Council Motion on Fracking and Associated Drilling

Scrutiny (Community & Regeneration) Committee

Recommendation of the Scrutiny (Community and Regeneration) Committee

RECOMMENDATION: That it be recommended to Council:

(a) That it notes that the Scrutiny (Community and Regeneration) Committee, while not anti-energy and accepting that there are risks inherent in the extraction of any natural resource, has the following primary concerns in the absence of sufficient independent peer reviewed data to reassure it:

(i) That the long term consequences of any pollution of the groundwater supply in the district due to chemicals used as part of the fracking process itself or contamination via improperly management, storage and disposal of contaminated ‘flowback’ water are unclear.

(ii) The impact of the high volume of water consumption involved in the hydraulic fracturing process on groundwater resources given that the Dover District is an identified area of water stress.

(iii) The risk of seismicity arising from the hydraulic fracturing process given the particular characteristics of the local geology and the close proximity of population centres to the areas identified so far as potential drilling sites.

(b) That it note that the Scrutiny (Community and Regeneration) Committee also has secondary concerns over the impact of noise, air pollution, light pollution and traffic on rural roads which it anticipates will be dealt with by the appropriate statutory bodies as part of the Kent County Council planning process in the event of any future applications.

(c) That the Council be mindful of (a) and (b) above in its response to any future planning application considered by Kent County Council involving hydraulic fracturing and/or associated drilling activity until such time as sufficient independent peer reviewed data exists to mitigate the concerns expressed by the Committee.

Executive Summary of the Views of the Committee

The Scrutiny (Community and Regeneration) Committee having considered the views received from those organisations that accepted the invitation to meet with it or respond in writing and the contents of the research report, has formed the following view at its meeting held on 18 November 2013.

The Scrutiny (Community and Regeneration) Committee, while not anti-energy and accepting that there are risks inherent in the extraction of any natural resource, has significant concerns around the limited availability of authoritative independent peer reviewed information in respect of the risks to the districts water supply and the possibility of seismic activity arising from the use of hydraulic fracturing to extract unconventional shale and coal-bed methane gas.

The main areas of risk where the Committee feels that it is unable to reassure local residents of their concerns are:

(iv) The long term consequences of any pollution of the groundwater supply in the district due to chemicals used as part of the fracking process itself or contamination via improperly management, storage and disposal of contaminated ‘flowback’ water.

(v) The impact of the high volume of water consumption involved in the hydraulic fracturing process on groundwater resources given that the Dover District is an identified area of water stress.

(vi) The risk of seismicity arising from the hydraulic fracturing process given the local geology and the close proximity of population centres to the areas identified so far as potential drilling sites.

The Committee recognises that the issues of traffic movements, air and light pollution and noise are a concern to the local community that will need to be addressed through the planning process.

The Committee does however, does note that a number of reports are expected to be published in 2014 that may provide the level of authoritative independent peer reviewed information necessary in the view of the Committee to provide clarity as to the realistic risks of the process of hydraulic fracturing in the UK.

Scope of the Review and Report

The Council at its meeting held on 18 September 2013 requested that the Scrutiny (Community and Regeneration) Committee action the following Motion:

> "This Council is concerned by the prospect of fracking and related drilling activity in the Dover District area and requests that a report is brought forward to the next meeting of this Council to inform the Council of the nature of the process, the potential impact on subsurface water resources and geological formations, the type and scale of the surface structures, and the impact of anti-fracking demonstrations in the light of recent experience in Sussex on the local communities and on the police."

This motion was formally accepted by the Scrutiny (Community and Regeneration) Committee at its meeting on 5 November 2013.

It should be noted that the motion does not require a conclusion to be made by the Committee on the merits of hydraulic fracturing (otherwise known as 'fracking') and related drilling activity and this report does not seek to draw any.

Research Report

Introduction

In compiling this report it should be noted that there is still a considerable amount of work being conducted by Government Departments, Non-Governmental Organisations and regulatory organisations in the UK into the risks involved in hydraulic fracturing. This has led to much emphasis being placed on the experience in the United States and Australia as an example of the risks involved in hydraulic fracturing.

In compiling this report there has been a necessity to use some information relating to other nations to achieve the objectives of the motion. While this has usefulness in compiling the report it should be noted that differences in geology, drilling techniques and regulatory frameworks mean that not all the data is directly applicable to the Dover District.

> "Many apprehensions over fracking in the UK are a result of the experience of regulation in the US. There each State regulates separately and to varying levels of stringency. A further key difference is that land owners own the mineral rights and these circumstances have led to a rapidly expanding industry with limited environmental controls."[1]

In England petroleum rights are held by the Crown not by individual land owners and 'unconventional' gas is regulated by the Department of Energy and Climate Change (DECC), the Health and Safety Executive (HSE), the Department for Communities and Local Government (DCLG), the Local Planning Authority (Kent County Council in respect of minerals), and the Environment Agency (EA). The DECC, the HSE and the EA are responsible for drafting appropriate regulations for the control and monitoring of well design for safety, drinking water protection and the disposal and/or recycling of fracture fluids.

Water companies are not currently statutory consultees in the planning process and it has been argued by bodies such as Water UK that they should be made so.

The recent (now withdrawn) applications to Kent County Council (as the Local Planning Authority) by Coastal Oil and Gas Ltd for 3 exploratory boreholes in the Dover District are not directly addressed by this report due to the scope of the motion but some information has been gathered in relation to them as part of the fact-finding process.

Nature of the Process (Fracking and Related Drilling Activity)

How does hydraulic fracturing work?

Hydraulic Fracturing is the fracturing of rock by a pressurised liquid and can occur naturally creating most mineral vein systems. Induced Hydraulic Fracturing or Hydrofracturing (more commonly known as 'fracking') is an industrial process for fracturing rock that involves the pumping of a pressurised liquid (a mixture of water together with other materials and chemicals) into the underlying strata in order to create small fractures within which oil and gas can flow towards a wellhead from where it can be extracted.

The hydraulic fracturing process is usually performed at the start of the life of a well, with several rounds of fracturing lasting no more than one to two hours each, spaced out over several weeks while readings are taken and assessed. Once fracturing is completed the well can go on to produce for 30-50 years without the need for further treatments.

Why fracking? (Conventional and Unconventional Gas)

[1] Chartered Institute of Water and Environmental Management

The process of hydraulic fracturing allows for the extraction of hydrocarbon reserves that were previously inaccessible using conventional extraction methods.

Conventional gas deposits are contained in porous reservoirs, often limestone or sandstone, which have interconnected spaces that allow the gas to flow freely in the rock and through well boreholes. These reservoirs may be many miles from the organic material that was the original source of the gas.

In contrast, unconventional gas deposits are contained in reservoirs of lower porosity, such as shale and coal which require greater levels of technology. The gas is held in fractures, tiny pore spaces and adsorbed on to the organic material of the rock. Unconventional gas reservoirs are often also the source of the gas. Unconventional gas cannot be extracted by conventional means due to being absorbed on to the organic material so it is extracted by cracking (fracturing) the rock at high pressure to create narrow fractures that allow the gas to flow into the well bore and to the surface.

How much oil and gas is obtained from this process?

Shale gas is classified in terms of 'resource' (the amount of gas in the ground) and 'reserve' (the amount of gas that can be extracted).

Table 1 Terms used in shale gas estimation [2]

Terms for resources and reserves	**Term**	**Acronym**	**Summary**	**Excludes**
Resource **'How much gas is in the ground'**	Original gas in place	OGIP	Total volume of gas	
	Gas (initially) in place	GIIP/GIP	Total volume of gas	
	Ultimately recoverable		Total recoverable volume	Gas not expected to be recovered
	Technically recoverable		Limited by technology	Ditto, as well as gas not recoverable with current technology
	Economically recoverable		Limited by economics	Ditto, as well as gas not economic to recover
Reserve **'How much gas could be extracted'**	Reserves		Total producible gas	Ditto
	Proved reserves	1P	Probability of reserves (proven)	Probable and possible reserves
	Median figure of reserves	2P	Proven and probable	Possible reserves
	High figure of reserves	3P	Proved, probable and possible	

The first commercially successful applications of hydraulic fracturing were in 1949 and by 2010 it was estimated that 60% of all new oil and gas wells worldwide were the subject of this process. The US Department of Energy estimates that out of the more than 4 million oil

[2] House of Commons Select Committee on Energy and Climate Change: http://www.publications.parliament.uk/pa/cm201213/cmselect/cmenergy/writev/isg/m17.htm

and gas related wells that have been drilled in the US over the last 150 years, at least 2 million have been the subject of hydraulic fracturing. Currently, 95% of new wells drilled in the US are hydraulically fractured accounting for over 40% of total US oil production and nearly 70% of US natural gas production.

In the UK the estimates for the amount of shale gas resources (resource and reserve) are variable but recent estimates suggest that the figure for resource may be very substantial. How much is technically and economically recoverable remains the subject of much speculation but even with a recovery rate of 10% there is the potential for substantial additional gas resources.

The UK Licensing Regime

Hydraulic Fracturing has taken place in the UK since the mid-1970s in the North Sea and elsewhere and it is estimated that in the last 20 years 200 wells have been 'fracked'.[3] The Elswick site operated by Cuadrilla Resources was hydraulically fractured in 1993 and has generated approximately 1MW of electricity.[4]

DECC has produced a map of the United Kingdom setting out the current fields and licences for onshore oil and gas (as of 6 November 2013). While the Petroleum Act 1998 vested all rights for the UK's petroleum resources in the Crown the Government can grant licences that confer exclusive rights to 'search and bore for and get' petroleum. Each Petroleum Exploration and Development License (PEDL) is conferred for a specific period and time. Each licence takes the form of a deed, which binds the licensee to obey the licence conditions regardless of whether or not they are using the licence at any given moment.

Due to concerns that a number of the licences have remained unexploited by the licence holders, DECC through its PILOT group, has instigated the 'Fallow Initiative' to ensure that licences are worked optimally to maximise economic recovery of oil and gas. The Fallow Initiative works by placing undeveloped prospective acreage into the hands of companies that wish to develop it.

Petroleum Exploration and Development Licences (PEDL) in East Kent

The areas marked in yellow indicate areas currently under license. Areas where there has been a discovery are marked in red (oil field), Green (gas field) or Black (Coal Bed Methane Field). A coloured dot is indicative of a well. The above image shows four areas where Petroleum Exploration and Development Licences (PEDL) have been granted in East Kent. These are centred on the Dover District.

The four licences in East Kent were awarded in July 2008 for a 6 year period to Eden Energy (UK) Ltd and Coastal Oil and Gas Ltd jointly. The PEDL listed the addresses of both companies as the same address in Port Talbot. However, Eden Energy (UK) Ltd has subsequently been sold by its Australian parent company Eden Energy Ltd to Shale Energy PLC in September 2013.

Each licence granted carries with it an annual charge, known as a rental, based on an escalating rate for each square kilometre the licence covers at the time of the annual charge. The purpose of this is to encourage licensees to surrender unwanted acreage and focus on the acreage that they do want to exploit.

A PEDL licence is divided into 3 terms, with qualifying criteria for continuation into a following term defined by the minimum amount of progress that the licensee must make. They confer

[3] The Telegraph, 'The Town Where Fracking is Already Happening' (10 August 2013): http://www.telegraph.co.uk/earth/earthnews/10233955/The-town-where-fracking-is-already-happening.html
[4] Cuadrilla Resources: http://www.cuadrillaresources.com/what-we-do/hydraulic-fracturing/

the right to search for, bore for and get hydrocarbons, but do not confer any exemption from other legal/regulatory requirements such as:

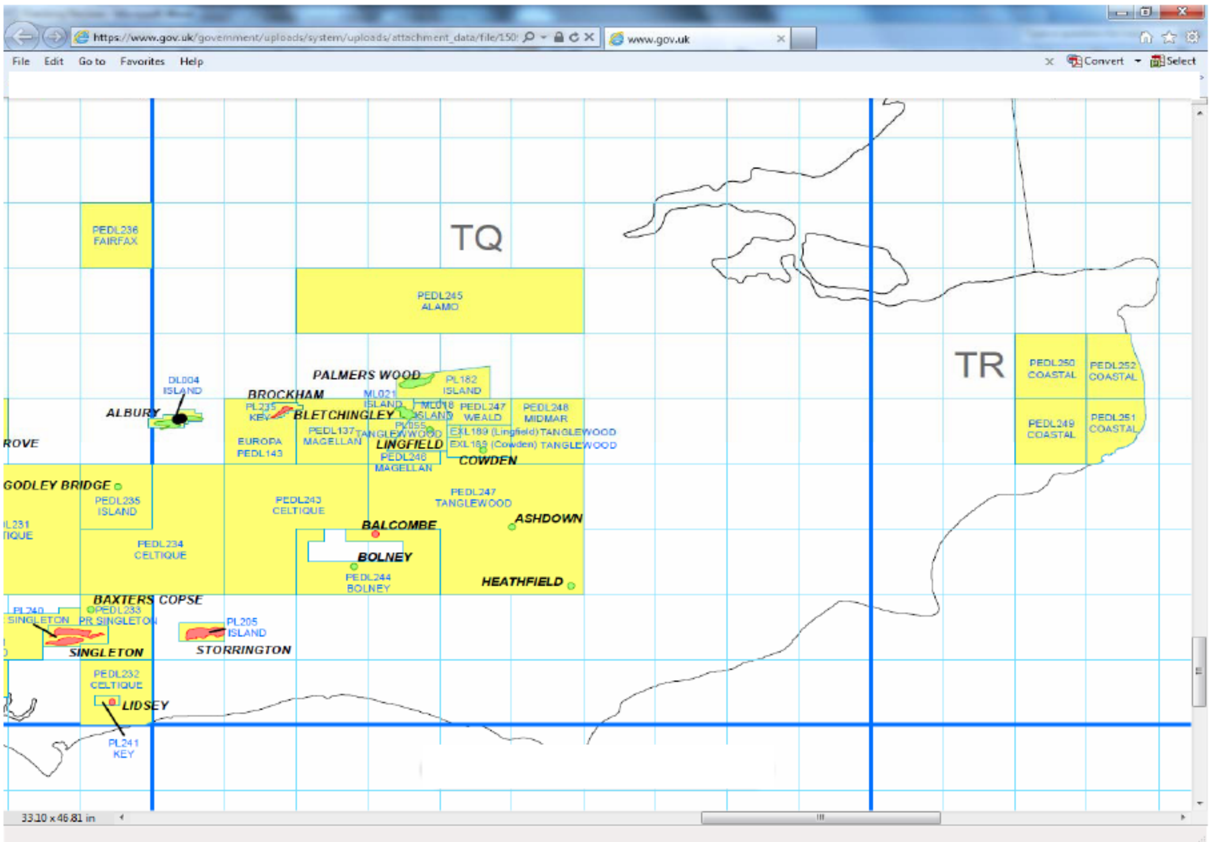
- Any need to gain access rights from landowners
- Health and safety regulations
- Planning permission from relevant local authorities (in our case Kent County Council).

For PEDL the initial term of the licence is set at 6 years and carries a work programme of exploration activity that DECC and the licensee will have agreed as part of the application process. This licence will expire at the end of the initial term unless the licensee has completed the work programme. At this time the licensee must also relinquish a fixed amount of acreage (usually 50%). The initial term is usually an exploration period.

The second term is intended for appraisal and development. It is for a period of 5 years and will expire at the end of the second term unless the Secretary of State has approved a development plan.

Finally, the third term is intended for production. It is for a period of 20 years although the Secretary of State has the discretion to extend the term if production is continuing.

Picture 1: Source Department of Energy and Climate Change - Areas Licensed for oil and gas extraction under the Petroleum Act 1998 (as of 1 November 2013)



The four PEDLs covering the Dover District are all in the initial exploratory stage (6 year term from 2008). The commitments of the work programme are as follows:

Licence	Firm (Minimum) Commitment
PEDL249	The Licensee shall obtain and reprocess 22km of 2D seismic data. The Licensee shall drill one well to a depth of 1000m.
PEDL250	The Licensee shall obtain and reprocess 22km of 2D seismic data. The Licensee shall drill one well to a depth of 1000m.
PEDL251	The Licensee shall drill one well to a depth of 1000m.
PEDL252	The Licensee shall obtain and reprocess 44km of 2D seismic data. The Licensee shall drill one well to a depth of 1000m.

The hydraulic fracturing undertaken by Cuadrilla Resources in the Bowland Basin in Northern England (potentially the biggest shale basin found so far in the world) takes place at depths generally in excess of 6,000 feet.

Coal-related Hydrocarbons

Coal Bed Methane (CBM) is methane formed through the geological process of coal generation. It is present in varying quantities in all coal and can be extracted using hydraulic fracturing techniques. The Coal Authority manages the UK's coal reserves and must agree to any access to coal formations for any purpose.

Certain processes capture native hydrocarbons, which originate in coal seams. The use of these require permission from the Coal Authority (for access to the coal) and a licence from DECC (for capture of the hydrocarbons). The processes include:

- Coal Bed Methane – liberates native methane from virgin coal seams
- Vent Gas (also called mines gas) – captures methane from working or disused mines

Coal bed methane is different to typical sandstone or other conventional gas reservoirs, as the methane is held within the coal by a process called adsorption. The process of extracting coal bed methane works by releasing pressure in coal seams by natural gas production or the pumping of water from the coal bed.

Kent Coalfield[5]

DECC in a report produced in 2010 stated that there have been few problems with methane encountered in Kent coal mining except at Betteshanger.

[5] Department of Energy and Climate Change, 'Unconventional Hydrocarbon Resources of Britain's Onshore Basins' (2010)

The DECC report, now potentially superseded by subsequent reports, suggested that multiple unconformities on the NE margin of the Mesozoic Weald Basin and the permeable overlying limestone and sandstone might have allowed migration of gas out of the coalfield over an extended period of time into the Weald Basin. The issue of freshwater influx from Mesozoic aquifers having formed biogenic methane was identified as a potential resource.

The Potential Impact on Subsurface Water Resources and Geological Formations

Sub-Surface Water Resources

As mentioned earlier in this report, the process of hydraulic fracturing is designed to release methane trapped in unconventional rocks. A concern identified in Australia and the United States from areas where there has been large scale hydraulic fracturing is the risk of contamination of the groundwater supply with methane gas through release of trapped methane into aquifers and pollution through the chemicals used as part of the hydraulic fracturing process. These issues are addressed as best as possible in this report given the problems in finding sufficient peer reviewed work on this matter. However, a number of government and non-government agencies are undertaking research on the matter currently.

As part of the research for this report, the British Geological Survey (BGS) was contacted and their comments can be found later in this report. In addition, the Chartered Institute of Water and Environmental Management (CIWEM) was contacted and they advised that they would be producing a report in 2014 in respect of the potential water implications of hydraulic fracturing.[6] In the United States where hydraulic fracturing has been undertaken for longer, the Environment Protection Agency at the request of the US Congress is conducting a study to “better understand the potential impacts of hydraulic fracturing on drinking water resources” that is expected to be released for peer review in 2014.

Sub-Surface Water Resources in the UK

Across the UK as a whole 35% of our drinking water comes from groundwater resources, though this figure is higher for the South East of England.[7]

Water issues arising from hydraulic fracturing process

There is much controversy over the level of risk involved in hydraulic fracturing to the water supply. In a publication from the Royal Society and the Royal Academy of Engineering[8] issued in June 2012, it was stated that:

> “the available evidence indicates that this risk is very low provided that shale gas extraction takes place at depths of many hundreds of metres or several kilometres. Geological mechanisms constrain the distances that fractures may propagate vertically. Even if communication with overlying aquifers were possible, suitable pressure conditions would still be necessary for contaminants to flow through fractures. More likely causes of possible environmental contamination include faulty wells, and leaks and spills associated with surface operations. Neither cause is unique to shale gas. Both are common to all oil and gas wells and extractive activities. Ensuring well integrity must remain the highest priority to prevent contamination.”

The Consumer Council for Water (CCWater) identifies the following potential risks involved to the safety of the UK’s water supply:[9]

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[6] Email from Laura Grant of the Chartered Institute of Water and Environmental Management
[7] British Geological Survey, ‘Can shale gas be extracted safely?’
[8] Royal Society and Royal Academy of Engineering, ‘Shale gas extraction in the UK: a review of hydraulic fracturing’ (June 2012)
[9] Consumer Council for Water: http://www.ccwater.org.uk/server.php?show=ConWebDoc.2867#

(a) Contamination of the aquifers (underground water sources) by allowing 'fugitive' methane to permeate into drinking water sources from rocks where it was previously confined or by the chemicals involved in hydraulic fracturing;

(b) Problems over the water demand involved (particularly in water stressed areas);

(c) Possible issues over contaminated effluents and discharges; or

(d) Damage to the water and sewerage infrastructure.

However, it should be noted that CCWater recognise that the evidence base in relation to potential risks is limited. As part of this, they are campaigning for water companies to be statutory consultees in all applications for fracking, although this would require legislation to be enacted.

Water UK, the representative body for UK water and wastewater service suppliers, identifies four areas of potential challenge for water companies in the UK:

(a) Water Quality

- Contamination of aquifers as a result of fracturing running through geology;
- Contamination via a failure in the well casing;
- The direct contamination of surface waters from poorly managed waste water or chemical handling; and
- Tertiary risk associated with traffic movement or drilling in general.

(b) Water Quantity

- The high volume of water use involved in hydraulic fracturing and the stress it places on existing potable water supplies.

(c) Removing and treating waste water

- Fluids involved in the hydraulic fracturing process will need to be treated by the local waste water company. This 'flowback' water will be contaminated with both the chemicals involved in the process and typically saline; and
- Naturally Occurring Radioactive Material (NORM) in waste water.

(d) Infrastructure

- Building of new infrastructure to connect water supply to drill site. This may present problems to install on the edges of a network; and
- Periods of variable use / what happens to infrastructure after drilling finishes

The Environment Agency identifies the following risks associated with exploring for and extracting unconventional gas:[10]

- gas or dissolved minerals moving through other rocks into aquifers;
- leaks from production wells into neighbouring rock formations and aquifers;
- leaks of gas to the atmosphere; and

[10] Environment Agency: http://www.environment-agency.gov.uk/business/topics/133885.aspx

- spills of fluids that come to the surface from storage tanks or lagoons.

It is the view of the Environment Agency that the above risks can be controlled through proper design and management of the drilling and extraction site. The Environment Agency is a statutory consultee in the planning process and provides local mineral planning authorities (in our case Kent County Council) with advice on the potential risks to the environment from individual gas exploration and extraction sites. Furthermore, any PEDL licence holder is required to consult with the Environment Agency (the environmental regulator for unconventional gas operations in England) and apply for environmental permits and other permissions for these activities.

The environmental permitting regulations cover:

- protecting water resources, including groundwater (aquifers) as well as assessing and approving the use of chemicals which form part of the hydraulic fracturing fluid
- appropriate treatment and disposal of mining waste produced during the borehole drilling and hydraulic fracturing process
- suitable treatment and management of any naturally occurring radioactive materials (NORM)

The International Energy Agency, founded in response to the 1973/74 Oil Crisis, is a 28 country group that includes the UK in its membership. In its publication 'Golden Rules for a Golden Age of Gas' it identifies the following golden rules in respect of unconventional gas extraction and water under the Rule 'treat water responsibly':

- Reduce freshwater use by improving operational efficiency;

- Reuse or recycle, wherever practicable, to reduce the burden on local water resources;

- Store and dispose of produced and waste water safely; and

- Minimise use of chemical additives and promote the development and use of more environmentally benign alternatives.

As part of its fact finding, the Scrutiny (Community and Regeneration) Committee was advised by the Campaign to Protect Rural England (CPRE) that any contamination of the groundwater supply would be "for all practical purposes, irreversible".

Turbidity Issues

Affinity Water in its response to the planning applications made by Coastal Oil and Gas Ltd raised questions over turbidity issues arising at public water supply borehole sources while any drilling may take place through the chalk layers. Affinity Water also highlighted the potential for outages at one or more of the pumping stations as a result.

Turbidity is defined as the cloudiness of a fluid caused by individual particles (suspended solids). While heavier particles will settle to the bottom, smaller particles can remain suspended in the fluid.

'Flowback' Water

Research undertaken by the water industry has concluded that the flowback water should be treatable at larger urban / industrial waste water treatment facilities. The flowback water itself is normally highly saline, which is toxic to the bacteria used by water companies in the treatment process and only larger facilities can provide sufficient dilution of the saline flowback water. It also contains minerals dissolved from rocks as well as small particles of rock. Due to the high mineral count, the Environment Agency requires that this flowback water should be properly disposed of.

The Environment Agency as part of its monitoring of the flowback water in the Bowland Basin in 2011 stated that typically a quarter of the water injected as part of the hydraulic fracturing process will return to the surface over a period of weeks to a few months through the drilled well.

As part of the monitoring, the Environment Agency found the minerals that it would expect to find naturally occurring in shale rock such as notably high levels of sodium, chloride, bromide and iron, as well as higher values of lead, magnesium and zinc compared with the local mains water that was used for injecting into the shale.

The flowback water could potentially also contain Naturally Occurring Radioactive Material (NORM) that would have to be treated.

Naturally Occurring Radioactive Materials (NORM)

Naturally Occurring Radioactive Material (NORM) is not exclusive to hydraulic fracturing and is found in conventional oil and gas exploration as well as coal mining. In hydraulic fracturing, wastewater from the drilling process may contain (NORM), although the exact levels will be dependent on the local geology.

The Environment Agency states the following in respect of NORM in their report on Bowland Basin samples:

> "Naturally occurring radioactive materials have been present in rocks since their formation, perhaps billions of years ago. All radioactive materials undergo decay to become more stable, eventually ceasing to be radioactive. Some radioactive materials decay over very long time periods and others more quickly, and so naturally occurring radioactive materials will contain many different radioactive isotopes in differing amounts. The radioactive materials with very long decay times are usually present in larger amounts. Commonly this is radium-226."[11]

The samples from the Bowland Basin taken by the Environment Agency found levels of radium-226 as the radioactive material present at the highest levels at between 14 and 90 Becquerel per litre compared to the average values for natural radioactivity in soil in Western Europe of radium-226 at 40 Bq/kg.

Methane levels in Groundwater

Methane is naturally occurring in most groundwater sources, and originates from one of two main sources – biogenic methane and thermogenic methane.[12] Biogenic methane is bacterially produced and is detectable in nearly all groundwater. It is usually associated with peat bogs, wetlands, lake sediments and landfills. Thermogenic methane is formed during the thermal decomposition of organic matter at depth under high pressures. It is usually associated with coal, oil and gas fields. The British Geological Survey (BGS) states that most methane in UK groundwater is likely to be biogenic in origin.

As a gas methane while not classified as toxic, is flammable and may form explosive mixtures in air. Methane becomes an explosive hazard at concentrations of 5–15% by volume in air.[13] It is also an asphyxiant and may (as a gas) displace oxygen in an enclosed space. In terms of methane in groundwater, assuming complete outgassing from water, this

[11] Environment Agency, Shale Gas 'North West – Monitoring of Flowback Water' (6 December 2011)
[12] British Geological Survey, 'Methane in UK groundwater research overview'
[13] British Geological Survey, 'Methane in UK groundwater research overview'

requires a minimum dissolved methane concentration of 1600 $\mu g/l^{-1}$ (micrograms per litre) for it to be a potential safety hazard.

Measurements from Cretaceous, Jurassic and Triassic carbonate and sandstone aquifers in the UK have shown mean methane concentrations of less than 10 $\mu g/l^{-1}$. The upper range of 500 $\mu g/l^{-1}$ for Cretaceous, Jurassic and Triassic carbonate and sandstone aquifers is well below the 1600 $\mu g\ l^{-1}$ level, though Aquiclude and thermal waters from the Carboniferous and Triassic have shown concentrations in excess of 1500 $\mu g/l^{-1}$.[14]

Baseline methane levels in the Dover District

The BGS is currently conducting studies to establish the baseline methane levels in the UK, including the Dover District and the results of this survey will be published in 2014. As part of the fact finding for this scrutiny review, contact was made with the BGS and while they are unable to provide analyses for individual sites in the district at this stage before publication, they advised that of the 11 sites (7 of which were Affinity Water boreholes) they tested in the Dover District none exceeded 5 µg/l for methane[15]. This is an extremely low background concentration and any leakage of methane gas into the district's aquifers would be readily detectable.

Water Stress

The Environment Agency (EA) defines areas of serious water stress as being where:

- The current household demand for water is a high proportion of the current effective rainfall which is available to meet that demand; or

- The future household demand for water is likely to be a high proportion of the effective rainfall available to meet that demand.

Under the methodology used by the EA, the Dover District areas served by both Affinity Water and Southern Water respectively are classified as being 'Areas of Serious Water Stress' in the most recent survey (2013) for the purposes of Regulation 4 of the Water Industry (Prescribed Condition) Regulation 1999 (as amended).

Water usage in hydraulic fracturing

There were many estimated figures quoted for water consumption involved in hydraulic fracturing as part of the research for this report and although no single definitive water consumption figure 'per frack' was found there were common ranges identified.

In terms of the UK, Cuadrilla Resources' website states that during operations at Preese Hall, Lancashire, 8,400 cubic metres of water were used for the fracture treatments.[16] Drilling at each site used around 900 cubic metres, some of which was recycled water. A distinction was however drawn over water usage in the exploratory stage and the production phase, with most fracturing water during the exploratory stage not being recycled as opposed to the production phase where it was "more practical to recycle the water".[17] Cuadrilla state that during dry spells and droughts, the supply for hydraulic fracturing would be restricted "well before residents and farmers see any impact on their supplies".

[14] British Geological Survey, 'Methane in UK groundwater research overview'
[15] Email from Dr George Darling, British Geological Survey
[16] Cuadrilla website: http://www.cuadrillaresources.com/protecting-our-environment/water/water-sourcing/
[17] Cuadrilla website: http://www.cuadrillaresources.com/protecting-our-environment/water/water-sourcing/

Cuadrilla cite as a comparison a figure of 1-6 gallons of water needed per million British Thermal Units[18] for deep shale natural gas production in comparison with 13-32 gallons of water per million British Thermal Units for coal (ready to use in a power plant) or 8-14 gallons of water per million British Thermal Units for nuclear power.

Water UK estimated that a single production field could have a peak demand of approximately 2 million litres per day during fracturing with a total demand in the order of 20 million litres per year. The research assumed no recycling of waste water and was based on the demand of a 1000 well field reaching peak production in around 3 to 6 years into the development.[19] This was on a par with large industrial usage and would require a 300mm pipe to deliver to the site.

The ‘Explore Shale’ website which is focused on the drilling activity in the Marcellus Shale in Pennsylvania, cites that each drill site uses between 3 – 5 million gallons of water per ‘frack’. The Groundwater Protection Council in the US states that every ‘fracked’ well requires up to 4 million gallons of water.

Any potential mitigation of the burden that hydraulic fracturing would place on local aquifers could involve utilising water tanker deliveries from sources outside the district, recycling waste water from the drill site, and collecting rain water. Water UK suggests that a water management plan should be developed by the operator of any drilling site.

Contamination of Groundwater by ‘Fracking Fluid’

In the UK the disclosure of the constituents of fracturing fluid is already mandatory although this does not mean that the chemical additives are non-hazardous. The use of non-hazardous chemical additives is identified by the Royal Society as a factor that would mitigate the environmental impact of any spill.

Cuadrilla Resources’ states that their fracturing fluid is 99.95% water and sand, leaving 0.5% as chemicals.[20] As was pointed out to the Committee during its fact finding process, the volume of liquid used in the hydraulic fracturing process can still make 0.5% a substantial quantity of chemical fluids.

According to the Cuadrilla Resources’ website, the fracturing fluid used at the Preese Hall exploration well site and for future exploration well sites used the following additives:

- Polyacrylamide (friction reducer)
- Sodium salt (for tracing fracturing fluid)
- Hydrochloric acid (diluted with water)
- Glutaraldehyde biocide (used to cleanse water and remove bacteria)

The website states that so far as an additive to fracturing fluid, Cuadrilla has only used polyacrylamide friction reducer along with a miniscule amount of salt, which acts as a tracer. There has been no need to use any biocide as the water supplied to the Lancashire exploration well sites had been treated to remove bacteria by United Utilities (the water supply company). They have not had to use diluted hydrochloric acid in fracturing fluid at

[18] A British Thermal Unit is the energy needed to heat one pound of water by one degree Fahrenheit (1055 Joules).

[19] Water UK, “Understanding the impacts of shale gas on the UK water industry”, Speech given at – UK Shale 2013, 17 July 2013: http://www.water.org.uk/home/news/press-releases/challenge-on-gas-fracking/publication-version---jm-shale-gas-speech.pdf

[20] Cuadrilla Resources: http://www.cuadrillaresources.com/what-we-do/hydraulic-fracturing/

Preese Hall. The additives proposed, in the quantities proposed, have resulted in the fracturing fluid being classified as non-hazardous by the Environment Agency.[21]

The concerns expressed in relation to fracking fluid are that the fractures caused by the fracking process could lead to the chemical permeating into the groundwater supply such as aquifers.

Restrictions on Drilling

The Chartered Institute of Water and Environmental Management (CIWEM) views the impact on amenity of hydraulic fracturing as likely to be greater in the UK than other countries where fracking is common practice, as the proximity and density of populations relative to possible UK sites are greater. CIWEM advocate the restriction or prevention of development in areas of high value or sensitivity with regard to biodiversity, water resources and local communities.

Furthermore, it considers that an Environmental Risk Assessment should be made mandatory for proposed shale gas operations to ensure that each site is individually assessed and the cumulative impacts of fields and the likelihood of a specific impact are taken into account.[22]

In Pennsylvania, gas wells cannot be drilled within 200 feet of structures, water wells or freshwater springs or within 100 feet of streams or wetlands. However, waivers do permit companies to drill inside of these limits with additional protective measures.[23]

Public Health Issues

On 31 October 2013, Public Health England published its draft 'Review of the Potential Public Health Impacts of Exposures to Chemical and Radioactive Pollutants as a Result of Shale Gas Extraction'.[24] The report focused on the impact of direct releases of chemicals and radioactive material from shale gas extraction and related activities, primarily through pollution to air, land and water.

The report also highlights the absence of peer reviewed research on the health implications of the hydraulic fracturing process. It identifies the problems in the United States as being due to "operational failures and inadequacies in the regulatory environment" and cautions over difficulties in accurately extrapolating information from events there.

The main areas of risk are summarised by Public Health England as:

- Contamination of groundwater as a result of borehole leakage; and
- Accidental spills and accidents above ground.

The report also draws a distinction between the risks from small scale exploratory drilling (a single well) and commercial scale operations. The cumulative impact of multiple wells at different phases of operation in a relatively small area is identified as needing careful scrutiny.

Public Health England concludes on the available evidence that "the contamination of groundwater from the underground fracking process itself is unlikely". However, it recognises the need for further work on:

[21] Cuadrilla Resources: http://www.cuadrillaresources.com/what-we-do/hydraulic-fracturing/fracturing-fluid/
[22] Chartered Institute of Water and Environmental Management: http://www.ciwem.org.uk/policy-and-international/policy-position-statements/hydraulic-fracturing-%28fracking%29-of-shale-in-the-uk.aspx
[23] Explore Shale website
[24] Public Health England http://www hpa.org.uk/Publications/Environment/PHECRCEReportSeries/

- baseline monitoring;
- development of emission inventories and monitoring programmes during and post production;
- early toxicological assessment of chemicals used in fracking fluids; and
- the cumulative impact of multiple wells.

The report emphasises the need for “good on-site management and appropriate regulation of all aspects of operations, from exploratory drilling to gas capture and use and storage of fracking fluid” and the importance of the planning and environmental permitting process.

Seismic Impact

The UK, on average, experiences seismicity of magnitude 5M (felt by everyone nearby) every 20 years and magnitude 4M (felt by many people) every 3 or 4 years. Coal mining related seismicity according to British Geological Survey records was no larger than magnitude 4M. As of June 2012, the Royal Society / Royal Academy of Engineering stated that the emerging consensus was that seismicity induced by hydraulic fracturing would be no greater than magnitude 3M and therefore less than coal mining related seismicity. The depth of the hydraulic fracturing would also determine the surface impact of any seismicity, with a lesser impact the deeper the fracturing.

The earth tremor attributed to the hydraulic fracturing undertaken near Blackpool in April and May 2011 was measured as magnitude 2.3M. The earth tremor that affected Folkestone in 2007 measured 4.3M, with a subsequent earth tremor in 2009 measuring 2.3M.

As a result of these earth tremors, the Secretary of State for Energy and Climate Change issued a Written Ministerial Statement in December 2012 announcing the outcome of investigations into the cause. The evidence was reviewed with the aid of independent experts and concluded that appropriate controls were available to mitigate the risks of undesirable seismic activity and that such controls would be required by DECC for all future shale gas wells.

All new applications for hydraulic fracturing require the applicant to conduct a review of fault lines in the area of the licence application and produce a plan showing any seismic risks. In the UK hydraulic fracturing is monitored by a ‘traffic light system’ and drilling must be stopped if seismic activity reaches 0.5 on the Richter scale above the background seismic activity.

However, a study conducted by Columbia University (in the US) concluded that the use of water to extract oil and gas in hydraulic fracturing could weaken existing fault lines and leave them vulnerable to being triggered by normal seismic activity. There is some controversy over how permanent this weakening of the fault lines could be.

The Type and Scale of Surface Structures

In the UK Shale gas operations are likely to require environmental permits from the Environment Agency under the Environmental Permitting Regulations 2010 and Shale gas wells must be designed, built and operated to standards set in the regulations governed by the Health and Safety Executive (HSE).

The Campaign to Protect Rural England (CPRE) state that a drilling site is approximately 1900 square metres in size with a drilling rig standing around 9 metres in height.[25] In

[25] Campaign to Protect Rural England - http://protectkent.org.uk/blog/fracking-coming-kent/

addition to the visual impact, there will be issues around the lighting of the site, the flaring of methane gas, the noise of production / drilling and traffic movements to and from the site. All of these issues are covered by the planning process.

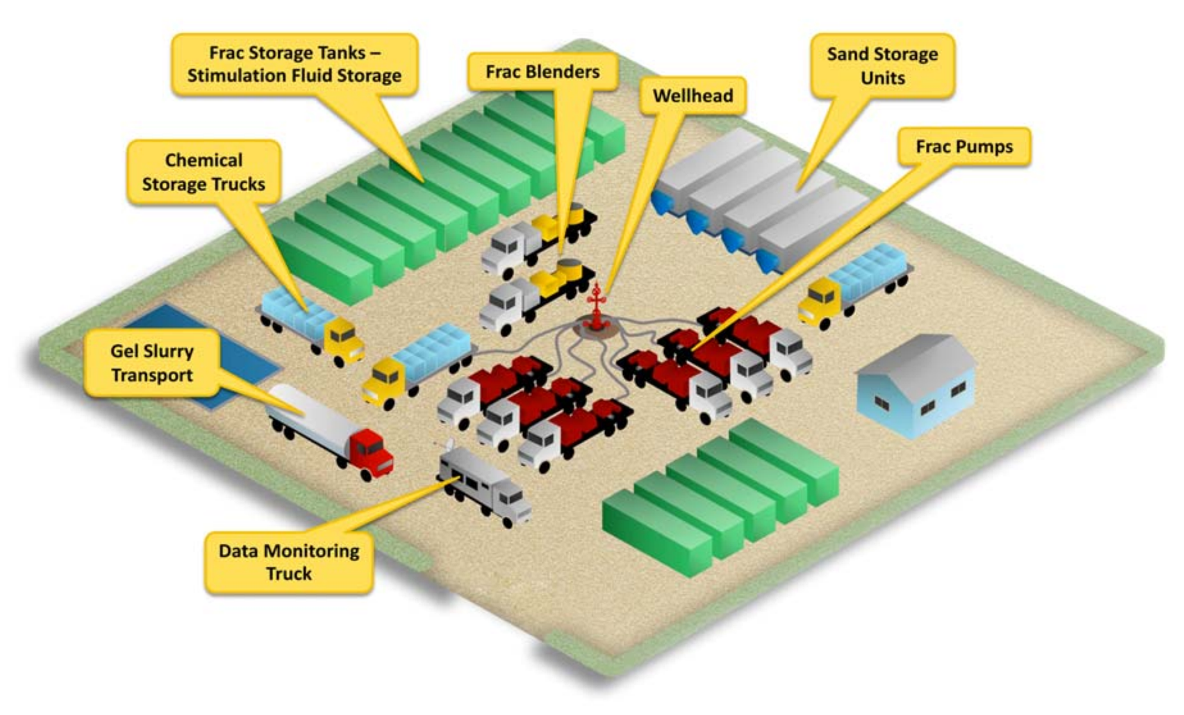
The image below is obtained from the Cuadrilla Resource website shows hydraulic fracturing equipment at Preese Hall in 2011.

Picture 2: Source Cuadrilla Resources - Image of Preese Hall.

The US Department of Energy leaflet on how shale gas is produced provides the following illustration of common equipment at a hydraulic fracturing drill pad.

The American energy company Chevron state that it takes up to a year to build the well site and drill and complete the well. This is based on a drilling rig that drills a vertical well approximately 8,000 feet (2,438 m) below the earth's surface. The rig then drills horizontally, about 2,000 to 6,000 feet (610–1,829 m) outward into the layer of shale rock.

Picture 3: Source US Department of Energy - Representation of common equipment at a natural gas hydraulic fracturing drill pad.



<u>Impact of Anti-Fracking Demonstrations on the Local Communities and on the Police</u>

Sussex Police has responsibility for policing the anti-fracking demonstrations at the Cuadrilla Resources site in Balcombe. The cost of policing the demonstrations was estimated at £2.381 million as of Thursday 5 September 2013.

As part of this report a letter was sent to Kent Police in respect of this area. The response from Paul Brandon, Assistant Chief Constable (Operations) recognises the possibility of protest at potential drilling sites (the letter was written at the time the planning applications to Kent County Council were live) and states that “Kent Police will facilitate lawful protest while also seeking to prevent crime and disorder”. The experience Kent Police has of policing peaceful protests is cited and that officers were “specially trained to deal with events of this nature, to uphold the law and police protests fairly and even-handedly”.

In addition, Kent Police have been liaising with Sussex Police to share lessons learnt from the experience at Balcombe. The costs for any deployment would be met by Kent Police.

Supporting Papers

Correspondence (Appendix 1)

- Cuadrilla Resources – Letter dated 24 October 2013
- British Geological Survey – Email dated 13 November 2013
- Kent Police – Letter dated 7 November 2013
- Affinity Water – Letter dated 4 November 2013
- Chartered Institute of Water and Environmental Management – Email dated 23 October 2013

Letters were written to Southern Water and Coastal Oil and Gas Ltd to which no reply was received.

Documentation Received by the Committee at its meeting held on 11 November 2013

- Campaign to Protect Rural England – Slides with explanatory information
- East Kent Against Fracking – Text of address to Committee
- Keep Shepherdswell Well – Text of address to Committee
- Keep Shepherdswell Well – Letter to Kent County Council Planning Department
- Shepherdswell Parish Council – Letter in respect of Planning Application (KCC/DO/0218/2013)
- Guston Parish Council – Report
- DVD ‘Fracking in the UK’ by Marco Jackson (Provided by Campaign to Protect Rural England)

Source Material Used in Compiling the Research Report

- US Department of Energy:
  http://energy.gov/sites/prod/files/2013/04/f0/how_is_shale_gas_produced.pdf
- British Geological Survey / Department of Energy and Climate Change, 'The Carboniferous Bowland Shale gas study: geology and resource estimation' (2013)
- Department of Energy and Climate Change, 'Historical Maps – Licensed Areas 1969' https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/63943/Onshore_1969.pdf
- Department of Energy and Climate Change, 'Current On-Shore Licenses' (November 2013): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/255514/landfield_lics.pdf
- Eden Energy Ltd, 'Australian Securities Exchange Announcement' (17 September 2013): http://www.edenenergy.com.au/pdfs/c6b848f1e3ddd7b9f4f1c26d7f4e966e.pdf
- PILOT - https://www.gov.uk/government/policy-advisory-groups/105
- Department of Energy and Climate Change, PEDL Licence Details: https://www.og.decc.gov.uk/web_files/recent_licences/oglicences.htm
- Department of Energy and Climate Change, 'The Unconventional Hydrocarbon Resources of Britain's Onshore Basins – Coalbed Methane (CBM)' (2010): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66171/promote-uk-cbm.pdf
- The Royal Society and Royal Academy of Engineering, 'Shale Gas Extraction in the UK: A Review of Hydraulic Fracturing' (June 2012): http://www.raeng.org.uk/news/publications/list/reports/Shale_Gas.pdf
- BBC News, 'Fracking Tests Near Blackpool 'Likely Cause' of Tremors' (2 November 2011): http://www.bbc.co.uk/news/uk-england-lancashire-15550458
- Cuadrilla Resources Ltd, 'Geomechanical Study of Bowland Shale Seismicity' (2 November 2011): http://www.cuadrillaresources.com/wp-content/uploads/2012/02/Geomechanical-Study-of-Bowland-Shale-Seismicity_02-11-11.pdf
- Environment Agency, 'Water Stressed Areas – Final Classification' (July 2013): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/244333/water-stressed-classification-2013.pdf
- Penn State Public Broadcasting, 'Explore Shale' website: http://exploreshale.org/
- BBC News, 'Fracking: Water Concerns Persist': http://www.bbc.co.uk/news/science-environment-23724657
- Chevron website: http://www.chevron.com/deliveringenergy/naturalgas/shalegas/?utm_campaign=Energy_Sources_-_Shale_Gas_English&utm_medium=cpc&utm_source=google&utm_term=fracking&utm_content=sQ6N3seZe_dc|pcrid|19965568009|pkw|fracking|pmt|p
- Health and safety Executive, 'The Regulation of Onshore Unconventional Oil and Gas Exploration (Shale Gas)' (November 2012): http://www.hse.gov.uk/offshore/unconventional-gas.htm

- Water UK, 'Water Industry Lays Down Challenge to UK shale gas fracking industry' (17 July 2013): http://www.water.org.uk/home/news/press-releases/challenge-on-gas-fracking
- Water UK, 'Understanding the Impact of Shale Gas on the UK Water Industry' (17 July 2013): http://www.water.org.uk/home/news/press-releases/challenge-on-gas-fracking/publication-version---jm-shale-gas-speech.pdf
- Water Systems Council, 'Methane Gas & Groundwater' (xx): http://www.watersystemscouncil.org/VAiWebDocs/WSCDocs/Methane_Gas_and_Groundwater_Revised_0311.pdf
- Methane Gas (Wikipedia): http://en.wikipedia.org/wiki/Methane
- Environment Agency website:

  http://www.environment-agency.gov.uk/business/topics/133885.aspx
- International Energy Agency, 'World Energy Outlook: Golden Rules for a Golden Age of Gas – Special Report on Unconventional Gas' (November 2012):

  http://www.worldenergyoutlook.org/media/weowebsite/2012/goldenrules/weo2012_goldenrulesreport.pdf
- US Environmental Protection Agency, Study of Hydraulic Fracturing and It's potential Impact on Drinking Water Resources: http://www2.epa.gov/hfstudy
- BBC News, 'Second Earthquake hits Coastal Town' (3 March 2009): http://news.bbc.co.uk/1/hi/england/kent/7921643.stm
- Campaign to Protect Rural England website: http://protectkent.org.uk/blog/fracking-coming-kent/
- The Global Warming Policy Foundation website: http://www.thegwpf.org/britain-holds-biggest-shale-basin-world/
- House of Commons Select Committee – Energy and Climate Change: http://www.publications.parliament.uk/pa/cm201213/cmselect/cmenergy/writev/isg/m17.htm
- Hydraulic fracturing (Wikipedia): http://en.wikipedia.org/wiki/Fracking
- UK Groundwater Forum: http://www.groundwateruk.org/Default.aspx
- Shale Gas Report: http://www.shalegas-europe.eu/en/index.php/about-us/the-expert-advisory-panel
- Centre for Energy Economics and Policy: http://www.rff.org/centers/energy_economics_and_policy/Pages/Shale-Gas-Expert-Survey.aspx
- The Telegraph, 'Shale could fuel UK for 10 years': http://www.telegraph.co.uk/finance/newsbysector/energy/oilandgas/10111793/Shale-could-fuel-UK-for-10-years-say-experts.html
- Science Media Centre: http://www.sciencemediacentre.org/expert-reaction-to-the-news-that-shale-gas-reserves-in-lancashire-and-yorkshire-are-greater-than-previously-thought/
- This is Money Website: http://www.thisismoney.co.uk/money/markets/article-2370168/Water-firms-warn-fracking-danger-Osborne-unveils-generous-shale-gas-tax-breaks.html
- The Telegraph, 'Prof Robert Mair: Here the facts about fracking': http://www.telegraph.co.uk/finance/newsbysector/energy/oilandgas/10266881/Prof-Robert-Mair-Here-are-the-facts-about-fracking.html
- Eythorne in the Side of Drilling: http://www.eythorneinthesideofdrilling.org/

- BBC News, ‘Fracking: Water concerns persist?’ (16 August 2013): http://www.bbc.co.uk/news/science-environment-23724657
- Water UK, ‘Water industry lays down challenge to UK shale gas fracking industry’ (17 July 2013): http://www.bbc.co.uk/news/science-environment-23724657
- UK Shale 2013 ‘Making it Happen’: http://www.shale-uk-2013.com/
- Greenpeace, ‘4 Reasons Why We Could All Be Fracked By Fracking’ (11 August 2013): http://www.greenpeace.org.uk/blog/climate/3-reasons-why-we-could-all-be-fracked-fracking-20130812
- Environment Agency, ‘Monitoring of Flowback Water’ (6 December 2011): http://www.environment-agency.gov.uk/static/documents/Business/6th_Dec_-_Shale_gas_-_North_West_-_Monitoring_of_flowback_water_-_update_(3).pdf
- Chartered Institute of Water and Environmental Management: http://www.ciwem.org.uk/policy-and-international/policy-position-statements/hydraulic-fracturing-%28fracking%29-of-shale-in-the-uk.aspx
- ‘Frack Off’ website: http://frack-off.org.uk/locations/bad-guys/
- East Kent Against Fracking: http://eastkentagainstfracking.blogspot.co.uk/
- Affinity Water: https://stakeholder.affinitywater.co.uk/home.aspx
- Environmental Impact of Mining:

  http://en.wikipedia.org/wiki/Environmental_impact_of_mining
- Public Health England:

  http://www.hpa.org.uk/Publications/Environment/PHECRCEReportSeries/
- Sussex Police ‘Balcombe Protests Policing Costs Update’ (6 September 2013): http://www.sussex.police.uk/whats-happening/latest/news-stories/2013/09/06/balcombe-protests-policing-costs-update