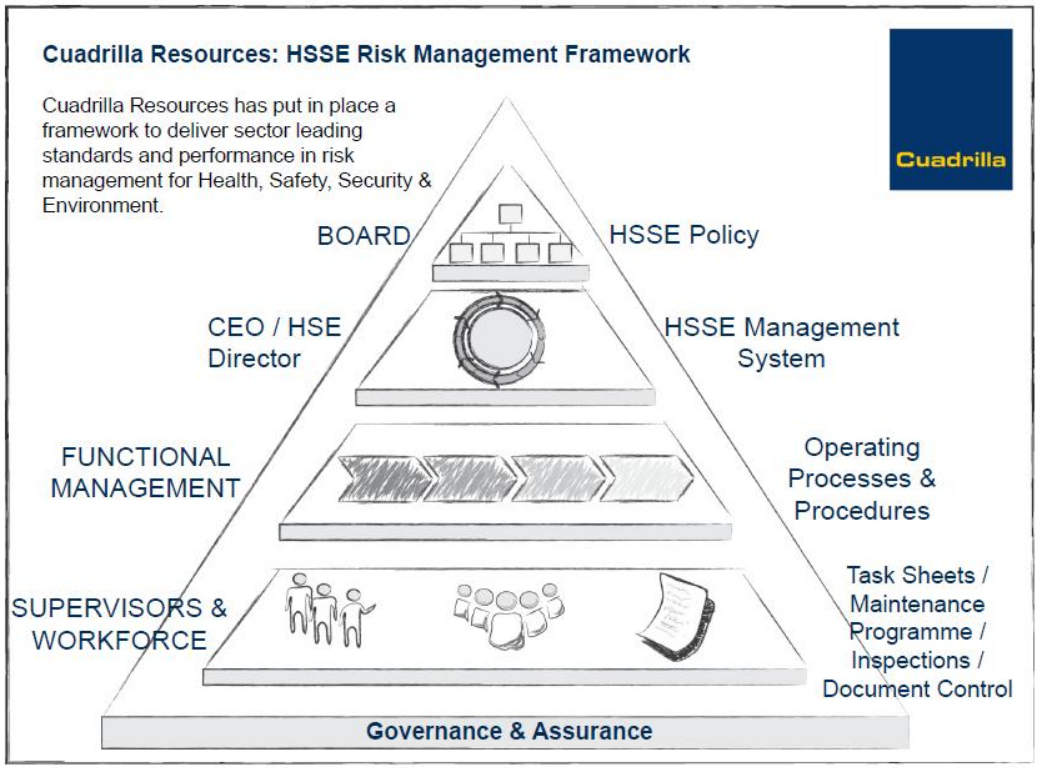

Figure 1: Cuadrilla's HSSE Risk Management Framework

This framework contains company policies including the principal Health and Safety Policy and Environmental Policy. All Cuadrilla staff, contractors and suppliers working on Cuadrilla's operations are expected and required to work in accordance with this framework when on a Cuadrilla site

The framework is formed of 12 'elements' overseen by the Group's Chief Executive Officer and Senior Management Team. These elements describe the overall corporate intent statements and inform the corporate Operating Standards and Operating Procedures at a site, which are governed at the Functional Management level. The elements of the framework and their intent are:

1. **Leadership and accountabilities:** To ensure active, visible and effective leadership with clear accountabilities during all operations
2. **HSSE Risk Identification, assessment, control & reporting**: Effectively identify, assess, mitigate and report HSSE risks in all lifecycle stages (Exploration, Development Operations, Closure and Restoration)
3. **Emergency preparedness & crisis management:** Ensure that procedures and resources are in place to effectively respond to any emergency events.

4. **HSSE competency and behaviour:** Develop and maintain appropriate HSSE competencies, attitudes and behaviours.
5. **Assets, plants and equipment:** All plant and equipment is installed, operated, tested and inspected using systems and procedures that manage HSSE risk.
6. **Management of Change:** Risks from planned and unplanned changes are identified, assessed and managed.
7. **Management of Suppliers and Contractors:** To ensure suppliers and contractors provide services and equipment aligned with the requirements of the Cuadrilla HSSE Risk Management Framework.
8. **Transport infrastructure and logistics:** To ensure effective planning for the movement of plant, equipment and other assets to minimise disruption to local road networks and local communities.
9. **Health and Wellbeing:** To ensure good working environments and practices to enhance the health and wellbeing of staff.
10. **Reporting and learning from events**: To ensure that all events are reported and investigated and the lessons learned are embedded into business improvement.
11. **Business Resilience and security:** To protect physical and information assets from loss, damage and theft and to minimise disruption to our operations from activities of criminals or opposition groups.
12. **Audit, Review, Compliance and Reporting:** Drive improvement by ensuring that procedures and resources are in place to effectively monitor, audit, review and report on HSSE systems and performance.

3.1 Site safety management

The management of site safety risks affecting site personnel is not included within this ERA, unless the consequences of a risk event have the potential to affect the wider community.

Workforce safety is managed by Cuadrilla at each one of their operational sites and is subject to regulatory enforcement and inspection by the Health and Safety Executive (see Section 3.3)

3.2 Environmental Operating Standards

The Environmental Operating Standards (EOS) will detail the environmental management arrangements and operating standards to be applied throughout the Project. The EOS will directly inform the Environmental Monitoring and Management Plan (EMMP) which will define Project operations, potential impacts, corresponding mitigations, detail the scope of inspections, their frequency, and reporting processes, to be undertaken by operatives on-site. The Health Safety Security and Environment (HSSE) framework will over-arch safety and security of site operations and processes.

The ERA will inform the EIA; the EIA will inform the EOS; the EMMP will be a bespoke, detailed management framework informed by the EOS. Therefore the ERA forms an initial stage in the Project planning and consenting process and will directly influence the eventual shape of Cuadrilla's management framework structure.

3.3 Legislation and regulation

The proposed activities covered by this ERA are subject to various legal requirements; the principle regimes of particular relevance to shale gas exploration are referred to below.

The Department of Energy and Climate Change (DECC) recent publication *Onshore oil and gas exploration in the UK: regulation and best practice*[2] provides a roadmap and explains the permitting and permissions process for onshore hydrocarbon operations from the issue of petroleum exploration and development licence (PEDL) by DECC to site operations. The roadmap includes the planning consent process, public engagement process, environmental permitting, DECC and Health and Safety Executive (HSE) involvement and the well examination requirements. The DECC document '*Environmental legislation applicable to the onshore hydrocarbon industry (England, Scotland and Wales)'*[7] also provides a list of relevant European and UK legislation, that is not repeated here.

The installation of onshore gas wells within the UK is principally regulated by the HSE and DECC, with the HSE monitoring operations from a well integrity and site safety perspective, under the following well-established regimes:

- The Offshore Installations and Wells (Design and Construction, etc.) Regulations, 1996 (referred to as DCR); and
- The Borehole Sites & Operations Regulations 1995 (referred to as BSOR).

The Environment Agency (EA) is responsible for regulation of waste and protection of water resources and has released the draft document '*Onshore oil and gas exploratory operations: technical guidance*'[8] for consultation in 2013 to explain the environmental regulations relevant to the sector, including:

- The Environmental Permitting (England and Wales) Regulations 2010 (as amended) (EPR)
- The Water Resources Act 1991.

In November 2012 the EA and HSE signed a 'working together' agreement relating to unconventional gas stating their commitment to coordinated regulation and to ensuring there are no material gaps between the safety, environmental protection and planning considerations.

[7] DECC (2014), "Environmental legislation applicable to the onshore hydrocarbon industry (England, Scotland and Wales)", available as 'onshore_leg_1.doc' from www.gov.uk
[8] Environment Agency (August, 2013), "Onshore oil and gas exploratory operations: technical guidance, Consultation Draft"

3.3.1 Industry good practice guidelines

The following are detailed UK-specific industry good practice guidelines, which Cuadrilla has committed to complying with:

- UK Onshore Operators Group *Onshore Shale Gas Well Guidelines*[9];
- Oil and Gas UK *Well integrity guidelines*[10];
- Oil and Gas UK *Guidance on suspension and abandonment*[11];
- Oil and Gas UK *Guidelines on qualification of materials for the suspension and abandonment of wells*[12].

The UKOOG Onshore Shale Gas Well Guidelines: Exploration and Appraisal Phase provides the following summary of overarching principles that should be applied relating specifically to hydraulic fracturing and environmental protection:

- To safeguard the quality of surface water and groundwater resources, through sound wellbore construction practices, sourcing fresh water alternatives where appropriate, and to recycle water for re-use, if practicable.
- To measure and disclose water usage with the aim of minimising environmental impacts and the use of potable water supplies.
- To support the development of fracturing fluids and additives with the least environmental risks.
- To continue to advance, collaborate on and communicate technologies and best practices that minimise the potential environmental risks of hydraulic fracturing.
- To eliminate or, if not practicable, to minimise any fugitive emissions.
- To make public the substances used in hydraulic fracturing fluids.
- The hydraulic fracturing programme should emphasise and commit the operator to environmental protection.

The DECC regulatory roadmap[13] identifies the notification and permitting requirements for each site, including: PON (petroleum operations notices) notifications to DECC, British Geological Survey (BGS) notification of intention to drill, environmental permits from the EA, notification to HSE of intention to drill, provision to HSE of proposed well design following examination by independent well examiner, agreed data reporting methods with DECC, agreed fracturing monitoring with DECC, submission of hydraulic fracturing programme to DECC.

3.3.2 Groundwater regulation relating to shale gas

Specific regulation relating to the environmental protection of groundwater includes:

[9] UKOOG (2013), Onshore Shale Gas Well Guidelines: Exploration and Appraisal Phase"
[10] Oil and Gas UK (2012a), "OP069 - Well Integrity Guidelines, Issue 1"
[11] Oil and Gas UK (2012b), "OP071 - Guidelines for the suspension and abandonment of wells, Issue 4"
[12] Oil and Gas UK (2012c), "Guidelines on qualification of materials for the suspension and abandonment of wells, Issue 1"
[13] DECC (2013), "Regulatory Roadmap: Onshore oil and gas exploration in the UK regulation and best practice"

- The Water Framework Directive (2000/60/EC) (European Council and Parliament, 2000) and the so-called Groundwater Daughter Directive (2006/118/EC) (European Council and Parliament, 2006). The GWDD is implemented in England and Wales by the Environmental Permitting (England and Wales) Regulations 2010 (as amended) (EPR).

3.3.3 Air Quality regulation

The air quality regulation described below is not specific to Cuadrilla's operations or the shale gas industry; it imposes national requirements on the local authorities.

In 1996, the European Commission published the Air Quality Framework Directive on ambient air quality assessment and management (96/62/EC). This Directive defined the policy framework for 12 air pollutants known to have harmful effects on human health and the environment. Limit values (pollutant concentrations not to be exceeded by a certain date) for each specified pollutant are set through a series of Daughter Directives, including Directive 1999/30/EC (the 1st Daughter Directive) which sets limit values for sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and oxides of nitrogen (NO_x), particulate matter less than 10 microns in size (PM_{10}) and lead in ambient air.

In May 2008, the Directive 2008/50/EC on ambient air quality and cleaner air for Europe came into force.

The above European Directives, 2008/50/EC and the 4th Daughter Directive, were transposed into legislation in England by the Air Quality Standards Regulations 2010. The Secretary of State for the Environment has the duty of ensuring the air quality limit values are complied with.

Part IV of the Environment Act 1995 places a duty on the Secretary of State for the Environment to develop, implement and maintain an Air Quality Strategy with the aim of reducing atmospheric emissions and improving air quality. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland adopted in 2007 provides the framework for ensuring the air quality limit values are complied with based on a combination of international, national and local measures to reduce emissions and improve air quality. This includes the statutory duty, also under Part IV of the Environment Act 1995, for [local authorities] to manage local air quality. Permits are required under the EPR for some 'Part B' activities likely to involve emissions to air that are not subject to permitting under other environmental regimes, such as the requirement for a greenhouse gas emissions permit.

Under provisions in the Environmental Protection Act 1990[14], dust nuisance is defined as a statutory nuisance with powers for local authorities to take steps to cause persons committing a nuisance to abate the nuisance.

3.3.4 Climate change regulations

The Greenhouse Gas Emissions Trading Scheme Regulations 2012 require operators of plant involving the combustion of fuels in installations with a total rated thermal input exceeding 20 MW to participate in the EU Emissions Trading Scheme (ETS) and to hold a greenhouse gas emissions permit. Permit holders

[14]Environmental Protection Act 1990, Chapter 43, Part III Statutory Nuisances and Clean Air

must acquire and surrender to the competent authority allowances equal to the tonnes of carbon dioxide emitted by the regulated activity over the course of the scheme year. According to the Environment Agency, emissions from flaring are covered under EU ETS.

3.3.5 Protected species and habitats

European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (the "Habitats Directive") and Council Directive 2009/147/EC on the conservation of wild birds (the "Wild Birds Directive") required Member States to introduce a range of measures for the protection of habitats and species. Where protected habitats or species are present, an appropriate assessment must be carried out to assess the potential for any significant negative impacts to them arising from the project.

The Conservation of Habitats and Species Regulations 2010 (SI 2010/490) transposes the Directive into law in England and Wales and also includes measures for the protection of further species and habitats protected under domestic law. This includes a prohibition against disturbing protected species without a licence to disturb obtained from Natural England in the case of projects in England.

3.3.6 Waste regulation - general

There are a number of relevant key policies and legislation that seek to influence sustainable waste management. These include:

- Waste Framework Directive 2008 (2008/98/EC);
- The Waste (England and Wales) Regulations 2011[15];
- Environmental Permitting (England and Wales) Regulations 2010;
- The Environmental Protection Act 1990[16];
- The Environment Act 1995;
- The Hazardous Waste Regulations 2005 No 898;
- Government Review of Waste Policy in England in 2011[17]; and
- The Updated Regional Waste Strategy for England's North West February 2010[18].

3.3.7 Mining Waste Regulation

Waste generated by the extraction of minerals is governed by a specific set of requirements which apply to the exclusion of those referred to in paragraph 3.3.6 above. These are derived from the Mining Waste Directive 2006 as implemented by Schedule 20 of the Environmental Permitting (England and Wales) Regulations 2010.

[15] The Waste (England and Wales) Regulations (SI 2011/988)
[16] The Environmental Protection Act 1990 c.43
[17] Department for Environment Food and Rural Affairs (2011) *Government Review of Waste Policy in England in 2011*
[18] 4NW (2010) *The Updated Regional Waste Strategy for England's North West February 2020*

3.3.8 Regulations relating to water resource and flooding risk

The following are relevant to the assessment of flood risk at the site:

- National Planning Policy Framework 2012 and supporting Technical Guidance[19];
- Fylde Borough Council Strategic Flood Risk Assessment (SFRA) 2011;
- Planning Policy Statement 25: Development and Flood Risk;
- Water Resources Act 1991;
- Land Drainage Act 1991; and
- Flood and Water Management Act 2010.

3.3.9 Workforce safety regulations

Worker safety regulation includes:

- Health and Safety at Work etc. Act 1974;
- The Management of Health and Safety at Work Regulations 1999; and
- G404: COSSH Essentials - Health surveillance for those exposed to respirable crystalline silica (RCS).

[19] Communities and Local Government (March 2012) "National Planning Policy Framework" and "Technical Guidance to the National Planning Policy Framework"

4 Framework for Risk Assessment

The recommended framework presented by DEFRA (2011)[4] is shown in Figure 2, below.

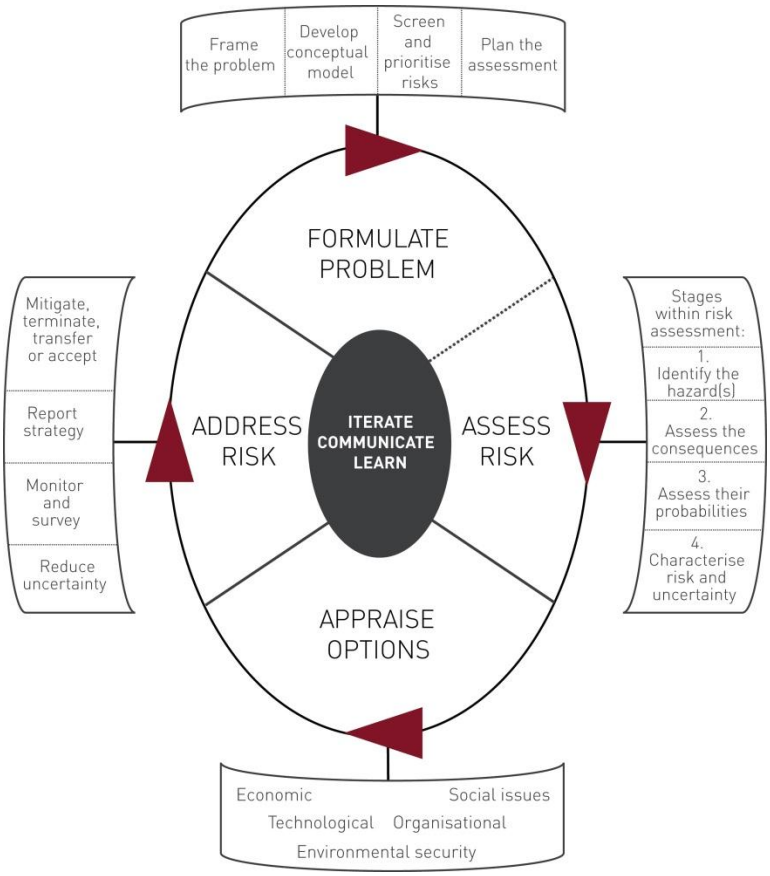

Figure 2: Framework for carrying out an Environmental Risk Assessment[4]

Each stage is discussed in the following sections, with reference to the proposed exploratory activities at the Preston New Road site.

4.1 Formulate the problem

The Royal Society and Royal Academy of Enginering report provides an overview of all key risks and impacts associated with shale gas activities, which focuses on potential high level environmental impacts related to groundwater, air quality and induced seismicity that could result from unplanned outcomes of the activities. However, local risk events, such as those related to unplanned traffic incidents are also included in this risk assessment, even though such events are not unique to the proposed operations, since these are very important to local communities.

The ERA considers all risks relevant to the proposed activities through to suspension and potential abandonment, that may reach an environmental receptor (both immediately surrounding the site and beyond) over which Cuadrilla management has a direct influence.

See also Section 2 which presents the scope of the report.

4.1.1 Conceptual model

The conceptual model uses the S-P-R (Source-Pathway-Receptor) methodology as recommended by DEFRA[4] and recommended by the Royal Society and the Royal Academy of Engineering[6] as best practice where:

- The **source** is the original cause of the hazard, for example the presence of a contaminant on site.
- The **pathway** is the route by which the source can reach the receptor e.g. overland flow of rainwater
- The **receptor** is the specific component of the local environment and/or community that could be reached by the hazard e.g. a surface water course.

Receptors can be split between primary and secondary (i.e. subsequent) receptors. Primary receptors receive the direct impact of the hazard/risk and the secondary receptors would receive an impact as a result of any effect on the primary receptor.

4.1.2 Categorise the risks

Risk types are categorised in terms of their primary *receptor* including but not limited to the following:

- Air quality
- Archaeology and heritage
- Ecology
- Hydrogeology and contamination
- Lighting
- Traffic
- Water resources
- Induced seismicity
- Waste
- Landscape and visual amenity
- Site management

4.1.3 Plan the assessment

To identify and assess risks appropriate to the Project, a series of tools and engagement activities were planned:

- Review of technical literature relating to Shale Gas activities (e.g. AEA, 2012; EA, 2013; AMEC, 2013; CIWEM, 2013; PHE, 2013; DNV, 2013; see section 9);
- Early engagement events with the local community, (generic and site specific discussions) (see Section 6); and

- Internal Project workshops with technical team

The magnitude of a risk event is expressed in terms of both its *likelihood* and *consequence*. The qualitative likelihood and consequence scales used by the Environment Agency[5] are used.

Table 1: Likelihood scale, based on EA guidance with additional comments/clarifications.

Likelihood	Descriptor[5]	Comment
High	Repeated occurrences expected	Based on experience in comparable industries and activities. Where no comparable industry experience is available, a cautious approach will typically be adopted to allow for uncertainty.
Medium	Can be expected to occur several times per year	Likelihood rating must consider the proposed duration of the activities.
Low	Infrequent occurrence.	These are events which may have been reported in the past in other similar operations. Can be considered as approximately a 1 in 10 year event
Very Low	Rarely encountered, never reported, or highly unlikely.	This category refers to events which, although rarely encountered or never reported in similar operations, cannot be ruled out.

Table 2: Consequence scale

Impact	Environmental descriptor[5]
High	A major environmental incident resulting in significant damage to the environment and/or harm to human health.
Moderate	Moderate, localised effect on people and/or the environment in the vicinity of the incident.
Low	Minor environmental effect which may breach a regulatory standard but is localised to the point of release with no significant impact on the environment or human health.
Very Low	Slight environmental effect that does not exceed a regulatory standard.

Figure 3 below, shows the risk matrix used.

Likelihood					
	High	Low	Medium	High	High
	Medium	Low	Medium	Medium	High
	Low	Low	Low	Medium	Medium
	Very Low	Low	Low	Low	Medium
		Very Low	Low	Moderate	High
Consequence					

Figure 3: Risk categorisation matrix[5]

The following risk assessment criteria have been used.

Table 3: Risk category definitions

Risk rating	Description
High	Red risks are unacceptable and must be acted upon as a priority and reduced before the project can continue. The level of exposure to the risk is considered to be too high to continue.
Medium	Amber risks must be acted upon, but they do not pose such an immediate threat and thus the project can continue while the risk response measures are integrated and/or performed
Low	Green risks may not require additional responses – it may be effective enough simply to monitor the risk to ensure that it does not arise during the project description.

4.2 Assess the Risk

The process of the risk assessment comprises the following steps:

- Hazard identification
- Assess the consequences
- Assess the likelihood (of the hazard occurring with the described consequences)
- Allocate the current risk level (considering all measures that are already in place)

Risks are prioritised once the risk assessment is complete, in order not to prejudge the significance of particular risk items until sufficient technical assessment has been carried out.

This is the formal process of assessing the likelihood and consequence of the risks identified. Risk allocations take into account embedded mitigation measures (i.e. actions to manage risks already in place, or planned and required to be in place, for the Project to continue). All identified risks were recorded in the ERA register recording the following details against each one:

1. Date risk was raised
2. Project phase risk is associated with
3. Category (section 4.1.2)
4. Source – Pathway – Receptor information
5. Embedded mitigation[20]
6. Record of any other comments to support the risk assessment

A risk register was used in the risk identification and assessment process. A number of risks and issues raised were not unique, and the risk register has been consolidated to reflect this.

Appendix A presents the ‘long list’ of issues recorded during the risk identification phase.

[20] Embedded mitigation measures are those measures which are already in place or planned and integral to the proposed operations.

The final 'short list' of high-level risks, presented in this report, is a simplified list, encompassing all identified risks, generally categorised in terms of a common receptor and a similar pathway, even though the sources may vary. For example, surface spillage is represented by a single risk item(Risk No. 4), which encompasses all possible sources of spillage during the various phases of the proposed operations (11 risks related to spills are included in the 'long list' in Appendix A).

The resulting list of risks was then assessed in relation to the specific site using the industry agreed method as described in section 4.1.3.

4.3 Appraise Risk Management Options

Options appraisal is the process of identifying and selecting the most appropriate risk management strategy given the constraints of the decision-maker[21]. The risk rating described in the previous section allows risks to be prioritised for defining additional mitigation measures, beyond those that are already embedded in the work.

Risk management options, including embedded mitigation, will fall into one of the following categories:

Eliminate Adopt alternative processes in order to eliminate the source of the hazard, or remove the receptor.

Reduce Adapt proposed processes such that either the likelihood or the consequence of the risk event can be reduced.

Isolate Use physical measures to ensure that should a risk event occur, it can be effectively isolated such that there is no pathway.

Control Ensure that appropriate control measures are in place (e.g. fire fighting equipment) so that, should a risk event occur, it can be controlled and managed.

Exploit It is possible that a risk can be exploited in a positive way as the mitigation method can give rise to new opportunities.

4.4 Address the Risk

Risks are addressed including consideration of undertaking measures to fulfil the risk management options identified in the appraisal process. As shown in Figure 2, the four activities required to address the risk are:

- Reduce uncertainty (i.e. reduce limitations of knowledge associated with a risk including any factors that may influence the risk allocation);
- Monitor and survey;
- Report strategy; and
- Mitigate, transfer or accept.

[21] HM Treasury (2003), "The Green Book Appraisal and Evaluation in Central Government. London, UK: The Stationary Office"

Details of studies, data gathering and monitoring will be addressed fully in the Environmental Statement, where some of the uncertainty associated with this high level ERA will be reduced. Detailed measures for addressing specific risks will be presented in the Environmental Operating Standards.

5 Project summary

This section presents a brief summary of the information already presented in:

1. Scoping report (issued to Lancashire County Council on 4th February 2014)[22]
2. Emerging Findings brochure (26th March 2014)[23]

Cuadrilla is applying to Lancashire County Council in its role as the Minerals Planning Authority for planning permission to undertake drilling and testing for shale gas at a site at Preston New Road. Four exploratory wells will be located within the site. The works will involve drilling, hydraulic fracturing and testing the flow of gas from the wells. These are known as exploratory works.

The exploratory works would be temporary. The drilling, hydraulic fracturing and initial flow testing works would last for between two and three years. After this all drilling, fracturing and associated equipment will be removed from the site. There may be a subsequent period of extended flow testing with the site connected to the mains gas pipeline which could last for a further period of approximately two years.

The works would enable Cuadrilla to make an assessment of how much gas could be extracted from the shale rock. In the future, if it is decided to produce shale gas from the site on a longer term basis, this would be subject to a separate planning application to Lancashire County Council.

The works at Preston New Road includes three elements:

1. Exploration and testing activities located on the site
2. An array of 88 seismic monitoring stations positioned around the site to monitor the fracturing process
3. Connection to local gas distribution networks

Separate planning applications subsequent to this ERA report, will be submitted for each works element, although the potential impacts of the three elements have been considered together as part of one Environmental Impact Assessment (EIA). An Environmental Statement, which presents the EIA findings, will be submitted with the planning applications.

The Project will entail the construction of a temporary well pad, landscape bunds and access track, approximately 2.5 hectares (ha) in area (referred to as 'The Site' hereafter), followed by the drilling, hydraulic fracturing and temporary flow testing of up to four exploration wells from the Site. Each of the exploration wells will consist of an initial vertical borehole drilled from surface into the subsurface shale rock, followed by a horizontal wellbore section drilled laterally underground through the shale rock.

[22] Cuadrilla (2014) "Temporary Shale Gas Exploration at Preston New Road, Lancashire: EIA Scoping Report"
[23] Cuadrilla (2014), "Emerging Findings of Environmental Impact Assessment Preston New Road"

5.1 Site location

The Preston New Road exploration well site (the "Site") is located west of the village of Little Plumpton and south-west of the village of Great Plumpton as shown in Figure 4 below. The site would be accessed from a newly constructed road running between the site and the A583.

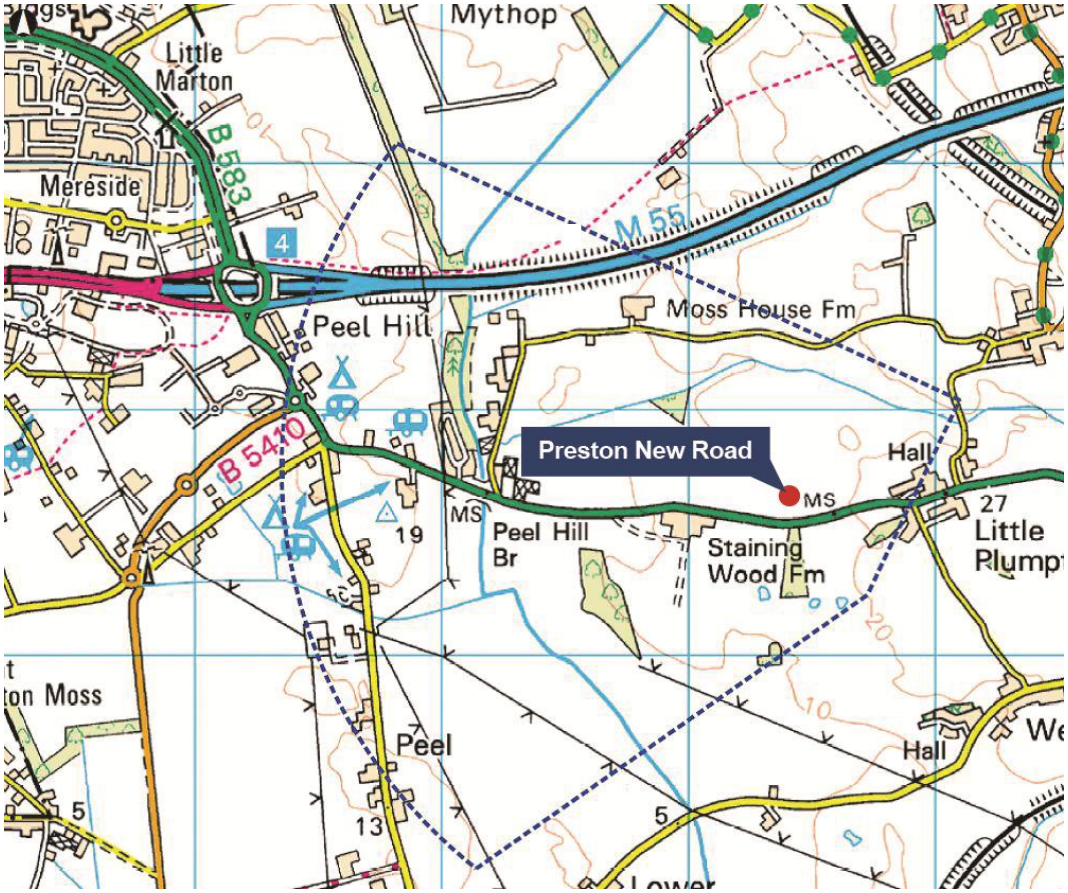

Figure 4: Site location (dashed line shows the maximum extent of below ground drilling)

The site covers 2.5 hectares (ha) of land between Moss House Lane and Preston New Road (A583). The A583 connects to M55 at Junction 4 approximately two kilometres west of the Site. The majority of the area (1.5ha) would be a stone surface known as a wellpad from which the drilling, hydraulic fracturing and flow testing activities would be undertaken. A new 200m access track would also be constructed. The remainder of the site would consist of surface water collection ditches, landscaped bunds and fencing.

The Site is surrounded by agricultural land on all sides. Carr Bridge Brook runs westward along the north boundary of the field upon which the site is located.

There are no known nationally important receptors or designated sites within the proposed site (surface works) boundary.

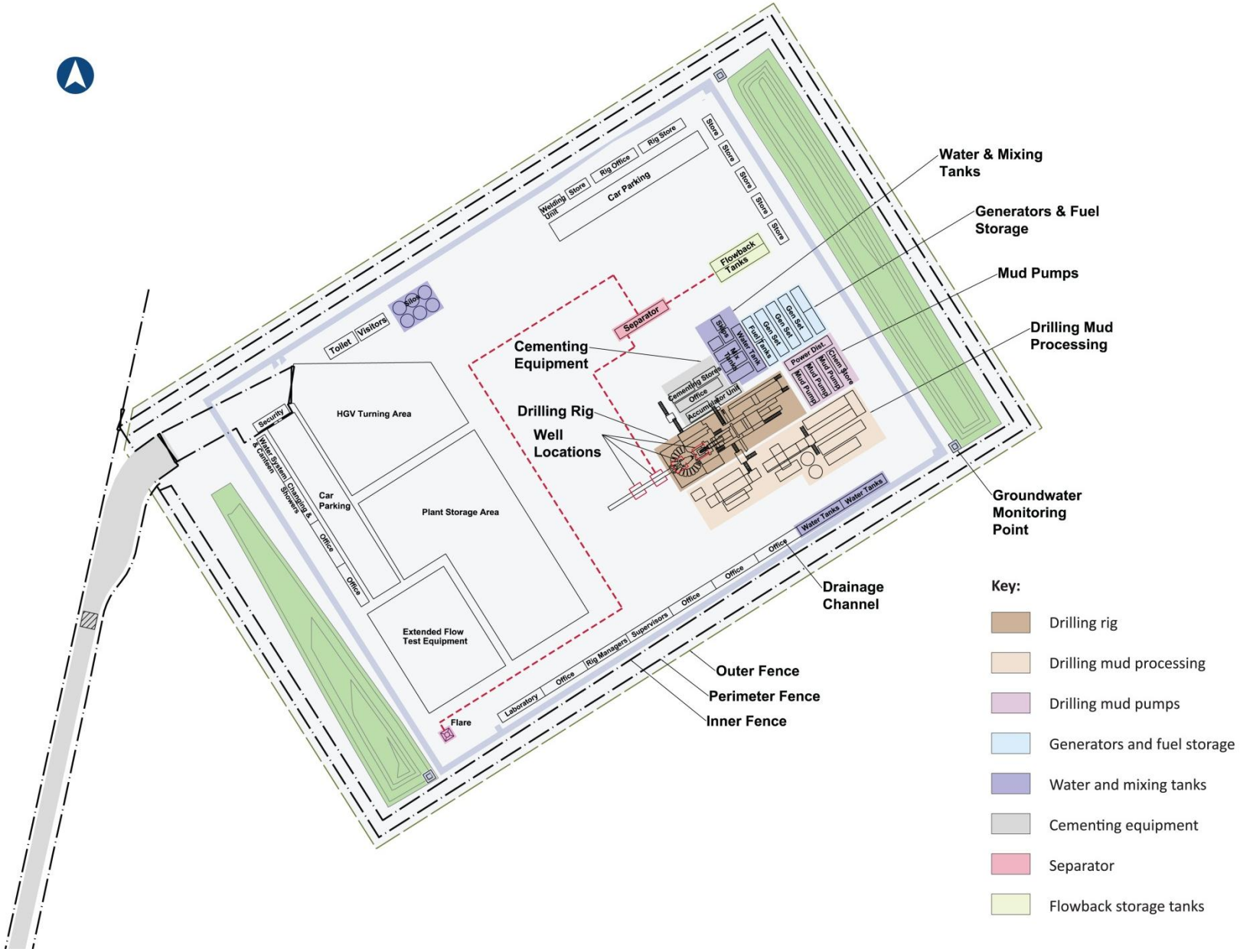

Figure 5: Indicative layout plan – drilling and flow testing

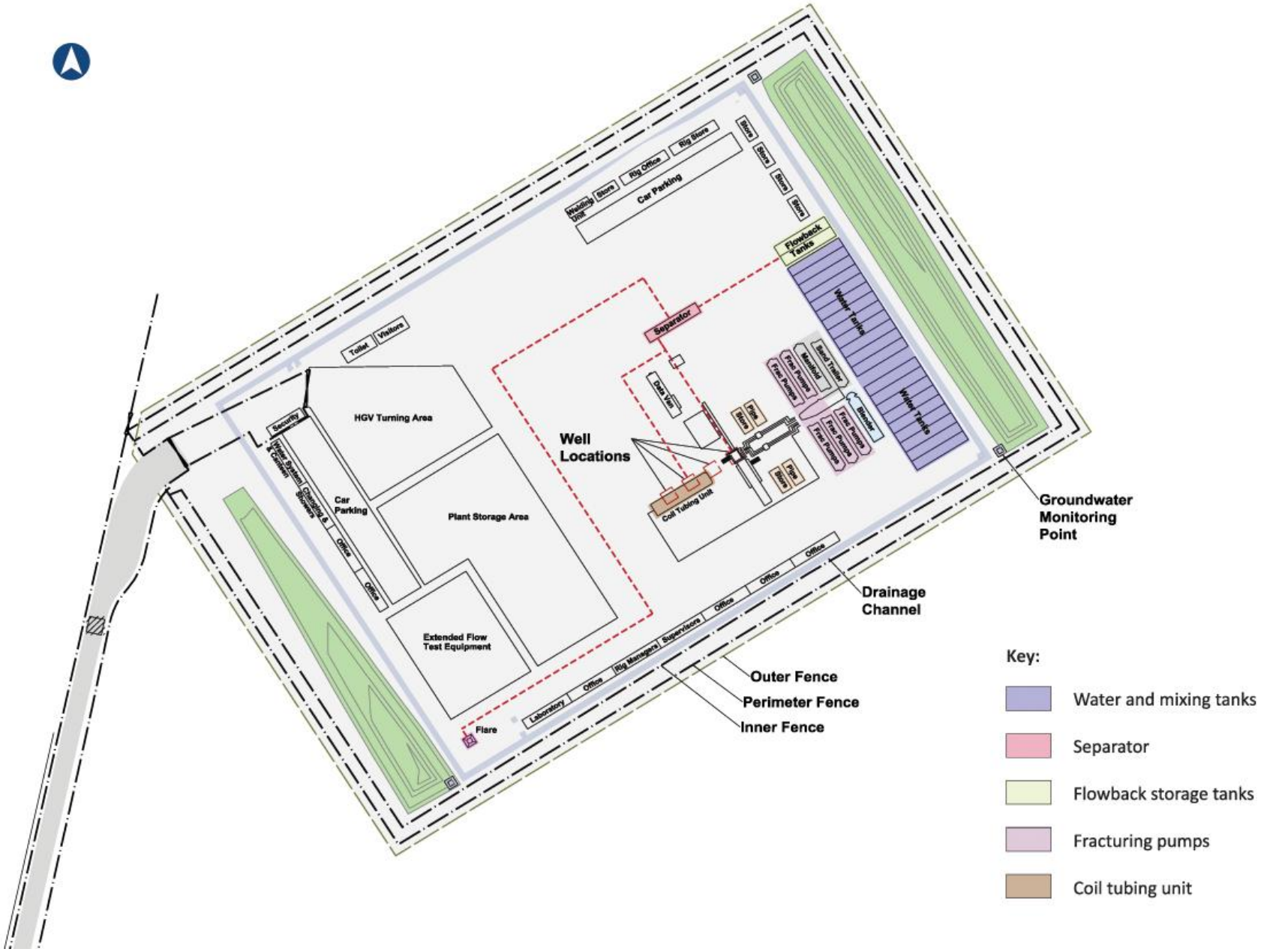

Figure 6: Indicative layout plan – hydraulic fracturing

The Project also consists of below ground works. These extend beyond the footprint of the surface works (as shown on Figure 4).

Key information relevant to this ERA includes:

- A number of small wooded areas and ponds are located in the adjacent fields.
- Moss House Farm is located approximately 800 metres to the north-west of the site, on the northern side of Moss House Lane.
- A couple of hundred metres further along the road is Moss Cottage. About 400 metres to the south-west of the site is Staining Wood Farm.
- A number of residential properties are located approximately 500 metres to the south east of the Site in the village of Little Plumpton and 900 metres to the east in the village of Great Plumpton. Another residential area is situated approximately 1,200 metres to the west at Carr Bridge.
- No statutory ecological designations are located within the proposed development site or within a 3km radius surrounding it. The following designations have been identified within a 10km radius surrounding the site:
    - Marton Mere Blackpool Site of Special Scientific Interest (SSSI) and Local Nature Reserve (LNR) – located approximately 3.2km north-west;
    - Lytham St Annes Dunes SSSI and LNR – located approximately 6.4km south-west;
    - Ribble and Alt Estuaries SPA and Ramsar Site – located approximately 6.7km south;
    - Ribble Estuary SSSI – located approximately 6.7km south;
    - Newton Marsh SSSI – located 8.7km south-east;
    - Morecambe Bay SPA and Ramsar - located approximately 6.7km to the north;
    - Wyre Estuary SSSI - located approximately 6.7km to the north; and
    - Liverpool Bay SPA – located approximately 7.4km to the west.
- There are no listed buildings or Conservation Areas within the 1km radius study area. There are 34 listed buildings within the 5km radius study area. With the exception of Lytham Hall (I) and an associated dovecote (II*) all of the listed buildings within the 5km radius study area are Grade II.
- Two Conservation Areas fall within the wider study area – St Anne's Road East, 4.5kms south west of the site and Wrea Green 2.3km to the south east. Lytham Hall Gardens (Grade II Registered Park) fall partly within the 5km radius study area.

5.2 Geological setting

Again, further details can be found in the Scoping Report[22] and key information relevant to this risk assessment includes:

- The Fylde Peninsula has been shaped by glacial processes to produce a relatively low lying area with limited topographic variation.

- During the Ice Age, successive ice sheets deposited clay with gravel and boulder inclusions (Glacial Till), plus glacial sand and gravel deposits. More recent fluvial and marine processes have further contributed superficial geological deposits including alluvium and tidal flat deposits. Bedrock of Triassic age underlies the shallow superficial deposits and these rocks were eroded considerably during the glaciations.
- The near surface solid geology across most of the western Fylde Peninsula comprises Triassic Mercia Mudstone Group, generally over 100 metres thick, overlying Sherwood Sandstone[24].
- This is in turn underlain by the Manchester Marl which locally forms a seal to underlying hydrocarbon bearing geological units. The Collyhurst Sandstone is the gas reservoir at Elswick gas field in central Fylde, where it immediately underlies the Manchester Marl.
- Beneath the Permian Manchester Marl and Collyhurst Sandstone there are several potentially productive Carboniferous shale gas zones including the Sabden Shales (part of the Millstone Grit Group, the Upper and Lower Bowland Shale and the Hodder Mudstone.
- The Site is located approximately 8km to the west of the Woodsfold Fault, and 1.5 km west of the Thistleton Fault at surface[24]. Further geological interpretation is ongoing and will be presented within the Environmental Statement.
- Three deep boreholes with available geological logs are located within 3.5 km of the site, Mythop (2 km north), Weeton Camp (3.4 km northeast) and Kirkham (6km east).

Figure 8 shows the geological layers through which the wells will be drilled.

5.3 Hydrogeological setting

- Although the superficial deposits are generally clay-rich, there are local water bearing sand and gravel deposits that can support small scale groundwater abstraction and also may locally interact with wetlands and watercourses. The Environment Agency defines these superficial sand and gravel deposits as Secondary A aquifers[25].
- Underlying the superficial deposits, the Mercia Mudstone Group comprises a thick unit of generally low permeability. The Mercia Mudstone Group is defined by the Environment Agency as a Secondary B Aquifer[25], but in this area it is not used and has no potential as a source of groundwater supply due to its hydraulic properties.
- The Sherwood Sandstone Group underlying the Mercia Mudstone Group is defined by the Environment Agency as a Principal Aquifer[25]; however in the Fylde Peninsula (west of the Woodsfold Fault) the Sherwood Sandstone is not used as a source of supply and is very likely to contain saline groundwater of

[24] British Geological Survey (1990), England and Wales Solid Geology 1:50,000, Sheet 67 Garstang.
[25] Environment Agency, (2013). Groundwater protection: Principles and practice (GP3). Version 1.1.

non-potable quality[26]. The nearest Groundwater Source Protection Zone (designated to protect public water supply groundwater abstractions) is in the Sherwood Sandstone Group approximately 10km to the east, beyond the Woodsfold Fault.

- The West Lancashire Quaternary Sand and Gravels Aquifer is a 'groundwater body' across the central Fylde area and is identified as having good quantitative and chemical status and predicted to have good quantitative and chemical status in 2015. This groundwater body is referred to in this assessment as the Middle Sands.

Figure 8 identifies the barriers incorporated in the well design and their relationship to the local geology and hydrogeology.

5.4 Hydrology

- The two main rivers of the Fylde Peninsula are the River Ribble in the south and the River Wyre in the north, both of which flow westwards to the coast. The area surrounding the Site drains to the north and west towards Carr Bridge Brook and a small tributary drain. Carr Bridge Brook is located approximately 200m north of the Site and flows west discharging into Main Drain approximately 1km to the west, which in turn discharges into the Ribble Estuary 6 km south of the site.
- Several small ponds are present in the vicinity of the Site, likely to have been formed by excavation of marl (from Glacial Till) for agricultural soil conditioning mainly in the nineteenth century.
- The small ponds and drains located within agricultural land around the Site are likely to be used for drinking water by livestock and possibly as a source of local irrigation.

[26] Mott MacDonald (1997), "Fylde Aquifer / Wyre Catchment Water Resources Study, Final Report"

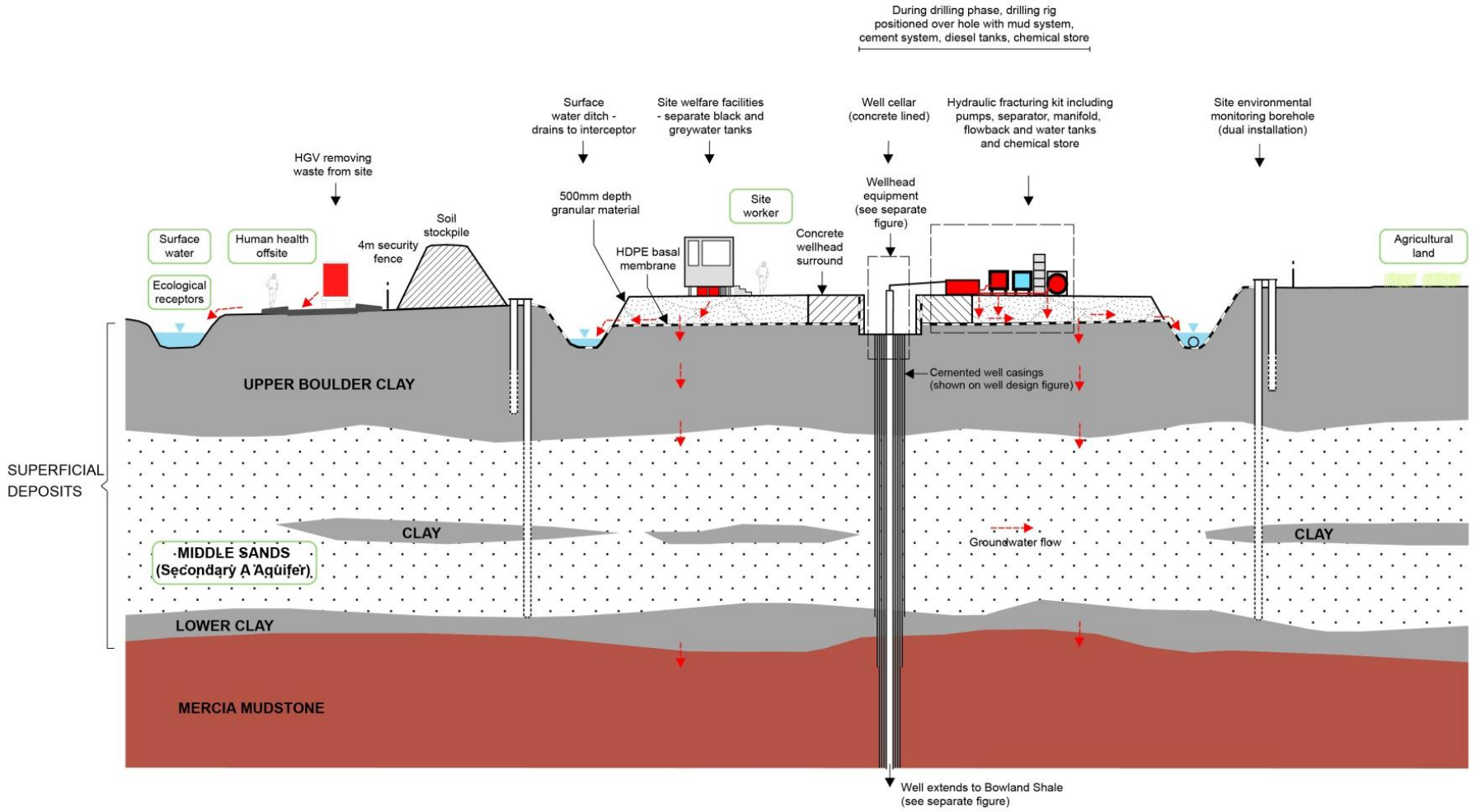

Figure 7: Conceptual model for potential pollutant linkages (red zones show potential sources, white boxes potential receptors, and red arrows the potential pathways).

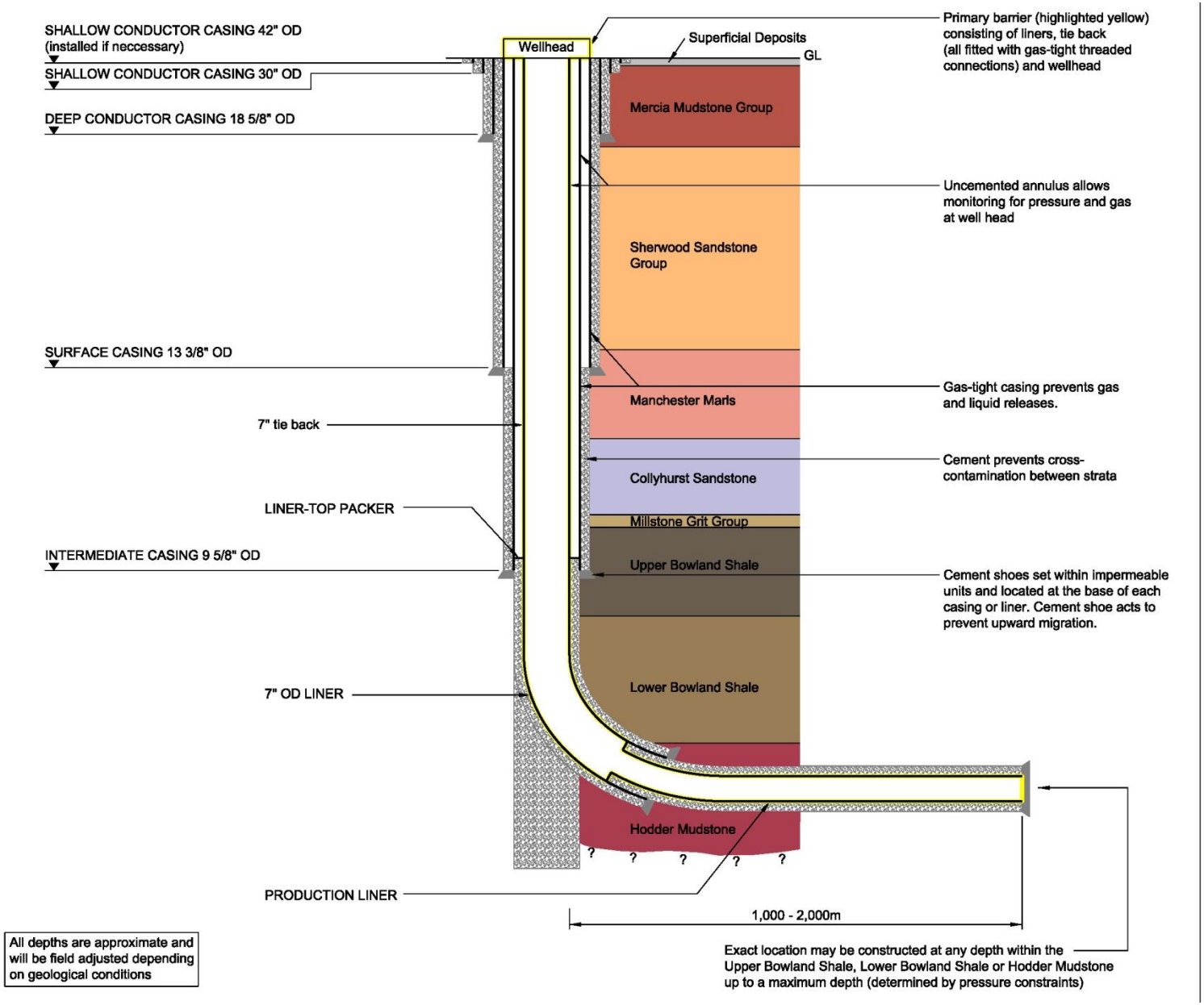

Figure 8: Well Design Section

5.5 Proposed activities

Again, the proposed activities are described in the Scoping Report and key information relevant to this ERA includes:

- Up to 4 exploration wells will be drilled from the Site:
- The first vertical well will be drilled to the base of the Bowland Shale formation to obtain geological data. A horizontal bore may then be drilled from the vertical well into the shale strata at a depth to be selected following analysis of geological information from the vertical well. Hydraulic fracturing will then occur in the vertical and/or horizontal sections of the well bore within the shale formation. Flow testing of gas will follow successful completion of the hydraulic fracturing stages.
- Depending on the well results, up to three further wells will be drilled (first vertically to the desired depth, and then horizontally), hydraulically fractured and flow tested from the well pad. These three wells are referred to in this Environmental Statement as horizontal wells. By drilling more than one well Cuadrilla will be able to hydraulically fracture the shale and test the flow of natural gas from different stratigraphic areas and horizons of the shale. This will provide data to appraise the commercial potential of the Bowland Shale for gas extraction in this part of the licence area.
- Two seismometer arrays will be constructed, one consisting of eight seismometers just below the ground surface (the ‘surface array’), and a second set of up to 80 seismometers located in boreholes up to 100m below ground level (the ‘buried array’).

The proposed development process is summarised in Figure 9.

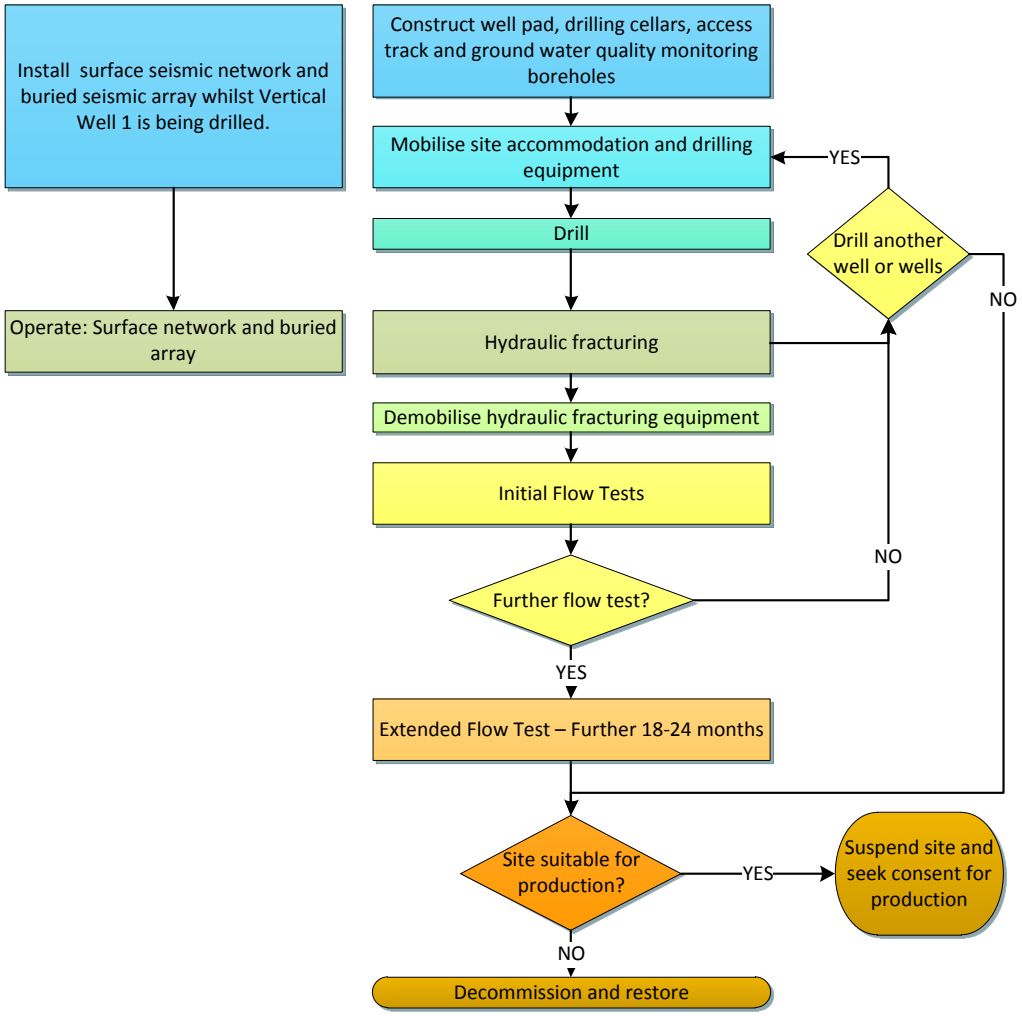

Figure 9: Overview of the exploration works related to the Project

5.6 Use of chemicals

The following information regarding use of chemicals during drilling and hydraulic fracturing has been used for this ERA:

- Two types of drilling mud are under consideration, a polymer drilling mud (primarily water based) and a low toxicity oil-based emulsion mud (LTOBM). In the first instance water based muds will be used, particularly when drilling through the permeable Sherwood sandstone formation. However, there is the possibility that Cuadrilla may wish to use LTOBM, when drilling through the deeper rock formations and once the shallower sections of well have been cased, cemented and barriers are in place to prevent any potential migration of drilling mud into shallower geological zones.

The hydraulic fracturing fluid will consist of:

- **Water** is the predominant constituent in the fluid. It is intended that the water will be sourced from the mains water supply and potentially from recycled flow back water.

- **Silica sand** (proppant) is mixed in with the fracturing fluid at specific stages during a fracturing event to keep the fractures created in the shale wedged open after the hydraulic pressure has been released.
- **Friction reducer** is added to the water to minimise the pressure losses incurred due to friction between the water and the well casings as the water travels several kilometres from surface through the well to the underground shale. The proposed friction reducer is polyacrylamide in a carrier fluid, which is classified as non-hazardous to groundwater by the Environment Agency.

As a contingency, dilute Hydrochloric Acid may be used ahead of hydraulic fracturing as follows:

- **Dilute (10%) Hydrochloric Acid** may be used to dissolve any residual elements of drilling mud remaining in the wellbore and to facilitate entry of the fracturing fluid from openings in the production casing to the body of shale. Approval has previously been granted from the Environment Agency for potential use of dilute hydrochloric acid. The hydrochloric acid would be transported to site and stored at a strength of no greater than 10% in solution, where it is classified as non-hazardous to groundwater. However it has not been necessary at other wells drilled in the licence area to date and it is thus included as a contingency.

Cuadrilla proposes to use a fracturing fluid with a composition consisting of 99.95% water and sand, and 0.05% friction reducer, by volume.

5.7 Baseline data

This ERA precedes the finalisation of the baseline data, which will be presented in the Environmental Statement. However, consistent with the identified risks presented in Section 7, ecological surveys have been undertaken or are underway, and a detailed assessment of the hydrogeological baseline conditions is being carried out.

5.8 Environmental Management and Monitoring Plan

See Section 3.2 for an overview of Cuadrilla's Environmental Operating Standards (EOS) and Environmental Management and Monitoring Plan (EMMP) relating to the Project.

6 Stakeholder engagement

As shown below, two stages of stakeholder engagement have taken place; general (i.e. non site-specific), followed by site specific.

6.1 Non-site specific engagement

Non site-specific community engagement in relation to the licence area of the Fylde was achieved through a number of methods:

- General Environmental Risk Exhibition, including evening public drop-in sessions with ERA information boards and feedback forms (July 2013). 15 members of the consultation team were available to answer questions during the exhibition
- Stakeholder workshops (by invitation) (July 2013). Key stakeholders participated in general risk identification workshops to identify and record risks associated with the Project.
- Following the initial events in July 2013, a total of 167 feedback forms were received. Of these, 135 respondents submitted a standard comments letter prepared by 'Residents Action on Fylde Fracking'. This raised a number of concerns and risks in relation to the different phases of the proposed exploration scheme. 32 respondents submitted individually completed feedback forms.
- Two Public Information Days, including feedback from the General ERA exhibition were held in November/December 2013.
- Stakeholder workshops (by invitation) were also held over these two days, to share feedback and developments with smaller groups.

A total of 69 different issues were identified from the initial feedback forms (July 2013) related to all three Project phases (Figure 10).

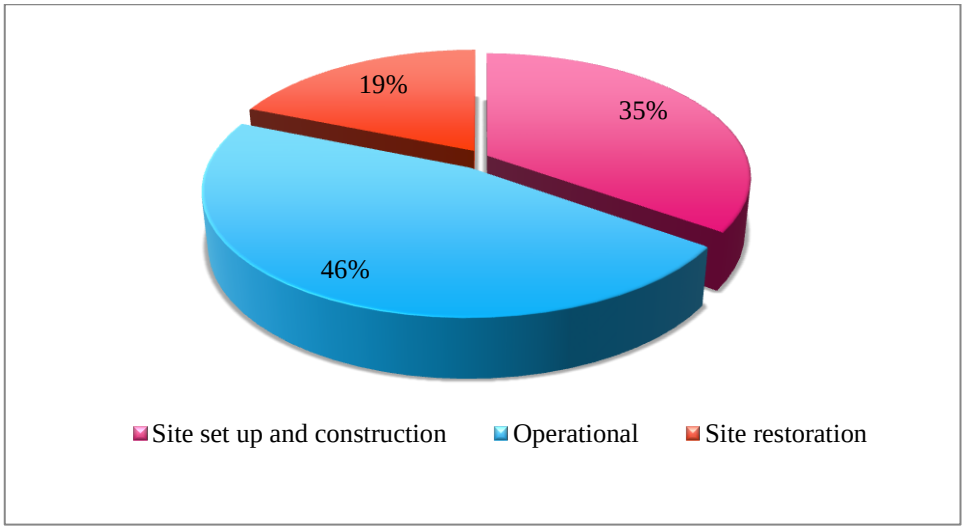

Figure 10: General exhibition feedback - risk by project phase

39 risks and issues were identified in the invited stakeholder workshops in July (Figure 11), with significant overlap with the 69 risks mentioned above.

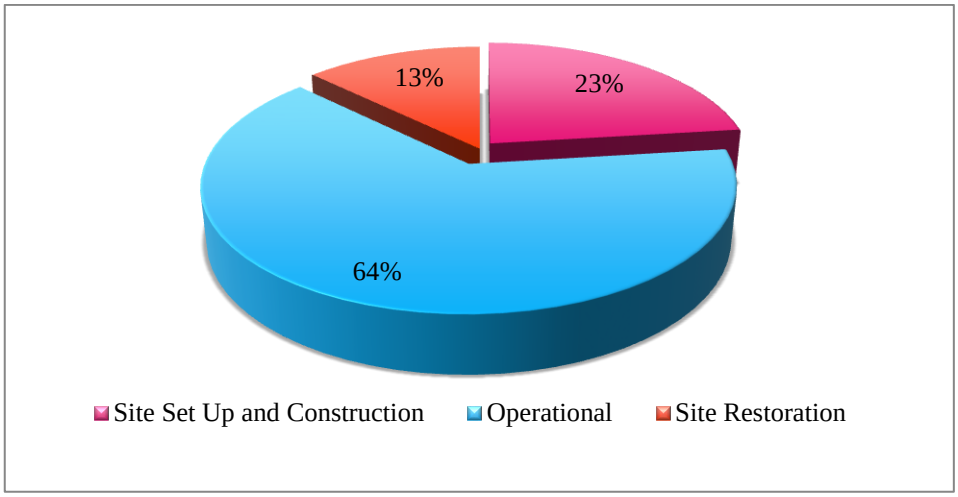

Figure 11: Stakeholder workshop feedback

Information Days in November/December 2013 resulted in a further 19 responses from the public. Feedback received covered a wide range of issues and concerns. Typically, issues related to the following aspects of the proposed works:

- Potential uncontrolled release of chemicals into the ground and the long term effects of them;
- Seismic events arising from operational phase
- The impacts of additional traffic and other site-related noise;
- The visual impact of the sites, and the effect of this on the local area including tourism;
- The long term integrity of the wells and the proposed future use of the sites post-abandonment;
- The water demands associated with the works, and the safe and effective treatment of the wastewater and other waste products;
- The potential 'industrialisation' of the area in the long term;
- The impact of the proposed works on house prices and house insurance; and
- Ecological impacts.

There were also more general concerns raised relating to the need for monitoring and enforcement by independent bodies, the as yet unproven technologies perceived to be used, evidence of poor environmental performance from the US, amongst others.

Particular risk items pertaining to specific aspects of the work included:

- The presence of high pressure gas pipes in the general area, which were perceived to be sensitive to sub-surface movements;
- Specific sites and facilities in the area, including Blackpool Airport, BNFL, BAE at Wharton, the salt mines near Stalmine and the local sewerage system;
- Proximity to designated valuable wildlife sites, Clifton SITA site and local water supply infrastructure;

- The removal of top soil during the site construction which could result in the release of muddy runoff into local watercourses;
- The presence of Naturally Occurring Radioactive Material in the return wastewater and potential negative impact on human health;
- The need for good baseline monitoring of all environmental variables before, during and after the operations; and
- The increased potential for spillages or transportation of contaminants during site set-up and restoration phases, when the amount of supervision and monitoring was perceived to be less.

6.1.1 Concerns and Risk Perception

The feedback received through the stakeholder engagement encompassed all issues related to the proposed activities, most of which are seen as 'risks 'by stakeholders, and indeed this is perpetuated in many published documents as well. To provide more clarity on the scope of this Environmental Risk Assessment, which focusses on assessing the high level risks to the environment and human health arising from unplanned or uncertain outcomes, the issues raised by stakeholders have been categorised as either:

Category	Description	Examples	Relevant Documentation
Risk	An identified hazard and consequence/impact (to the environment or human health) that is not certain to occur. A risk has a likelihood of happening as well as an impact if it does happen. Risk = Likelihood x Impact	Accidents related to increased traffic cause damage to local property and infrastructure, or harm to the local population	The EIA and ES submitted for planning, this ERA, and subsequent risk assessments that will be submitted for permitting.
Impact	An identified hazard that is likely to occur. Mitigation of significant impacts would not consider the likelihood of the event, only their significance.	Increased traffic leads to increased congestion on local roads. Air quality affected by increased traffic and site operations. Visual intrusion of site.	The planned impacts will be comprehensively assessed and covered by the Environmental Impact Assessment and submitted for planning.
Concern	An issue that does not align with the definitions of an environmental risk or impact but is still of local concern. These would include outcomes with no feasible means of occurrence, or those which, if they did occur, would not represent a significant effect on the environment or human health	Will the proposed flare stack interfere with operations at Blackpool Airport? Will there be a visual impact due to power cabling? Potential impact on local property prices.	The Statement of Community Involvement (SCI) will record all issues raised during stakeholder engagement, including concerns, and will include signposting to where stakeholders can find more information.

It is important to note that all risks and impacts raised during stakeholder engagement sessions are being comprehensively assessed. However, the impacts

are more appropriately presented in the Environmental Statement, where there is sufficient level of detail available (e.g. maximum HGV movements, baseline and predicted noise levels) to provide a realistic assessment of the impacts. See also Section 7.1 and 7.2.

6.2 Site specific engagement

Once the proposed exploration site was publically announced on 4th February 2014, additional stakeholder engagement was undertaken to ensure that stakeholders had an opportunity to raise site specific concerns. In general, whilst risk sources would be the same, there may be site specific pathways or receptors to include in the risk assessment.

On the day of the site announcement, a house-to-house door knocking exercise of all residential properties in the immediate vicinity took place. A drop in session was held in the evening at Pipers Height Caravan Park between 3pm and 7.30pm.

A further information event was held on 13th February 2014 to continue to engage with local community stakeholders, provide updates of the work completed and to understand any site specific issues.

Brochures[23] presenting emerging findings on the EIA were circulated on 26th March 2014 preceding a consultation session on 2nd April.

Full details of all the above events and a comprehensive assessment of community engagement will be available in the Statement of Community Involvement (SCI) which will be published as part of the Planning Application submission.

Feedback from the engagement sessions, as well as a follow-up session with representatives from the Westby-with-Plumpton's Parish Council, and Warton and Westby Fylde Borough Council has been considered in this ERA report.

It is expected that discussion of both risks and impacts, and their mitigation, will continue during the current pre-planning consultation period, and that these will inform the final measures for mitigating both risks and impacts, in the Environmental Statement which will accompany the Planning Application.

7 High level Environmental Risk Assessment

This section provides a high level assessment of the summary risks identified by stakeholders, the technical team and in relevant publications. The long list of risks and issues raised is presented in Appendix A. This includes some 124 line items, which are colour coded as to whether they are risks, covered by the 15 'umbrella' risks presented in this section; impacts, covered in detail in the Environmental Statement, or concerns (see also Section 7.2).

The ERA assesses risks over the whole life of the exploration Project. The planned operation activities include:

1. Site preparation
2. Well design, drilling and cementing ('Well design')
3. Hydraulic fracturing activities ('Hydraulic Fracturing')
4. Well testing
5. Well suspension, including management of wastewater ('Well suspension')
6. Well/pad abandonment ('Abandonment')
7. Aftercare and monitoring

For the purposes of this high level assessment, where many risk items can occur during more than one Project stage, the risks are presented according to all phases in which they could occur, and the assessed risk considers the worst case manifestation of the risk, in terms of likelihood of occurrence and severity of impact.

It is important to note that the risks are assessed only once, considering all the planned mitigation measures which are embedded in the Project, i.e. there is no pre- and post-mitigation risk assessment. Controls imposed on the operations by relevant legislation is also considered in the assessment (Section 3.3). This differs slightly from the approach used by the EA[5] and AEA Technology[27], where the unmitigated risk is firstly evaluated and the risk then re-evaluated after inclusion of the relevant legislation and regulations.

7.1 Impacts

As can be seen in Appendix A, the key matters raised during stakeholder engagement sessions, which are categorised as impacts rather than risk events or concerns, relate to:

- The impacts of traffic on local roads, in terms of road condition, congestion and disruption.
- The visual impacts of the proposed sites, and related loss of countryside.
- The impact of the proposed operations on local ecology in terms of disturbance to habitats etc.
- The noise impacts, related to traffic, drilling and hydraulic fracturing.

[27] AEA Technology (2012), "Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe."

- The impact of operations on air quality (exhaust emissions and generators, traffic, flaring etc.).

All these impacts, as well as many others, have been identified in the Scoping Report[22], which confirms that they will be assessed, and the proposed approach for this detailed assessment.

As such, including these within this ERA would not provide any additional information, in that the issues have been identified and a detailed assessment methodology, including data gathering, has already been proposed.

The 'Emerging Findings' brochure (26th March 2014)[23] provides stakeholders with initial findings from the assessment of the key impacts, as well as high level mitigation measures.

7.2 Concerns

As can be seen in Appendix A, there are, inevitably, a number of issues raised during stakeholder engagement which are outside the scope of this ERA. These generally relate to either:

- Activities or aspects of the work which will not be taking place, such as the visual impact of power cabling, or the venting of methane directly to the atmosphere.
- Risks or impacts described in opposition literature, which is not representative of the proposed operations.
- Wider policy concerns about adopting Shale Gas in the UK.
- Issues which relate to perception, that have no direct or measurable pathway to affect the environment or human health, such as property prices.

It is recognised that there are a large number of such concerns, and primary mitigation of these is outside the ERA, but relies on continued communication with all those affected, throughout the process.

7.3 Discussion

Of the 15 risks presented on the following pages, all have been assessed to be 'Low' (see Figure 3 and Table 3). However, within this categorisation, some risks can be assigned lower priority, based on embedded regulatory control and mitigation measures. Those risks which have been assigned lower priority are:

Risk No. 8 Subsidence

Risk No. 10 Water Supply

Risk No. 11 Flood risk

Risk No. 12 Archaeology and local heritage

Risk No. 13 Use of wireline logging tool with radioactive sources

All 15 risks will be carried forward to the EOS and detailed risk management processes are to be developed that will take them into account. These risks will

continue to be monitored over the life of the Project to ensure likelihood or consequence does not change from this assessment's conclusions.

Risk 1 Gas escapes at, or above ground surface	
Source	Naturally occurring ground gas (e.g. methane from Bowland Shale)
Pathway	• Escape of gas from above ground infrastructure on the well pad, due to equipment failure, including of the flare, or human error • Migration of gas to surface via an inadequately sealed well casing, • Leaks from ground processing equipment (e.g. separator, piping) • Potential ignition source coming into contact with gas
Receptor	• Air quality • Climate • Local ecology • Site workers and visitors • Local population
Project Phase	Well design, Well testing, Hydraulic fracturing, well suspension and abandonment
Mitigation Measures embedded in the Project	• The Preston New Road exploration wells will be drilled, constructed and integrity tested in accordance with regulatory guidance (DECC and HSE) and industry guidance (Oil and Gas UK and UKOOG), providing multiple barriers between the shallow groundwater and deep underlying hydrocarbon production zones. Well design will be reviewed by an Independent Well examiner and by the HSE. Well construction will likewise be reviewed by the Independent Well examiner and the HSE. • Cuadrilla HSSE Risk Management Framework • Air quality monitoring (including methane, VOCs and BTEX) will be undertaken. Results shall be submitted to the Environment Agency (EA). The EA can also take its own samples. • Radon monitoring • Use of green completions i.e. closed systems for handling and separating flowback fluid. • Hydrostatic pressure testing of surface pipes and connections • Ground gas monitoring in groundwater monitoring well • DSEAR zoning and ATEX lighting to remove ignition source
Likelihood	Low
Consequence	Low
Risk Score	Low
Justification for Risk Score	Robust well design and quality assured construction is a key mitigation measure. These measures are designed to prevent a continuous pathway from gas bearing strata to the ground surface. There is no intention to vent gas – any significant gases produced during the testing of the well would be flared. Preventative maintenance will reduce likelihood of unplanned failure of equipment on site. This will be managed through the Cuadrilla HSSE Risk Management Framework; appropriate site safety measures will be in place as required under the Health &Safety at Work etc. Act.1974
Comments	Note that air quality impacts associated with traffic operations, site emissions, such as planned flaring are covered in the EIA as this will be a planned outcome from the activity with a low predicted consequence after mitigation.

Risk 1 Gas escapes at, or above ground surface	
	Further qualitative assessment of the risk of fugitive gas emissions will be included in the Environmental Statement. This will include modelling the potential volume of radon gas that could be emitted through the flare stack. Well integrity will be considered in detail in the Environmental Statement. Climate change assessment will be included in the Environmental Statement, and will consider the effects of both direct and embedded emissions associated with the Project.

Risk 2 Uncontrolled release of gas and fluid from the well bore at surface during drilling operations ("Blowout")	
Source	Gas or fluid under pressure in deep rock formations.
Pathway	• Error in well design, error in drilling design, error during drilling, inadequate cementing • Equipment failure
Receptor	• Air quality • Local ecology • Site workers and visitors • Local population
Project Phase	Well design
Mitigation Measures embedded in the Project	• The Preston New Road wells will be drilled in accordance with regulatory guidance (DECC and HSE) and industry guidance (Oil and Gas UK and UKOOG). • Well design will be reviewed by an Independent Well examiner and by the HSE. Well construction will likewise be reviewed by the Independent Wall examiner and the HSE. • Blow-out preventer valve (BOP), Casing pressure testing, Formation integrity testing, Well control and kick detection • Compliance with DSEAR regulations to prevent ignition sources • Trained staff (HSSE Framework) • Crisis management planning
Likelihood	Very Low
Consequence	Moderate
Risk Score	Low
Justification for Risk Score	Cuadrilla's HSSE framework recognised the potential for blowout and extensive measures are in place to both reduce the likelihood and control the impact, using a bow tie analysis approach.
Comments	

Risk 3 Contamination of groundwater from sub-surface sources	
Source	Contaminants and gases in the subsurface: • Drilling fluid, cement • Hydraulic fracturing fluid (including recycled flowback if used) • Flow back fluid • Ground gas • Naturally occurring poor quality groundwater.
Pathway	• Drilling muds lost to the formation during well construction • Poor well integrity creates a pathway to shallow groundwater. • Fractures propagated beyond target zone create pathways for contaminants and ground gases.
Receptor	Primary receptor is shallow groundwater.
Project Phase	All except site preparation
Mitigation Measures embedded in the Project	The Preston New Road wells will be drilled, constructed and integrity tested in accordance with regulatory guidance (DECC and HSE) and industry guidance (Oil and Gas UK and UKOOG), providing multiple barriers between the shallow groundwater and deep underlying hydrocarbon production zones. Appropriate integrity testing will be performed during installation and following installation. Cuadrilla will fully disclose the composition of the proposed drilling and fracturing fluid prior to use and will only use substances assessed and approved for use by the EA. Proposed fracturing fluid contains one chemical additive (friction reducer) and this has previously been classified by the EA as non-hazardous to groundwater. If required to be used a 10% HCl solution has also been previously approved by the EA. Groundwater and ground gas monitoring before during and after operations. Results shall be submitted to the EA, who can also take their own independent samples. Well integrity, depth of target formation (>8,000 feet), and presence of a thick section of low permeability rock (Manchester Marl) above the target shale rock restricts potential upward flow pathway. A Hydraulic Fracturing Programme will be submitted to DECC for review before any fracturing starts. Amongst other things the Hydraulic Fracturing Programme will identify how risks associated with hydraulic fracturing operations will be managed.
Likelihood	Low
Consequence	Low
Risk Score	Low
Justification for Risk Score	In addition to the mitigation measures listed above, there are no groundwater abstraction points in the vicinity of the site. No long term pressure gradient exists to cause fluids to move upwards.
Comments	Groundwater used for public drinking water supplies is located beyond the Woodsfold Fault, several kilometres east of the proposed site, and our assessment is that there is no hydraulic connection to groundwater at the site. No recorded groundwater abstraction within several kilometres of the site. On-going public consultation to determine presence of unrecorded wells.

Risk 3	**Contamination of groundwater from sub-surface sources**
	Further technical detail to be provided in the Environmental Statement which will present a detailed contamination risk. Post abandonment considered in Risk 14.

Risk 4 Spillage of contaminants on site surface causes pollution of surface water, shallow groundwater and/or soil around site.	
Source	Possible spills or releases at the Site of: • Drilling fluids and waste • Fuel and lubricants • Hydraulic fracturing fluid and additives (including recycled flow back if used)* • Flow back fluid • Foul wastewater • Fire fighting foam or water. * indicates specific sources related to Shale Gas exploration as opposed to standard practises for onshore hydrocarbon industry, or other industries where spill risks must be managed
Pathway	Site containment system is breached due to mechanical failure, exceeding containment capacity, fire, vandalism or failure in site management practices. Contaminant reaches receptor by: • Overflow or discharge from Site drainage system into watercourse or infiltration into ground • Fluid jet or spray from high pressure equipment failure.
Receptor	• Surface watercourse (tributaries of the Rivers Wyre or Ribble) • Shallow groundwater • Soil, crops and livestock • Secondary receptors would be humans, flora or fauna coming into contact with contaminated soil or water.
Project Phase	All
Mitigation Measures embedded in the Project	Cuadrilla HSSE Management Framework and Environmental Operating Standards Cuadrilla will fully disclose the composition of the proposed drilling and fracturing fluid prior to use and will only use substances assessed by the EA. Proposed fracturing fluid contains one chemical additive (friction reducer) and this has previously been classified by the EA as non-hazardous to groundwater. If required to be used a 10% HCl solution has also been previously been approved for use by the EA. The proposed site drainage design and well pad containment system comprises a welded HDPE membrane overlain by 300mm drainage stone, draining to perimeter ditches, designed to ensure appropriate containment of the site and operations. Discharge to watercourse during operations and discharge to watercourse via interceptor would only occur with EA approval and prior testing of fluid to be discharged. All potentially polluting materials (e.g. diesel for generators) used on the pad will be stored in suitable vessels in designated locations and will be managed properly. Good on-site management of spills and leaks (e.g. spill kits and trained spill warden; co-ordinated vehicle movement plan; site supervisor and HSE Advisors, drip trays/ secondary containment used to store chemicals, pollution incident plan to identify locations of spill kits and directional flow of spillages). Well maintained equipment with preventative plant maintenance schedule. Cuadrilla bow tie analysis. Pollution incident plan, emergency response and clean-up procedures,

Risk 4 Spillage of contaminants on site surface causes pollution of surface water, shallow groundwater and/or soil around site.	
	secondary containment systems.
Likelihood	Low
Consequence	Low
Risk Score	Low
Justification for Risk Score	The likelihood of this event occurring requires a combination of a spill plus a failure in the containment system (e.g. capacity exceedance due to extreme rainfall, membrane damage or defective drain), not just one or the other. Consequence is Low due the lack of source or mechanism that would result in a large volume release.
Comments	Low permeability Boulder Clay immediately beneath the site and across the surrounding area also offers a level of protection to groundwater. Further technical detail to be provided in the Environmental Statement.

Risk 5 Inadequate management of waste treatment of site waste creates a potential pathway for waste products to enter the environment	
Source	• Foul waste water from Site welfare facilities and general waste • Construction waste • Drilling waste from water-based muds and Low toxic oil-based mud if used • Flow back fluid • Wastewater (rainwater captured by the pad during and outside operation) • Wastewater (foul effluent) • Accumulation of solids containing NORM after separation from flowback fluids These sources are not specific to Shale Gas exploration but standard practices for onshore hydrocarbon industry and other industries requiring treatment of waste
Pathway	Waste from operations is not treated properly by waste management contractor due to human error or accident.
Receptor	Surface water, soils and ecology local to the site Surface water, soils and ecology local to treatment plants.
Project Phase	Site preparation, well design, hydraulic fracturing, well testing, and well suspension
Mitigation Measures embedded in the Project	On reaching the surface all flow back fluids will be passed through an enclosed treatment system that allows solids, liquids, and gases to be separated for optimal waste recovery and management. This process will separate out wastes including residual sand and flowback fluid initially for temporary storage in enclosed and bunded tanks and then subsequent removal to an EA approved licenced waste treatment facility. As per regulatory requirements, a Waste Management Plan will be developed for mining wastes generated by the Project and its implementation regulated by the EA under the environmental permit for a mining waste activity. The Duty of Care (DoC) forms part of the Environmental Protection Act 1990 and associated amendments. The DoC requires waste producers to take all reasonable steps to ensure waste is managed correctly, recovered or disposed in a safe manner, does not cause environmental pollution or harm to human health and is only transferred to a person or persons who are authorised to receive it. Cuadrilla will only engage professional waste management contractors for offsite treatment and/or disposal of waste generated by the Project. Such contractors are required to hold and comply with the necessary waste management permits from the EA.
Likelihood	Very Low
Consequence	Moderate
Risk Score	Low
Justification for Risk Score	Suitable waste treatment management plan and demonstration of DoC is required for an environmental permit licence to be granted. A criterion for selection of waste treatment contractors will be that they should be able to demonstrate a long term track record of treating the materials they have a licence for in accordance with regulatory requirements.

Risk 5 Inadequate management of waste treatment of site waste creates a potential pathway for waste products to enter the environment	
Comments	Cuadrilla shall ensure that all inert materials exported off site are segregated and collected for recycling by a waste management contractor. Where this is not feasible (e.g. lack of space or insufficient quantities of materials) materials shall be recovered through a Materials Recovery Facility (MRF) to divert waste from landfill. Further technical detail to be provided in the Environmental Statement. Note that spillage of waste products on site is covered by Risk No. 4. Some wastes from the drilling process contain low level Naturally Occurring Radioactive Material (NORM). NORM management is not unique to shale gas extraction, as it is common in certain geological formations, including shale.

Risk 6 Spills in transit which pollute local environment	
Source	• Drilling fluids/muds and waste • Fracturing chemicals • Flowback fluid • Waste containing NORM
Pathway	• Vehicle movement to/from site via leaks/drips from transport containment and site soil which has become contaminated and picked up on vehicle tyre tread - spread on roads (fluids, muds) or becomes airborne (gases, powders, particulates) • Road traffic accident off site involving site vehicles causing release of contaminants onto public highway
Receptor	• Surface water and any supported ecology along transit route • Surface soils along transit route • Groundwater along transit route • Human health (from exposure to spilled contaminants)
Project Phase	All
Mitigation Measures embedded in the Project	• Transport Plan, developed in liaison with the local Highways Authority. • Use of specialist vehicles for purpose of material movements • Container maintenance and inspection, and specialist vehicles where appropriate. • Spill kits available on each delivery vehicle • Where appropriate, doubled bunded containers, integrated drip trays within containers • Defined procedures for cleaning up spillage • Competent, experienced and appropriately registered contractors
Likelihood	Low
Consequence	Low
Risk Score	Low
Justification for Risk Score	The likelihood has been assessed as Low rather than Very Low, since industry examples have been recorded. However considering the measures in place the likelihood of spill reaching a receptor is considered Very Low. The potential consequence is Low considering the volume and types of contaminated materials being transported.
Comments	Further technical detail to be provided in the Environmental Statement. Impacts related to the volume of traffic and related noise/air quality are not part of this risk assessment, but will be covered in detail in the ES.

Risk 7 Induced seismic event causes damage to local infrastructure	
Source	Either an engineered fracture or the movement of an existing fault plane.
Pathway	The travel path of the seismic waves from the 'source' to the location of a 'receptor' that could potentially be damaged. The passage of seismic waves through ground is typically modelled using 'ground motion prediction equations' or GMPEs.
Receptor	Physical damage to environment or built environment, including wells. Anxiety to local community related to perception of risk
Project Phase	Hydraulic fracturing
Mitigation Measures embedded in the Project	• A 3D seismic survey has been carried out to provide a detailed characterization of the geology beneath the proposed exploration site. Horizontal wells will not be drilled through, or close to, existing critically stressed regional faults. • Hydraulic fracturing of horizontal wells will be carried out in multiple stages with monitoring between each individual stage. • Reduce volumes of hydraulic fracturing fluids used and flow back between hydraulic fracturing stages; • Monitor background induced and natural seismicity before, during and after the hydraulic fracturing; • Implement the Traffic Light System (TLS) recommended by the Royal Society and Royal Academy of Engineering to reduce scale of risk; and • A comprehensive Hydraulic Fracturing Programme will be submitted to DECC for review and approval before any fracturing starts. Amongst other things the Hydraulic Fracturing Programme will identify how risks associated with hydraulic fracturing operations will be managed. Prior to undertaking hydraulic fracturing activities, all other relevant consents will be obtained.
Likelihood	Low
Consequence	Low
Risk Score	Low
Justification for Risk Score	With mitigation measures in place, particularly the traffic light system, no events greater than magnitude $1.5M_L$ are assessed as likely to occur. The consequences of $1.5M_L$ events are assessed as low. Anxiety related to the perceived risk should be mitigated by the level of detail presented in the ES related to induced seismicity, and the mitigation measures in place.
Comments	Well integrity would only be affected if the displaced fault actually crosses the well. This is not likely to be the case. Only damage to the well above the shale level would be of concern from a well integrity perspective, since the well section in the shale layer is designed to accept gas and does not function as a barrier to gas migration. Further technical detail to be provided in the Environmental Statement, including a quantitative assessment of the ground motion hazard levels. Independent peer review of the work will be undertaken. Significant learnings from the Preese Hall events have led to the development of rigorous embedded measures.

Risk 8 Subsidence of ground related to gas extraction	
Source	Ground subsidence during and post-exploration leads to ground settlement at surface.
Pathway	Extraction of gas by hydraulic fracturing from the Bowland Shale causes subsidence and the ground surface
Receptor	Local infrastructure and properties
Project Phase	Hydraulic fracturing activities, Well testing, Well suspension, well/pad abandonment, aftercare and monitoring
Mitigation Measures embedded in the Project	Unlike coal mining, shale gas production does not remove large quantities of rock from underground, which can cause subsidence. The horizontal wells in the shale will be just 6-8 inches diameter, and the fractures created are equivalent in size to a grain of sand. The characteristics of shale rock means that volume changes due to the extraction of gas are expected to be almost zero. Ground surface is some 6,000ft or more above the shale extraction zone.
Likelihood	No plausible pathway
Consequence	No plausible pathway
Risk Score	Negligible (no plausible pathway)
Justification for Risk Score	The possibility for ground subsidence resulting from the operations, similar to that seen above mines for example, is a cause of concern to the public. However, there is no mechanism for the extraction of gas from shale or the fracturing of the target shale formation to cause subsidence due to the depth of the extraction and the fact that no volume change occurs in the Bowland Shale due to its lack of compressibility. See "About Shale Gas and Hydraulic Fracturing", p18, DECC, December 2013.
Comments	Subsidence remains an area of stakeholder concern, although it has been discounted from a technical perspective. This risk item reflects stakeholder feedback and discussions.

Risk 9 Road traffic accidents involving site vehicles cause damage to local infrastructure, property and/or harm to residents	
Source	Site traffic
Pathway	• Road traffic accidents involving vehicles travelling to or from the Preston New Road site. • Increased vibration from large vehicles. • Deterioration of roads due to change in traffic profile. *Note that this risk is common to very many industries, and not unique to Shale Gas exploration. Normal industry controls will be employed.*
Receptor	• Pedestrians (joggers, cyclists, runners etc.) • Other road users • Local buildings • Local infrastructure
Project Phase	All
Mitigation Measures embedded in the Project	• Cuadrilla Environmental Operating Standards • Traffic Management Plan, developed in liaison with the local Highways Authority. • Design of access from the site on to the highway to include visibility. • Drivers' hours will be managed in accordance with the EU Working Time Directive etc.
Likelihood	Low
Consequence	Low
Risk Score	Low
Justification for Risk Score	Low accident rate on roads planned to be used for site operations. Local accident hot spots will be identified and avoided where practicable. Site traffic will be travelling at low speeds. Peak traffic flows are likely to occur as a result of combined activities at more than one well. This will be mitigated through the site Traffic Management Plan.
Comments	Transportation includes the movement of drilling equipment, fluids, wastes and cuttings. Likelihood of accidents remains the same throughout all site operation phases. Principal site traffic movements are planned to be between 7am and 7pm. This will be agreed through the local planning/highways authorities as part of the planning permission process. The site will be entered through a new opening in the hedgerow on the A583. A wide entrance will be created to allow for the passing of two heavy goods vehicles (HGVs) to avoid waiting and blocking of the main highway. A new access road will be constructed to the site which will be surfaced appropriately to withstand HGV traffic. Mitigation measures to manage and control the movements of HGVs to and from the site will help to mitigate the risk of accidents. Further technical detail to be provided in the Environmental Statement. Deterioration and condition of road surface will be covered as a planning condition.

Risk 10 Local water shortages or reduction of mains pressure caused by the water usage at the site during hydraulic fracturing	
Source	Site operational water demands
Pathway	Hydraulic fracturing water requirements limit the ability of United Utilities to maintain adequate supply to its other customers. Hydraulic fracturing requirements result in over abstraction by United Utilities from surface or groundwater sources in order to meet its supply obligations
Receptor	• Local residents' water amenity provisions • Local and regional environment
Project Phase	Well design (drilling), Hydraulic fracturing
Mitigation Measures embedded in the Project	Estimates of predicted Project water demands have been supplied to United Utilities (UU) to allow them to assess their existing systems and any impacts on their wider network. In the event of any constraint, water supply to the site would be limited by UU rather than limiting supplies to existing customers. Where possible, site water storage vessels to be filled outside of peak demand times.
Likelihood	Very Low
Consequence	Low
Risk Score	Low
Justification for Risk Score	Water resource availability and is managed by UU in line with its duties under the Water Industry Act 1991 to maintain adequate supply to domestic customers and the EA also has a role in approving water resources plans produced by water undertakers and in regulating the sustainability of abstraction licensing. At regional scale (within the UU 'Integrated supply' zone), the peak daily water demands anticipated during drilling and hydraulic fracturing operations are only a small proportion of the daily headroom figures available (a term used to define the quantity of water that is not already allocated for use within the water supply network). The score is based on the most onerous stage of the operations. It does not take into account external events such as extreme weather events that may occur. In the event of a prolonged drought UU would restrict and potentially cut off supplies to the Site before domestic supplies would be affected and/or seek permission from the EA in the form of a drought order to increase its permitted levels of abstraction. UU may also have recourse to other water undertakers to call for a bulk supply to be made to it. United Utilities have assessed capacity at the proposed point of connection for the project water supply, and confirmed the network has capacity to accommodate all flow rate scenarios with no impact to local water supplies.
Comments	Further technical detail to be provided in Environmental Statement. The north west of England is not an area of limited water resource. Water abstraction by Cuadrilla is not part of the Project.

Risk 11 Increased risk of flooding due to site operations	
Source	Increased risk of flooding due to change in land use at site increasing impermeable area, or from increased storm runoff leaving the site *This risk is not unique to Shale Gas exploration and would be considered with any proposed development*
Pathway	• Overland flow, local field drainage ditches and watercourses
Receptor	• Local property • Local infrastructure • Local agricultural land and supported ecology
Project Phase	All
Mitigation Measures embedded in the Project	Well pad drainage design, perimeter containment ditches and well pad liner act to manage, attenuate and limit the runoff leaving site such that peak flows are not increased beyond pre-developed 'greenfield' levels. The well pad is designed to achieve this for all return periods up to and including the 1 in 100 year storm event (1% annual probability of occurrence) making an allowance for future climate change. Cuadrilla HSSE Framework will address mitigation measures should a short period of very intense rainfall occur, which may include shutting the site temporarily should drains be overloaded.
Likelihood	Very Low
Consequence	Moderate
Risk Score	Low
Justification for Risk Score	The proposed site lies within The Environment Agency's designated 'Flood Zone 1' and is therefore at very low risk of fluvial flooding. The well pad has 300mm deep layer of stone which will provide storm water attenuation, and perimeter ditches to store storm water. The site is considered unlikely to be affected by sewer flooding because there are no foul sewers on site and the all foul water will be removed from site to an appropriate waste water treatment works. It can be concluded that the development will not increase flood risk either on or off-site as result of development proposals.
Comments	Further technical detail to be provided in the Environmental Statement. A site specific Flood Risk Assessment will be submitted with the planning application and this will contain a quantitative assessment of runoff. Cumulative effect of multiple sites on increasing flood risk should be considered in future risk assessments.

Risk 12 Loss of heritage through damaging unknown archaeological artefacts at site location, or known listed buildings due to an offsite accident	
Source	Unknown archaeological artefacts damaged by site traffic and operations. *This risk is not unique to Shale Gas Operations and should be considered for any proposed development.*
Pathway	• Site activities damage archaeological artefacts
Receptor	• Loss of local heritage • Local community • Local infrastructure
Project Phase	Site preparation
Mitigation Measures embedded in the Project	None required at this stage Sites are selected as having no known heritage status.
Likelihood	Low
Consequence	Low
Risk Score	Low
Justification for Risk Score	The County Council planning archaeologist has approved the methodology proposed to mitigate any direct effects on heritage It is possible that archaeological remains could be found at the site. However, it is not thought that these will be of more than local significance or substantial in scale.
Comments	Likelihood score can be refined by further research activities which are part of the planning application process. The effects deriving from the construction activities at the well pad and along the access route can be mitigated by implementing a programme of archaeological works which would seek to preserve and record any remains within those areas where excavation is proposed. Further technical detail to be provided in Chapter 7 of the Environmental Statement. Further assessment of this issue will be undertaken as part of the EIA, including a desk based review to provide a robust baseline for the assessment. Sources used will include: • The Lancashire Historic Environment Record; • National Monuments Record; • Lancashire Historic Landscape Characterisation; • Northwest England Archaeological Research Framework; • Lancashire Record Office for historic maps and local history publications; and • Published and online resources such as the Victoria County History.

Risk 13 Dust particles from proppants are either inhaled or released into air	
Source	Proppants (sand) brought to site for fracturing operations
Pathway	Release of sand particles during mixing and storing
Receptor	• Air quality • Site workers and visitors to site • Local population
Project Phase	Hydraulic fracturing
Mitigation Measures embedded in the Project	Cuadrilla HSSE Risk Management Framework and Cuadrilla Environmental Operating Standards will present appropriate procedures for the storage, handling and transfer of particulate materials including proppant. Sand stored in enclosed containers so potential pathways are limited. All proppant containers will be double bunded and sealed to prevent unplanned release of materials. Transfer of sand from vehicles to storage bins in enclosed connections Documented process for transferring raw materials to on site storage bins. Weekly visual inspection of storage facility integrity. Air quality monitoring around the site including PM10 and PM2.5, dust nuisance. Occupational health monitoring
Likelihood	Very Low
Consequence	Low
Risk Score	Low
Justification for Risk Score	It is very unlikely that the particulate matter will reach local off site receptors.
Comments	Nearest residential location several hundred meters from the site. May be a pathway if not enclosed; the risk of it becoming airborne and travelling a long distance to human receptor is low.

Risk 14 Lack of long-term well integrity leads to contamination of groundwater due to migration of gas or contaminants post-abandonment	
Source	Ground gases, residual drilling fluid and hydraulic fracturing fluid remaining in the well and the target formation, naturally occurring poor quality groundwater
Pathway	• Migration of gas or contaminants via the plugged and abandoned well due to loss of well integrity. • Migration of contaminants via induced fractures to shallow groundwater
Receptor	Shallow groundwater and users of groundwater. Air quality
Project Phase	Well suspension and post well abandonment
Mitigation Measures embedded in the Project	The Preston New Road wells will be drilled, constructed and integrity tested in accordance with regulatory guidance (DECC, HSE and EA) and industry guidance (Oil and Gas UK and UKOOG), providing multiple barriers between the shallow groundwater and deep underlying hydrocarbon production zones. Wells will be plugged and abandoned in accordance with Oil & Gas UK guidelines, BSOR regulations and Environmental Permitting Regulations Groundwater, methane emissions and ground gas monitoring will be undertaken post abandonment and regulated by the EA through the environmental permit prior to its surrender. Cuadrilla will fully disclose the composition of the proposed fracturing fluid prior to use and will only use substances assessed and approved by the EA. As part of the site decommissioning process, aftercare operations and monitoring will be agreed with relevant regulatory stakeholders. The aftercare operations and monitoring will be performed in accordance with regulatory requirements at the time when site decommissioning is performed.
Likelihood	Low
Consequence	Low
Risk Score	Low
Justification for Risk Score	The well abandonment process is well established for both onshore and offshore, requiring notification to HSE and in accordance with HSE, industry and DECC well abandonment best practice. There is no post-abandonment pressure gradient to cause residual fracturing fluid to travel upwards from fractured zone at over >8,000feet depth to near surface. Natural geological barriers (e.g. Manchester Marl) are present.
Comments	Details of restoration of the site will be part of the planning application. The site will be restored to agriculture with aftercare period agreed with the landowner and planning authority. Further technical detail to be provided in the Environmental Statement which will present a detailed contamination risk assessment.

Risk 15 Radioactive emissions from borehole wireline testing materials	
Source	Wireline testing tool uses a radioactive source.
Pathway	Ionising radiation release
Receptor	Site personnel
Project Phase	Well design, drilling and cementing
Mitigation Measures embedded in the Project	Authorised contractor owns and operates the equipment. Cuadrilla qualified Radiation Protection Supervision staff will oversee contractor's operations. Cuadrilla HSSE Framework Radiological protection advisor
Likelihood	Very Low
Consequence	Low
Risk Score	Low
Justification for Risk Score	Similar operations have been undertaken by the [onshore] oil and gas industry numerous times over a long period of time. Exposure time is very short and only operators who are very close to the source would be affected. Logging sources are shielded and only un-shielded by trained operators for up to 2 minutes during insertion/removal of the tool from the well. There is nothing new about this practice, and it is not unique to Shale Gas operations or to onshore hydrocarbon operations.
Comments	These operations require careful planning and risk assessment in accordance with permits, and appropriately and qualified operators.

8 Summary

This report presents an environmental risk assessment (ERA) for the proposed shale gas exploration at Preston New Road, Lancashire. The objective of the report is to demonstrate, in advance of the detailed planning application and accompanying Environmental Statement, that risks to the environment and human health have been robustly identified and have or will be robustly assessed and that mitigation measures have been defined which will be fed into the Project development.

The report presents a summary of the proposed operations and goes on to describe Cuadrilla's environmental risk management structure, which is designed to assure the safe and environmentally responsible management of the exploration operations over their entire life cycle.

Stakeholder engagement has been undertaken over a period of 9 months to understand the areas of particular concern in the local community, and the identified risks reflect these concerns as well as published documentation and internal risk identification.

Concerns raised by external stakeholders do not always align with the scope of this report, which is to assess significant potential risks to the environment and human health associated with uncertain or unplanned events. Therefore the full list of concerns has been filtered and organised using the following definitions:

Risk	An identified hazard and consequence (to the environment or human health) that is not certain to occur i.e. there is a likelihood of realisation of the risk;
Impact	A planned outcome from the proposed operations.
Concern	An issue that does not align with the definitions of an environmental risk or impact but is still of local concern.

This report presents a high level assessment of the key risks that have been raised relating to the proposed exploration. A total of 15 high-level risks are presented. A high-level risk is one which encompasses a number of individual specific risks which all have similar pathways and receptors. Risks have been assessed using the risk matrix and definitions presented by the EA[5].

The assessment allows for embedded mitigation measures that will be in place as part of the design of the Project.

All 15 risks are assessed to be Low, considering the mitigation measures already embedded as required by the regulators and planning authorities and those intended to be incorporated into the Project and/or in place as part of Cuadrilla's working practices. This assessment also takes into account the specific features of the site and the temporary nature of the proposed exploration works.

9 References

4NW (2010), "Updated Regional Waste Strategy for England's North West"

AEA (2013) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe.

British Geological Survey, 1990, England and Wales Solid Geology 1:50,000, Sheet 67 Garstang.

Broderick, J., Anderson, K., Wood, R., Gilbert, P., Sharmina, M., Footitt, A., Dlynn, S. & Nicholls, F. (2011) Shale Gas: an updated assessment of environmental and climate change impacts

Center for Energy Economics and Policy (2013) Risk Matrix for Shale Gas Development

CIWEM (2014) "Shale Gas and Water: an independent review of shale gas exploration and exploitation in the UK with a particular focus on the implications for the water environment"

Communities and Local Government (March 2012), "National Planning Policy Framework"

Cuadrilla Bowland Limited (2012) "A Description of Arrangements of Disposing of Radioactive Wastes"

Cuadrilla Bowland Limited (2014) "Emerging Findings of the Environmental Impact Assessment - Preston New Road"

DECC & AMEC (2013) "Strategic Environmental Assessment for Further Onshore Oil and Gas Licensing – Environmental Report"

DECC (2012) "Strategy for the Management of Solid Low Level Radioactive Waste from the Non-Nuclear Industry in the United Kingdom"

DECC (2013) "Onshore oil and gas exploration in the UK: regulation and best practice"

DECC (2014), "Environmental legislation applicable to the onshore hydrocarbon industry (England, Scotland and Wales)", available as 'onshore_leg_1.doc' from www.gov.uk (last accessed 10/04/14)

DEFRA and Cranfield University (2011) "Guidelines for Environmental Risk Assessment and Management: Green Leaves III"

DEFRA (2011) "Government Review of Waste Policy in England in 2011"

DNV (2013) Risk Management of Shale Gas Developments and Operations

The Environment Act 1995

Environmental Protection (2011), "England and Wales The Waste (England and Wales) Regulations".

Environment Agency (2012) "Position Statement: Regulating the recovery of drilling muds", MWRP PS 037 Version 1

Environment Agency (2013) "An Environmental Risk Assessment for shale gas exploratory operations in England"

Environment Agency (August, 2013), "Onshore oil and gas exploratory operations: technical guidance, Consultation Draft"

Environment Agency (2013) "Groundwater protection: Principles and practice (GP3)", Version 1.1

The Environmental Protection Act 1990 Chapter 43.

European Commission (2008) Revised Waste Framework Directive.

Krupnick, A., Gordon, H. & Olmstead, S. (2013) Resources for the Future (RFF) Pathways to Dialogue: What the experts say about the environmental risks of shale gas development

HM Treasury (2003), "The Green Book Appraisal and Evaluation in Central Government. London, UK: The Stationary Office"

Cuadrilla (2014) "Temporary Shale Gas Explorations at Preston New Road, Lancashire – EIA Scoping Report"

Mott MacDonald (1997) "Fylde Aquifer / Wyre Catchment Water Resources Study, Final Report"

Oil and Gas UK (2012a), "OP069 - Well Integrity Guidelines, Issue 1"

Oil and Gas UK (2012b), "OP071 - Guidelines for the suspension and abandonment of wells, Issue 4"

Oil and Gas UK (2012c), "Guidelines on qualification of materials for the suspension and abandonment of wells, Issue 1"

Public Health England (PHE) (2013) "Review of the Potential Public Health Impacts of Exposures to Chemical and Radioactive Pollutants as a Result of Shale Gas Extraction: draft for comment"

The Radioactive Substances Act (1993) (RSA93)

Royal Society & Royal Academy of Engineering (2012) "Shale gas extraction in the UK: a review of hydraulic fracturing"

UKOOG (2013), "UK Onshore Shale Gas Well Guidelines: Exploration and Appraisal Phase"

UKWIR (2014) "Understanding the potential impacts of shale gas fracking on the UK water industry"

Appendix A

Long List of Stakeholder Comments

A1

Key:

White cells – risks (unplanned events) synthesised within the risks presented in Section 7

Blue cells – impacts (planned outcomes) assessment of these will be presented in the Environmental Statement

Grey cells – concerns raised by stakeholders. These are included to record additional issues raised during our discussions with local stakeholders

Long list of issues identified through technical workshops, literature review and stakeholder engagement

Unique ID	Date raised	Project phase	Category	Descirption (from feedback forms, technical publications, project workshops etc.)	Source	Pathway(s)	Receptor	Signpost
001	16/07/13	All except site preparation	Hydrogeology & Contamination/Ecology	Contaminants (fluid or gas below ground) migrate into strata other than Bowland Shale	Contaminants and gases in the sub-surface	Poor well integrity or fracture propagation	Shallow groundwater	See Risk #3 in ERA, will be covered in ES chapter on Hydrogeology and Ground Gas
002	16/07/13	Hydraulic fracturing	Induced seismicity	Induced seismic event caused by hydraulic fracturing causes damage to local critical infrastructure (e.g. schools, hospitals, hazardous industries, airport, existing power stations, local COMAH sites, bridges, pipelines/utilities)	Hydraulic fracturing induces a seismic event	Ground vibration travels through rock and surface material between event location and receptor	Local critical infrastructure	See Risk #7 in ERA, will be covered in ES Chapter on Induced Seismicity
003	16/07/13	Hydraulic fracturing	Induced seismicity	Induced seismic event caused by hydraulic fracturing causes damage to local properties	Hydraulic fracturing induces a seismic event	Ground vibration travels through rock and surface material between event location and receptor	Local properties	See Risk #7 in ERA, will be covered in ES Chapter on Induced Seismicity
004	16/07/13	Hydraulic fracturing	Induced seismicity	Induced seismic event caused by hydraulic fracturing causes distress to local community - anxiety, drop in house prices, increased insurance premiums	Hydraulic fracturing induces a seismic event	Rock and surface material between event location and receptor	local community	House prices not covered within ERA or ES, as this is an issue of perception rather than a measurable impact. Insurance premiums are not expected to be impacted. Anxiety is covered in the ERA. Communication to mitigate anxiety.
005	16/07/13	All except site preparation	Induced Seismicity / hydrogeology & contamination /air quality	Seismic event (caused by hydraulic fracturing or naturally) causes damage to well integrity - and hence release of gas and/or fluid above or below ground	Induced seismicity as a result of hydraulic fracturing or naturally occurring event	Compromised well integrity provides pathway for fluid or gas	Groundwater in principal aquifer and Sherwood Sandstone. Atmosphere	See Risk #3 and #7 in ERA, ES chapter on Hydrogeology and Ground Gas will also cover Well Integrity
006	16/07/13	Hydraulic fracturing	Induced Seismicity / hydrogeology & contamination /air quality	Induced seismic event caused by hydraulic fracturing causes damage to sensitive equipment on site which leads to release of material/fluid as per other risks	Hydraulic fracturing induces a seismic event	Rock and surface material between event location and receptor	Sensitive equipment on site	There is no equipment planned for use on site that is sensitive to the small vibrations caused by earth tremors
007	16/07/13	All	Hydrogeology & Contamination	Damage to impermeable membrane (e.g. fire or penetration/puncture) combined with on site spillage	fire, accident, human error + spillage	Permeation of fluids at surface	Surface water and soil, local water courses	See Risk #4 in ERA and will be covered in ES Chapter on Hydrogeology and Ground gas
008	16/07/13	All	Air quality	Exhaust emissions (particulates and nitrogen oxides) caused by increase in HGV traffic	Vehicles transporting equipment to site	Airborne	Local air quality	Will be covered in ES Chapter on Air Quality. There is no 'unplanned' aspect to this therefore outside the scope of the ERA.
009	16/07/13	All	Air Quality	Emissions from generators	Diesel generators	Airborne	Local air quality, carbon emission	ES for details of air quality and greenhouse gas emissions. There is no 'unplanned' aspect to this therefore outside the scope of the ERA.
010	16/07/13	Well testing	Air Quality	Emissions from flaring causes reduction in local air quality	Emissions from flaring activities	Airborne	Local Air quality	Will be covered in ES Chapter Air Quality. There is no 'unplanned' aspect to this therefore outside the scope of the ERA.
011	16/07/13	Well design, Hydraulic fracturing, Well testing	Lighting / Noise	Flaring & other activities cause light and noise pollution, affecting local population	Flaring during flow testing, lights on site	Distance between well and local properties	Local community	Noise and Landscape and Visual Amenity will be covered in the ES. There is no 'unplanned' aspect to this therefore outside the scope of the ERA.
012	16/07/13	Well testing	Ecology	Flaring has negative impact on local ecology (e.g. bats & invertebrates)	Flaring during flow testing	Light & noise created by flaring	Local flora & fauna	See ES Chapter on Ecology. There is no 'unplanned' aspect to this, therefore outside the scope of the ERA
013	19/07/13	Well design (drilling)	Hydrogeology & Contamination	Drilling fluids lost to formation following or during well construction	Drilling fluid	Migration from bore hole into formation via ground water flow	Groundwater	See Risk #3 in ERA, will be covered in ES Chapter on Hydrogeology and Ground Gas
014	19/07/13	Site preparation, well design (drilling), Hydraulic fracturing	Water resources	Water shortages in surrounding area as a result of high water demands of hydraulic fracturing process leading to drop in mains pressure, affect local residents' water supply or contribute to a hosepipe ban in dry periods	Water resource requirements of hydraulic fracturing and drilling	Local water supply network	Amenity of local residents and local environment	See Risk #10 in ERA, will be covered in ES chapter on Water resources and flood risk
015	19/07/13	Site preparation, well design (drilling) Hydraulic fracturing	Water resources	Wider regional water shortage, even if mains supply not used, caused by balance of water abstracted for project use.	Water resource requirements of hydraulic fracturing	Insufficient water availability	Amenity of local residents and local environment	See above, but there is no plan to abstract water
016	19/07/13	Well design (drilling)	Hydrogeology/Ecology	Uncontrolled release of gas and fluid from well bore during drilling	Ground gas at high pressure	Blowout during fracturing leads to uncontrolled release	Safety of site staff, ground & surface water, local flora and fauna, farmland	See Risk #2 in ERA, will be covered in ES Chapter on Hydrogeology and Ground Gas
017	19/07/13	All	Traffic	Damage to other road users, local buildings, structures, ecology as a result of HGV collision near site	Increased HGV movement	Collision on or near site	Pedestrians, road users, local buildings, structures (fencing, signage etc.) or ecology (hedgerows, trees etc.)	See Risk #9 in ERA, will also be covered in ES Chapter on Traffic and transportation
018	19/07/13	Well suspension, well abandonment and aftercare	Induced Seismicity / hydrogeology & contamination	Ground subsidence post-exploration leads to migration of contaminants	Removal of ground gas	Subsidence damages local structures	Local properties	See Risk #7 in ERA and ES Chapter on Induced Seismicity
019	19/07/13	All	Traffic	Increase in HGV traffic leads to congestion or requirement to alter local road network, resulting in loss of amenity for residents	Additional HGV traffic in local area	Insufficient capacity of current network leading to congestion or requirement for change	Amenity of local residents	Will be covered in ES Chapter on Traffic and transportation, there is no 'unplanned' aspect to this issue, therefore outside the scope of the ERA
020	19/07/13	All	Community	Workforce presence has negative impact on community	Site workforce	Increased congestion, antisocial behaviour, disturbance to local business etc.	Amenity of local residents	Will be covered in ES Chapter on Community Impact, this is outside the scope of the ERA
021	19/07/13	Hydraulic fracturing	Induced seismicity	Induced seismic event as a result of geological disposal of fracturing fluids, as per US where return fluids are disposed of in surrounding rocks				Geological disposal of flow back is not part of the proposed operations
022	20/07/13	Hydraulic fracturing, Well testing, Well suspension	Waste	Wastewater treatment facility does not have safe working practice and material is released at that location	Treatment of flow back at a water treatment plant	Accident or human error causes spillage	Local environment and water courses around water treatment facility.	See Risk #5 in ERA, will also be covered in ES Chapter on resources and waste
023	24/07/13	Site preparation	Hydrogeology & Contamination	Uncontrolled release of contaminants prior to bunds, lagoons being fully operational	Contaminants stored on site	Storage failure, plus rainfall run off	Surface soil and surface water around pad	Operations would not take place before site is fully established.
024	24/07/13	Site preparation	Ecology	Removal of topsoil and other construction activities releases runoff into local watercourses	Mud & soil on site,	Surface runoff	Local watercourses (2 known on/ around site)	Will be covered in ES Chapter on Ecology, there is no 'unplanned' aspect to this issue, therefore outside the scope of the ERA
025	24/07/13	All	Community	Loss of farmland / negative impact on quality of agricultural land	Contaminants on site, noise, vibrations	Runoff or proximity to site	Local farmland	Risk of contaminants reaching surface soil or surface water, through spillage or escape into atmosphere is covered in ERA Risks #1 and #4. Loss of farmland is considered in the assessment and mitigation of this risk.
026	24/07/13	All	Visual impact	Loss of countryside / visual impact	Site buildings & equipment	Visual impact	Local amenity	Will be covered in ES Chapter on landscape and visual amenity. There is no 'unplanned' aspect to this, therefore outside the scope of the ERA.
027	24/07/13	All	Community	Shale gas exploration results in residents being unable to obtain home insurance and a reduction in property values	Shale gas exploration in the area	Negative perception of impacts of work	Local amenity	The ERA/ES do not address public perception of property or land values.
028	24/07/13	All	Community	Exploration sites too close to populated areas	Not defined			This concern is taken into acount in both the ES and ERA
029	24/07/13	Site preparation		Archaeology	Not defined			See ERA Risk #12, and ES Chapter 7 on Archaeology
030	24/07/13	Site preparation		ARUP have not assessed any other shale gas sites	Not defined			Arup have a large team of technical experts from a number of different disciplines, which is appropriate for the assessment of the environmental impact of the proposed operations
031	24/07/13	All, particularly hydraulic fracturing	Traffic	Cumulative impact of increased traffic / noise from a number of exploration sites	Not defined			The ES considers cumulative impacts of the two proposed exploration sites (Roseacre Wood and Preston New Road). Additional sites would be assessed when proposed.

Unique ID	Date raised	Project phase	Category	Descirption (from feedback forms, technical publications, project workshops etc.)	Source	Pathway(s)	Receptor	Signpost
032	24/07/13	Site preparation, well design, hydraulic fracturing, well testing & well suspension	Waste	Where and how far away are the waste material treatment facilities	Not defined			Risk unclear. Spills in transit are considered in ERA Risk #6, and impact of vehicle emissions is covered in the ES.
033	29/07/13	All	Ecology	Well Pad construction works cause disturbance to local fauna (e.g. foraging bats) due to the movement of plant & personnel, lighting and noise generated	Movement of plant & personnel during construction of Well Pad	Vibrations, movement, lighting and noise	Local fauna (e.g. foraging bats)	Will be covered in the ES Chapter on Ecology. There is no 'unplanned' aspect to this, therefore outside the scope of the ERA
034	29/07/13	Hydraulic fracturing	Induced Seismicity	Ground shaking causes liquefaction of surface soil.	Hydraulic fracturing causing movement of adjacent fault	Liquefaction, leading to subsidence	Local infrastructure	Will be covered in the ES Chapter on Induced Seismicity, there is no evidence that liquefaction could be caused by events of ML 1.5 or lower.
035	30/07/13	All	Waste	Surface spillage of waste water (not flowback) due to engineering failure, vandalism, site vehicle collision, or operative error	Waste water in vehicles & vessels on site	Direct run-off from site across ground surface, via surface water drains, ditches etc.	Surface waters and soil near to and downstream of the site; groundwater	Risk #4 surface spillage
036	30/07/13	Hydraulic fracturing	Waste	Surface spillage of flow back due to engineering failure, vandalism, site vehicle collision, or operative error	Flow back in vehicles & vessels on site	Direct run-off from site across ground surface, via surface water drains, ditches etc.	Surface waters and soil near to and downstream of the site; groundwater	Risk #4 surface spillage
037	30/07/13	Hydraulic fracturing	Waste	Release of scale due to engineering failure, vandalism, site vehicle collision, or operative error	Scale in vehicles and vessels on site	Airborne	Site personnel, local population, local environment.	Resources and waste will be covered in the ES. Reference to treatment management in Risk #5 in ERA
038	30/07/13	Hydraulic fracturing, Well testing, Well suspension	Air Quality / Waste	Release of dissolved methane in returned waters during storage in vessels	Returned waters stored in tanks and vessels	leakage/fugitive emissions from storage vessels	Atmosphere	See Risk #1 in ERA. Air quality will be covered in the ES.
039	30/07/13	Hydraulic fracturing, Well suspension	Air quality / Waste	Odour emissions	Release of odours from waste stored in vented tanks	Leakage/fugitive emissions from storage vessels	Local human population	See Risk #1 in ERA. Air quality will be covered in the ES.
040	30/07/13	All	Waste	Significant fire resulting in the sustained use of fire fighting foam or water to control / extinguish the fire	Fire fighting foam and contaminated firewater run-off	Direct run-off from site across ground surface, via surface water drains, ditches etc. or through compromised basal membrane	Surface waters near to and downstream of the site; local ecology; groundwater	See Risk #4 in ERA. Hydrogeology and ground gas will be covered in detail in the ES.
041	30/07/13	Hydraulic fracturing, well testing	Air quality / Waste	Release of Methane in the form of surplus natural gas	Unabated natural gas release directly to the air	Through the air	Atmosphere	There will be no venting of gas directly to the atmosphere. See Risk #1 in ERA.
042	30/07/13	All	Noise / Traffic	Reversing road tankers visiting site to collect waste	Audible reversing alarms fitted to vehicles	Noise	Local human population	Noise will be covered in the ES
043	02/08/13	All	Traffic	Damage to local road network due to unsuitability for increased HGV traffic	Increased HGV movement	Heavy loads and high usage on roads not designed for it	Local road network	The ES will include a detailed assessment of traffic and transportation, including traffic impacts.
044	05/08/13	Hydraulic fracturing, Well testing, Well suspension	Hydrogeology & Contamination	Propagation of fractures beyond the target zone which then create vertical and horizontal pathways for pollution (gas or fluid) to travel into other geological strata	Ground gases from target formation, hydraulic fracturing fluid	Fractures propagating beyond the target zone which then connect to natural discontinuities or natural pathway or abandoned boreholes	Groundwater - superficial and Sherwood Sandstone, surface receptors for gas	See Risk #3 in ERA. Hydrogeology and ground gas will be covered in detail in the ES.
045	05/08/13	Hydraulic fracturing	Air quality	Proppant delivery and mixing causes human health risk (respiratory disease) if breathed in.	Proppant delivery and mixing	Breathing in dust and airborne particulate matter (PM) categorised as PM10 and PM2.5, and potentially containing silicates.	Site workers, site visitors, locals near site boundaries	See Risk #13 in ERA. Air quality will be covered in the ES.
046	05/08/13	Hydraulic fracturing, well testing	Waste	Accumulation of solids containing NORM after separation from flow back fluids in site infrastructure (e.g. tanks and pipework)	NORMs / scale	Exposure to radiation as a result of onsite storage of NORM or movement of the solids to transport them offsite for treatment.	Site workers, site visitors, locals near site boundaries	Minimizing potential for exposure to hazardous materials on site is covered by Cuadrilla's site management procedures. As this does not have potential to affect the wider community it is not within the scope of the ERA. Risks in transit/at point of treatment are covered in ERA Risks #5 and #6.
047	09/08/13	Hydraulic fracturing	Induced seismicity	Traffic light system failing (either instruments, human error, vandalism or currently unproven at these trigger levels) - results in larger than Ml 1.5 event	Hydraulic fracturing induces a seismic event	Ground vibration travels through rock and surface material between event location and receptor	local infrastructure, local community	See Risk #7 in ERA. The ES will include a detailed chapter on Induced Seismicity
048	05/09/13	Well design, hydraulic fracturing	All	Use of unproven technologies produces unexpected negative impact	Use of technologies with limited historic data on which to base assumptions	Unexpected negative outcome from hydraulic fracturing process	Ecology, wildlife, local population, environment, workers, visitors.	All risks and impacts consider data and precedent. Cuadrilla's HSSE framework includes both barriers to prevent unplanned outcomes, and responses should they occur (bow tie approach).
049	05/09/13	Well abandonment, Aftercare	Waste	Lack of site security post-abandonment leads to vandalism and release of contaminants	Contaminants left on site	Vandalism causes damage to storage vessels	Ground & surface water, soil, local flora and fauna, farmland	Nothing will remain on surface following abandonment. ERA Risk #14 considers long term well integrity, which is the only pathway post-abandonment for potential contaminants to escape.
050	05/09/13	Well suspension, well abandonment and aftercare	Land use	Impact on planning designation - explorations sites designated as 'Brownfield' and eligible for development - potential for future exposure to contaminants	Gas and fluid remaining in well	Development activities cause release of contaminants	Local community, environment	See ERA Risk #14. Hydrogeology will be covered in detail in the ES.
051	05/09/13	Hydraulic fracturing, Well testing	Lighting	Flaring causes interference with aircraft.	Flaring of gas during testing phase	Visual impact provides a distraction causing aircraft to crash	Local population and property	This is an extremely unlikely scenario. Flares will be 15m or less, and covered.
052	05/09/13	All	Community	Impact on tourist economy due to negative perception of Shale Gas exploration operations	Shale gas exploration in the area	Negative perception of impacts of activities	Local tourist-dependent business	Community and Socio-economics, are considered in the Esm which considers the direct impact of the proposed operations, Issues of perception are beyond the scope of the ERA/ES.
053	05/09/13	Well suspension, well abandonment and aftercare	Waste	Unauthorised disposal of construction equipment.	Not defined			Construction equipment will not be illegally disposed of.
054	13/09/13	Well design (drilling), Hydraulic fracturing	Hydrogeology & Contamination	Mechanical failure of equipment, such as a hose connection, during fracturing or well testing leading to release of fluids at high pressure	Fracturing fluids	Failure of equipment at well head leads to release of fluid at high pressure	Humans near site boundary, site workers, local soil/ground	See Risk #2 in ERA. Hydrogeology will be covered in detail in the ES.
055	18/09/13	All	Ecology	Development/operation disrupts nesting site/ breeding site/ wintering grounds of protected species	Enabling works, light & noise on site, vibration etc.	Disruption of local physical environment	Local protected species	Ecological Impacts wll be considered in detail in the ES. There is no 'unplanned' aspect to this, therefore outside the scope of the ERA
056	07/10/13	Site preparation	Archaeology & heritage	Archaeology is unknown at site	Possible archaeological items	Discovered during site preparation	Local heritage	See Risk #12 in ERA, will be covered in detail in the ES chapter on Archaeology. This is primarily a programme and commercial risk.
057	07/10/13	Hydraulic fracturing, Well testing, Well suspension	Hydrogeology	Multiple lateral interactions and potential gas/fluid leakage	Fracture propagation	Interaction between laterals and fractures creates a larger pathway	Groundwater	See Risk #3 in ERA and ES Chapter 11 on Hydrogeology and Ground Gas
058	07/10/13	Site preparation	Hydrogeology & Contamination	Drilling location under residential houses	Drilling activity/ fracturing operations	Not defined		Risk (source pathway receptor) not clear. Subsidence risk is negligible and covered in ERA Risk #8
059	07/10/13	All	Community/Health /Landscape and visual amenity	Adverse perception at new site (green fields, health and well being etc.)	Site buildings & equipment	Visual impact, perception	Local community	Perception is not a measureable environmental impact and not covered in the ERA or EIA
060	07/10/13	Site preparation	Community	Crime or vandalism on site	Crime/vandalism	Unauthorised access to site	Site personnel, local population, local environment.	Community and Socio-economics, will be considered in the Esm which considers the direct impact of the proposed operation.
061	07/10/13	All	Land use	Operations interfere with communication equipment	Drilling activities/ fracturing operations	Not clear	Neighbouring sites and operations	Not in scope of ERA
062	07/10/13	All	Water resources	Shale gas operations increase the risk of flooding, property flood risk increasing	Flood events	Rainwater surface run off	Local properties	See ERA Risk #11. Flooding will also be assessed in the ES.

Unique ID	Date raised	Project phase	Category	Descirption (from feedback forms, technical publications, project workshops etc.)	Source	Pathway(s)	Receptor	Signpost
063	07/10/13	All	Land use	Residential planning permission granted near drilling site prior to exploration	Proposed operations	Local community developments	Local community	All local properties considered as potential receptors in ERA and EIA.
064	07/10/13	Site preparation	Landscape and visual amenity	Planned drill equipment cannot be used	Drilling activity/ fracturing operations	Site setup	Local landscape	Operational risk to Cuadrilla therefore outside scope of ERA and EIA
065	07/10/13	All	Air Quality	Construction site air quality (overall operations such as dust, particulates etc.)	Site buildings & equipment	Air	Site workers, site visitors, locals near site boundaries	Will be covered in ES Chapter on Air Quality. There is no 'unplanned' aspect to this, therefore outside the scope of the ERA.
066	07/10/13	All	Traffic and transportation	Physical access to site, damage to local roads and junction improvements may be required	Site traffic	Local roads and junctions	Damage to local roads and junctions	Will be covered in ES Chapter 18 on Traffic. Road condition will be considered within the planning conditions.
067	07/10/13	All	Landscape and visual amenity	Site and operations visible from road	Site buildings & equipment	Visual sight line	Local community	See ES Chapter 14 on Landscape and Visual Amenity. There is no 'unplanned' aspect to this, therefore outside the scope of the ERA.
068	07/10/13	All		Risk of not implementing mitigation measures				Mitigation measures will be part of planning conditions and environmental permits. Implementation to be monitored through Cuadrilla's Environmental Operating Standards
069	11/10/13	All	Community	Lack of sufficient financial resources of Cuadrilla to address, mitigate and remediate impacts of risks that may arise	Lack of sufficient financial resources of Cuadrilla	Mitigation and remediation actions not carried out adequately		The Joint Venture of Cuadrilla / Centrica / AJ Lucas has adequate collective financial resources to properly address risk areas. Adequacy of operator/licenceholder financial resources is considered by DECC.
070	11/10/13	All	Community	As a result of lack of confidence of public in shale gas related activities leads to public disorder - results in community disruption and perception of lack of safety	Protestors	Public disorder	Local amenity - lack of safety, local environment	Potential impact of local protestors off site is not part of the project being assessed. On site security plan will be put in place by Cuadrilla.
071	11/10/13	All	Site management	Lack of sufficient experience of contractor as a result of start-up nature of organisation and operations in the UK - leads to adverse impacts on people, ecology, environment and economy	Lack of sufficient experience within Cuadrilla organisation	Mitigation and remediation actions not carried out adequately, or risks not identified	All	Managed through appropriate policies and procedures, competence and experience of Cuadrilla staff and consultants & contractors (e.g. Arup) and strength of the Joint Venture including Centrica. Proposed exploratory Operations are reviewed, permitted abd subject to regulatory enforcement by Regulators (HSE, EA, DECC, LCC)
072	11/10/13	All	Site management	Lack of definitive best practice as a result of lack of full knowledge exchange of development; formulation; assessment; accreditation and improvement across the worldwide expertise-base - leads to adverse impacts on people, ecology, environment and economy	Lack of definitive best practice	Insufficient expertise to carry out work without damage to environment	All	Managed through appropriate policies and procedures, competence and experience of Cuadrilla staff and consultants & contractors (e.g. Arup) and strength of the Joint Venture including Centrica. Proposed exploratory Operations are reviewed, permitted abd subject to regulatory enforcement by Regulators (HSE, EA, DECC, LCC)
073	11/10/13	All	Site management	Lack of effective compliance and governance framework as a result of recognised world-class expertise, infrastructure, processes organisation and appropriate resources being applied in a timely manner deployed & applied ahead of the activities subject to compliance and governance - leads to adverse impacts on people, ecology, environment and economy	UK regulatory environment	Compliance & governance ineffective	All	The risk and impact assessments for the two proposed exploration sites recognise that Cuadrilla will follow appropriate guidance and regulation and will implement best practice on site. The various external regulators (DECC, EA, HSE, LCC) have each committed to providing sufficient resource to provide regulatory oversight of this high profile activity which will have been the subject of detailed scrutiny and review in advance of operations commencing. The Regulators have powers of intervention and enforcement to be used where required.
074	11/10/13	All	Site management	Lack of sufficient external governance expertise as a result of insufficient resources applied to the provision of recruitment, training, tools, techniques, operations, motivation, direction and control - Leads to adverse impacts on people, ecology, environment and economy	Lack of external governance	Lack of sufficient external governance expertise	All	See above.
075	11/10/13	All	Site management	Lack of critical mass of locally based external governance results in insufficient competent governance resources to ensure safety standards at all times through out the life-cycle of shale gas activities and its remediation assurance - Leads to adverse impacts on people, ecology, environment and economy	Lack of critical mass of locally based external governance	Lack of sufficient external governance expertise	All	See above.
076	11/10/13	All	Traffic	As a result of the increase in HGV traffic - adverse impact on properties due to damage caused by traffic induced vibration	Increased HGV movement	Traffic induced vibration in ground surrounding roads	Local properties	See ERA Risk #9 . The ES Chapter Traffic will consider potential traffic accidents. Vibration induced damage related to traffic is extremely unlikely.
077	11/10/13	All	Landscape and visual amenity	Undertaking Utility ducting trenching & laying & restoration - will have an adverse disruptive impact on character of rural landscape	Additional utility demands of hydraulic fracturing	Utility ducting and trenching work	Local amenity - visual impact	Landscape and visual amenity will be assessed in the ES. There is no 'unplanned' aspect to this, therefore outside the scope of the ERA. Only short trenching to connect to existing utilities
078	11/10/13	All	Landscape and visual amenity	Provision of Power cabling - will have an additional disruptive impact on visual character of rural landscape	Additional utility demands of hydraulic fracturing	Works required for the provision of power cabling	Local amenity - visual impact	No power cabling proposed for the site. Generators
079	11/10/13	All	Community	As a result of the provision of utilities ducting and cabling for shale gas related activities - there will be an adverse impact on land use for rural leisure and agricultural activities	Additional utility demands of hydraulic fracturing	Utility ducting and trenching work	Local farmland	Community and socio-economic impacts will be assessed in the ES. Only short trenches to connect to existing utilities, and no power cabling, therefore no significant impact on land use.
080	11/10/13	All	Lighting	As a result of increased Traffic lighting during periods of poor visibility - will create an adverse visual impact on the rural character of the environment	Increased HGV movement	Traffic lighting	Local amenity - visual impact	Lighting impacts will be assessed in the ES. Not clear what this item refers to - use of headlights?
081	11/10/13	All	Community	As a result of lack of local recruitment of skilled staff for shale gas related activities - there will be an adverse impact on the growth of skilled employment related to shale gas activities	Lack of local recruitment	Inability of local workforce to obtain employment in shale gas sector	Local workforce, national skills	See ES Chapter 9 on Community and socio-economics
082	11/10/13	All	Archaeology & heritage	As a result of direct and induced damage caused by shale gas related activities damages local archaeology & heritage - leads to damage to and Loss of archaeology & heritage	Induced seismicity as a result of hydraulic fracturing	Surrounding ground	Local archaeology & heritage	See ERA Risk #12, Archaeology and cultural heritage impacts will be assessed in the ES. Also ERA Risk #7 and ES Chapter on Induced Seismicity
083	11/10/13	All	Archaeology & heritage	As a result of Increased volumes and vehicle weight of traffic causes direct and induced damage to local archaeology & heritage - leads to Loss of archaeology & heritage	Increased HGV movement	Traffic induced vibration in ground surrounding roads	Local archaeology & heritage	See ERA Risk #9 and #12, and ES Chapter on Traffic for potential damage caused by traffic accidents. Vibration induced damage related to traffic is extremely unlikely.
084	11/10/13	All	Community	Construction and set-up interferes with public rights of way - Loss of access of public rights of way – adverse effect on community environment, leisure & tourism	Land take of construction & setup activities	Public rights of way interrupted	Local amenity & tourism	Community and socio-economic impacts will be assessed in the ES.
085	15/10/13	Well testing	Climate Change	Flare stack failing to ignite	Stack	Air	Site workers, site visitors, local community	See Risk #1 in ERA. Air quality impacts will be assessed in the ES.

Unique ID	Date raised	Project phase	Category	Descirption (from feedback forms, technical publications, project workshops etc.)	Source	Pathway(s)	Receptor	Signpost
086	15/10/13	Hydraulic fracturing, Well testing, Well suspension	Hydrogeology	Gas in drinking water supply	Fracturing operations	Gas permeation through rock to potable water sources	Local community, water supply	See Risk #3 in ERA. Hydrogeology and ground gas will be covered in detail in the ES.
087	15/10/13	Hydraulic fracturing, Well testing, Well suspension	Hydrogeology	Multiple lateral interactions and potential gas leakage	Fracturing operations	Interaction between laterals and fractures creates a larger pathway	Other laterals/wells	Connectivity between fractures does not present a risk, migration of gas or fluids through fractures to other strata is covered in Risk #3 in ERA and ES Chapter on Hydrogeology
088	15/10/13	All	Traffic/Hydrogeology	Off site road traffic accident results in a spill that potentially contaminate operations	Local vehicles	Permeation of fluids at surface	Local community, local environment	See Risk #6 in ERA, and ES Chapter on Resources and waste
089	15/10/13	Well design, hydraulic fracturing, Well testing	Hydrogeology	Release off pad of fluid/gas from equipment or infrastructure failure				Off pad risks (spillage #4, transit #6, waste treatment #5 in ERA) - not clear what this refers to.
090	18/10/13	All	Community	House prices drop due to social opposition to operations (unrelated to physical damage from seismicity in 33)	All aspects of proposed operations		Local community	Perception is not a measureable environmental risk and not covered in the ERA or EIA
091	18/10/13	All	Traffic	Accidents caused by site traffic collision (e.g. buildings)	Increased HGV movement	Vehicle collision or vibration	Local building	See ERA Risk #9 and ES Chapter on Traffic
092	18/10/13	All	Traffic	Damage to local utilities/infrastructure off site	Increased HGV movement	Vehicle collision or vibration	Local utilities/infrastructure	See ERA Risk #9 and ES Chapter on Traffic
093	18/10/13	All	Traffic	Damage to utilities/infrastructure on site near new access track	Increased HGV movement	Vehicle collision or vibration	Infrastructure adjacent to site or at site entrance	See ERA Risk #9 and ES Chapter on Traffic
094	21/10/13	Site preparation	Waste	Circulating mud system - Returned muds	Overfilling mud tanks and surface pipe leaks	Surface runoff and percolation into the ground, down gradient if raining	Surface water, surface soil	See ERA Risk #4. Hydrogeology and ground gas will be considered in detail in the ES.
095	21/10/13	Site preparation	Waste	Circulating drilling muds - Returned drill cuttings (waste)	Overfilling drill cuttings skips	Surface runoff and percolation into the ground, down gradient if raining	Surface water, surface soil	See ERA Risk #4. Hydrogeology and ground gas will be considered in detail in the ES.
096	21/10/13	Site preparation	Waste	Circulating muds - Drilling muds left in situ through any losses to surrounding underground rock whilst drilling the well	Drilling mud	Geology around well bore	Groundwater	See ERA Risk #3. Hydrogeology and ground gas will be considered in detail in the ES.
097	21/10/13	Site preparation	Waste	Drilling exploration well - Methane / C2-C4 hydrocarbons & petroleum hydrocarbons	Methane or other hydrocarbons	Migration through defective/ inadequate cementing annuli	Groundwater or Air quality	See ERA Risks #1, #3 and #14. Hydrogeology and Air Quality will both be considered in detail in the ES. .
098	21/10/13	Site preparation	Waste	Drilling exploration well -Formation waters containing heavy metals/ earth metals/ chloride and bromide	Deep geological strata	Preferential migration through defective casing annuli	Shallower formations	See ERA Risk #3. Hydrogeology and ground gas will be considered in detail in the ES.
099	21/10/13	Site preparation	Waste	Leak from storage of chemicals and oil on the surface-Oil and Chemicals (i.e. , diluted hydrochloric acid, diesel, lubricants, drilling fluids)	Materials stored on site	Leaks, drips, spills,	Surface soils, surface water	See ERA Risk #4. Hydrogeology and ground gas will be considered in detail in the ES.
100	21/10/13	Site preparation	Waste	Leak from storage of powder chemicals	Powder chemicals stored on site	Airborne contaminant	Air quality	Part of Cuadrilla's Site Management Processes, not considered likely to affect the wider community
101	21/10/13	Site preparation	Waste	Cement returns - Cement at surface with residue of extractive waste (muds and drill cuttings)	Cement returns at surface	Spillage	Surface water, soil, groundwater	See ERA Risk #4. Hydrogeology and ground gas will be considered in detail in the ES.
102	21/10/13	All	All	Contamination and potential loss of any water resources encountered, loss of or damage to a habitat, respiratory illnesses caused by VOCs, asphyxiation, explosion and fire risks from methane. Methane is a potent greenhouse gas that contributes to anthropogenic climate change.				Broken down into individual issues below
103	21/10/13	All except site preparation	Hydrogeology	Contamination of any water resources encountered	Contaminants and gases in the subsurface (inc. drilling mud, hydraulic fracturing fluid, flow back, ground gas)	Lack of well integrity or migration through habitats	Groundwater	See ERA Risk #3. Hydrogeology and ground gas will be considered in detail in the ES.
104	21/10/13	Site preparation, well design, hydraulic fracturing, Well testing	Water resources	potential loss of any water resources encountered	Water usage	Water requirements conflicting with local and regional demands	Local resident's water, local and regional environment	See ERA Risk #10. Resources and waste impacts will be assessed in the ES
105	21/10/13	All	Ecology	loss or damage to a habitat	Multiple sources	Through groundwater, surface water, surface soil, air	Local ecology	Ecological Impacts will be considered in detail in the ES.
106	21/10/13	All	Air Quality	respiratory illness caused by VOCs	Fugitive emissions	Inadequately sealed surface equipment	Air quality and hence local population	See ERA Risk #1. Air quality will be assessed in detail in the ES.
107	21/10/13	All	Air Quality	asphyxiation	Fugitive emissions	Inadequately sealed surface equipment	Air quality and hence local population	See ERA Risk #1. Air quality will be assessed in detail in the ES.
108	21/10/13	Site preparation, well design, hydraulic fracturing	Air Quality and Site Management	explosion and fire risks from methane	Fugitive emissions	Inadequately sealed surface equipment	Site personnel and local population	See ERA Risk #1 and #2. Air quality will be assessed in detail in the ES.
109	21/10/13	All	Air Quality and Climate	methane is a potent greenhouse gas that contributes to anthropogenic climate change	Fugitive emissions	Inadequately sealed surface equipment	Climate	Local impact of methane and other emissions to climate are covered in ERA Risk #1 and will be further assessed in the ES.
110	21/10/13	Site preparation	Waste	Local contamination of habitats and resources and exposure of people to that contamination.	Contaminants and gases in the subsurface or above ground	Lack of well integrity, inadequately sealed equipment, leaks and spills	Habitats, resources and local community	Loss or Damage to habitat is covered in the ES Chapter 10 on Ecology; Contamination of water resources - see ERA Risk #3, and ES Chapter on Hydrogeology; Exposure of people to contamination, ERA Risks #1 - #6, #13, #14 and will be considered in detail in the ES chapters on Air Quality and Hydrogeology
111	23/10/13	Hydraulic fracturing	Induced seismicity	first event exceeds the 'red' threshold, or a larger event occurs even though the traffic system has been followed.	Hydraulic fracturing induces a seismic event	Ground vibration travels through rock and surface material between event location and receptor	Local infrastructure, local community	The ES chapter on Induced Seismicity will consider the impact of the theoretical maximum event. Mechanisms in Bowland Shale well understood of smaller event as precursor
112	23/10/13	Hydraulic fracturing	Induced seismicity	frequent small magnitude events cause vibrations that exceed tolerance of sensitive equipment (e.g. in hospitals)	Hydraulic fracturing induces a seismic event	Ground vibration travels through rock and surface material between event location and receptor	Local infrastructure, local community	See ERA Risk #7, and will be assessed in detail in ES Chapter on Induced Seismicity
113	23/10/13	Hydraulic fracturing	Induced seismicity	Induced seismic event causes damage to local Halite salt mines, which may in future store Hydrocarbon gas - release of stored gas to atmosphere	Hydraulic fracturing induces a seismic event	Ground vibration travels through rock and surface material between event location and receptor	Stored gas released to environment	See ERA Risk #7, and will be assessed in detail in ES Chapter on Induced Seismicity. No current or approved planned storage of gas in local salt mines.
114	28/10/13	All	Ecology	Disturbance impacts on local fauna due to seismic array check-up visits	Seismic array requirement to replace batteries & perform maintenance	Disturbance due to traffic to sites etc.	Local fauna (esp. birds)	Ecological impacts will be assessed in the ES
115	06/11/13	All	Air Quality	Release of ground gases due to lack of well integrity - explosion risk	Ground gas (methane)	Integrity loss from: poor design & construction, seismic event, seismic event from off site sources, loss integrity over time	Local population, local ecology, site personnel, local agriculture	Risk #1 and #2 in ERA, Hydrogeology and Ground Gas, and Air quality wil be assessed in detail in the ES
116	06/11/13	All	Air Quality	Release of ground gases due to lack of well integrity - air quality emission risk	Fracture Fluids, Return water, Ground gases (e.g. Bowland Shale or Collyhurst Sandstone), naturally occurring poor quality grounds water	Integrity loss from: poor design & construction, seismic event, seismic event from off site sources, loss integrity over time	Air quality	Risk #1 and #3 in ERA, Hydrogeology and Ground Gas, and Air quality wil be assessed in detail in the ES

Unique ID	Date raised	Project phase	Category	Descirption (from feedback forms, technical publications, project workshops etc.)	Source	Pathway(s)	Receptor	Signpost
117	06/11/13	All	Hydrogeology & Contamination/Ecology	Spillage of contaminants, as a result of vehicle accidents off site	Vehicles to and from site, contaminant releases from site traffic	Vehicle accident off site causing spillage - contaminant enters ground water or reaches fields/hedges	Ground & surface water, local flora and fauna, farmland	See Risk #6 in ERA. Hydrogeology and Ground Gas will be considered in detail in the ES, as will traffic impacts including potential accidents.
118	06/11/13	All	Hydrogeology & Contamination/Ecology	Spillage of contaminants on site from site activities	Contaminants on site (fuel, fracturing additives, flow back etc.)	Overflow of installed site drainage ditch	Surface watercourses adjacent to the pad, groundwater in superficial aquifer and Sherwood Sandstone, surface soil	See ERA Risk #4. Hydrogeology and ground gas will be considered in detail in the ES.
119	28/11/13	All	Community	Technical experts will be biased	Not defined			Technical expertise comes from Cuadrilla, Arup and sub-consultants, and the regulators. The MPA may also commission technical advisors.
120	28/11/13	All	Community	Shale gas operations will not be regulated in a robust manner	Drilling operator	Exploration activities	Local community distress	The risk and impact assessments for the two proposed exploration sites recognise that Cuadrilla will follow appropriate guidance and regulation and will implement best practice on site. The various external regulators (DECC, EA, HSE, LCC) have each committed to providing sufficient resource to provide regulatory oversight of this high profile activity which will have been the subject of detailed scrutiny and review in advance of operations commencing. The Regulators have powers of intervention and enforcement to be used where required.
121	28/11/13	All	Community	Shale gas operation will be self regulated	Drilling operator	Exploration activities	Local community distress	As above.
122	01/04/2013	All	Hydrogeology	Potential for unrecorded water wells as noted by Roseacre Awareness Group	As for Risk 001	As for Risk 001	Unrecorded groundwater abstraction points	Requires further investigation, risk is assessed with Risk #3 of ERA, see also ES Chapter on Hydrogeology and Ground Gas
123	26/03/2013	Drilling	Air quality	Use of radioactive source for wireline logging	Radioactive tool used for well logging	Handling of radioactive source	Site personnel	Risk #15 of ERA, and Cuadrilla Site Safety Management
124	01/04/2013	All	Traffic	Potential for traffic vibrations to damage sensitive structures	Increased HGV movement	Ground-borne vibrations	Local sensitive structures	There is no evidence of traffic vibrations damaging sensitive structures.

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