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To Whom It May Concern,

Response to Public Health England's 'Review of the potential public health impacts of exposures to chemical and radioactive pollutants as a result of the shale gas extraction'

We are writing to comment on Public Health England (PHE)'s 'Review of the potential public health impacts of exposures to chemical and radioactive pollutants as a result of the shale gas extraction' and to outline key issues that must be resolved before the extraction of shale gas using hydraulic fracturing should be allowed to proceed in the UK.

The review from PHE states that fracking to extract shale gas is unlikely to have a detrimental effect on the health of people living nearby, provided that operations are properly run and regulated.

However, the body has admitted that little robust research has looked specifically at the health implications of fracking and that most of the existing data come from the United States, which has a different geology and may use different chemicals and procedures to the ones that could be used in the United Kingdom.

Furthermore, the review makes clear that it focuses solely on the potential effects on health of the chemicals used and any radioactive material released. Crucially, the report excludes considerations which are key to any public health assessment, including occupational health and safety, climate change and greenhouse gas emissions and the quality and availability of water resources.

The review also fails to mention the risks of workers at shale gas extraction sites inhaling crystalline silicaⁱ, which is known to increase the risk of lung disease. Also excluded from the review is an assessment of the risks of other methods of unconventional hydrocarbon extraction, such as coal bed methane extraction.

The Government's reaction to the review's findings could lead the public to believe that it had covered extensively all potential public health risks linked to fracking, but these gaps are significant public health considerations and therefore must be thoroughly assessed before any conclusion that fracking is a 'low risk' to public health can be drawn. As highlighted in the review's

recommendations (p.33), this should only be considered an initial review – further assessment is crucial before any decision is made to allow hydraulic fracturing is allowed to proceed in the UK.

When energy minister Michael Fallon promised that ‘companies will only be granted permission to frack for shale if their operations are safe’, he should be aware that this review does not give the green light to fracking – no conclusion that fracking is safe has been drawn.

Furthermore, it must be noted that the review’s conclusions are based on the assumption that the fracking operations are ‘properly run and regulated’. John Harrison, director of PHE's centre for radiation, chemical and environmental hazards states that “in this country we do have very strong regulatory procedures”, and Fallon has hailed the UK as having “the most robust regulatory regime in the world for shale gas.”ⁱⁱ

But far from carrying forward a strict regulatory regime, the Government seems determined to deregulate the shale gas industry as far as possible, and has cut the budget of the environmental regulator. It is difficult to see how a government committed to a deregulatory agenda will be capable of guaranteeing that fracking companies operate safely.

Our comments in this submission cover PHE’s areas of consideration for the review and draw on additional sources to highlight our concerns about the public health impacts of fracking.

However, we would also like to reiterate that no conclusions about the safety of fracking should be drawn before the relevant assessments have been carried out, both with regard to additional public health impacts, as well as further important considerations including: potential seismic activity; safety and environmental impacts; implications for climate and energy policy and objectives.

The majority of these concerns are categorically not addressed in the PHE review, which is therefore no substitute for an independent scientific assessment of hydraulic fracturing. The report is extremely limited in scope and is not a reliable basis from which to conclude that fracking is either safe or advisable.

Regulatory environment

The review’s conclusion that ‘the potential risks to public health from exposure to emissions associated with the shale gas extraction process are low’ is based on the assumption that the fracking operations are ‘properly run and regulated’. John Harrison, director of PHE's centre for radiation, chemical and environmental hazards states that “in this country we do have very strong regulatory procedures”, and Fallon has hailed the UK as having “the most robust regulatory regime in the world for shale gas.”

However, serious concerns remain as to whether the regulatory system is effective, robust or transparent enough to instill public confidence should permission be granted to the industry to proceed with fracking. The Chartered Institute of Water and Environmental Management has warned against encouraging fracking as a part of the energy mix in the UK “until there is more evidence that

operations can be delivered safely, that environmental impacts are acceptable and that monitoring, reporting and mitigation requirements are comprehensive and effective”.ⁱⁱⁱ

Furthermore, while regulation may seek to make fracking safer, it cannot make it safe. As the United Nations Environment Programme (UNEP) has concluded “Hydrologic fracking may result in unavoidable environmental impacts even if UG [unconventional gas such as shale gas] is extracted properly, and more so if done inadequately. Even if risk can be reduced theoretically, in practice many accidents from leaky or malfunctioning equipment as well as from bad practices are regularly occurring”.^{iv}

Far from carrying forward a strict regulatory regime, the Government seems determined to deregulate the shale gas industry as far as possible. The Government only recently put out proposals to revise planning laws to make it even easier for companies to acquire fracking permits by ending people’s right to be notified about plans to drill for gas and oil beneath their homes and land.

Simultaneously, the government has just announced a 30% budget cut to The Department for Environment, Food and Rural Affairs (Defra), which is considerably higher than the government average of 19%, with the result of major job losses and consequently reduced capacity in the agencies that have oversight of environmental pollution.^v

As highlighted by Greenpeace energy campaigner Leila Deen, when it comes to regulation of the shale gas industry it is “effectively allowing companies to mark their own homework.”^{vi}

It is difficult to see how a government intent on reducing our capacity to effectively regulate, and indeed reduce regulation itself, will be capable of guaranteeing that fracking companies operate safely.

Moreover, although PHE seems satisfied that any shale gas will be regulated within the current regulatory requirements governing onshore oil and has exploration (p.5), the UNEP point out that “Existing laws and regulations of the mining activities often do not address specific aspects of hydraulic fracturing” and as such, for governments who decide to pursue fracking, dedicated regulations will be required.^{vii}

A study by the European Commission supports the statements of the UNEP, pointing to a number of gaps in the current EU regulatory framework concerning hydraulic fracturing, most importantly relating to Environmental Impact Assessments, the Water Framework Directive and REACH, all of which are dealt with in this submission.^{viii}

The necessary legislative revisions at EU level are all currently underway and it is vital that these are completed and transposed into Member State legislation before any shale gas extraction is permitted in the UK.

Experience shows that shale gas activities can generate serious environmental cross-border issues that cannot be solved with inconsistent and potentially conflicting legislation at the national level. While the EU may not have the authority to set an EU-wide ban on shale gas activities, it is the institutions’ duty to take a leading role in this legislative process and make sure the precautionary

principle is applied properly. It is crucial not to repeat the mistakes made in the U.S. – legislating only once the environmental impacts have been felt – and to ensure that every European country uses consistent adequate standards to regulate, prevent and monitor these risky industrial activities.^{ix}

Air quality

We welcome the consultation's attention to the issue of air quality. We would like to highlight the need to take the broadest view in terms of the total air pollution impacts arising from all aspects of proposed exploration and operational fracking. We would also like to highlight the need to assess air pollution impacts in the light of the UK's ongoing failure to meet EU air quality standards and legal limits, and the evidence that air pollution is a major health hazard for the public.

We welcome the attention paid to the impacts from volatile organic compounds (VOCs) and the formation of secondary pollutants such as ozone (O₃) which can be generated from photochemical reactions of other pollutants in the presence of sunlight.

EU study concludes health risk category is high

The European Commission's detailed assessment^x of the health risks of hydraulic fracturing considered the impacts on air quality. It gave the following assessment:

“Emissions from numerous well developments in a local area or wider region could have potentially significant effect on air quality. Emissions from wide scale development of a shale gas reservoir could have a significant effect on ozone levels. Exposure to ozone could have an adverse effect on respiratory health and this is considered to be a risk of potentially high significance.” (page viii).

The study considered 6 aspects of the hydraulic fracturing process - 1. site identification and preparation; 2. well design, drilling, casing and cementing; 3. fracturing; 4. well completion; 5. production; and 6. well abandonment and post-abandonment. (page vi, table ES1). It assessed the risk levels at each stage for an individual site, and also looked at the cumulative effect, also across these 6 stages. Finally it gave an overall risk assessment taking all the stages into account.

Crucially, the study found that cumulative overall risk to the environment and health from releases to air were high. Greatest air pollution risks were attributed to categories 2-5: well design, drilling, casing and cementing; fracturing; well completion; and production. (page vi, table ES1)

This study, and the areas it identifies as high risk, should inform the scope of assessment made regarding the air pollution impacts of fracking.

Traffic impacts must be taken into account

The EU study also includes the impacts of traffic and we would urge that this be fully factored in to any health impact assessments.

The EU study in fact concluded that traffic associated with hydraulic fracturing operations posed a high risk to health and the environment (page vi, table ES1). High risk impacts occur from the first three phases of operations: 1. site identification and preparation; 2. well design, drilling, casing and cementing; 3. fracturing.

It found that total truck movements during the construction and development phases of a well are estimated at between 7,000 and 11,000 for a single ten-well pad – an impact that would have “a significant effect in densely populated areas”. It estimated potentially 250 truck trips per day onto an individual site during the most intensive development phase, and expressed concern about the impact on local traffic flows, road safety issues and “increased risk of spillages and accidents involving hazardous materials” (page x1).

Traffic increases, especially involving large or diesel vehicles, will have additional air pollution impacts – especially for NO2 and PM.

Air pollution in England - an unseen killer

The UK is currently failing to meet EU air quality standards, with major public health implications. At least 29,000 UK deaths are caused directly by air pollution each year. It particularly impacts children, older people, asthma sufferers, people living near busy roads and low income groups.^{xi}

London has the highest level of NO2 of any capital city in Europe, and over 4000 Londoners die each year from long-term exposure to air pollution. The Government is insisting that London cannot meet safe NO2 levels until 2025 at the earliest. The South East of England is also in breach of EU air quality standards.^{xii}

The UK is facing potential legal proceedings from the EU as a result of this health and policy failure.

Given this context, we find it wholly unacceptable that licenses have been granted for exploratory drilling which could lead to fracking in the London boroughs of Croydon and Bromley and in Balcombe in the South East and elsewhere.

The health impacts of air pollution will only be exacerbated by fracking and will make it harder for the UK to meet EU air quality standards. The chronic levels of air pollution in London in particular should rule out fracking in London boroughs.

We urge that the full air pollution health impacts of all aspects of fracking exploration and operation are taken into account. This should be looked at in the context of EU air quality standards and the ongoing failure of the UK to meet these legal limits, and it's ongoing and outstanding obligation to do so.

Radon

Radon is present in natural gas, such as shale gas, and is a serious public health threat. According to the U.S. Environmental Protection Agency (EPA), radon is the leading cause of lung cancer among

non-smokers and is the second leading cause of lung cancer overall. Radon is responsible for about 21,000 lung cancer deaths every year, and 2,900 of these deaths occur among people who have never smoked.^{xiii}

Radon is produced when radium undergoes radioactive decay and does not burn so it could be released into houses and workplaces by gas-fired appliances. As highlighted in the report, concentrations of radon can be significantly higher in buildings due to indoor pressure differential and the containment caused by the building.

We welcome the recognition in the review that there is potential for radon to be present in natural gas extracted from UK shale, and the recommendation that where shale gas extraction takes place, levels of radon are monitored. We stress that baseline testing for levels of radon, as well as monitoring during and after any operations, should be a mandatory requirement wherever shale gas extraction takes places.

Naturally Occurring Radioactive Materials (NORM)

We welcome the consultation's focus on the need to determine the levels of NORM resulting from fracking exploration and operations.

We note the report's important assessment that flowback water from shale gas extraction is likely to contain significant levels of NORM (p20).

It is important to highlight the report's assessment that radium levels in flowback water are likely to be high enough to require environmental permits under the Environmental Permitting (England and Wales) Regulations for the accumulation and disposal of radioactive substances (p19).

We agree that regulatory authorities must take into account the cumulative radiation exposure to the public and workers, such that other nearby sites (eg nuclear operations) or multiple shale gas operations need to be accounted for in assessing total radiation exposure to individuals.

We urge that the regulatory authorities should be required to take cumulative exposure levels into account in any assessment for the granting of permits.

Water and wastewater

Water use

The report rightly recognises that the process of hydraulic fracturing requires vast volumes of water (p.21), potentially putting pressure on water supplies in drilling areas. It is difficult to estimate exactly how much water is required, as it varies per well and depends on a number of variables including the geology and density of the rock, the depth and horizontal distance of the well, as well as the number of times the well is fracked. The most recent estimate by Department for Energy and Climate Change (DECC) puts the amount of water required per well between 10,000 and 30,000

cubic metres.^{xiv} According to Friends of the Earth, the water used for one single well could supply almost 10,000 Europeans for a year.^{xv}

It is therefore particularly worrying that exploration is already taking place in the UK in water stressed areas, such as one of our constituencies – South East England – which is classified by the Environment Agency (EA) as an area of ‘serious water stress’.^{xvi}

The potential impact of such high water demand for fracking was evident during the 2012 summer drought in a significant part of the US, when some areas in Texas and Kansas were forced to halt shale gas activities, while in Pennsylvania, access to river water was forbidden. Elsewhere, fracking operators went to extreme lengths to gain access to water resources, by offering vast sums to landowners in order to outbid farmers.^{xvii}

Similarly, in the UK the EA has predicted a ‘medium probability’ that acquiring water for fracking will impact on water supplies for the natural environment as well as increasing competition for the resource.^{xviii} A report by the UNEP also states that “the needs of water for exploitation and the depletion of aquifers has (and will) create conflicts in water usages. Notably, competition with agricultural users is likely to be a serious issue.”^{xix}

Although fracking is generally considered less water intensive than coal or nuclear, it is unlikely that it will simply substitute either energy source. Instead fracking is likely to create an additional demand for water, especially when the cumulative effects of multiple installations are taken in consideration.

The review proposes using recycled wastewater to reduce water demand, but even this only goes so far in reducing the total amount of water needed and will need to increase considerably to make a significant impact. The sheer volume of wastewater produced is likely to increase with increased production despite recycling efforts, due to the number of wells required for economically viable extraction. And, according to a report by sustainability charity Ceres, “recycling can only go so far in solving water sourcing problems since much of the water injected remains in the formation.”^{xx}

Furthermore, as highlighted in the review, there is even less potential to recycle flowback waters in Europe due to their high salinity (p.22).

There is also a suggestion in the review that waterless fracking fluids such as gels or gases could be an effective method in reducing water usage. However, such techniques remain at the testing stage and concerns remain surrounding the safety and cost of such technology.^{xxi}

It therefore seems likely that drilling techniques will continue to rely on toxic chemicals. As such, the basic risk of undisclosed chemicals leaking into groundwater and actual water supplies remains.

Water contamination

There is increasing evidence from the U.S. linking fracking-related activities to water contamination.^{xxii} The highly toxic chemicals associated with fracking operations makes leaks and spills even more troubling, and there is growing concern about high levels of naturally occurring

radiation in wastewater.^{xxiii} A recent study released by Duke University demonstrates a link between fracking and elevated levels of methane, ethane, and propane in nearby groundwater.^{xxiv}

As well as the numerous examples of water contamination in the U.S. noted in the review (p.23), there have already been a number of accidents in fracking operations in Europe, including the incident at Söhligen in Germany in 2007 when groundwater sources were contaminated with benzene and mercury after waste water pipes leaked.^{xxv}

The review points to a study from the Massachusetts Institute of Technology which found two common causes of groundwater contamination as a result of drilling operations: leakage through the vertical borehole (often related to inadequate cementing or casing) and surface spills of stored fracking fluids and flowback water.

Well integrity

In relation to the first of these, the review points to well integrity as a crucial factor in the prevention of public health risks. It should be noted that industry documents have revealed that 6 per cent of hydraulic fracturing wells fail immediately, and 50 per cent fail over 30 years;^{xxvi} bringing into question the ability of the industry to ensure well integrity is maintained. Furthermore, there are potential difficulties when it comes to the monitoring of well integrity; according to Richard Davies, professor and director of the energy institute at Durham University, “Of the 2152 wells drilled onshore in the UK since 1902, approximately 50% are buried and therefore not easily monitored, and 1138 were drilled by companies that no longer exist. If the rocks are suitable and the UK presses ahead, then well integrity is an area that will need a great deal more focus.”^{xxvii}

Flowback wastewater

Fracking operated on a commercial scale generates a high volume of waste water, which typically includes more chemicals and radioactive particles brought up from underground,^{xxviii} and there is currently no satisfactory solution to its safe containment.^{xxix}

Flowback water is characterised as a mining waste and requires a permit for safe disposal. If the wastewater is improperly treated then it risks entering and contaminating the surface waters and/or the groundwater. The risk of a surface spill of flowback water - which could occur due to defective pipes or storage tanks, or the transfer of fluids from storage to tanker for example - is classified as medium according to the Environment Agency.^{xxx}

If the flowback water is not recycled for future use, there are several methods of disposal: re-injecting it deep within the earth; decontaminating it and then disposing in surface water body; disposing of directly on the land; on-site treatment (or direct removal for treatment elsewhere) and then disposing to a licensed waste treatment and disposal facility; and disposing of it - with permission - to foul sewer.

The first of these methods – injecting these fluids into porous bedrock via deep disposal wells – is commonly practiced. However it should be noted that the DECC has stated that “large scale re-injection of frac disposal fluids poses a recognised earthquake risk”.^{xxxi} A recent study by Columbia

University demonstrated that deep-well injection of fracking waste can stress geological faults in ways that make them vulnerable to slipping. The research showed that distant natural earthquakes triggered swarms of smaller earthquakes on these critically stressed faults.^{xxxii}

Evidence from the U.S. causally links a number of earthquakes with the use of underground wells to dispose of waste water produced by fracking, including a swarm of earthquakes in 2011, which included a magnitude 5.7 earthquake - the largest ever cause by wastewater injection - that injured two people, destroyed 14 homes, and was felt across 17 states.^{xxxiii}

In April and May 2011, Cuadrilla Resources, the company carrying out fracking at Preese Hall, Lancashire, suspended exploration following two earthquakes with magnitudes of 1.5 and 2.3. Experts investigating the quakes stated that they occurred as a result of the fracking process.^{xxxiv} An independent scientific report commissioned by the British government confirmed that “the earthquake activity was caused by direct fluid injection” during the fracking process and conceded that it was not possible “to categorically reject the possibility of further quakes”.^{xxxv} However it concluded that operators could resume fracking operations, as long as they were effectively regulated, despite the obvious understatement of the risks generated by the earthquakes (such as the impacts on wells’ integrity, deformation of well casings, likely to create leakages).

Underground leaks

The review dismisses the risk of contamination from leaks underground, either through natural or through artificial fractures or pathways (p.25). However, most of the fracking fluid remains underground (up to 80 per cent of the input), and studies now show that it can migrate towards natural drinking water supplies (such as aquifers and springs) often in the course of just a few years.^{xxxvi} According to the Cuadrilla Resources website, in the UK between 20-40 per cent of the water used during the fracturing process flows back to the surface during the first few weeks. The rest of the water remains underground, some of which resurfaces during the well’s overall lifetime. We therefore urge a thorough assessment of the risk from underground leaks to water supplies.

Summary

Water contamination from all stages of the fracking operations presents a significant threat to public health. We welcome the recommendations in the review for baseline monitoring of water supplies as well as testing throughout and after operations for water contamination. We also stress the need for the necessary revision of the EU Water Framework Directive, to consider the protection of water resources from accidents due to fracking and related activities, to be complete before any shale gas operations are allowed to go ahead in the UK.

There is also a clear need to await proposals on the revision of European Waste Directive (EWD) and Mining Waste Directive (MWD). Permits for mining waste management and other waste from drilling for shale gas should be integrated into the main authorisation procedures under the EWD and the MWD. The components of fracking fluids are not explicitly recognised as ‘hazardous waste’ by the EWD as it currently stands. Their inclusion would help to ensure that stricter waste regulation was applied to fracking fluids so as to guarantee safe and controlled disposal. Treating fracking

fluids as hazardous waste can both help to limit unsafe disposal and ensure that all fracking fluids are treated at specialised wastewater disposal plants.

We warn against the assumption in the review that the risks to water supplies from fracking operations will be sufficiently minimised through robust regulation in the UK as this fails to take account of the government's deregulatory agenda as outlined in the 'regulatory environment' section.

Hydraulic fracturing fluid

The fracking process involves a number of toxic chemicals, and the volumes required depend on the permeability of the rock. According to the industry, the injected fluid typically contains 98-99.5 per cent water, with the chemical component making up 0.5 – 1.5 per cent.

As a standard shale gas well requires around 15 million litres of water, this means a single fracking project can involve tons of highly toxic chemicals, as recognised in the review (p.30). For example, a typical fracking site in the Marcellus Shale in the US is thought to use around 133 tons of chemicals, including hydrogen chloride, ammonium persulfate and potassium hydroxide.^{xxxvii}

Often the full details of the chemicals used are not disclosed. For example, almost half of the chemicals used for fracking at one site in Pennsylvania were unidentified – potentially equating to 65 tons of 'mystery chemicals'.^{xxxviii} And, as noted in the review, there is limited data on fracking fluid composition from UK operations (p.28).

The industry tends to downplay the risks related to the chemicals used in the extractive process, referring to them as substances that are regularly used in domestic cleaning products, in cosmetics and food, and that they do not pose a threat if ingested or inhaled. However, industry data shows that fracking fluids can include chemicals which are officially classified as: carcinogens, mutagens, reproductive toxicants, neurotoxins, allergens, and hormone disruptors, including toxic chemicals such as benzene, toluene, ethylbenzene and xylenes.^{xxxix}

Furthermore, according to chemical experts, fracking fluid can contain as many as 300 chemicals, out of which 40 per cent are endocrine disruptors, known to interfere with the hormone system in animals and humans, and a third of which are suspected carcinogens. Over 60 per cent of the chemicals used can harm the brain and nervous system.^{xl} In addition, further research needs to be done on the 'cocktail effect' of these several chemicals mixed together, making their effects more potent.^{xli}

In other countries, including the U.S., the exact chemicals used in fracking have been covered by commercial confidentiality and are not disclosed fully. It is difficult therefore to see how their risks can be fully assessed and cleared for UK use.

Due to the hazardous nature of the chemicals used in fracking operations, we welcome the recommendation in the review for monitoring to take place before, during and after operations, as well as the strong recommendation for full disclosure of all chemicals used in the fracking process (p.31). EU legislation on the Registration Evaluation, Authorisation and Restriction of Chemicals

(REACH), which applies to the use of chemical substances in any industrial process, does not oblige companies to disclose the substances used for fracking. Operators, who want to keep their chemical use confidential, as in the case of most fracking operators, are required to conduct their own assessment of the chemicals and report this to the European Chemicals Agency.

However, as companies involved in fracking have not disclosed an exhaustive and detailed list of the chemicals used for each project, it is impossible to assess the environmental and health risks from exploitation and exploration (including full life cycle impacts).

In September 2011, an official from the Commission said that no company had registered any of the 10 chemicals typically used for shale gas extraction for that use under the EU's REACH legislation.^{xiii}

The different deadlines and requirements in the REACH legislation mean that the information about chemicals is not automatically available to the public and, indeed REACH controls on fracking will not come into force until November 2013. In order for proper independent assessments to be carried out, as recommended in the review, companies must therefore be required to disclose the full list of chemicals used in their operations.

Role of health impact assessment

The health and environment impacts of fracking and unconventional fossil fuel (UFF) exploration and operations need thorough and systematic assessment. With fracking bans or moratoriums in a number of EU countries and US cities or states, the technology remains highly controversial and opposed by much of the public.

The Precautionary Principle should be employed and, in our view, fracking should not proceed in the UK or anywhere in the EU.

In the absence of a UK ban or moratorium we favour stringent controls with comprehensive impact assessment of the health and environmental effects.

Unfortunately fracking and other UFF projects are not yet subject to mandatory environmental impact assessment under the Environmental Impact Assessment (EIA) Directive (2011/92/EU). However, Green MEPs are pressing for fracking and UFF projects to require an Environmental Impact Assessment under the directive, and this is also the recommendation of ENVI, the European Parliament Environment and Health Committee.

In our view, mandatory Environmental Impact Assessments under the Environmental Impact Assessment (EIA) Directive (2011/92/EU) is the single most effective way for fracking projects to be rigorously assessed in compliance with the standards required of other fossil fuel operations under EU law. We urge Public Health England to support this as a recommendation.

Conclusion

We do not believe that this review goes far enough in its scope to conclude that shale gas extraction presents a low risk to public health.

The review fails to mention the impacts of silica sand and other forms of unconventional hydrocarbon extraction. The review also fails to account for key considerations such as occupational health and safety, climate change and greenhouse gas emissions, and is therefore not a reliable basis from which to conclude that fracking is either safe or advisable.

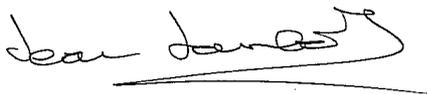
Furthermore, the review's assumption that risks can be minimised through robust regulation in the UK, fails to recognise the Government's commitment to reducing regulation for the shale gas industry.

Significant legislative gaps have been identified at both EU and UK level, and it is vital that these are implemented before any conclusions are drawn before the extraction of shale gas using hydraulic fracturing should be allowed to proceed in the UK.

Yours sincerely,



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Jean Lambert, Green MEP for London

ⁱ <https://www.osha.gov/>

ⁱⁱ <https://www.gov.uk/government/news/shale-gas-health-review-by-public-health-england>

ⁱⁱⁱ <http://www.ciwem.org/policy-and-international/policy-position-statements/hydraulic-fracturing-%28fracking%29-of-shale-in-the-uk.aspx>

^{iv} http://www.unep.org/pdf/UNEP-GEAS_NOV_2012.pdf

^v <http://www.theguardian.com/environment/2010/oct/20/spending-review-cuts-environment>

^{vi} <http://www.bbc.co.uk/news/science-environment-24761980>

^{vii} http://na.unep.net/geas/getUNEPPageWithArticleIDScript.php?article_id=93

^{viii} <http://europeecologie.eu/IMG/pdf/shale-gas-pe-464-425-final.pdf>

^{ix} http://www.foeurope.org/sites/default/files/publications/foe_shale_gas_unconventional_unwanted_0.pdf

^x <http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf>

^{xi} <http://www.jeanlambertmep.org.uk/DocumentStore/Pollutionweb7.pdf>

^{xii} <http://www.keithtaylormep.org.uk/2011/07/18/air-pollution-the-invisible-killer/>

^{xiii} <http://www.epa.gov/radon/healthrisks.html>

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