Lancashire County Council

Cabinet

Thursday, 6th November, 2014 at 2.00 pm in Cabinet Room 'B' - County Hall, Preston

Supplementary Agenda

We are now able to enclose, for consideration at the next meeting of the Cabinet to be held on Thursday, 6th November, 2014, the following information which was unavailable when the agenda was despatched

Part I (Open to Press and Public)

No. Item 9

9. Potential Health Impacts of the Proposed Shale Gas Exploration Sites in Lancashire (Pages 1 - 68)

Jo Turton
Chief Executive

County Hall
Preston

Lancashire County Council

Cabinet - 6 November 2014

Report of the Director of Public Health

Electoral Division affected:
All

Potential Health Impacts of the Proposed Shale Gas Exploration Sites in Lancashire
(Appendices 'A' - 'J' refer)
NB. Appendices 'C' - 'G' can be found on the website

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Executive Summary

Lancashire County Council (LCC), the Environment Agency (EA) and the Department for Energy and Climate Change (DECC) are currently in the process of determining the planning applications, environment permits and consent to drill respectively for the two proposed shale gas exploration sites in Lancashire. On 8 May 2014, LCC's Cabinet agreed that the Director of Public Health (DPH) would undertake a Health Impact Assessment (HIA) of these sites at Preston New Road and Roseacre Wood, to be followed in due course by an HIA of the wider industry.

Shale gas exploration, like any other industrial activity, has its risks to the health and wellbeing of the population. Having completed the HIA for each of the two sites the DPH has concluded that the key risks to the health and wellbeing of the residents who live near the two proposed sites in Lancashire include:

- Lack of public trust and confidence, stress and anxiety from uncertainty that could lead to poor mental wellbeing
- Noise related health effects due to continuous drilling, and
- Issues related to capacity for flowback waste water treatment and disposal.

The DPH advises that these risks and other issues highlighted in this report can be mitigated by LCC, EA, DECC, and the Health and Safety Executive (HSE) to protect the health and wellbeing of local residents. In particular:

- There is also a need to be vigilant during the operations, and in emergency preparedness.
- A robust baseline and long term monitoring of environmental and health conditions is required in order to reassure communities and to understand the cumulative and long term effects.
- Local communities should be actively involved and the risks should be communicated in a transparent and reliable manner that is proportionate to the exploratory phase of the industry. This needs a closer working relationship between the industry, national and local agencies as well

Lancashire County Council

organisations with an interest in local shale gas exploration.

- If this industry is to develop further, there is a need for shale gas specific spatial strategy at a local level and an onshore oil and gas industry specific integrated regulatory framework at a national level. Further research on effects of shale gas development on health and wellbeing will help to improve the policy and regulatory framework as the industry moves into production phase.

This is deemed to be a Key Decision and Standing Order 25 has been complied with.

Recommendation

Cabinet is recommended to:

(i) Endorse the recommendations that the County Council can address and those that are directed to other agencies in this report;

(ii) Authorise the Director of Public Health (DPH) to take steps to action the recommendations;

(iii) Note the advice of the DPH to the County Council's Development Management Group (Appendix J refers).

Background and Advice

1. Although onshore oil and gas extraction is a familiar technique in the United Kingdom (UK), unconventional gas extraction through horizontal drilling and hydraulic fracturing is a relatively new industry. The current UK Government's policy is to actively pursue the production of onshore oil and gas. Recent estimates by the British Geological Survey suggests large shale gas deposits to be present in Lancashire.

2. The shale gas industry is at the exploratory phase and is likely to take a number of years before it enters into the production phase. If commercial production occurs in the future, it may bring economic benefits to the region and the country.

3. Various national and local agencies are involved in the planning and regulation of this industry[1]. A summary of the current regulatory road map from Department of Energy and Climate Change (DECC) is shown in Figure 1 shown on Page 3. Appendix 'A' refers to the difference between conventional and shale gas exploration.

4. Like any other industrial activity, shale gas exploration involves potential risks to the environment and health that need to be managed. The policies, regulation and operational standards for shale gas extraction are likely to develop further over the coming months and years in the UK as new scientific and local knowledge emerge.

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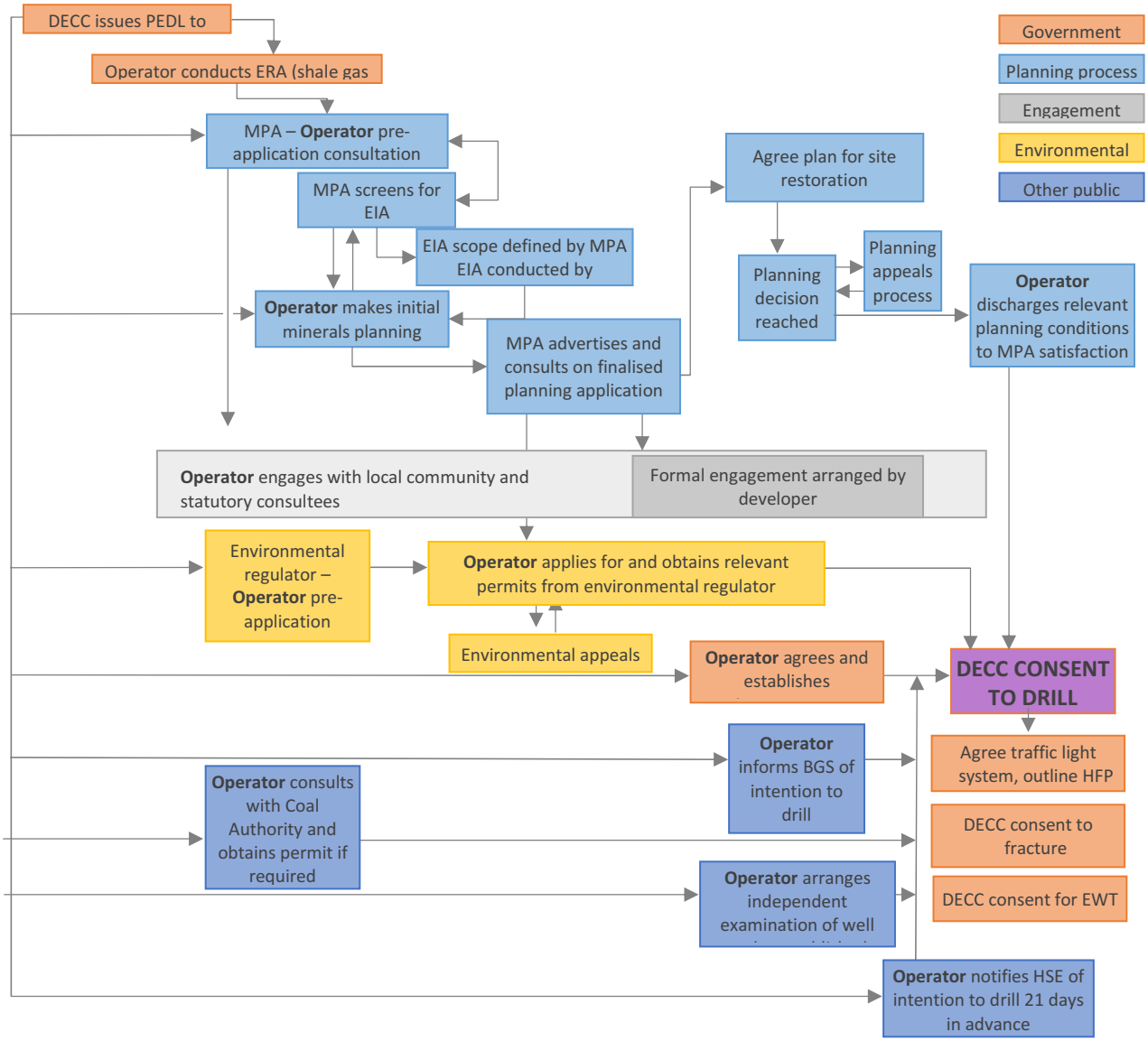
1 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/265988/Onshore_UK_oil_and_gas_exploration_England_Dec13_contents.pdf accessed on 14/10/2014

5. Protecting and improving the environment, health and wellbeing should be of paramount significance for the national Government, local Government, policy makers, planners, regulators, local decision makers and the wider society. This will ensure safer gas extraction and help develop sustainable communities.

6. In Lancashire, planning applications for two proposed sites (Preston New Road, near Little Plumpton and Roseacre Wood near Roseacre) for temporary exploratory drilling, hydraulic fracturing and flow testing over an extended period have been received by LCC. Applications for environmental permits for these sites are also being determined by the EA.

7. Under the Health and Social Care Act 2012, LCC became responsible to protect and improve public health and wellbeing of Lancashire residents. The role of the Director of Public Health (DPH) is to provide expert advice and support to the Council, the public and any other relevant body, with an aim to protect and improve the health and wellbeing of the population.

Figure 1: Roadmap for onshore oil and gas regulation in the UK



8. The primary aim of this report is to inform the planning, environmental permitting and consenting process by LCC and the regulatory roles of Environment Agency (EA), DECC and HSE respectively. Hence, this should be seen as an ongoing process and not a summary of all potential health impacts and the related literature. The findings of this HIA will be kept under review on a regular basis and any new knowledge will be used to advise relevant agencies. Appendix 'J' refers to the DPH's consultation response to the Mineral Planning Authority (LCC).

9. Although undertaking a HIA is not a separate statutory requirement under the onshore oil and gas planning and regulatory regime, considering health issues is generally done as part of an environmental impact assessment (EIA), which can be required through the planning and environmental permitting processes. In addition, there is also an opportunity to consider risks to human health as part of

the environment risk assessment that is required by the DECC before issuing petroleum exploration and development licenses (PEDL).

10. HIA is defined as a combination of procedures, methods and tools that systematically judges the potential, and sometimes unintended, effects of a policy, programme or project on both the health of a population and the distribution of those effects within the population. It identifies appropriate actions to manage those effects. The aim is to maximise the positive health impacts and minimise the negative ones as a result of a proposal.

11. Health is defined by the World Health Organisation (WHO) as the state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. UK Government defines public health as helping people to stay healthy, and protecting them from threats to their health[2].

12. Health is not only influenced by environmental factors but also through social, economic and commercial determinants. Therefore, an HIA is different to the EIA. Generally speaking, planning applicants submit an EIA to demonstrate that they are complying with the legal requirements and that there is no significant impact on environment due to the development. An HIA refers to legal environmental standards but it also aims to support the policy making and planning process to consider the contextual information and the wider impacts of the proposed development on the health and wellbeing of the affected communities.

13. To assess the health impacts effectively, the stages below are usually followed[3]:

13.1.1. **Screening**: Do we undertake an HIA?

13.1.2. **Scoping**: What are the parameters for the HIA study? What are the governance and management arrangements?

13.1.3. **Appraisal**: What are the potential impacts on health? How can we address those impacts?

13.1.4. **Reporting**: Including a Public Health management plan of recommendations to control and manage the health impacts

13.1.5. **Supporting decision-makers**: How do we present the results so that they are both useful and usable by relevant decision-makers?

13.1.6. **Monitoring and evaluation**: This can be process evaluation, effectiveness evaluation or (health) outcome evaluation.

14. The methodology for this HIA follows the recognised stages and is based on desktop research combined with community and stakeholder engagement. The screening for the HIA was completed when the Council's Cabinet decided to undertake a HIA of the two proposed sites initially followed by an HIA of the wider industry. It was also agreed that this work would be supported by the Health Advisory Group (HAG), led by the DPH.

15. The HAG was established to support the HIA process and agreed the terms of reference at its first meeting on 19 May 2014 (Appendix 'B' sets out the terms of reference).

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[2] https://www.gov.uk/government/topics/public-health

[3] Scott-Samuel, A., Birley, M., Ardern, K., (2001). The Merseyside Guidelines for Health Impact Assessment. Second Edition, May 2001. 20 pages. ISBN 1 874038 56 2. Published by the International Health Impact Assessment Consortium.

Scoping of potential health impacts from the proposed exploration sites

16. Ben Cave Associates Ltd was appointed as the expert HIA Consultant in June 2014, to provide expert HIA support during the HIA process. They supported the scoping and initial appraisal by reviewing the documents submitted by the applicant. The HIA consultants delivered two HIA awareness sessions, which were attended by elected Members and planning officers of LCC and district councils. They also facilitated two community workshops, which were attended by local residents living near the two proposed sites (Preston New Road and Roseacre Wood), interest groups as well as county councillors, district councillors and parish councillors representing the two areas of the proposed sites. Appendices 'C' - 'G' refer to the reports produced by Ben Cave Associates Ltd.

17. The scope for this HIA includes the human health impacts of the following:

17.1.1. Air quality
17.1.2. Greenhouse gases
17.1.3. Hydrogeology and gas
17.1.4. Induced Seismicity
17.1.5. Waste
17.1.6. Transport
17.1.7. Noise
17.1.8. Water
17.1.9. Lighting

Appraisal of potential health impacts from the proposed shale gas exploration sites

18. The appraisal of the potential health impacts of the proposals was based on the scoping and the initial appraisal conducted by Ben Cave Associates Ltd. Ben Cave Associates Ltd completed their work by providing their reports which included an overview and a set of questions for further clarification, to be considered by the DPH before completing the appraisal and making recommendations.

19. The appraisal was completed by the DPH, with support from the HAG, by analysing a range of information available. This included:

19.1.1. Reports from Ben Cave Associates Ltd
19.1.2. Clarification response received from Arup
19.1.3. Documents submitted by the applicant to LCC, EA and DECC
19.1.4. Data available on the health profile of the local population
19.1.5. Key national and local policy documents
19.1.6. Literature collated by LCC PH department
19.1.7. Communications from local residents and elected members.

20. The summary of the preliminary literature search can be found in the overview report produced by Ben Cave Associates (Appendix 'C' refers)

21. Limitations of this HIA

21.1. While the recent publications on shale gas have been appraised, this did not include a systematic review and a meta-analysis of all the emerging evidence as part of this HIA. This was due to the time constraints in making the recommendations available within the period for the determination of the planning applications and environmental permits.

21.2. However, the evidence base available mainly covers experience in the United States of America, Canada and Australia, with relatively little being found that related to the situation in the UK[4] [5] [6][7]. Hence, any local quantitative health risk assessment was not possible.

Findings and Recommendations

The following sections describe:

- The summary baseline health profile
- Site specific findings and recommendations for addressing the health impacts associated with the proposed developments
- Recommendations for future policy development and research based on this HIA.

22. Summary baseline health profile

22.1. The summary baseline health profile is based on the Fylde district health profile[8], and the Environment and Health Atlas for England and Wales[9] showing the relative risks for a 25 year period (1985-2009), for a number of health conditions at a ward level. Ward level small area statistics should be interpreted with caution as they are often based on small numbers. The profile presented below provides an estimate of current baselines of health outcomes and will be monitored for any changes in the future.

22.2. The proposed temporary Roseacre Wood in Lancashire site is situated within the Newton and Treales ward of the Fylde district, on the east side bordering with the Preston and Wyre districts. In 2013, the Office for National Statistics (ONS) estimated that this ward had a total population of 3,160.

22.3. The Newton and Treales ward has the highest life estimated life expectancy at birth (2008-12) for females in the Fylde district of 89 years old. The England national average was 83 years old. For males the ward has a life expectancy at birth (2008-12) of 79, which again is one of the highest estimates in the district and in line with the England national average, across all wards, of 79 years old.

22.4. Using the Environment and Health Atlas for England and Wales, the Newton and Treales have above average relative risk for females, for the following conditions: Bladder Cancer; Chronic obstructive pulmonary

[4] Potential Public Health Impacts of Natural Gas Development And Production In The Marcellus Shale In Western Maryland accessed online at http://www.marcellushealth.org/final-report.html
[5] Please refer to Table 5.2 in Appendix 3 for the list of studies on shale gas extraction and health
[6] Review of potential public health impacts from shale gas extraction by PHE https://www.gov.uk/government/news/review-of-potential-public-health-impacts-from-shale-gas-extraction
[7] Researching Fracking in Europe: https://www.dur.ac.uk/refine/
[8] Public Health England. (2014). *Local Health.* Available: http://www.localhealth.org.uk. Last accessed 30/09/2014
[9] Small Area Health Statistics Unit (SAHSU). (2014). The Environment and Health Atlas for England and Wales. Available: http://www.envhealthatlas.co.uk/. Last accessed 01/10/2014

disease (COPD); Heart Disease; Liver Cancer; Low Birth Weight; Lung Cancer; Mesothelioma Cancer; Sill births; and Skin Cancer. And for males, it is estimated to have above average relative risk for the following areas: Chronic obstructive pulmonary disease (COPD); Heart Disease; Liver Cancer; and Lung Cancer.

22.5. The proposed temporary Preston New Road in Lancashire site is situated within the Warton and Westby ward of the Fylde district, situated fairly centrally within the district and boarding with the River Ribble to the South and the Blackpool district to the North. In 2013 The Office for National Statistics (ONS) estimated that this ward had a total population of 4,736.

22.6. Warton and Westby ward has one of the highest life estimated life expectancy at birth (2008-12) for males in the Fylde district of 80 years old. The England national average was 79 years old. For females the ward has a life expectancy at birth (2008-12) of 82 years old and although this is one of the lower estimates in the district, it is in line with the England national average, across all wards, of 83 years old.

22.7. Warton and Westby ward has above average relative risk for females, for the following conditions: Bladder Cancer; Chronic obstructive pulmonary disease (COPD); Heart Disease; Liver Cancer; Lung Cancer; Mesothelioma Cancer; Sill births; and Skin Cancer. For males, it is estimated to have above average relative risk for the following areas: Chronic obstructive pulmonary disease (COPD); Heart Disease; Liver Cancer.

22.8. Relevant issues for this HIA at Fylde district level are levels of physical activity (but not obesity); mental wellbeing (as indicated by levels of self-harm); and road safety.

22.9. A more detailed health profile of the wards in which the two proposed sites are located in is included in Appendix 'H'.

23. Site specific findings and recommendations for addressing the health impacts associated with the proposed developments (Appendices 'C' - 'G and 'H' - 'J' refer)

It is recognised that there will be an ongoing process to ensure health related issues are considered throughout the development of this industry. Various agencies including DECC, EA, HSE, PHE and LCC will be involved in this process. Hence, the primary aim of this report is to inform the site specific planning, environmental permitting and consenting process by LCC, EA and DECC of the two proposed sites.

Potential health impacts identified in the literature have been considered in this local context and applied to the exploratory phase of the industry. Many of the issues raised by Ben Cave Associates Ltd have been clarified with Arup, EA, HSE and PHE. Hence, the findings and recommendations in the following sections only relate to the outstanding issues at the time of publication of this report and are proportionate to the exploratory phase of the industry.

Most of the findings and recommendations apply to both Roseacre Wood and Preston New Road sites. However, where relevant, site specific recommendations have been made. Recommendations for future policy and research, based on this HIA are also presented in the subsequent sections. The findings of the HIA will be

kept under review on a regular basis and any new knowledge will be used to advise relevant agencies.

24. Community understanding of risks associated shale gas exploration (Appendix 'F' refers)

24.1. The over-riding responses about the two proposed exploration sites voiced by members of the local communities who attended the workshops were those of fear, anxiety and stress, which are affecting their mental wellbeing, with some people experiencing sleep disturbance and depression.

24.2. Residents who attended the workshops felt that they did not have a voice, and that their concerns were not being addressed. These responses were associated with a lack of trust and/or confidence in the statutory and regulatory authorities responsible for either the regulation of shale gas exploration and extraction or the protection of residents' health and wellbeing. Again, these issues were affecting residents' mental wellbeing.

24.3. Furthermore, the residents in attendance were concerned about the inconsistencies in the information provided by the applicant and other agencies at various points during the planning application process, which led to further anxiety and stress. Residents also raised questions about practices in the shale gas exploration and extraction industry in general, which were a source of worry for them.

24.4. In the absence of information from other sources and/or the provision of information that appeared to be inconsistent, many of the residents who attended the workshops had found information on the effects of shale gas extraction and exploration from the published literature and the internet. This information mainly covered experience in the United States of America, Canada and Australia, with relatively little being found that related to the situation in the UK. Residents felt strongly that this information should be considered during the planning process.

24.5. Residents felt that, if planning permission was granted for the two proposals, they would be placed at a disadvantage, while receiving no benefits whatsoever. Residents thought the Government would be the main beneficiary, with the possibility of only some benefit accruing to the wider region as a whole.

24.6. Anxiety over emergency scenarios featured. Although emergency planning is a requirement for this type of development, this process has not been 'visible' to residents. Anxiety fuelled by uncertainty over this issue could potentially have wider health impacts than the risks themselves.

Recommendations to address community understanding of risks associated shale gas exploration

R.1. Lancashire County Council (LCC) as the mineral planning authority, along with the Environment Agency (EA), Department of Energy and Climate Change (DECC) and the Applicant should jointly seek to address the issues raised by the local residents through the community engagement workshops conducted as part of this HIA.

R.2. LCC in partnership with DECC/EA/Public Health England (PHE)/Department of Health (DH), and the Applicant should establish a local public information and assurance programme to communicate and address the local health risks associated with shale gas exploration. Local communities should be actively involved in developing such a programme through existing liaison meetings.

R.3. LCC, along with EA, DECC, HSE, and the Applicant should publish statements of adherence on the planning and regulatory regime to the local communities at regular intervals.

R.4. The Applicant should have an effective, swift and consistent process for handling complaints. Local communities should be involved in designing this process.

R.5. A multiagency protocol should be developed between the national and local agencies to deal with any health related complaints arising from the development.

25. Air Quality

25.1. The air quality impact assessment did not include pollution due to particulate matter, particularly PM_{10} and $PM_{2.5}$ levels. The Applicant has explained that this is due to the following reasons:

25.1.1. PM_{10} from flare emissions is screened out as not significant because the temperature at the flare is very high that the emissions will not include significant levels of PM_{10}

25.1.2. PM_{10} emissions from the generators have been screened out because the emissions at ground level will only affect an area that is few 100 metres away

25.1.3. PM_{10} from drilling and vehicles on site have been screened out as insignificant.

25.1.4. Therefore, cumulative levels of PM_{10} have been screened out.

25.2. Hence, it is not possible to estimate the health impacts due to cumulative emissions of particulate matter from various sources associated with this development but any impacts are likely to be small because of the

likelihood of low levels of emissions. However, it is noted that the applicant has proposed to install ambient air quality monitors on site.

25.3. Discussion with EA confirms that emissions from the drilling, generators and vehicles are not covered by the EA permit. However, Fylde Borough Council is the responsible authority for air quality management in the area. The proposed sites are not part of an existing Air Quality Management Area (AQMA).

25.4. Comparison of UK Air Quality Standards and WHO Guide values used to inform the recommendations in this report is given in the Table 1 below.

Table 1: Comparison of UK Air Quality Standards and WHO Guide Values

Pollutant	UK Air Quality Standards	WHO Guide Values
Particles (PM_{10})	50 $\mu g/m^3$ 24 hour mean (Not to be exceeded more than 35 times a year)	50 $\mu g/m^3$ 24 hour mean
	40 $\mu g/m^3$ annual mean	20 $\mu g/m^3$ annual mean
Particles ($PM_{2.5}$)	25 $\mu g/m^3$ annual mean	10 $\mu g/m^3$ annual mean
Nitrogen dioxide	200 $\mu g/m^3$ 1 hour mean	200 $\mu g/m^3$ 1 hour mean
	40 $\mu g/m^3$ annual mean	40 $\mu g/m^3$ annual mean
Ozone	100 $\mu g/m^3$ 8 hour mean	100 $\mu g/m^3$ 8 hour mean
Sulphur dioxide	125 $\mu g/m^3$ 24 hour mean	20 $\mu g/m^3$ 24 hour mean

Recommendations to address air quality

R.6. LCC should ensure through the planning process that during the project, the cumulative levels of air pollution do not exceed the national air quality objective thresholds during the peak activity period. Specifically, the cumulative PM_{10}, 24 hour mean levels from the flare, generators, drilling and vehicles should not exceed 50 $\mu g/m^3$ 24 hour mean (not to be exceeded more than 35 times a year).

R.7. An agreement should be reached with the Applicant to monitor ambient air quality on site measuring all the common air pollutants representative of the activity at the site, including PM_{10} and combustion gases. The results should be reported to LCC and Fylde Borough Council on a regular basis.

R.8. The Applicant should demonstrate to LCC that best available techniques are being used to keep air pollution due to the development as low as reasonably

26. Greenhouse Gases

26.1. As greenhouse gas emissions have the capacity to contribute to global warming, and therefore climate change, it is pertinent to consider the part the project may play in either contributing to or detracting from global warming.

26.2. Carbon dioxide is a greenhouse gas, which is a natural and vital part of the atmosphere. It helps to prevent the earth from cooling down overnight from heat loss to the atmosphere, acting as a protective blanket. Too much, however, prevents the appropriate release of heat from an otherwise balanced system. As the global temperature increases, the earth's climate becomes more unstable, leading to extreme weather events, with attendant problems, such as the flooding experienced in the UK during winter of 2013/14.

26.3. Other gases in the atmosphere have a global warming potential too. For example, methane has a global warming potential 24 times greater than that of CO2.

26.4. A recent study by DECC Chief Scientist who examined the carbon footprint and climate change implications for UK shale gas found that the carbon footprint for shale gas is significantly less than that for coal when used for electricity generation (423 – 535 gCO2e/kWh(e) versus 837 – 1130 gCO2e/kWh(e)). The study also found that, if well regulated, local greenhouse gas emissions from shale gas operations should represent only a small part of the carbon footprint. Most carbon emissions will come from its final use as a fuel.

26.5. The duration of the initial flow testing is be between 60 and 90 days. It is apparent that depending on the sequential viability of the exploration stage, the wells will be drilled, fractured and flared sequentially with some overlap. It is therefore expected that there will be drilling, hydraulic fracturing, and flaring of the four wells in each site and this could last for at least 240 to 360 days during this project. Although this is temporary, it is not considered short term for the purposes of this HIA.

26.6. Discussion with EA indicates that there is no current threshold or permissible levels for regulating fugitive emissions. However, it is understood that the level of fugitive emissions will be measured.

26.7. Limited evidence is available on the long term fugitive emissions from the wellhead and migration of gas in the UK context. Well integrity has also been identified as a priority by the review of hydraulic fracturing conducted by the Royal Society and the Royal Academy of Engineering in their review and in the literature[10][11].

[10] Accessed online at https://royalsociety.org/policy/projects/shale-gas-extraction/report/

[11] Richard J Davies et al; Oil and gas wells and their integrity: Implications for shale and unconventional resource exploitation; Marine and Petroleum Geology; Volume 56, September 2014, Pages 239–254

26.8. There is a specific set of occurrences that the well operator must report to HSE under RIDDOR (Reporting of Injuries, Diseases and Dangerous Occurrences Regulations) process.

26.9. It is understood that an application for the variation of the environmental permit will be required by the Applicant to continue with the extended flow testing phase. However, the land use planning permission will be determined for both initial flow testing and extended flow testing.

Recommendations to minimise greenhouse gas emissions

R.9. EA should consider requiring the Applicant to measure the levels of fugitive emissions and establishing conditions on the maximum permissible levels for fugitive emissions.

R.10. EA should consider requiring substantial permit variation when the Applicant applies for extended flow testing period.

27. Emergency preparedness

27.1. During the extended flow testing, which could happen for 18 – 24 months, gas will not be flared. Instead, it will be treated and piped in to the gas grid. To allow connection to the gas grid a buried pipeline will be laid (1.2m depth and 6 inches in diameter). It will run 55m eastwards to the Roseacre Wood site to connect to the gas line running north to south direction. At the connection point, National Grid would require separate fenced off areas of approximately 8m x 9m. It is understood that LCC is awaiting a response from the National Grid.

27.2. Modelling to identify the zone of risk in the event of pipeline failure or the risk assessment of pipeline safety during the extended flow testing phase is not apparent in the Environmental Statements or in the Environmental Risk Assessment submitted to the DECC.

27.3. Without the details of this planning application, it is not possible to assess the health impacts relating to emergency preparedness at this stage.

Recommendations for emergency preparedness

R.11. LCC should seek further guidance from HSE to establish whether the site and the associated developments at the connection point to the gas grid during the extended flow testing period is within any zone of a consultation distance from the pipeline.

R.12. DECC should consider pipeline safety risk assessment during the extended flow testing period to be included in ERA before giving consent to drill.

R.13. HSE should confirm that the requirements for land use including the associated developments at the connection point to the gas grid during the extended flow testing period, can be met with the two proposed sites.

28. Noise

28.1. Health effects that may result from community noise are well documented and include interference with communication; annoyance responses; effects on sleep, and on the cardiovascular and psychophysiological systems; effects on performance, productivity, and social behaviour; and noise-induced hearing impairment[12]

28.2. The National Planning and Policy Framework (NPPF) describes observed effect levels for noise as below:

- Significant observed adverse effect level above which significant adverse effects on health and quality of life occur
- Lowest observed adverse effect level: this is the level of noise exposure above which adverse effects on health and quality of life can be detected
- No observed effect level: this is the level of noise exposure below which no effect at all on health or quality of life can be detected.

28.3. The NPPF guidance also suggests that mineral planning authorities should aim to establish a noise limit, through a planning condition, at the noise-sensitive property that does not exceed the background noise level (LA90,1h) by more than 10dB(A) during normal working hours (07:00 - 19:00)[13]. Where it will be difficult not to exceed the background level by more than 10dB(A) without imposing unreasonable burdens on the mineral operator, the limit set should be as near that level as practicable. In any event, the total noise from the operations should not exceed 55dB(A) LAeq, 1h (free field). For operations during the evening (1900-2200) the noise limits should not exceed the background noise level (LA90,1h) by more than 10dB(A) and should not exceed 55dB(A) LAeq, 1h (free field). For any operations during the period 22:00 – 07:00 noise limits should be set to reduce to a minimum any adverse impacts, without imposing unreasonable burdens on the mineral operator. In any event, the

[12] http://www.who.int/docstore/peh/noise/introduction.htm

[13] http://planningguidance.planningportal.gov.uk/blog/guidance/minerals/assessing-environmental-impacts-from-minerals-extraction/noise-emissions/

noise limit should not exceed 42dB(A) LAeq,1h (free field) at a noise sensitive property.

28.4. The WHO guideline values used for the purposes of determining health impacts due to noise is given in Table 2 below. In particular, the WHO general health based threshold of 50/55 dB LAeq, 16hr and the WHO night noise threshold of 40 dB L night, outside.

Table 2: WHO guideline values on critical health effects due to noise

Specific environment	Critical health effect(s)	Leq [dBA]	Time base [hours]	Lmax, fast [dBA]
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling, indoors	Speech comprehension and moderate annoyance, daytime and evening	35	16	45
Inside bedrooms	Sleep disturbance, night-time	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60
School class rooms and pre-schools, indoors	Speech intelligibility, disturbance of information extraction, message communication	35	during class	-
Pre-school bedrooms, indoors	Sleep disturbance	30	sleeping-time	45
School, playground outdoor	Annoyance (external source)	55	during play	-
Hospital, ward rooms, indoors	Sleep disturbance, night-time	30	8	40
	Sleep disturbance, daytime and evenings	30	16	-
Hospitals, treatment rooms, indoors	Interference with rest and recovery	#1		
Industrial, commercial shopping and traffic areas, indoors and outdoors	Hearing impairment	70	24	110
Ceremonies, festivals and entertainment events	Hearing impairment (patrons:<5 times/year)	100	4	110
Public addresses, indoors and outdoors	Hearing impairment	85	1	110
Music through headphones/ earphones	Hearing impairment (free-field value)	85 #4	1	110
Impulse sounds from toys, fireworks and firearms	Hearing impairment (adults)	-	-	140 #2
	Hearing impairment (children)	-	-	120 #2
Outdoors in parkland and conservation areas	Disruption of tranquillity	#3		

#1: as low as possible; #2: peak sound pressure (not Lmax, fast), measured 100 mm from the ear; #3: existing quiet outdoor areas should be preserved and the ratio of intruding noise to natural background sound should be kept low; #4: under headphones, adapted to free-field values

28.5. While hydraulic fracturing will only happen during the day, drilling is planned to happen continuously, 24 hours a day, including night time. Given that the wells

will be drilled sequentially, it is expected that the noise levels will be continuous for at least 14 months. The Applicant's predicted noise level at sensitive receptors is given in the Table 3 below.

Table 3: Night time noise levels due to drilling at various receptors compared against significant levels

Receptor	Baseline noise level (night time)	Predicted noise levels (dBLAeq)	Criteria used in the environmental statements (dBLAeq)	Significant effect levels in NPPF LAeq,1h/WHO dB Lnight, outside thresholds during night time
Plumpton Hall farm (PNR)	42	39	45	42/40
Staining wood cottages (PNR)	46	47	50	42/40
Old Orchard Farm (RW)	33	45	45	42/40
Roseacre Farm (RW)	36	41	45	42/40

28.6. It is evident from the table above that baseline noise levels near Roseacre Wood site is within the WHO thresholds but not near the Preston New Road site. In particular, the night time noise level at Old Orchard farm is likely to be 12 dB more than its baseline. Left unmitigated, this is likely to cause significant health effects, particularly related to sleep deprivation.

28.7. It is noted that the background levels near Preston New Road site is already at or above the recommended levels. Although the additional noise due to the development is not considered significant, levels of night time noise in the vicinity of Preston New Road cannot be ignored.

28.8. It is very likely that the increase in the night time indoor noise levels, particularly from the Roseacre Wood site, will be noticeable and intrusive. There is a significant risk of health effects, particularly sleep disturbance and the related effects, during the project.

Recommendations to address health impacts of noise

R.14. LCC should consider further noise assessment and require that mitigation measures are in place to keep the night time outdoor noise to below 40dBLnight, outside.

29. Induced Seismicity

29.1. There is a residual concern amongst resident attending the community engagement workshops that in spite of seismicity monitoring array, there is a rare chance of surface tremor being felt and damage occurring to the local properties.

29.2. Although extremely unlikely, it is not clear how the risk of minor surface tremors that might be perceived will be communicated with the local communities.

Recommendations to address issues related to induced seismicity

R.15. The Applicant should demonstrate to LCC that liability/compensation arrangements are put in place to cover the structural damages to properties due to any unlikely event of induced seismicity.

R.16. The Applicant and DECC should confirm how the risk of minor tremors that might be perceived will be communicated with the local communities. This should be established before DECC provides the consent to drill.

30. Waste

30.1. The Environment Statements (ES) submitted by the Applicant describe that the waste generated by the personnel on site, in the form of general waste from canteen and office areas will not result in a significant effect. This also applies to inert and non-hazardous waste. Similarly, the quantity of waste generated by the Project (construction, drilling, hydraulic fracturing, initial and extended flow testing and decommissioning) is reported not to result in a significant effect. The chapter states that this is because there is sufficient capacity to treat the waste generated by the Project. However, the applicant concludes that, although there is sufficient capacity to treat flowback fluid it is still anticipated to result in a significant effect because at peak times it will utilise a major proportion of the available treatment capacity within 100 miles of the Site (based on radiation levels and physical treatment capacity).

30.2. Therefore, it can be expected that additional, onsite, temporary capacity to store flowback fluid might be needed.

30.3. Measures proposed by the environmental statements (ES to mitigate this effect are being developed and these include:

- 30.3.1. Use of additional treatment capacity at facilities within northern England.
- 30.3.2. Investment in on site treatment to recycle flowback fluid for use in hydraulic fracturing and to reduce the quantity of waste generated.
- 30.3.3. Regulating the quantity of flowback fluid generated at the Site to not exceed the available waste treatment capacity.

30.4. The application provides the general pre-construction description of how waste will be managed, and disposed. It does not make any reference to

minimisation of consumption, re-use, circular economy, and re-deployment of equipment.

30.5. It is clear that waste from this activity will place additional demand on the landfill regime. The Applicant indicates that the percentage space to be occupied is around 1% for landfill.

30.6. The Environmental Impact Assessment scoping document also refers to production of liquid hydrocarbons. This is an area of uncertainty for the project as the presence of oils can only be determined once the process is underway. Management of waste potentially containing hydrocarbons remains an issue.

30.7. The limited capacity of identified treatment facilities to manage the flowback fluid from both sites is identified in the resources and waste chapter of the ES as a very substantial significant impact. When the output is assessed with the potential for being cumulative with Roseacre Wood, the quantity produced would be 68% of available capacity. The applicant states that care would be taken during operation not to lead to a capacity issue.

30.8. The ES notes that mitigation may include additional tank capacity onsite to store flowback fluids temporarily. The aim appears to create buffer capacity issues at treatment plants. In the ES there is no indication of a limit on such additional storage. The maximum onsite capacity should be determined in advance to ensure the site's surface spill containment capacity is appropriate in the event of worst case containment failure. Discussion with EA suggests that the site has the sufficient containment capacity. Although containment failure is referred to in the Environment Risk Assessment submitted to the DECC, it is not clear whether the maximum additional capacity of the onsite tanks for storing flowback fluids temporarily has been taken into account for calculating the risk of surface water contamination.

Recommendations to address issues related to waste

R.17. EA should establish whether remaining fracking fluid left in the wells will be considered as waste and how they will be monitored in the long term following the surrender of the permit.
R.18. EA and LCC should satisfy themselves that there are adequate waste treatment facilities available for safe storage, transport and disposal of the waste generated before the permit is granted.
R.19. EA should establish the maximum additional storage for flowback fluid and ensure that the site's spill containment capacity takes into account additional capacity.

31. Lighting

31.1. The ES conclude that due to the combination of relatively few sources of night time lighting at the sites, use of lighting during the project is predicted to have a significant effect for all project activities without mitigation except for installation of the surface and buried arrays, construction, decommissioning and restoration. By implementing mitigation measures it is reported that the potential effects of lighting being directed towards windows of properties and the intensity of lighting used are not significant. The ES states that these measures also help to reduce the magnitude of the sky glow and building luminance effects although there is a temporary residual significant effect which remains following mitigation.

31.2. Although the use of the flare stacks will be keeping the flames within the stack, it is possible that there is still a glow from this. Flare light is mentioned in the project's permit application. The permitting application assesses the potential for light impacts from the enclosed flares as a low risk and does not carry the issue forward to the risk assessment management plan. The issue is not explicitly discussed in the ES lighting chapter, but would contribute to sky glow.

31.3. The ES acknowledges that the project is to be centred in a dark sky area, and as such any light which is to be introduced will be an increase on existing levels. The applicant intends to adhere to good practice, ensuring that lights are focused downwards. It is noted that this would not be possible for sky glow from the flare stacks.

31.4. When the drill rig has been put into place the lighting which is on the rig will be at height, and visible from quite a distance, above any hedgerows which may have grown upwards. The Applicant acknowledges that this will be a major significant impact pre-mitigation and expects to offset this by good practice, and by responding to complaints rapidly.

31.5. When exposed to overnight light, people can have disturbed sleep patterns. Although uncertainty remains, there is plausible epidemiological evidence that circadian rhythm disruption has a variety of adverse physiological effects[14][15].

31.6. The sensitive receptors identified will have light from several sources: the security lighting at about 10 feet in height; transient, intermittent intensive lighting from construction, and the longer term rig lighting, which will be at height and is likely to impact a greater number of receptors.

[14] The health impacts of environmental nuisances and their contribution to health inequities. http://www.cieh.org/assets/0/72/948/129834/2b7f0c99-0531-4c0a-81ef-a37c5fe98f32.pdf

[15] Missing the Dark: Health Effects of Light Pollution; http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2627884/

Recommendations to address issues related to light

R.20. LCC should ask the Applicant to consider offering to fit blackout blinds in the bedrooms facing the site of the homes where impacts are expected.

32. Transport

32.1. The health profile for the Fylde district shows that road injuries and deaths in Fylde are significantly worse than the England average. Any change caused by the project that could affect road safety is therefore an important issue for the HIA.

32.2. The specific focus for this HIA is on the potential increase in accidents, use of the routes for cycling and walking; and the safe transport of waste and flowback water.

32.3. Specific issues for Roseacre Wood site include:

32.3.1. The roads in the vicinity of the site are narrow and that it will be necessary to construct passing places.

32.3.2. The impact on the village of Wharles depends on the viability of the Defence High Frequency Communications Service (DHFCS) Inskip route. It is understood that a risk assessment has been conducted by MoD but the results are not available while conducting the HIA.

32.3.3. The site visit by Ben Cave Associates Ltd shows that HGVs with large loads e.g. 40ft trailers for office space and work space would have difficulty safely negotiating the routes in proximity to the project site.

32.3.4. Report by Ben Case Associates Ltd also suggests that although distant from the site surface infrastructure, the potential traffic impact at Clifton should not be overlooked. It notes that Clifton village is residential with a playground accessed across the main road with no formal crossing point. The road capacity does not appear to be any greater in Clifton than elsewhere on the route (once off the A583). Clifton could be viewed as an already saturated location rather than one that is justifiable due to existing levels of traffic movements. The ES notes that accident rates for this stretch are higher than the route section closer to the site. Pedestrian impacts (particularly children accessing the playground) are likely to be a concern, particularly given that the project's operations include transport movements outside of normal work hours, including Saturday mornings.

32.3.5. It is understood that the road through Clifton is a 20 mph zone and also the route for the nuclear reprocessing plant in the area.

32.4. Although it is accepted that there are two different routes through Lancashire to the main highways (from Roseacre Wood and Preston New Road respectively) for transportation of waste, the impact then becomes aggregated on the motorways. Although an assessment of this is not

required within the planning regime, the health impacts over time and at geographical locations which are not local to the proposed activity need to be considered by relevant agencies depending on the final transport routes for waste disposal.

32.5. Although the proposed sites and associated developments do not affect any public rights of way, perception of risks by the community about the safety of the routes could have an impact on how the routes will be used for walking and cycling.

Recommendations to address issues related to transport

R.21. The Applicant should demonstrate to LCC how the specific risks due to using the MoD site for transport will be addressed.

R.22. LCC should establish that appropriate traffic management options to address the public concerns, particularly in Roseacre Wood, are available.

R.23. LCC should satisfy itself that appropriate actions can be taken to maintain road safety, particularly on the access routes to Roseacre Wood site and continue to monitor road safety related incidents on the access to both the sites.

33. Occupational health risks

33.1. There is limited evidence on occupational health risks due to cumulative exposure to silica dust, noise and air pollution during shale gas exploration in the UK context.

33.2. Health and Safety Executive (HSE) approach is based on goal setting to keep the exposure to occupational hazards as low as reasonably practicable. HSE will not seek regular report from the employer but will respond to concerns raised. Discussion with HSE suggests that there was an issue related to exposure to silica at the Preese Hall site which was addressed by requiring silica to be handled in enclosed containers.

33.3. It is understood that there are no specific occupational health standards for onshore oil and gas extraction. The Applicant has proposed a framework for health and safety at work as part of their governance system that will comply with HSE requirements.

Recommendations to address occupational health risks

R.24. Given this is a relatively new industry with a complex set of regulations, HSE should consider requiring the operator to undertake a comprehensive health surveillance of workers comprising of exposure to noise, air pollution, fugitive emissions, dust, silica, and handling waste.

R.25. The Applicant should share the data collected on occupational health surveillance of workers involved in shale gas exploration activities with LCC.

R.26. HSE should consider sharing the information on RIDDOR incidents related to the shale gas exploration sites with the Director of Public Health.

34. Baseline and long term monitoring of environmental and health conditions

34.1. It is apparent that a variety of environmental baseline data will be collected by the Applicant and required by various agencies before any activity starts on the sites. There is no similar requirement for measuring health impacts on the communities living in the vicinity of the sites. It is not known how data from various sources measuring operating standards, environmental and health conditions will be collated, analysed and shared with the public.

34.2. Robust baseline and ongoing monitoring could be used to reassure local communities and identify any association between the industrial activity and health effects in the longer term.

34.3. Long term well integrity is based on a variety of factors including the local geology. There is paucity of data on the long term environmental and health effects of fractured onshore wells in the UK. Long term monitoring of well integrity, environmental and health conditions is not a requirement by EA when the operator surrenders the permit. However, the EA must be satisfied that environmental conditions are acceptable and will remain so before it accepts the surrender of a permit.

34.4. Establishing a comprehensive baseline and long term monitoring of environmental and health conditions would also inform future development of the industry and the regulatory framework.

Recommendations to establish baseline and monitoring of environmental conditions

R.27. LCC should seek agreement with the Applicant to establish a baseline and ongoing monitoring of environmental and health conditions prior to beginning any activity on the sites. This is mainly to reassure local communities about the safety of shale gas exploration activities.

R.28. The Applicant should consider establishing a baseline and monitoring as a community benefit and commit resources to enable this happen.

R.29. HSE should consider publishing the findings from well integrity inspections on a regular basis.

R.30. EA should ensure long term plans should be in place for monitoring any contamination.

R.31. DECC should confirm that operators have an open-ended liability to remedy any well leakage problems after permit surrender and site restoration. In the event an operator can no longer be identified, DECC should clarify who is liable for remediation.

R.32. LCC, EA, HSE and DECC should inform the Director of Public Health if there is a breach to the planning permission, environmental permit, consent to drill or any other regulatory control that relates to health and wellbeing of local residents.

35. Areas for future policy development

While this report is focussed on the proposed sites, a number of themes for future policy and research development have been identified during the HIA. These are described below:

Local

35.1. The Lancashire Joint Advisory Committee for Strategic Planning oversees the production of the Minerals and Waste Local plan and is currently consulting on the Onshore Oil and Gas Supplementary Planning Document. There is no specific spatial strategy for future development of shale gas in Lancashire.

35.2. The two tier nature of LCC's administrative area means that district councils are responsible for certain issues like air, quality and nuisance due to noise while mineral extraction and waste planning is the responsibility of LCC. Like most industrial processes, it was evident from the HIA that no one organisation is responsible for the regulation of the cumulative impacts of shale gas exploration in the area. For example, flare emissions are regulated by the EA while Fylde Borough Council is responsible for air quality management. However, in determining the planning applications, LCC must take account of cumulative impacts.

35.3. The new responsibilities of LCC in protecting and improving health of local residents require much more closer working between EA, HSE, LCC, PHE, Fylde Borough Council and DECC in implementing the planning and regulatory regime.

Recommendations for local policy and practice

R.33. The Lancashire Joint Advisory Committee for Strategic Planning should consider developing a shale gas spatial strategy to inform the future development of the industry in Lancashire.

R.34. LCC should consider developing an integrated shale gas planning process through more closer working between EA, HSE, LCC planning and public health functions, PHE, Fylde Borough Council and DECC.

R.35. LCC should consider a site specific HIA to be conducted for future applications related to shale gas development. Where applicable, LCC should embed a full site specific HIA as part of the scoping for the EIAs.

R.36. LCC should evaluate the implementation of the recommendations in the HIA report.

National

35.4. The policies relating to the health impacts of shale gas industry crosses various Government departments and national agencies i.e. DECC, Department for Environmental Food and Rural Affairs (DEFRA), EA, HSE, Department for Communities and Local Government (DCLG), British Geological Survey (BGS), Department of Health (DH) and Public Health England (PHE). While there is a lot of focus on environmental issues, considering unplanned scenarios and wider health and wellbeing impacts of shale gas industry on the local communities could be improved. This is particularly important when the industry enters into the production phase.

35.5. It is not clear how the scoping opinion of environmental risk assessment was determined and whether the risks associated with extended flow testing have been considered by the DECC.

35.6. If the industry increases in scale, an industry specific integrated regulatory framework for onshore oil and gas industry is likely to bring some focus on issues like hydraulic fracturing, fugitive emissions and climate change, and long term well integrity.

Recommendations for national policy and guidance development

R.37. DECC should consider bringing the relevant regulations into a single onshore oil and gas specific regulatory framework to enable a safer and sustainable development of the industry. However, local planning control should be maintained. This is likely to support the developers in navigating the regulatory regime more easily and also protect the health and wellbeing of local residents.

R.38. DECC and EA should consider embedding public health impact assessment in their future policies and guidance related to shale gas.

R.39. DECC and EA should consider producing policy, guidance and standards for fugitive emissions of greenhouse gases from shale gas exploration as soon as possible.

R.40. EA should consider monitoring cumulative impact of all sources of emissions on ambient air quality and not just the flare emissions.

R.41. EA, DECC, DH and PHE should consider establishing a national framework to monitor the health and environmental impacts of onshore unconventional oil and gas extraction.

R.42. UKOOG should work together with Local Government Association (LGA) and other national agencies in developing a risk communication framework to be used with the local communities.

R.43. The LGA should consider establishing a network of local authorities involved in onshore oil and gas exploration to share examples of good practice and protect the health and wellbeing of local communities.

R.44. The LGA, Association of Directors of Public Health (ADPH) and PHE should support the local authorities in developing a comprehensive HIA framework and promote its use in areas where shale gas exploration is being planned.

36. Areas for future research

36.1. Lancashire is at the forefront of shale gas exploration in the UK. While the research on the environmental and geological aspects of shale gas exploration are under way, there is very little, if any, research on human health impacts in a UK context.

36.2. Recent reports on public health impacts of shale gas highlight the need for further development of HIA methodologies specifically for unconventional gas extraction in the UK.

Recommendations for research

R.45. LCC, in partnership with PHE, EA and the Department of Health, should lead the development of a research programme on shale gas and human health impacts. There should be a particular focus on long term effects and a community understanding of risk is needed in the UK context. This will inform the development of policies, regulation, industrial practice and risk communication with the public.

37. Conclusions

37.1. The findings from the HIA suggests that whilst there might be benefits of shale gas exploration to the economy, there are also risks. The HIA recognises that although the exploration of shale gas is temporary, it is not short term.

37.2. The risks to health and wellbeing of the population from the two proposed sites in Lancashire include lack of public trust and confidence, stress and anxiety from uncertainty which could lead to poor mental wellbeing, noise related health effects, and issues related to capacity for flowback waste water treatment and disposal. These risks can be addressed by implementing the recommendations in this report.

37.3. The risks are particularly prominent for residents living near the Roseacre Wood site compared to the Preston New Road site due to the lower levels of background noise, access through narrow roads, and proximity to major gas pipeline of the national grid. These need to be prevented, mitigated and monitored through the permitting and planning process.

37.4. There is a need to be vigilant during the operations to minimise the impact of shale gas exploration on air quality, greenhouse gases, light pollution, transport, occupational health, and in emergency preparedness.

37.5. A robust baseline and monitoring of environmental and health conditions in required in order to reassure local communities and understand the cumulative and long term effects. The applicant and the industry should play their part in supporting this.

37.6. Local communities should be actively be involved and the risks should be communicated in a transparent and reliable manner that is proportionate to the exploratory phase of the industry. This needs a closer working relationship between the industry, national and local agencies as well organisations with an interest in local shale gas exploration.

37.7. LCC, EA and DECC should satisfy themselves that the recommendations in this report are addressed prior to granting permits, planning permission or consent to drill.

37.8. Ensuring adequate resources are available with the regulatory and public health agencies will be a key factor in improving public confidence and address risks.

37.9. If this industry is to develop further, there is a need for local shale gas specific spatial plan and a national industry specific integrated regulatory framework.

37.10. Further research and development of methods for assessing the cumulative health impacts of shale gas is also needed.

37.11. LCC should be engaged on an ongoing basis in protecting and improving the health of its residents and share the lessons learnt from this HIA with other authorities.

Acknowledgements:
The author of this report is grateful to the all those who have given their valuable time throughout the process of undertaking this Health Impact Assessment (HIA). This includes:

- Local residents
- County Councillors, District Councillors and Parish Councillors
- Health Advisory Group
- Fylde Borough Council
- Environment Agency
- Health and Safety Executive
- Public Health England
- ARUP
- Colleagues in Lancashire County Council

Consultations

N/A

Implications:

This item makes recommendations to various agencies in improving the policy, planning and regulatory framework.

Risk management

N/A

Finance

Any impact on the Council regarding Shale Gas Extraction will be addressed within the appropriate planning process.

List of Background Papers

Paper	Date	Contact/Directorate/Tel
Report to Cabinet – 'Proposal to undertake a Health Impact Assessment of Shale Gas Extraction in Lancashire'	8 May 2014	Dave Gorman, Office of the Chief Executive, (01772) 534261

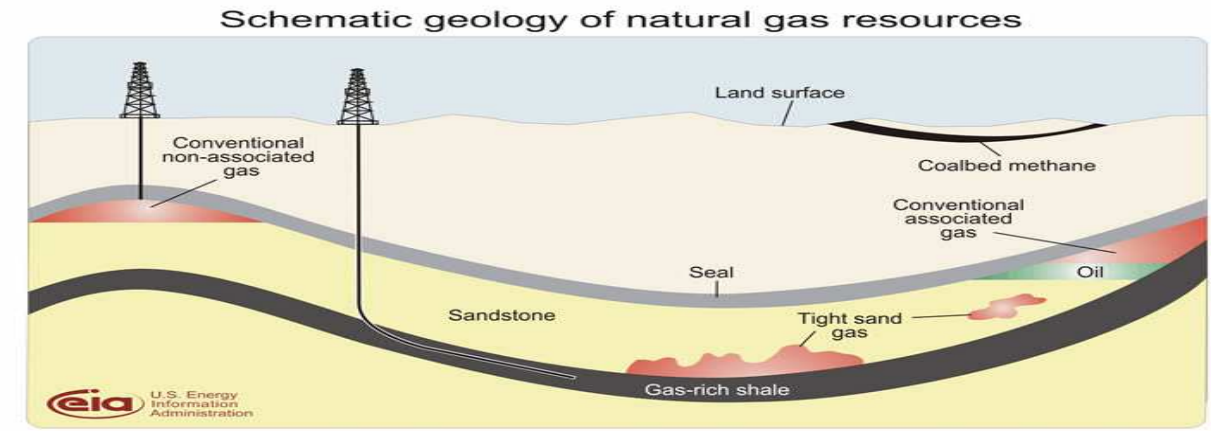
Reason for inclusion in Part II, if appropriate

N/A

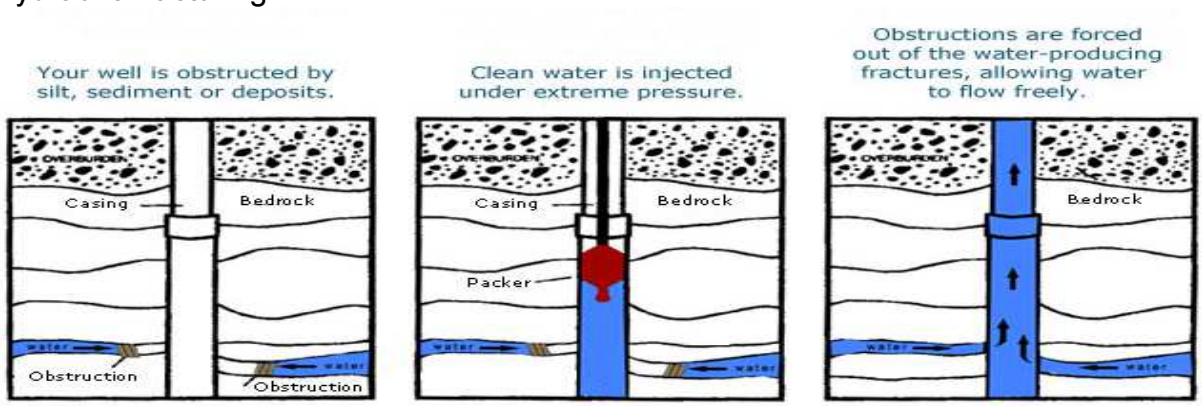
Appendix 'A'

Difference between conventional and shale gas exploration

In the UK, there has been a long history of extraction of natural oil and gas from ‘conventional’ onshore fields, where the gas comes from absorbent reservoirs, usually composed of sandstone or limestone. Conventional gas extraction is relatively straightforward because the gas generally flows freely, unlike unconventional gas where it is situated in rocks with extremely low absorption ability, making it very difficult to extract (see diagram below):



Industries use advanced technologies to extract the unconventional gas following a process commonly known as 'hydraulic fracturing' or 'fracking'. This involves pumping water, mixed with a small proportion of sand and chemicals, underground at a high enough pressure to split and keep open the rock and release natural gas that would otherwise not be accessible. The diagram below shows the process of hydraulic fracturing:



Stages of high volume hydraulic fracturing and differences from conventional hydrocarbon production (copied from Evidence: Monitoring and control of fugitive methane from unconventional gas operations, Environment Agency, 2012

Development and production stage	Step	Decision factors	Differences from conventional hydrocarbon production
Site selection and preparation	Site identification	Production yield versus development cost	None
	Site selection	Proximity to buildings / other infrastructure	None
		Geologic considerations	None
		Proximity to natural gas pipelines	None
		Feasibility of installing new pipelines	None
		Site area (around three hectares/well needed during fracturing)	More space required during hydraulic fracturing for tanks / pits for water / other materials required for fracking process
		Access roads / requirement improvements	More lorry movements during hydraulic fracturing than conventional production sites due to need to transport additional water, fracking material (including sand/ceramic beads) and wastes
		Availability and cost of water supply and wastewater disposal	Obtaining/disposing of large volumes of water (10,000–20,000 m^3 per well)
		Availability of space to store make up water and wastewater	For example may require 20,000 m^3 of make-up water onsite before fracturing Will require sufficient trucks / tanks onsite to manage flowback (e.g. 40–50 trucks at 90 m^3 per tank)
	Site preparation	Number of wellheads per pad and per hectare Well pad design to control run off and spills and contain leaks Amount of water / proppant needed for production activities	Installation of additional tanks / pits More wells/pad Fewer wells/hectare
Well design	Deep well (directional) Shallow vertical	Separation of aquifer from hydrocarbon bearing formation by impermeable layers Existence of fault / fracture zones	Both conventional and unconventional wells are drilled through water-bearing strata and require same well design

Development and production stage	Step	Decision factors	Differences from conventional hydrocarbon production
		Maximising access to hydrocarbon in strata	standards
Well construction and development	Drilling	Depth to target formation (vertical or horizontal)	Horizontal drilling produces longer well bore (vertical depth plus horizontal leg) requires more mud and produces more cuttings/well Horizontal drilling requires special equipment, larger diesel engine for the drill rig, burns more fuel produces more emissions. Equipment is on site for a longer time. However, fewer horizontal wells would be needed to extract a similar quantity of gas
	Casing	Casing required or open hole construction (competent conditions only): casing would normally be required Conductor (for wellhead) Surface (to isolate near-surface aquifer from production) Intermediate (to provide further isolation) Production (in target formation) Centred casing to enable cementing	Casing material must be compatible with fracking chemicals (e.g. acids) Casing material must also withstand the higher pressure from fracturing multiple stages
	Annular packers Inflatable downhole tools installed on the outside diameter of a casing can provide a back-up to cement in hydraulically fractured wells	Need to prevent annular gas migration or separate horizontal wells into segments.	Could be used on both conventional and unconventional wells
	Cementing	Correct cement for conditions in well (e.g. geology	Hydraulic fracturing has the potential to

Development and production stage	Step	Decision factors	Differences from conventional hydrocarbon production
		Number, size, timing and concentration of delivery slugs of fracturing fluid and proppant	depending on formation thickness) More equipment required: Series of pump trucks, frack tanks, much greater intensity of activity.
	Hydraulic fracturing: pressure reduction in well / to reverse fluid flow recovering flowback and produced water	Chemical additions to break fracking gels (if used) Planning for storage and management of flowback recovered before the well starts gassing (varies from 0%-75% but strongly formation dependent). Planning for storage and management of smaller volumes of wastewater generated during production (decreasing flow rates and increasing salt concentrations)	'Flowback' of fracturing fluid and produced water containing naturally occurring materials (mostly salt) and hydrocarbons
	Connection of well pipe to production pipeline		None
	Reduced emission completion	Capture gas produced during completion and route to production pipeline or flare it if pipeline is not available	Larger volume of flowback and sand to manage than conventional wells
	Well pad removal	Amount of wastewater storage equipment to keep on site Remove unneeded equipment and storage ponds. Re-grade and re-vegetate well pad.	Larger well pad (with more wells/pad) with more ponds and infrastructure to be removed
Well production	Construction of pipeline	May need to construct a pipeline to link new wells to gas network.	Exploitation of unconventional resources may result in a requirement for gas pipelines in areas where this infrastructure was not previously needed
	Production	May need to re-fracture the well to increase recovery (e.g. after five years of service). Wastewater management (e.g. discharge to surface water bodies, reuse or disposal via	Produced water will contain fracturing fluid as well as hydrocarbon Conventional wells are often in wet formations that require dewatering to

Development and production stage	Step	Decision factors	Differences from conventional hydrocarbon production
		underground injection including transport to disposal site)	maintain production. In these wells, produced water flow rates increase with time. In shale and other unconventional formations, produced water flow rates tend to decrease with time.
Well site closure	Remove pumps and downhole equipment Plugging to seal well	Need to install surface plug to stop surface water seepage into wellbore and migrating into groundwater resources Need to install cement plug at base of lowermost underground source of drinking water Need to install cement plugs to isolate hydrocarbon, injection/disposal intervals	Likely to be similar to conventional well
Post-closure	Long-term monitoring to ensure well integrity	Methane can continue to be produced after well closure, at rates which are not commercially viable but which could result in methane seepage in the long term if seals or liners break down.	None

Appendix 'B'

Health Advisory Group – Terms of Reference

Aim

The role of the Health Advisory Group is to support the Health Impact Assessment (HIA) process and where appropriate, members of the Health Advisory Group will provide expert technical advice.

Objectives

A Rapid HIA will be undertaken of the shale gas exploratory stage, specifically to the proposed sites at Roseacre Wood and Preston New Road. This will include:

- Establishing and quantifying the potential health impacts.
- Identifying the potential distribution of health impacts across different groups in the population.
- Making recommendations for action to mitigate negative and maximise positive impacts of the health and wellbeing these residents.

It is preferred that the Rapid HIA will be completed within a 10 to 12 week period from receipt of the two proposed applications for shale gas exploration.

Membership

Lead

Director of Public Health

The following will provide expert advice to the Director of Public Health, where appropriate:

- LCC Environmental Technical Expert
- Public Health England Environmental Scientist
- HIA Consultant
- LCC Knowledge and Intelligence
- Deputy County Secretary and Solicitor
- Head of Communications
- Fylde Borough Council

Stakeholders

The following representatives will be asked to submit written evidence and/or attend a Health Advisory Group meeting to provide expert advice to the Director of Public Health:

- Regulators (Environment agency, Department of Energy and Climate Change, Health and Safety Executive, Lancashire County Council Planning, Environmental Health – Fylde Borough Council)
- Industry Sector
- Academics

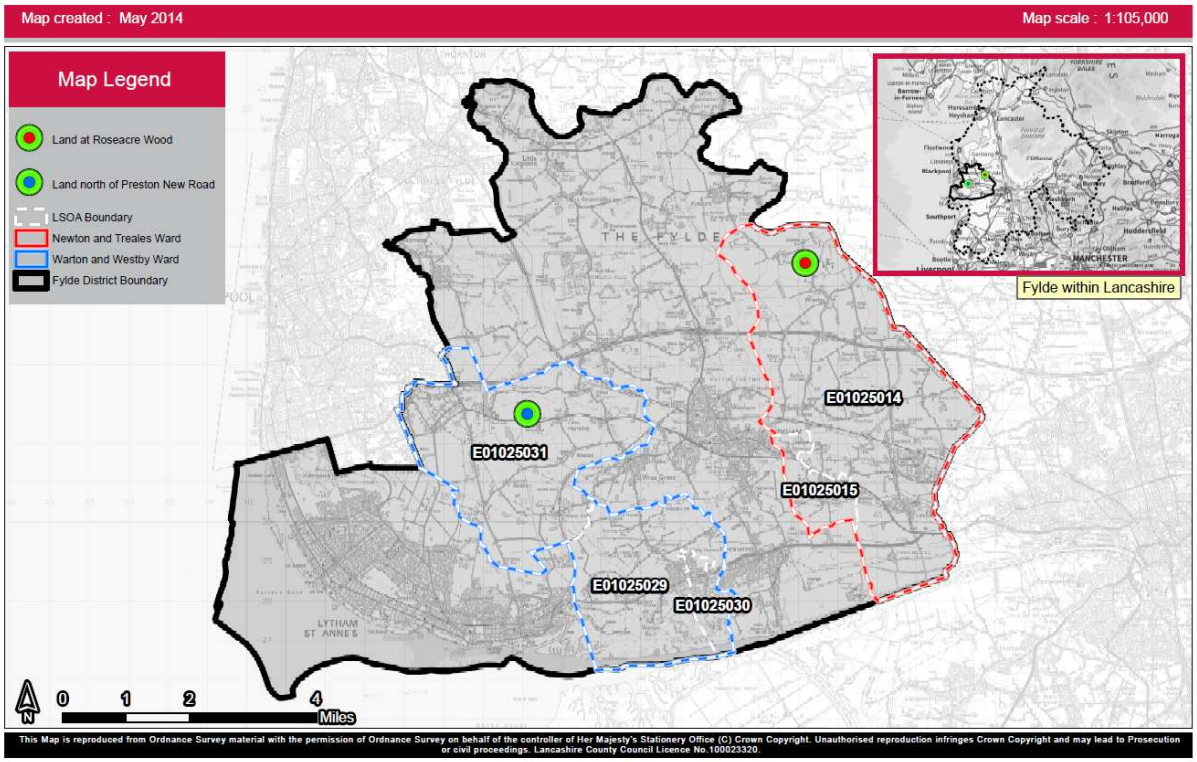
Community engagement

Existing mechanisms will be used to engage with local residents living in the two areas and Parish, District and County Councillors representing the two areas of the proposed sites for shale gas exploration. This is to inform them about the process of undertaking the HIA and to understand their concerns regarding the health impacts of shale gas exploration.

Appendix 'H'

Local Health Profile

The two proposed temporary sites in Lancashire to explore for shale gas extraction is situated within the Fylde district, as seen below:

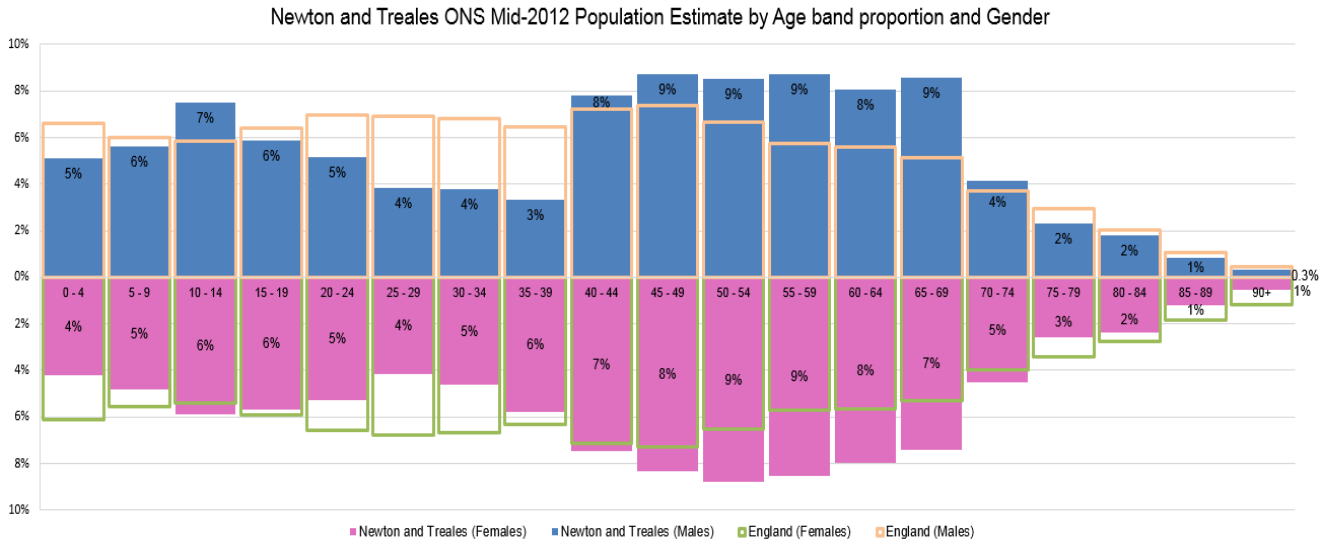


Proposed temporary Site: Roseacre Wood in Lancashire

The proposed temporary Roseacre Wood in Lancashire site is situated within the Newton and Treales ward of the Fylde district, on the east side boarding with the Preston and Wyre districts.. In 2013, the Office for National Statistics (ONS) estimated that this ward had a total population of 3,160[1], with 49% (1,560) of residents aged 40 to 69 years old and 51% of the population estimated to be females. An age gender breakdown of the population estimate shows that this ward has higher estimated proportions of residents aged between 10 to 14 years old and aged 40 to 74 years old compared to England as a whole (Figure 2).

[1] ONS 2012 Mid-Year Population Estimate, Published November 2013

Figure 2: Newton and Treales ONS Mid-2012 Population Estimate by Age band proportion and Gender



Using the MOSAIC Public Sector Profiler produced by Experian[2], 29% of the population was classed in **Group G: Rural Reality**. This referred to people who live in rural communities and generally own their relatively low cost homes. Their moderate incomes come mostly from employment with local firms or from running their own small businesses.

A further 28% of residents were classed in **Group A: Country Living**, which referred to people as being considered to be well-off homeowners, who lived in the countryside often beyond easy commuting reach of major towns and cities. Some people were landowners or farmers, others ran small businesses from their homes, some were retired and others commuted distances to professional jobs.

Using Public Health England's Local Health profile tool[3], the Newton and Treales ward has the highest life estimated life expectancy at birth (2008-12) for females in the Fylde district of 89 years old. The England national average was 83 years old. For males the ward has a life expectancy at birth (2008-12) of 79, which again is one of the highest estimates in the district and in line with the England national average, across all wards, of 79 years old.

The Environment and Health Atlas for England and Wales[4] is an independent publication produced by the UK Small Area Health Statistics Unit (SAHSU). It is part of the MRC-PHE Centre for Environment and Health and is funded by the Medical Research Council and Public Health England. It was published in April 2014 and shows the relative risks for a 25 year period (1985-2009), for a number of health conditions. The relative risks represent the risk of an area (ward) relative to average risk in England and Wales. These are adjusted for age, deprivation and chance fluctuations due to small numbers.

[2] http://www.segmentationportal.com

[3] Public Health England. (2014). *Local Health.* Available: http://www.localhealth.org.uk. Last accessed 30/09/2014.

[4] Small Area Health Statistics Unit (SAHSU). (2014). The Environment and Health Atlas for England and Wales. Available: http://www.envhealthatlas.co.uk/. Last accessed 01/10/2014.

Using the atlas, the Newton and Treales have above average relative risk for females, for the following conditions:

- Bladder Cancer;
- Chronic obstructive pulmonary disease (COPD);
- Heart Disease;
- Liver Cancer;
- Low Birth Weight;
- Lung Cancer;
- Mesothelioma Cancer;
- Sill births; and
- Skin Cancer.

And for males it is estimated to have above average relative risk for the following areas:

- Chronic obstructive pulmonary disease (COPD);
- Heart Disease;
- Liver Cancer; and
- Lung Cancer.

All-cause mortality is a fundamental and probably the oldest measure of the health status of a population. It represents the effect of the prevalence of risk factors, prevalence and severity of disease, and the effectiveness of interventions and treatment. Differences in levels of all-cause mortality may reflect health inequalities between different population groups.

The Local Health profile tool enables comparisons to the standardised mortality ratio (SMR)[5] for this ward against not only the ratio of the other wards from the district but also against the Fylde district as a whole ratio, the Lancashire county[6] ratio and the England national ratio. Looking at the ratio for all-cause mortality, All-cancers, All-circularly diseases, Coronary heart disease, Stroke and Respiratory diseases the ward had a significantly better ratio than the England national average for all-cause mortality and Respiratory diseases (Figure 3).

[5] SMRs calculated by dividing the observed total deaths in the area by the expected deaths and multiplying by 100

[6] The Lancashire county geography covers the Burnley, Chorley, Fylde, Hyndburn, Lancaster, Pendle, Preston, Ribble Valley, Rossendale, South Ribble, West Lancashire and Wyre districts

Figure 3: Newton and Treales, Causes of death, all ages, standardised mortality ratios (SMRs), 2008-12)

Indicator	SMR	Fylde district	Lancashire county	England
All-cause mortality	81.1	99.7	108.4	100
All-cancers	83.1	97.8	103.7	100
All-circulary diseases	71.2	100.7	111.2	100
Coronary heart disease	71.2	91.3	115.3	100
Stroke	59.6	106.3	110.8	100
Respiratory diseases	39.4	106.3	117.2	100

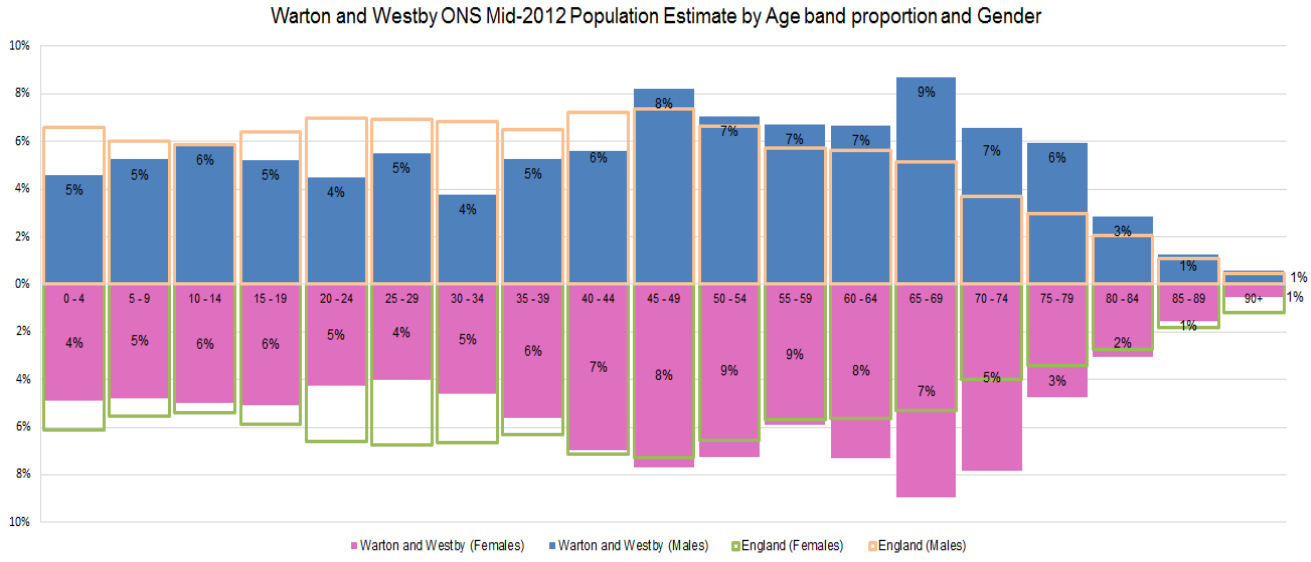
Significantly better than England | Not significantly different | Significantly worse than England

Looking at the premature mortality ratios, the ward was not reporting any significantly different ratios to the England national average.

Proposed temporary Site: Preston New Road in Lancashire site

The proposed temporary Preston New Road in Lancashire site is situated within the Warton and Westby ward of the Fylde district, situated fairly centrally within the district and boarding with the River Ribble to the South and the Blackpool district to the North. In 2013, the Office for National Statistics (ONS) estimated that this ward had a total population of 4,736[7], with 44% (2,104) of residents aged 45 to 74 years old. An age gender breakdown of the population estimate shows that this ward has higher estimated proportions of residents aged between 45 to 84 years old than England as a whole (Figure 4).

Figure 4: Newton and Treales ONS Mid-2012 Population Estimate by Age band proportion and Gender



Using the MOSAIC Public Sector Profiler, 19% of the population is categorised in **Group A: Country Living**, which referred to people considered to be well-off homeowners, who lived in the countryside often beyond easy commuting reach of

[7] ONS 2012 Mid-Year Population Estimate, Published November 2013

major towns and cities. Some people were landowners or farmers, others ran small businesses from home, some were retired and others commuted distances to professional jobs.

17% were classed in **Group F: Senior Security**, which relates to elderly singles and couples who lived independently in comfortable homes that they own. Property equity gives them a reassuring level of financial security. This group included people who have remained in their family homes after their children have left, and those who have chosen to downsize to live among others of similar ages and lifestyles.

Additionally, 14% of the population were classed in **Group E: Suburban Stability**, considered to be typically mature couples or families, some enjoying recent empty-nest status and others with older children still at home. They live in mid-range family homes in traditional suburbs where they have been settled for many years.

Using Public Health England's Local Health profile tool, the Warton and Westby ward has one of the highest life estimated life expectancy at birth (2008-12) for males in the Fylde district of 80 years old. The England national average was 79 years old. For females the ward has a life expectancy at birth (2008-12) of 82 years old and although this is one of the lower estimates in the district, it is in line with the England national average, across all wards, of 83 years old.

The Environment and Health Atlas for England and Wales, reports that the Warton and Westby ward has above average relative risk for females, for the following conditions:

- Bladder Cancer;
- Chronic obstructive pulmonary disease (COPD);
- Heart Disease;
- Liver Cancer;
- Lung Cancer;
- Mesothelioma Cancer;
- Sill births; and
- Skin Cancer.

And for males it is estimated to have above average relative risk for the following areas:

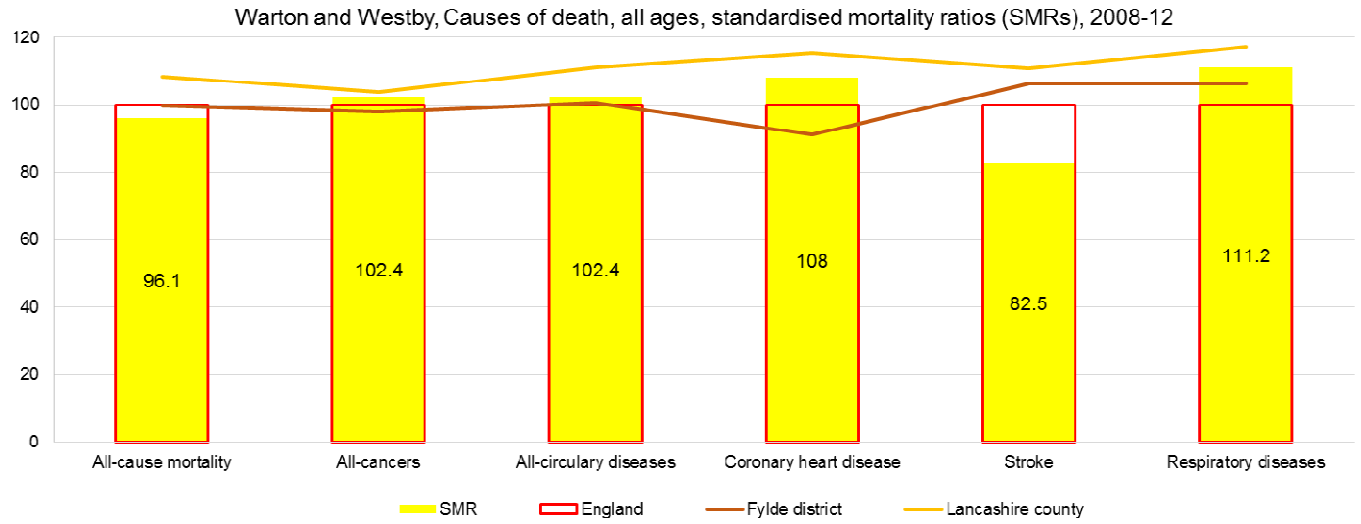
- Chronic obstructive pulmonary disease (COPD)
- Heart Disease
- Liver Cancer

Looking at the latest all-age mortality ratios, using the Local Health profile tool, this ward was not reporting any significantly different standardised mortality ratios (SMR), for any of the conditions examined (Figure 5).

Figure 5: Warton and Westby, Causes of death, all ages, standardised mortality ratios (SMRs), 2008-12)

Indicator	SMR	Fylde district	Lancashire county	England
All-cause mortality	96.1	99.7	108.4	100
All-cancers	102.4	97.8	103.7	100
All-circulary diseases	102.4	100.7	111.2	100
Coronary heart disease	108	91.3	115.3	100
Stroke	82.5	106.3	110.8	100
Respiratory diseases	111.2	106.3	117.2	100

Significantly better than England | Not significantly different | Significantly worse than England



The situation was the same with the premature mortality figures, with the ward not reporting any significantly different SMRs from the England national ratios.

F.

A separate profile of people living within 2 and 5 mile radius is described below.
Proposed Site: Plumpton Hall Farm

2 mile radius

The population within a 2 mile radius is 4,332.A little more than half of them are women. The population density of the area is 20 people per hectare. There are 922 people aged 0-19 years old within a 2 mile radius. They make up 21.3% of the area population. There are 2,384 people aged 20 to 64 years (55% of the population). 1,026 people are aged 65 and over (23.7% of the population).

Total population	Males	Females	Area (hectares)	Population density	0-19	20-64	65 and over
4,332	2,108	2,224	3,545	19.9	922	2,384	1,026

Most of the population (3,331 people, 77%) did not have long-term conditions or health problems that limited their day-to-day activities. 482 people (11%) had day-to-

day activities limited a lot and a further 519 (12%) people had them limited a little. Most of the population (3,329 people, 76.8%) had very good or good health. 324 people (7.5%) had very bad or bad health.

Day-to-day activities limited a lot	Day-to-day activities limited a little	Day-to-day activities not limited	Health – very good	Health – good	Health – fair	Heath – bad	Health – very bad
482	519	3,331	1,792	1,537	679	254	70

The population aged 16 to 74 years within a 2 mile radius is 3,164. 416 people (13%) are employed full-time and 718 are retired (22.7%). 940 people (29.7 %) are unemployed.

All usual residents aged 16 to 74	Economically active; employee; full-time	Economically active; unemployed	Economically inactive; retired
3,164	416	940	718

Mosaic analysis: 1,902 households (Mosaic)

Group 'country living', is dominant (23%) (483 households) for households.
Described as well-off owners in rural locations enjoying the benefits of country life. The key features are:

- Rural locations;
- Well-off homeowners;
- Attractive detached homes;
- Higher self-employment;
- High car ownership; and
- High use of Internet.

Second group at 19.1% is 'prestige positions', described as established families in large detached homes living upmarket lifestyles. (363 households). The key features are:

- High value detached homes;
- Married couples;
- Managerial and senior positions;
- Supporting students and older children;
- High assets and investments; and
- Online shopping and banking.

5 mile radius

The population within a 5 mile radius is 196,510. A little more than half of them are women. The population density of the area is 55 people per hectare. There are 42,917 people aged 0-19 years old within a 2 mile radius. They make up 22% of the

area population. There are 112,814 people aged 20 to 64 years (57.7% of the population). 40,779 people are aged 65 and over (20.9% of the population).

Total population	Males	Females	Area (hectares)	Population density	0 - 19	20 - 64	65 and over
196,510	96,086	100,424	18,201	55.27	42,917	112,814	40,779

Most of the population (149,960 people, 76.3%) did not have long-term conditions or health problems that limited their day-to-day activities. 23,521 people (12%) had day-to-day activities limited a lot and a further 23,029 (11.7%) people had them limited a little. Most of the population (149,187 people, 76%) had very good or good health. 15,719 people (8%) had very bad or bad health.

Day to day activities limited a lot	Day to day activities limited a little	Day to day activities not limited	Health – very good	Health – good	Health – fair	Heath – bad	Health – very bad
23,521	23,029	149,960	82,769	66,418	31,604	12,157	3,562

The population aged 16 to 74 within a 5 mile radius is 143,128. 20,040 people (14%) are employed full-time and 25,237 are retired (17.6%). 7,106 people (5%) are unemployed.

All Usual residents aged 16 to 74	Economically active; employee; full-time	Economically active; unemployed	Economically inactive; retired
143,128	20,040	7,106	25,237

Mosaic analysis: 92,274 households (Mosaic)

Group 'transient renters' is dominant (15.4%) (14,245 households) for households within a 5 mile radius. Described as single people privately renting low cost homes for the short term. The key features are:

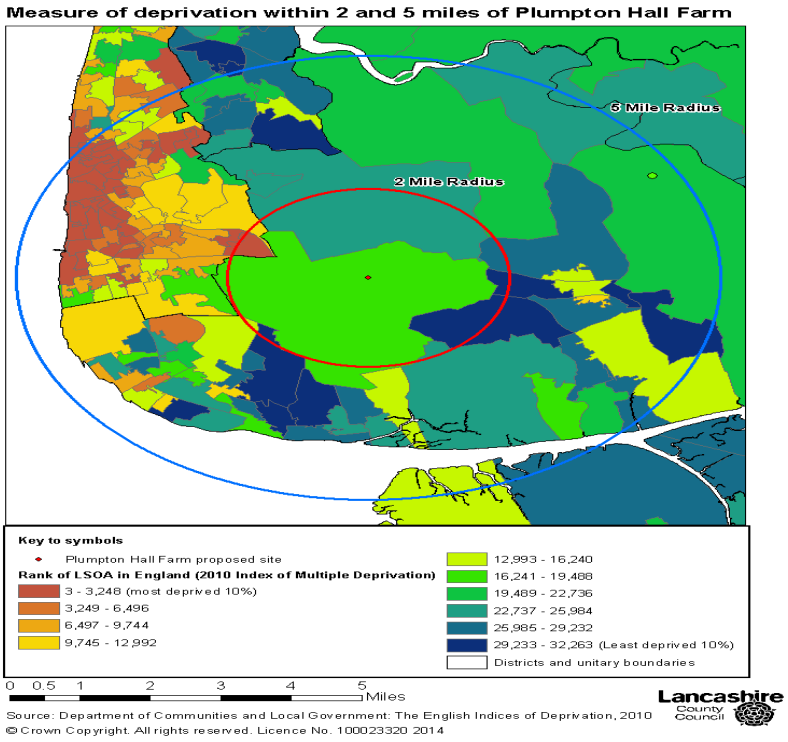
- Private renters;
- Low length of residence;
- Low cost housing;
- Singles and sharers;
- Older terraces; and
- Few landline telephones.

The second largest group is senior security, described as elderly people with assets who are enjoying a comfortable retirement, 12.9% (11,871 households). These groups are residents of Blackpool, parts of which are covered by this large radius. The key features are:

- Elderly singles and couples;

- Homeowners;
- Comfortable homes;
- Additional pensions above state;
- Don't like new technology; and
- Low mileage drivers.

Index of Multiple Deprivation 2010



The proposed Plumpton Hall Farm site is in an LSOA that is in the least deprived 50% of all LSOAs in England. Similarly, the vast majority of surrounding area within a 2 mile radius is not deprived. To the west, the area covers most of an LSOA in Blackpool that is in the 10% most deprived in England.

The 5 mile radius area is very varied in terms of deprivation. Generally speaking it splits east to west. To the east, the LSOAs are mostly in the 50% least deprived in England. To the west, they are generally in the least deprived 50% of areas in England (with some exception in the north west and south west). Many of the areas in the west are in the 10% most deprived in England.

ProposedSite: Roseacre Wood

2 mile radius

The population within a 2 mile radius is 2,522.The gender split is almost equal. The population density of the area is 4.4 people per hectare. There are 539 people aged 0-19 years old within a 2 mile radius. They make up 21.4% of the area population.

There are 1,501 people aged 20 to 64 years (59.5% of the population). 482 people are aged 65 and over (19.1% of the population).

Total population	Males	Females	Area (hectares)	Population density	0-19	20-64	65+
2,522	1,235	1,287	3,628	4.37	539	1,501	482

Most of the population (2,088 people, 82.8%) did not have long-term conditions or health problems that limited their day-to-day activities. 187 people (7.4%) had day-to-day activities limited a lot and a further 247 (9.8%) people had them limited a little. Most of the population (2,083 people, 82.6%) had very good or good health. 427 people (17%) had very bad or bad health.

Day-to-day activities limited a lot	Day-to-day activities limited a little	Day-to-day activities not limited	Health – very good	Health – good	Health – fair	Heath – bad	Health – very bad
187	247	2,088	1,246	837	356	71	12

The population aged 16 to 74 years within a 2 mile is 1,890. 245 people (13%) are employed full time and 326 are retired (17%). Only 37 people (less than 2%) are unemployed.

All usual residents aged 16 to 74	Economically active; employee; full-time	Economically active; unemployed	Economically inactive; retired
1,890	245	37	326

Mosaic analysis: 995 households (Mosaic)

Group 'country living' is dominant group at 618 households and at 62.1% is described above. Group 'rural reality' is second at 306 households and 30.8%. Described as householders living in inexpensive homes in village communities. The key features are:

- Rural locations;
- Village and outlying houses;
- Agricultural employment;
- Most are homeowners;
- Affordable value homes; and
- Slow Internet speeds.

5 mile radius

The population within a 5 mile radius is 39,132. The gender split is almost equal. The population density of the area is 23.8 people per hectare. There are 9,119 people aged 0-19 years old within a 5 mile radius. They make up 23.3% of the area

population. There are 22,960 people aged 20 to 64 years (58.7% of the population). 7,053 people are aged 65 and over (18% of the population).

Total population	Males	Females	Area (hectares)	Population density	0 - 19	20 - 64	65+
39,132	19,385	19,747	19,668	23.8	9,119	22,960	7,053

Most of the population (32,373 people, 82.7%) did not have long-term conditions or health problems that limited their day-to-day activities. 3,167 people (8.1%) had day-to-day activities limited a lot and a further 3,592 (9.2%) people had them limited a little. Most of the population (32,269 people, 82.5%) had very good or good health. 1,907 people (4.9%) had very bad or bad health.

Day-to-day activities limited a lot	Day-to-day activities limited a little	Day-to-day activities not limited	Health – very good	Health – good	Health – fair	Heath – bad	Health – very bad
3,167	3,592	32,373	19,166	13,103	4,956	1,510	397

The population aged 16 to 74 within a 5 mile radius is 29,001. 4,070 people (14%) are employed full time and 4,890 are retired (17%). 759 people (2.6%) are unemployed.

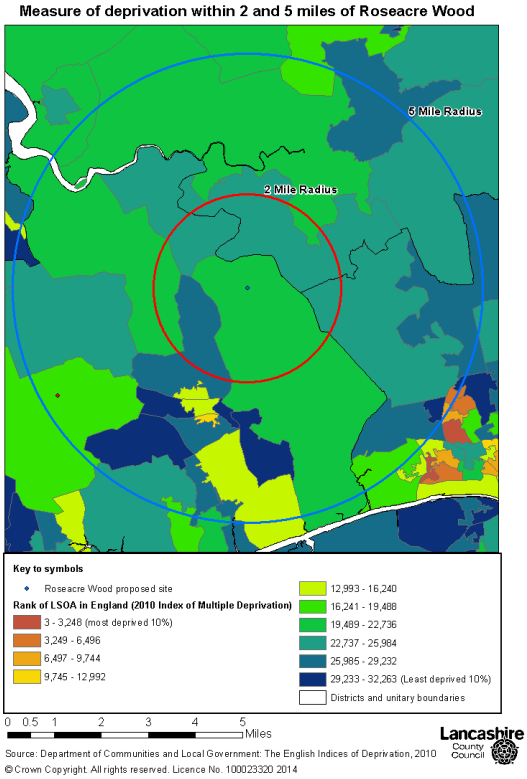
All usual residents aged 16 to 74	Economically active; employee; full-time	Economically active; unemployed	Economically inactive; retired
29,001	4,070	759	4,890

Mosaic analysis: 16,426 households (Mosaic)

Group 'country living' is dominant at 21.6% and 3,546 households, second is 'rural reality' at 1,966 households and 12%, and 'suburban stability' group comes next at 11% and at 1,811 households, described as mature suburban owners living settled lives in mid-range housing, as outskirts of Preston fall within this radius. The key features are:

- Older families;
- Some adult children at home;
- Suburban mid-range homes;
- 3 bedrooms;
- Have lived at same address some years; and
- Research on internet.

Index of Multiple Deprivation 2010



The proposed Roseacre Wood site is in an LSOA that is in the least deprived 50% of all LSOAs in England. Similarly, the surrounding area within a 2 mile radius is not deprived.

The vast majority of the 5 mile radius area is not deprived. Three areas fall just inside the 50% most deprived in England. One is in the 40% most deprived.

Fylde comparative data

At the 2011 Census, the population of Fylde was 75,757 people. Just over half (51%) were women.20% were aged 0-19 years old. 55% were aged 20 to 64 years and 24% were aged 65 or over.

Most of the population (78%) did not have their day-to-day activities limited by long-term conditions or ill health. 10% had their activities limited a lot and a further 11.5% were limited a little. 59,406 people (78.4%) had very good or good health. 4,732 (6%) people had very bad or bad health.

There were 54,544 residents aged 16 to 74 years old. 20,222 (37%) were employed full time and 11,262 (20.6%) were retired.1,687 people 3%) were unemployed.

Total population	Males	Females	Area (hectares)	Population density
75,757	36,781	38,976	16,569	36.0

0 - 19	20 - 64	65 and over
15,284	42,130	18,343

Day-to-day activities limited a lot	Day-to-day activities limited a little	Day-to-day activities not limited
7,849	8,714	59,194

Health – very good	Health – good	Health – fair	Heath – bad	Health – very bad
33,815	25,591	11,619	3,692	1,040

All usual residents aged 16 to 74	Economically active; employee; full-time	Economically active; unemployed	Economically inactive; retired
54,544	20,222	1,687	11,262

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Our ref 230382/GR
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22 September 2014

Dear Dr.Karunanithi

Health Impact Assessment of Shale Gas Exploration in Lancashire

Thank you for your time at our meeting on 11th September, and for your letter of 16th September setting out the contextual issues for which you seek clarification in respect of Cuadrilla's proposed exploration for shale gas at the Preston New Road and Roseacre Wood temporary exploration sites in Lancashire. We are also grateful for the opportunity to respond to the points for clarification summarised in your consultant's summary of points for clarification, dated 19th August 2014.

It is noted that some of your points relate to the post-exploration stages of operation and, while we are able to provide generic information on these points, they are outside the scope of the proposal to undertake exploration activities at the Preston New Road and Roseacre Wood sites. All relevant information has already been provided in the detailed Environmental Statements and accompanying planning application documentation and the information set out below is therefore intended to clarify the content of the Environmental Statements for these sites, or their accompanying planning application documentation.

To maintain consistency of formatting, and to ensure that all of your queries are resolved, the following text sets out the questions first (in italics), followed by responses from the applicant:

1. *Further information around the extent of horizontal drilling and whether there is the potential to have more than one horizontal well per vertical bore hole?*

It is technically possible to drill more than one horizontal wellbore per vertical bore, however the planning applications make clear that Cuadrilla will only drill a single horizontal wellbore from each of the vertical bores at the two proposed exploration sites. The actual length of the horizontal wellbore will be determined by geology but will not exceed 2000 metres, as noted in Table 3 of the Planning Statement for the projects.

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2. How is the monitoring of fracture propagation post hydraulic fracturing being planned?

The primary purpose of the micro-seismic array is to monitor propagation of fractures induced in the shales. The precise timescale over which fracture propagation will take place cannot be defined at this stage, however micro seismic monitoring will continue after cessation of the hydraulic fracturing activity for a number of hours; within this time the mechanism for which fracture growth is required is no longer active.

In addition to micro-seismic monitoring, the Traffic Light System (TLS) array will actively monitor the entire hydraulic fracture operation, including pumping, fracture propagation, stand-by, and flow back.

3. What monitoring arrangements are being planned for post abandonment stage?

Monitoring requirements may be imposed by the Environment Agency through the environmental permit for each site in respect of plugged and abandoned wells. Any such requirements deemed necessary in respect of circumstances at that time will form part of the closure plan for the site, compliance with which will form part of the Agency's decision under the relevant regulations whether to accept a surrender of the environmental permit. Groundwater monitoring at the Site will be performed for a minimum of one year following abandonment of the exploratory wells or in accordance with extant best practice or regulatory requirements at the time of abandonment. (see s.11.4.5; para.68 of ES).

4. What health related criteria was used for site selection referred to in chapter five and what consideration was given to how close to the residential area could the well be placed?

The criteria for site selection is set out in Tables 5.1 and 5.2 of the ES. Assessment criteria for individual topics (e.g. lighting, air quality, noise etc.) drawn from the relevant guidelines were used to evaluate each proposed site. Proximity of potential receptors to the site was considered in relation to these various thresholds.

5. What quantitative risk assessments have been completed with reference to health risks?

In response to the scoping report for Preston New Road, Public Health England set out its requirements (in its letter dated 27th February 2014) for a dedicated section in the ES, to summarise key information relating to public health, to be drawn from relevant technical chapters. This did not include a quantitative health risk assessment.

6. What health risk assessments have been conducted for MOD sites as another potential transport site?

Part of the MoD site at DHFCS Inskip has been proposed as a potential Heavy Goods Vehicle (HGV) transport route for the proposed Roseacre Wood shale gas exploration location. The MoD has completed assessments of health & safety issues associated with activities on its land at DHFCS Inskip.

7. What health related standards were considered when formulating the Environmental Operating Standards?

Thresholds for specific parameters such as air quality and noise may incorporate health standards, and where applicable these will be included in individual Control Plans within

the EOS. The EOS structure is summarised in the ES, pending receipt of planning conditions, and will be a live document, updated at regular intervals throughout the project. A separate Health, Safety, Security and Environment Risk Management Framework will be implemented, as set out in section 11.4.5 of the ES (para.64).

8. Further information about the storage, transport and disposal of waste.

Details of proposals for storage, transport and disposal of all relevant materials (including wastes) are set out in Appendix K; sections K2.3 and K2.5.

9. What considerations were given to undertaking a full health impact assessment as part of the environmental impact assessment?

In the scoping report for Preston New Road, a signposting section was proposed under section 4.4.2. In response to this, Public Health England set out requirements (in its letter dated 27th February 2014) for a dedicated section in the ES, to summarise key information relating to public health, to be drawn from relevant technical chapters. This comprises chapter 20 of the ES for Preston New Road.

10. How is the completion of combusting during the flaring going to be measured?

Flare monitoring details are contained in the Environmental Permit application, HSE-Permit-PNR-INS-007 and HSE-Permit-RW-INS-007 Emissions Monitoring Plan submitted to the Environment Agency. The combustion of natural gas will be flared in accordance with BAT Reference Document cww_bref_0203 "Best Available Techniques in Common Waste Water and Waste Gas Treatment / Management Systems in the Chemical Sector.

The temperature of the flare will be continuously monitored using thermocouples up to 1000°C (+). BAT requires the flare to operate at 800°C (+). At this temperature 98% of natural gas is converted into carbon dioxide and water vapour. Once the temperature and feedstock (natural gas) of the flare is recorded, a calculation method will be utilised to establish conversion rates.

In addition to continuous monitoring the flare, the well pad perimeter fence line will have 4 ambient air quality monitoring stations. Detail of the ambient air quality monitoring is outlined with the HSE-Permit-PNR-INS-006 and HSE-Permit-RW-INS-006 including Methane, Oxides of Nitrogen, Sulphur Dioxide and Volatile Organic Compounds.

11. What unplanned scenarios were considered in the development of the environmental statements?

Unplanned scenarios are considered in the Environmental Risk Assessment (ERA) issued to DECC for consideration on 24th April 2014. DECC confirmed that the ERA submitted in respect of Preston New Road met its requirements, and can be found on the Cuadrilla website http://www.cuadrillaresources.com/protecting-our-environment/ .

Points for clarification arising from the study by Ben Cave Associates (BCA)**:**

(NB: paragraph numbering has been amended to provide continuation from the above responses)

General

We (BCA) suggest that the Director of Public Health for LCC:

12. *Seeks further detail on the influence of people's understanding of safety on the surrounding areas. Including consideration of: property values; amenity value of outdoor space; and levels of physical activity*.

    It is assumed that this point relates to the potential for public anxiety arising from shale gas exploration. The approach undertaken to site development, including mitigation that could influence public health, reflects this issue and the following responses are intended to provide further clarification of information contained within the ES, or accompanying planning application documents.

    Property values

    Detailed assessment of property values is not within the scope of the EIA.

    Other sections of the planning documentation - principally the Statement of Community Interest and the Environmental Risk Assessment – refer to perceived potential effects of shale gas exploration on property values and related issues.

    The potential for perception of effects of exploration activity to generate health impacts via anxiety is considered in section 20.5.4 of the ES, with the provision of adequate information being identified as the primary means of mitigating such effects. A comprehensive programme of community engagement has been implemented, is ongoing and is reported in the Statement of Community Interest (SCI) (s.3 (ERA) s.6 (Site selection) s.7 & 8 (EIA) and s.9 (engagement with parish councils)).

    Amenity Value of Outdoor Space

    Effects on outdoor space are considered in the ES, chapters 9 – Community and Socio-economic, and ch.14 – Landscape and Visual Amenity.

    Ch.9 confirms that no Public Rights of Way would be affected by the proposed works (table 9.7 and Figure 9.15) and that there would be no adverse community effects associated with public access and recreational amenity;

    Chapter 14 confirms that no significant visual impacts would be evident over the whole working period, however very localised changes would be observed during the drilling and hydraulic fracturing activities.

    Levels of Physical Activity

    The site and its surroundings are not publicly accessible and no Public Rights of Way are affected by the proposals (ES: Fig.9.15). There is therefore no mechanism for adverse effects on levels of physical activity.

13. *Seeks clarification of what effect (for example: direct, indirect, cumulative, differential, synergistic) the Project will have on proposed development within Fylde, including the proposed mental health unit at Whyndyke Farm.*

Cumulative effects are included in each technical chapter of the ES. It is not clear why the proposed mental health unit has been highlighted but the most relevant chapter in the ES in this context may be ch.18 – Transport; s.18.8 reviews cumulative effects on the local road network, and confirms that there will be no adverse effects arising from traffic flows associated with the proposals.

14. *Confirms when, and what, further information will be available regarding quantitative risk assessment (including unplanned events and reference to ½LFL).*

    An Environmental Risk Assessment (ERA) has been submitted to DECC in line with the recommendation of the Royal Society and the Royal Academy of Engineering Report and an environmental risk assessment was also submitted to the Environment Agency as one of the supporting documents to the environmental permit applications. No further risk assessments or information relating to quantitative risk assessments are required as part of the current regulatory regime. Therefore, no further risk assessment is planned for the temporary exploration works at Preston New Road or at Roseacre Wood.

15. *Confirms how the proponent will ensure and demonstrate that all pollution will be as low as reasonably practical using BAT. This applies to air quality (including PM^{10} and $PM^{2.5}$), noise, vibration, light and any other release from the activities on site or associated with the site*.

    Each technical chapter of the ES contains comprehensive mitigation measures that will minimise residual effects arising from the proposed temporary development. Any conditions deemed necessary to ensure that Cuadrilla's operations represent Best Available Techniques (as defined in environmental regulation) will be included in the environmental permit for the Project.

    Appendix E to the ES describes the Environmental Operating Standard (EOS) that will provide rigorous environmental management of the proposed temporary exploration site. Section 6 of Appendix E sets out the format of a series of Control Plans; this will define actions and responsibilities for maintenance of environmental control measures on the site.

    Lighting (see Chapter 15 of the ES)

    All lighting on the Project will be designed, specified, installed and commissioned in accordance with the relevant light obtrusion and design standards and guidance to ensure minimum light pollution. All design work undertaken will be completed by an appropriately qualified lighting designer using appropriate software. The lighting design details will be submitted and agreed with the local authority prior to installation of lighting on site. Viewpoints from neighbouring properties and local sensitive ecological receptors will be regularly monitored to assess the visibility of the light sources from the Project at all stages of construction and final installation.

    Air quality (see Chapter 6)

    The effects of emissions of particulate matter are assessed to be not significant. The main risk of PM emissions occurs during construction and demolition. Mitigation measures to ensure no significant impacts occur have been recommended and delivery of these measures can be secured through planning conditions.

Noise and vibration (see Chapter 16)

Use of best practicable means is required and has been assumed in the assessments. Where significant effects are predicted, mitigation is proposed to achieve targets and delivery of the mitigation can be secured through planning conditions.

Air quality

16. *Seeks clarification as to whether there will be periods of higher exposure to radon (e.g. during the 120 day flare period assumed by the radon modelling) than is suggested by the ES reporting the exposure levels as an annual effective dose. Notably whether peak levels will exceed 100 Bq/m^3 at any receptor*.

    The estimated exposure (0.3 microSv) associated with a maximum 120 d flare period has been normalised to an annual effective dose to allow for comparison with the statutory annual dose limit for a member of the public (see Appendix F of the ES). Based on the estimated concentrations of radon within the flared gas, and a maximum flare period of 120 d, it is not envisaged that there will be periods of higher exposure. It is pertinent to note that the estimated exposure (0.3 microSv) represents 0.02 % of the average annual public exposure to radon in the UK. Based on an estimated radon concentration of 200 Bq/m^3 within the flared gas, it is highly improbable that a radon (in air) concentration will exceed 100 Bq/m^3 at any off-site receptor.

17. *Request clarification of whether one or two flares been modelled by the radon modelling. It would be useful for actual receptors and weather data to be used in the radon modelling.*

    The radon assessment assumed that the flaring of gas would occur from a single stack. With regard to weather data, the Environment Agency's Initial Radiological Assessment Methodology assumes a sectorised Gaussian plume model (with a breakdown of atmospheric stability classes which is considered appropriate for discharges made within mainland UK). Given the radiologically-insignificant exposure estimated using the methodology (Appendix F), which allows for the calculation of a relatively cautious ('order of magnitude') estimate, it was determined that no additional refining of the assessment was required.

18. *Request additional modelling of the likely radon exposure levels during unplanned events (e.g. loss of gas containment at ground level) for occupational and residential receptor doses. For each radon modelling result (including those requested above), data in unit of μSv/year and Bq/m^3 would be useful.*

    With regard to unplanned events ['loss of gas containment at ground level' is cited as an example], the on-site storage of significant volumes of natural gas is not part of the proposal (Chapter 4 of ES), hence there is no feasible risk of a significant unplanned event with off-site radiological consequences of the nature suggested. In terms of a ground-level release, if the 120 d flare period discharge occurred at 0 m, the dose to the local population (resident at 100 m from the discharge point) is estimated to be 1.5 microSv (i.e. approximately 50 % of the daily exposure due to background radon, received by a member of the public within the UK). Assessment of the risk of occupational exposure to potentially dangerous substances is a requirement of the Ionising Radiations Regulations 1999 as well as serving to fulfil l employer's general

duties to safeguard employees and others under the Health and Safety at Work etc., Act 1974.

19. *Seeks clarification on the approximate minimum period of time between extraction of natural gas containing radon during extended flow testing and its final combustion by domestic and commercial end users. If this period of time is short and large volumes are being used by single sources, the risks of the carcinogenic decay products of radon further down the supply chain should be investigated.*

    Sampling of natural gas and analysis for radon will occur during flow-testing of the wells (and subsequent assessment of any potential, significant domestic exposure), prior to any transporting of natural gas to domestic consumers. Natural gas must be sampled and meet the requirements of the UK National Gas Grid prior to being allowed entry into the gas grid network and onwards to domestic or industrial customers

20. *Request information on what alternatives have been considered for the capture and the use of methane during the 90 day initial flow testing stage and clarify how the decision to flare has been reached.*

    The requirement to flare natural gas is based on a need to collect natural gas data. As described within the Waste Management Plan (HSE-Permit-INS-PNR-006) the initial flow test purpose is to enable a continual uninterrupted flow from the well head to a natural gas flare. The uninterrupted flow of natural gas is required to provide the necessary data to measure the flow rate of natural gas and the initial decline rate of flow and pressure, as well as the gas composition. This allows for the forecasting of potential future production flow from the well. Interrupting the flow, or risk of interruption from utilising the natural gas on site, would impact the necessary data collection and ability to predict future decline curves of natural gas.

    Once the initial flow test has established the required data, natural gas flowing from the well during the extended well test would be sent to the gas grid rather than flaring. The extended well test is based on site specific information e.g. the gas composition and flow rates established during the initial flow test, to enable a connection to be made into the gas grid.

    This approach is recognised in UKOOG standards (Clause 10) and in the USA EPA.

    Clause 10 from UKOOG states:

    10. Minimising Fugitive Emissions

    Operators should plan and then implement controls in order to minimise all emissions. Operators should be committed to eliminating all unnecessary flaring and venting of gas and to implementing best practices from the early design stages of the development and by endeavouring to improve on these during the subsequent operational phases.

    Emphasis should be placed on “green completions” whereby best practice during the flow-back period is to use a “reduced emissions completion” in which hydrocarbons are separated from the fracturing fluid (and then sold) and the residual flow-back fluid is collected for processing and recycling. However this approach will not always be practicable at the exploration/appraisal stage of a development where separation and flaring of natural gas should be the preferred option, minimising venting of hydrocarbons wherever practicable.

EPA Standards for Gas Well Affected Facilities:

Each well completion operation begun on or after January 1, 2015, must employ REC in combination with use of a completion combustion device to control gas not suitable for entering the flow line (we refer to this as REC with combustion). (EPA, Page 41, 40 CFR Part 63 Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews)

Once reliable data is validated from the initial well testing phase and reviewed by the infrastructure body (i.e. gas is suitable to enter a flow line), a connection to the gas grid will be made for the extended well testing phase.

Noise

21. *Requests additional mitigation be incorporated into the Project to ensure that at all receptors noise levels attributable to the Project neither exceed the WHO general health based threshold of 50/55 dB LAeq, 16hr (45); nor the WHO night noise threshold of 40 dB Lnight, outside.*

    The ES presents the highest assessed noise levels associated with drilling and hydraulic fracturing pumping operations. The drilling noise levels will comply with the suggested daytime criteria at the closest dwellings. At night, there is a forecast slight exceedence of the ES assessment criterion at the closest property on Preston New Road. However the measured ambient night time noise level here during the quiet night time period (46dBLAeq) was only 1dB(A) below the predicted drilling noise level and is in excess of the WHO night noise guideline.

    The hydraulic pumping stage of the fracturing process will cause higher noise levels, but will not be undertaken at night and will be typically for a period of only 3 hours per day in the period whilst hydraulic fracturing of drilled wells is ongoing. The hydraulic fracturing pumping operation is predicted to cause 67dBLAeq at the closest dwelling. This compares to a measured daytime level during quiet time of day of 62dBLAeq.

    As the existing daytime level of 62 dBLAeq is well above the WHO daytime target, work is daytime only, the site is temporary (and the fracturing operation itself is only part of the time for which the site would operate) and the noise level is only for a few hours per day, we have assessed this as a 'not significant' effect and as such are not currently proposing further mitigation.

22. *We suggest that the Director of Public Health for LCC requests regulatory authorities control the working hours and days for Project activities, particularly drilling and hydraulic fracturing, to ensure that at all receptors noise levels attributable to the Project do not exceed the WHO thresholds (44;45) of the preceding recommendation. Consideration could be given to only operating the fracturing pumps during weekday daytime and ceasing activity during weekends and bank-holidays*.

    The hydraulic fracturing pumping, which is the major noise source, will be restricted to weekday daytimes and will be typically for a period of only 3 hours per day during daytime hours, (and the hydraulic fracturing itself is only part of the time for which the site would operate)as set out in the ES.

    Drilling will be a 24 hour operation, but gives rise to much lower noise levels.

    It would be inappropriate to design to the target noise levels provided by the WHO Night Noise Guidelines for Europe, for drilling activity, because existing noise levels are already in excess of the target values.

23. *For noise impacts attributable to the Project which are justified on the basis of being of a similar decibel level to background noise, requests further reporting of the frequency spectrum and time-structure of such noise to evidence that it will not be clearly audible against background levels.*

    It has not been stated in the ES that the noise will not be audible, but favourable comparison has generally been made with the existing noise levels Sections 16.7.1 to 16.7.7 incl.).

    Traffic noise is broadband, containing noise from tyre-road interaction, engine noise and exhaust noise. The drilling and fracturing processes are also broadband, the fracturing using diesel engine pumps, similar to a HGV, so except for the absence of tyre noise, the sound character should be similar to road traffic.

Hydrogeology and ground gas

24. *Seeks clarification of how, and for how long, the applicant will monitor the ground water quality to the east of the Woodfold fault to confirm the hypothesis, advanced in the ES, that the fault creates a barrier to water movement between the ground water contamination of the application and the public water supply. Sufficient information should be provided to satisfy the Director of Public Health for LCC that public water supply will not be contaminated directly or indirectly as a result of the Project, including long-term impacts. This issue is also applicable to the Roseacre Wood application which is closer to the Woodfold fault.*

    As discussed in Section 11.6.7 of the ES, evidence to support the hypothesis that the Woodsfold Fault acts as a barrier to groundwater flow includes: observed groundwater level change across the fault; groundwater quality change across the fault; calibrated EA groundwater model with the fault modelled as impermeable; observations from comparable faults in the area. In addition the Woodsfold Fault is distant from the volume of rock that will be fractured, approximately 8km east of PNR and 3km east of Roseacre Wood at surface. The public water supply abstractions are in turn several kilometres east of the Woodsfold Fault and there is no plausible pathway between PNR and RW wells and the public water supply abstractions (Section 11.7.7 Induced fractures extend beyond the target zone). Groundwater monitoring is proposed around the PNR and RW well pads and will be subject to EA approval.

25. *Requests further information on how the application will affect long-term low level gas permeation to the surface including permeation to the surface which may be distant to the proposed site. Estimates of potential surface concentrations and areas of effect would be helpful.*

    Existing ground gas sources, present before any drilling or hydraulic fracturing, are identified in the ES (Section 11.6.11), and include an existing conventional gas reservoir in the Collyhurst Sandstone, below the Manchester Marl. The potential for gas migration as a result of the proposed development is discussed in the ES Section 11.7.7 (Ground gas migration due to loss of well integrity, Induced fractures extend beyond the target zone and Gas migration via induced fractures). Considering the geological setting, controls on fracture growth and other mitigation measures to ensure well integrity (Section 11.4.5), there is no plausible pathway for gas migration to receptors at the surface.

26. *Seeks confirmation of what action will be taken if a significant pathway, along a fault or other discontinuity, is established for gas to the surface.*

Cuadrilla has undertaken extensive characterisation of the subsurface including the mapping of faults (see section 12.4.2, para.18), prior to drilling in order to avoid hydraulically fracturing directly into regional faults.

The fracturing programme has been designed to keep induced fractures offset from regional faults by a distance of two times the anticipated fracture length. Micro-seismic monitoring will be used to detect fracture growth. If, during hydraulic fracturing, monitoring data indicate possible interactions with a preferential flow pathway, the pumping of fracturing fluid would be terminated and the HFP would be adjusted as necessary (Ch.4). However even if a fault or other discontinuity was encountered during hydraulic fracturing, a permeable pathway would need to be present along the full distance between the source (in the Bowland Shale) and the surface for gas migration to the receptors. Based on several lines of evidence set out in Chapter 12 in the ES, the extent and permeability of faults in the site area is considered to be too low to allow significant migration.

27. *Requests that regulators require an appropriate long-term monitoring plan post decommissioning / abandonment to ensure that the Project does not cause adverse legacy issues for air, ground or water contamination. Responsibility for monitoring should be clearly defined and set through condition, legal agreement and / or bond. The Director of Public Health for LCC should remain engaged with the monitoring information that emerges from the planning and permitting processes.*

Groundwater monitoring, including baseline, during operation and post-abandonment, is addressed by the environmental permitting regime and regulated by the EA. Groundwater monitoring post-well abandonment will be performed in accordance with the Environment Agency's requirements or other regulatory requirements in place at the time of abandonment.

Waste

28. *Confirms with the regulator (EA) that the Project's impact on the capacity of regional waste sites to treatment/disposal of medical waste is being considered as part of the permitting process. The Director of Public Health for LCC should remain engaged with the process and information that emerges on this issue from the planning and permitting processes*.

Material that could compete with medical waste for treatment or disposal capacity will not be generated by the exploration process, and is therefore not included in the environmental impact assessment.

29. *Seeks clarification on how suspension brine will be disposed of, as the ES does not describe this waste management pathway*.

Suspension brine (salty water) disposal is stated in the environment permit application in the mining waste management plan. For reference, section 5.7 of the mining waste management plan describes the waste under the European Waste Code (EWC) 01 05 08. This will be sent for disposal to a waste facility permitted accept the waste stream.

Induced seismicity

30. *Considers Verdon (47), who, having looked at analogous drilling, fracking and deep injection associated with CO2 storage, concludes that deep injections have a direct action on fault lines; and requests clarification of how this analysis relates to conclusions in the ES concerning impacts on induced seismology associated with hydraulic fracturing.*

    The comparison between induced seismicity associated with CCS storage and shale gas exploration is not appropriate as the volumes of injected liquid associated with CCS storage are significantly larger that for shale gas exploration. In addition the mitigation measures set out in section 12.9 of the ES, for limiting induced seismicity includes the mapping of faults prior to drilling in order to avoid hydraulically fracturing directly into regional faults, and real time monitoring that allows the Fracturing Manager to stop hydraulic fracture operations if a fault is suspected of being activated.

31. *Requests clarification that the applicant has considered the implications of seismic activity on historical and/or current salt/brine mining activity in the area (other than the Preesall proposed gas storage site). If so, this information should be provided.*

    The potential effects of induced seismicity on Preesall salt mining have been considered in section 12.7.4 and assessed and the risk is considered to be very low. It is considered that the Preesall salt mining is analogous for other salt mining operations (historical, current and future) in the region. Salt cavern collapse associated with salt mining is understood to be a source of induced seismicity rather than a consequence of induced seismicity related to another source.

32. *Seeks supporting evidence on the degree of accuracy to which the microseismic arrays measure the extent of hydraulic fractures. Including clarification of the relationship between fracture growth and the measurement of induced seismicity as a surrogate for this growth.*

    The ES provides a description of how the proposed buried (microseismic) array will detect the extent of hydraulic fractures and how this will be used to control hydraulic fracture growth (chapter 4). This is an established and successful methodology for detecting the location and extent of hydraulic fractures and more information can be found on the websites of companies that offer this service (i.e. Microseismic Inc).

    As set out in section 4.4 of the ES, micro-seismic monitoring will take place in real time and with subsequent post processing. The accuracy of real time microseismic monitoring depends on position of the hydraulic fractures relative to the buried instruments and the strength of the seismic signal. The location that is determined is a statistical best fit solution, and due to the collective listening power of the buried array the detection accuracy is expected to be in the order of a few 10s of metres.

    The relationship between fracture growth and the measurement of induced microseismicity is described in Chapter 4 of the environmental statement. The intention of hydraulic fracturing is to induce tensile fracture opening, which as a result will create shear slippage of the rock around the fracture producing a microseismic signal. This shear slippage creates microseismic signals, which will be detected by the proposed buried (microseismic) array and allow the growth of hydraulic fractures to be accurately monitored and controlled.

Visual impacts

33. *Seeks clarification on whether the flares will be associated with condensation plumes due to convection effect in the atmosphere under certain weather conditions. Any plume could increase visual disturbance and introduce an industrial element into the rural landscape.*

    The flare stack is designed to minimise visual intrusion, including effects of flame or condensation. Under extreme weather conditions a small condensation plume may be visible, however this would be likely to occur for a short period of time, during the maximum 90-day flow test period which, by definition, will be a temporary activity. Any such plume is therefore extremely unlikely to contribute to adverse effects on landscape character (see s.14.11 of the ES).

Transport

34. *Confirms if the transport safety audit included the transport of hazardous wastes (including those with NORM) from the site to treatment facilities. It is noted that hazardous loads are a familiar feature of the UK road network. Once the locations of relevant treatment facilities have been identified, the Director of Public Health for LCC could comment on the need for routing away from population centres and accident hotspots.*

    A road safety audit is intended to identify any road safety issues and suggest measures to eliminate or mitigate any concerns. The road safety audit covers all potential road users, including vehicles, cyclists and pedestrians. This would include the vehicles used to transport materials to and from the site.

    Chapter 11 (Section 11.7.3 – Table 11.10) identifies "Off-site road traffic accident resulting in spill of potentially contaminating materials" as potential source of pollution along a single exposure pathway to two potential receptors (water environment and human health). This assessment covers all potentially contaminating materials including any that contain quantities of low level NORM (e.g. flowback fluid).

    Section 11.7.7 then goes on to assess the risk in more detail, specifically in paragraphs 211 and 212 which states the control measures Cuadrilla would have in place to minimise the likelihood of a spill occurring and also the measures in place to manage any impacts in the event of a spill. These control measures apply to the transport of all material including flowback fluid which could contain quantities of NORM. With these measures paragraph 212 concludes that the probability of a source-pathway-receptor linkage being created would be low.

    On the basis of the above the planning submission has considered both the road safety issues associated with using the proposed access routes and the risks to receptors if a spillage on the highway were to occur.

35. *Confirms that the traffic impacts (including air quality) of the proposals have considered seasonal road congestion, for example during the summer months standing traffic can become a feature of roads leading into Blackpool.*

    Traffic impacts have been based on assessment of flows collected in October, which represents a recommended month for data collection as defined by the Department of Transport in their Guidance on Transport Assessment.

A review of traffic flows in 2013 on the M55 (which is the main route into Blackpool) indicates that there is limited seasonal variation between months and October represents an above average month.

Water resources

36. *Confirms with the regulator (EA) that the Project's impact on public water capacity in the event of hot weather, drought or other unusually high periods of increased demand is being considered as part of the permitting process. The Director of Public Health for LCC should remain engaged with the process and information that emerges on this issue from the planning and permitting processes.*

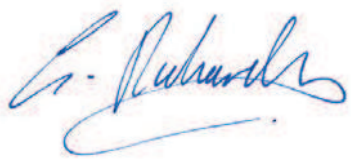
    An assessment of water stress/scarcity in the region has been made using water availability maps from the Environment Agency to understand if the volumes of water required during hydraulic fracturing could result in water stress (see ES s.19.6.4). This shows the Site is located within a zone with high water resource availability, where water is available at least 95% of the time. This shows that generally, the region is not 'water stressed'.

    The Site is located within United Utilities' "Integrated Resource Zone" supply zone. This means that water supplies are not fed from specific sources (i.e. an individual water treatment works), but are supplied via an integrated network of water mains and sources that are interconnected to maintain resilience of the network and flexibility of supply. UU are able to move water supplies around this region to meet demand. This helps UU to maintain adequate supplies to major areas of the Integrated Resource Zone in times of dry weather.

    For Preston New Road, United Utilities PLC has been consulted and has confirmed, through modelling, that drawing up to 765m^3 over a 24 hour period from their 15" water main can be undertaken without flow restriction and will not adversely affect the supply to other users of their network, providing a Pressure Management Valve is installed to reduce the risk of bursts. Their letter is contained in ES Appendix S.

I hope the above information provides sufficient clarification to enable you to complete your report to the Council, however if you require any further clarification please let me know.

Yours sincerely



Gordon Richardson
Associate Director – Environment & Sustainability

Appendix J

Advice to the Development Management Group to inform the planning process and provide public health advice to protect and improve the health of local residents living near the proposed shale gas exploration sites of Preston New Road (planning application numbers LCC/2014/0096 and 0097) and Roseacre Wood (planning application numbers LCC/2014/0101 and 0102).

This advice is based on a Health Impact Assessment that has been carried out by the Director of Public Health in respect of the above planning applications and primarily those relating to the respective site development works (applications LCC/2014/0096 and 0101).

In summary, the key risks to health and wellbeing of the population from the two proposed sites in Lancashire is considered to include a lack of public trust and confidence in the regulatory process and the industry, stress and anxiety from uncertainty about the industry that could lead to poor mental wellbeing; potential noise related health effects due to continuous drilling for at least five months for the initial borehole on each site and for three months for each of the subsequent three boreholes per site (in other words at least 14 months continuous drilling), and potential health risks due to the presence of mining wastes generated as part of the drilling and hydraulic fracturing process being retained on site if adequate off site treatment facilities are not found.

There are considered to be more risks for residents living near the Roseacre Wood site compared to the Preston New Road site due to lower levels of background noise, vehicular access by HGVs delivering plant and equipment along narrow country roads, and the proximity of the site to the national grid major pipeline notwithstanding it is proposed to interconnect into this as part of any flow testing during the appraisal stage. These risks could be prevented, mitigated and monitored through the planning determination.

Key recommendations to inform the planning process include:

1. Consider the need for further noise assessment, particularly on the proposed Roseacre Wood site and if necessary, require additional mitigation measures to reduce noise associated with the development of the sites and more particularly the drilling and hydraulic fracturing phases of the development and which could be controlled by conditions attached to any planning permission.
2. Establish with the Applicant that liability and compensation arrangements are in place to cover any structural damages to properties that can be attributed to an unlikely event of induced seismicity.
3. Undertake an independent verification of the assessment of air quality, transport, waste management and induced seismicity prior to determining the planning applications.
4. Seek agreement with the Applicant to establish an independent comprehensive baseline and on-going long term monitoring of environmental and health conditions prior to any activity on the sites. An indicative framework is described at the end of this document.

5. The Director of Public Health should be informed of the results of the measurements and any breaches to the planning condition or environmental permit.
6. Consider the need to seek further clarification from the Applicant that the cumulative impacts of the operations from the flare, generators, vehicles and drilling will not exceed the national air quality objective thresholds, particularly for PM_{10}, 24 hour mean levels.
7. As part of either the planning or permitting process, the Applicant should be required to submit regular data on the ambient air quality on site measuring all the common air pollutants relevant to the activity and report them regularly. PM 10 and PM2.5 should be reported separately.
8. The Roseacre Wood site is within 55m of a National Grid gas transmission pipeline. Interconnections into national transmission pipelines are proposed at both sites. Advice should be sought and an assessment undertaken as to whether the nearby gas transmission pipelines are considered to be a major hazard.
9. Any extended flow testing provided for by any planning permissions should be aligned with the permits to be issued by the Environment Agency.
10. An assessment of light pollution as part of the site operations should be carried out, and if there are likely to be significant impacts associated with light pollution from the sites that cannot be mitigated or controlled, the Applicant should be requested to consider the opportunity to offer to fit blackout blinds to those homes most likely to be affected.
11. Further clarification or new information on the occurrence and magnitude of equipment likely to be contaminated with radioactive waste and how such waste would be managed on the site and disposed of should be sought.
12. Should planning permission be granted, it should be a pre requisite that no activity can start until the onsite and offsite waste treatment capacity is defined.
13. Further clarification should be sought that any specific risks due to using the MoD site for accessing the Roseacre Wood site have been addressed before any planning permission is granted.
14. A full assessment of the impacts of additional traffic associated with the proposals on road safety should be carried out and appropriate traffic management options considered to address the public concerns, particularly in respect of the Roseacre Wood site.
15. Should planning permission be granted, provision should be made with the Applicant to maintain road safety, particularly on the access routes to Roseacre Wood site and road safety and any related incidents on the access to both the sites should be monitored.
16. In the event planning permissions are granted, any breach of planning conditions should be reported to the Director of Public Health so that necessary steps can be taken in protecting and improving the health of local communities from issues arising due to the alleged or identified breaches of planning control.

Indicative framework for long term monitoring of environmental and health conditions

1. Context

It is understood that a range of data will be collected by the operator and reported to the regulatory authorities, particularly the EA. What this will constitute is not available to LCC's public health department until the environment permit, planning condition and environmental operating standards are agreed. This document is written with that gap in knowledge.

Following the Applicant's surrender of the permit to the EA (who must be satisfied that environmental conditions are acceptable and will remain so before accepting the surrender), current practice suggests there will not be a requirement for long term monitoring of the environment in and around the restored sites of former wells..

Establishing a shale gas monitoring unit in Lancashire as an independent source of reliable information will help with the understanding of any environment and health impacts and the communication of risks to the local communities. It will also support the development of future policy and practice of shale gas extraction.

2. Aim

To establish an independent, reliable, single source of local information on shale gas exploration in Lancashire.

2.1 Objectives

- To develop a framework to establish a baseline and ongoing monitoring of environmental and health conditions

- To support risk communication and reassurance to local communities on the safety and impacts of shale gas activities in Lancashire.

The governance and management of the shale gas observatory should be determined in consultation with various stakeholders including the local communities, the industry, and the regulatory agencies.

3. The framework for data collection

It is expected that most of the data will be collected under the existing regulatory regime. Hence, the focus should be collating the data in one place with independent verification, analysis and communication of risks to the public in a transparent, reliable and proportionate manner.

Both qualitative and quantitative methods of data collections should be used. It is anticipated that the data collection will start prior to any activities beginning if the applications are approved. It will mainly focus on the geographical area affected by the two planning applications. This is currently understood to be approximately a 2 kilometres radius from the proposed location of the well pads.

The time period for long term monitoring should be at least 30 years post abandonment or until such time there is national guidance on long term monitoring. The suggested 30 year time period is based on the long term monitoring of landfill gas migration.

3.1 Data collection and analysis (an indicative list)

- Profiling of drill cuttings, fracturing fluids to identify substances hazardous to human health including NORM.
- Information on decontamination of equipments.
- Characterisation of the extent of fracture propagation and the permeability of layers above and beyond the faults
- Characterisation of combustion gases at the flare, particularly the levels of hydrocarbons, radon, methane, volatile organic compounds and any other substances deemed hazardous to human health
- Levels of fugitive emissions at well pads, on potential pathways and at receptor households.
- Ground water monitoring of methane.
- Measuring long term well integrity.
- Particulate Matter at source and confirmation of the modelling findings for receptors in the ES
- Levels of noise at source and receptors
- Information on any existing private water supplies that aren't covered by abstraction license within 2 km zone.
- Sampling of ground/food chain.
- Information on local climate within the 2 km zone to identify potential hotspots.
- Safety profile of transport routes and modelling to minimise road traffic accidents
- Safety profile of waste management sites.
- Household survey of human health and wellbeing, and sampling of environmental conditions within the 2km zone. The sampling to be based on modelling from source data.
- Survey of any other sensitive receptors in the vicinity of the two sites.
- Analysis of routinely collected data on health and health care utilisation.
- Analysis of occupational health surveillance data collected by the operator.

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