North Yorkshire County Council, City of York and North York Moors National Park Authority Minerals and Waste Joint Plan Examination

Joint Plan Authorities' Supplementary Note for the Inspector with regard to Matter 1 Hydrocarbons

1.0) Introduction and context to the hydrocarbon policies

1.1 The purpose of this Supplementary Note is to provide clarification and further justification in relation to:

(a) the distinctions between conventional and unconventional hydrocarbons and the way these are addressed through Policies M16, M17 and M18, including Policy M16 Part b) i) in particular;

(b) the definition of hydraulic fracturing as applied in the Minerals and Waste Joint Plan (MWJP);

(c) the approach to sub-surface development as addressed in Policy M16 part b) ii).

1.2 As noted in the Authorities' response to MIQ58, the overall emphasis, within the spatial policy in M16 and the criteria-based policies in M17 and M18, is to apply policy consistently to all forms of hydrocarbon development, unless there are particular considerations, relevant to the use and development of land, which justify an alternative approach.

1.3 The hydrocarbon policies in the MWJP have been informed by national policy and guidance which, in the view of the Authorities, needs to be considered in a holistic way in determining an appropriate local policy approach for the Plan area.

1.4 The Authorities have prepared the hydrocarbons policies consistently with guidance which recognises the national need to explore and develop shale gas resources, but in a "safe, sustainable...way" and whilst "maintaining the very highest safety and environmental standards" (see the Ministerial Statement 16th September 2015, LPA19). Similarly, the Framework recognises that great weight should be given to the benefits of minerals extraction, but without causing unacceptable adverse impacts on the natural and historic environment (paragraph 143). Planning Practice Guidance also advises that energy supplies should come from a variety of sources, including onshore oil and gas (ID 27-124-20140306) but also highlights the protection which applies to designated European sites (ID 27-123-20140306), as well as National Parks AONBs and World Heritage sites. In preparing the Joint Plan the Authorities have sought to

balance the potential benefits from hydrocarbons development generally with ensuring that high standards of environmental protection are maintained in accordance with national policy.

1.5 More specifically, national guidance in the PPG distinguishes conventional and unconventional hydrocarbons development by acknowledging that the latter is “an emerging form of energy supply” where exploratory drilling will be necessary to establish whether there are sufficient quantities to enable viable full-scale production (ID 27-091-20140306). It recognises that such drilling “may take considerably longer” than conventional hydrocarbons development, “especially if there is going to be hydraulic fracturing and, in the case of coalbed methane, removing water from the coal seam” (ID 27-0987-20140306). The differing forms of activity at the appraisal stage are also identified (ID 27-100-20140306).

1.6 The PPG advises that local plans should include policies for the exploration, appraisal and production phases of hydrocarbons development and this is to be seen in the context of the earlier guidance which outlines the potential differences between the various forms of hydrocarbons development. It goes on to provide further specific explanations for shale gas, coalbed methane and underground coal gasification (ID 27-128-20140306 -27-229-20141017). Specific advice is provided in relation to the determination of unconventional hydrocarbons development affecting National Parks, AONBs and World Heritage Sites (ID 27-223-20140728). The PPG therefore draws land use distinctions between conventional and unconventional hydrocarbons.

1.7 Wider government policy also proceeds on the basis that particular issues arise in relation to hydraulic fracturing (which is used mainly, but not exclusively, in the extraction of the shale gas form of unconventional hydrocarbon). This has resulted in ministerial statements on shale gas and oil development (see LPA19, NEB10-16 and 18) and the publication of “Surface Development Restrictions on hydraulic Fracturing: Government Response to the Consultation” (NEB07). NEB07 is to be read in conjunction with the Infrastructure Act 2015 section 50 and the Onshore Hydraulic Fracturing (Protected Areas) Regulations 2016. Together the legislation and the policy at Annex A of NEB07 identify restrictions to be placed on hydraulic fracturing. This confirms the rationale in drawing a distinction between differing forms of hydrocarbon development, as explained further in later sections of this note.

1.8 Planning for both conventional and unconventional hydrocarbons is particularly relevant to the Plan area. There is a well-established conventional gas industry, with an expectation that further proposals for such development will come forward during the life of the Plan. However, it is also known that the geology of the Plan area is likely to be favourable to the existence of all three

types of unconventional hydrocarbons addressed in PPG Annex A[1] (and elsewhere in PPG), with known commercial interest in exploitation of two of them (shale gas and coal bed methane), as well as substantial new areas of land covered by PEDLs. This serves to emphasise the relevance of this issue to the Plan area and, consequently, the need for a comprehensive policy approach should further proposals for development of unconventional forms of hydrocarbon come forward.

1.9 It is recognised, however, that unconventional hydrocarbons development, in particular that which involves hydraulic fracturing, is an emerging form of supply. There is as yet no practical experience in the Plan area of shale gas development or underground coal gasification or, on any significant scale, coal bed methane (in respect of which only limited exploratory drilling has so far been carried out). In this circumstance, the Authorities consider that it is justified in adopting a precautionary approach to the preparation of policy by setting out the highest standard of protection to the most sensitive designated areas in the Plan area. This approach is consistent with national policy which seeks to protect against unacceptable environmental impacts.

1.10 The Authorities' position is explained further below. Appendix 1 provides an annotated extract of Policy M16, with summary comments setting out the basis for the policy distinctions made. Appendix 2 contains extracts from PPG relating to planning for hydrocarbons, including PPG Annex A, together with a comment by the Authorities on the relevance of these to the hydrocarbon policies in the MWJP. Appendix 3 provides a more detailed comparison of the different land-use planning issues that may be expected to arise in association with the appraisal and production stages for conventional onshore gas (without use of hydraulic fracturing) and for the shale gas form of unconventional hydrocarbon development, where hydraulic fracturing is involved. Appendix 3 focusses on a comparison between conventional gas development and shale gas as there is more information available for the latter to indicate the nature of the development that maybe expected, in comparison with other forms of unconventional hydrocarbons potentially present in the area.

2.0) Justification for the distinction between conventional and unconventional hydrocarbons in the MWJP policies

a) Policy M16: Key spatial principles for hydrocarbon development

2.1 The overall spatial policy for hydrocarbon development is addressed in **Policy M16**.

[1] Although not addressed specifically in PPG Annex A, the Plan area also contains resources of coal mine methane, a further source of unconventional gas which is currently being exploited in the Selby area and which is addressed specifically in MWJP Policy M16 c).

2.2 In general terms, Policy M16 sets out a more restrictive spatial approach for unconventional gas development (other than for exploration for unconventional gas where hydraulic fracturing is not involved) by establishing particular restrictions against such development in certain highly protected categories of sites or areas. The justification for this distinction is referred to in the text of the MWJP at paragraph 5.120, and in the additional text inserted into paragraph 5.119 g) via proposed change PC62 of the Addendum of Proposed Changes July 2017 (CD09). Further explanation of the basis for the distinction is explained below.

2.3 A distinction is drawn as there can be significant differences in the scale and/or nature of development activities associated with unconventional hydrocarbon resources, as compared with conventional resources. In some instances such differences are likely to give rise to planning considerations that are appropriately addressed in the Plan. This approach is consistent with the fact that PPG, in the section entitled *Planning for Hydrocarbons*, also identifies a number of distinctions, and contains a specific Annexe (Annex A) dealing with *Shale gas, coal bed methane and underground coal gasification*. This indicates that Government recognises particular matters, arising in association with these forms of hydrocarbon, to which planning authorities should have regard when planning for them.

2.4 Further support for making a distinction in planning policy between conventional and unconventional hydrocarbons is found in a 2017 House of Commons Briefing Paper on shale gas and fracking[2], which contains an extract from a 2012 World Energy Outlook Special Report on unconventional gas[3]. This states:

"Producing unconventional gas is an intensive industrial process, generally imposing a larger environmental footprint than conventional gas development. More wells are often needed and techniques such as hydraulic fracturing are usually required to boost the flow of gas from the well. The scale of development can have major implications for local communities, land use and water resources. Serious hazards, including the potential for air pollution and for contamination of surface and groundwater, must be successfully addressed. Greenhouse-gas emissions must be minimised both at the point of production and throughout the entire natural gas supply chain. Improperly addressed, these concerns threaten to curb, if not halt, the development of unconventional resources."

2.5 Examples of factors that may be particularly relevant to the development of unconventional hydrocarbons, compared with conventional resources, in terms of the material planning considerations or the scale or nature of impacts that may arise, include:

[2] House of Commons Library briefing paper Number 6073, 13 April 2017 (LPA71)
[3] IEA, Golden rules for a golden age of gas WEO special report, 29 May 2012

- the likelihood of the need to drill a greater number of wells, from a greater number of well pads, in order to achieve efficient commercial exploitation of the resource. This is because, in general terms, a higher density of wells is required in order to extract significant quantities of unconventional sources of hydrocarbons, as a result of the different (typically less permeable) geological settings in which they occur, as compared with conventional resources. There is, as yet, no established UK experience or development model to draw on in order to gain a full understanding about the number of well pads and wells that could be sought by industry, should commercially viable resources of shale gas or other unconventional hydrocarbons be found. In any event, local geological and other constraints would be likely to impact on this. However, industry representatives have acknowledged that, for shale gas, multiple well pads, each with multiple wells, potentially several dozen per pad, would be likely to be involved;
- the potential for more intensive development activity to take place, over longer periods of time, compared with development relating to conventional resources;
- the potential need for additional items of plant and equipment (eg pumps, coil tubing towers, storage silos, water treatment equipment) to serve the additional processes required, including for hydraulic fracturing for shale gas and in some instances coalbed methane, and to produce oxygen and steam for use in the underground gasification of coal;
- the potential for high noise levels during periods of hydraulic fracturing activity in particular, as a result of the need to generate high hydraulic pressures;
- the likelihood of increased traffic movements as a result of the need to bring in additional plant and equipment, materials or water and remove waste materials, including waste water, potentially in large volumes.

2.6 There is also the potential for greater cumulative impact to arise as a result of some or all of the above matters. For example multiple well pads, each with multiple individual wells, under development within a single PEDL, or across a number of PEDL areas, would lead to a situation where a range of development activities were taking place simultaneously but with potential interactions and overlaps in terms of matters such as traffic movements, visual and wider landscape impact or noise, as well as implications for the total duration over which an area may be subject to more intensive development impacts.

2.7 These factors are all likely to give rise to considerations relevant to land use planning, including the potential for increased magnitude and/or duration of individual impacts as well as greater potential for in-combination impacts, compared with those typically associated with development of conventional gas resources as previously undertaken in the Plan area.

2.8 In general terms, these material considerations are likely to be of greatest

significance at the appraisal and production stages of development, as a result of the more extended timescales typically involved and the need for repetition of development activities at established or new sites to ensure on-going production of the resource. In some instances there may also be the need for additional plant and equipment not used at exploration stage (eg PPG Annex A in the context of Underground Coal Gasification).

2.9 Whilst hydraulic fracturing, as a specific activity with the acknowledged potential to give rise to increased environmental impacts (eg PPG paragraph 119), is mainly associated with development of the shale gas form of unconventional hydrocarbons, it may also be used during the production of conventional gas, as well as at the exploration stage for shale gas (see eg PPG paragraph 098). It is therefore considered appropriate to apply the same policy approach to these forms of development as to the appraisal and production of unconventional hydrocarbons.

2.10 These circumstances are reflected in the Plan by establishing a more restrictive spatial policy for development involving the appraisal and production of unconventional hydrocarbons, as well as to all development involving hydraulic fracturing, to help ensure that the most sensitive parts of the Plan area are protected from these potentially more intrusive forms of hydrocarbon development.

2.11 The Authorities emphasise that designations which are subject to the more restrictive spatial approach in Policy M16 part b) i), applying to appraisal and production of unconventional hydrocarbons and to other forms of hydrocarbon development involving hydraulic fracturing, are very sensitive environmental receptors which are recognised in national planning policy as requiring a very high level of protection from harmful impacts. The justification for affording similar protection to Areas which Protect the Historic Character and Setting of York is addressed in the separate Joint Authorities' Note 'York's Historic Character and Setting.'

2.12 In setting out a restrictive policy for highly sensitive designations, it is considered that the Plan is consistent with Government planning policy, specifically relating to shale gas, requiring that exploration and testing of shale gas potential must be done whilst maintaining the very highest safety and environmental standards (Written Ministerial Statement on Shale Gas and Oil Policy, September 2015) (LPA19). This latter policy statement is expressly required to be taken into account in both planning decisions and plan-making. The Authorities consider that it is appropriate, in a plan-led planning system (NPPF paragraph 17, 1st bullet), to support this national policy requirement through establishment of a correspondingly robust local policy framework.

2.13 Similarly, the Authorities consider that the highly protected areas, subject of spatial restrictions through Policy M16 b), are also of key importance in terms of the contribution they make to the character of the Plan area, the quality of life

for residents and visitors and to the visitor economy of the area. Effective protection of these areas is therefore justified in order to help achieve an appropriate balance across all three main elements of sustainability, ie economic, social and environmental and, consequently, to help achieve the Government's objective of ensuring that exploration and development takes place in a "safe and sustainable … way" (LPA19).

2.14 It should be noted that Policy M16 b) does not apply to development relating to coal mine methane, a further unconventional form of gas. This is covered separately in Policy M16 c). This approach reflects the particular locational circumstances applying to this form of gas which, by definition, can only occur in association with active or abandoned coal mines. PPG does not make specific reference to coal mine methane, although NPPG (paragraph 147, 4th bullet) states that mineral planning authorities should encourage capture and use of methane from coal mines in active and abandoned coalfield areas.

2.15 Coal mine methane is already exploited in the Plan area, within the former Selby Coalfield and at Kellingley Colliery. This is in the form of relatively small containerised generator engines, burning gas vented from the mine workings in order to produce electricity. At the present time there are three known locations where this is taking place. These are at the former Kellingely Colliery surface site, and at the former Gascoigne Wood Mine and Stillingfleet Mine surface sites (both within the Selby Coalfield area). It is not expected that further proposals will come forward for extraction of coal mine methane, and it is likely that the flow of mine gas will reduce over time as the mine workings flood. However, in line with NPPF policy, MWJP Policy M16 c) seeks to direct any such proposals towards more sustainable locations as encouraged by other elements of national policy, although Policy M16 c) does not specifically preclude alternative locations. The Authorities acknowledge that it would be useful to clarify this matter in the supporting text to Policy M16, by inserting a new paragraph, to follow existing paragraph 5.130:

Coal mine methane from former mine workings at Kellingley Colliery and within the Selby Coalfield is currently extracted in the Plan area and used to generate electricity. National planning policy encourages capture and use of this resource and it is appropriate to provide corresponding support in the Plan, through Policy M16 part c). It is likely that such development, which is small in scale, can be accommodated within surface sites associated with the former mine workings, or on industrial estates or employment land, and these are likely to remain the most appropriate locations for this form of development. However, where it is not practicable to access the resource from such a location, then proposals in other locations will be considered in relation to the development management policies in Chapter 9 of the Plan.

b) Flexibility for conventional hydrocarbons

2.16 The text of the Plan acknowledges specifically (in paragraph 5.99) that exploration, appraisal and production of conventional hydrocarbons in the Plan area, including the National Park, have so far been carried out without giving rise to unacceptable impact on the environment, and that such activity remains an established part of the local economy. However, it also acknowledged in the Plan (paragraph 5.124) that development of conventional hydrocarbons can, in some cases, involve use of hydraulic fracturing techniques. This is in order to stimulate flow of gas to the well bore. This gives rise to the potential for impacts of a similar character to those that may be associated with use of hydraulic fracturing techniques in the development of shale gas (for example in terms of increased levels of noise, traffic and requirements for plant and equipment).

2.17 The Authorities therefore do not consider it appropriate, when considering this matter from a land use planning perspective, to differentiate the policy approach that should be applied to development of conventional resources where hydraulic fracturing would be involved, from that applied where hydraulic fracturing is to be used for development of unconventional resources, as the range of planning issues to be considered is likely to be generally the same.

2.18 However, the Authorities do recognise that development of conventional gas resources in the Plan area is a well-established activity and that, based on their experience to date of the relatively limited scale and intensity of development associated with this form of development in the area, it would be appropriate in such circumstances to apply this more restrictive policy with a degree of flexibility. Additional text inserted into paragraph 5.124 via proposed change PC66 of the Addendum of Proposed Changes July 2017 (CD09) therefore sought to provide additional clarification of how Policy M16 b) will be applied in such circumstances. This text states:

Similarly, it is considered that where hydraulic fracturing is proposed for the purposes of supporting the production of conventional gas resources, there is potential for this to give rise to a generally similar range of issues and potential impacts, although it is acknowledged that fracturing for stimulation of conventional gas production would be likely to involve generally lower volumes and/or pressures. In these circumstances it is therefore appropriate that such development is subject to the same policy approach. However, it is not the intention of the Mineral Planning Authorities to unreasonably restrict activity typically associated with production of conventional resources, which is a well-established industry in the Plan area and they will therefore apply the policy accordingly and reasonably based on the specific circumstances of the proposal under consideration.

2.19 It is acknowledged that it would, however, be beneficial to provide further clarity on the approach to be taken when applying the Policy to conventional hydrocarbons involving hydraulic fracturing. A main modification is therefore

suggested to the above text:

Similarly, it is considered that where hydraulic fracturing is proposed for the purposes of supporting the production of conventional gas resources, there is potential for this to give rise to a generally similar range of issues and potential impacts, although it is acknowledged that fracturing for stimulation of conventional gas production would be likely to involve generally lower volumes and/or pressures. In these circumstances, whilst it is ~~therefore~~ appropriate that such development is subject to the same policy approach~~.~~, ~~However,~~ it is not the intention of the Mineral Planning Authorities to unreasonably restrict activity typically associated with production of conventional resources, which is a well-established industry in the Plan area. Where hydraulic fracturing is proposed in association with development of conventional hydrocarbons, the Authorities will consider exceptions to the more restrictive approach set out in Policy M16 Part b) where it is satisfied that, based on the circumstances of the specific proposal, it would not result in unacceptable impact on the protected area and full compliance with other relevant elements of the Plan can be demonstrated. ~~and they will therefore apply the policy accordingly and reasonably based on the specific circumstances of the proposal under consideration.~~

c) Criteria based policies for hydrocarbon development (Policies M17 and M18)

2.20 Additional policy criteria applying to hydrocarbon development are set out in **Policies M17 and M18**. The large majority of the criteria within these two policies apply equally to all forms of hydrocarbon development. Specific reference is made to unconventional hydrocarbons (or to hydraulic fracturing as an activity particularly associated with the 'unconventional' shale gas form of hydrocarbons) in only a very limited number of instances and where it is considered that there is particular justification. These are:

i) M17 1) iii) within the part of the Policy dealing with accessibility and transport and relating specifically to availability of water supply for development involving hydraulic fracturing. This reflects the potential for the hydraulic fracturing process to require substantial volumes of water. As an example, a requirement to import 10,000m^3 of water by road (the minimum volume required to meet the Petroleum Act total fracture fluid volume threshold to meet the definition of Associated hydraulic fracturing) would equate to over 300 large articulated road tanker loads, with corresponding potential for impacts on traffic, local amenity and air quality, relative to a situation where water in bulk quantity is supplied without the need for road transport.

ii) M17 2) ii) within the part of the Policy dealing with cumulative impact, which requires that proposals for production of unconventional hydrocarbons should include information on how the development would fit within an overall scheme

of production development within the relevant PEDL area and ensure, so far as practicable, that production sites are located in the least environmentally sensitive areas of the resource. This reflects the potential for proposals for development of unconventional resources to involve a greater number of well pads and individual wells, as well as additional items of plant and equipment, compared with development of conventional resources, with correspondingly greater potential for off-site impacts such as traffic, as well as cumulative impacts.

iii) M17 4) iii) within the part of the Policy dealing with local amenity, which requires that proposals involving hydraulic fracturing be accompanied by an air quality monitoring plan and Health Impact Assessment. This reflects the potential for the hydraulic fracturing process to give rise to a range of impacts including emissions to air and that there is a very substantial degree of public interest and concern in relation to the potential for shale gas development on a substantial scale to give rise to impact on health. The Authorities note that the 2014 review by Public Health England on the potential health impacts of the shale gas extraction process (LPA76) states, in an Executive Summary: "*The risks from small-scale drilling for exploratory purposes (eg single wells) are clearly different from the risks from commercial-scale operations. The potential health impact from single wells is likely to be very small, but the cumulative impacts of many wells in various phases of development in relatively small areas are potentially greater and will need careful scrutiny, during the planning process*."[4]

iv) M18 2) iii) within the part of the Policy dealing with a requirement, in certain circumstances, for provision of a financial guarantee to provide for restoration of the land. This reflects the fact that development involving hydraulic fracturing and some other forms of unconventional hydrocarbons, including development relating to Underground Coal Gasification, would represent new and unfamiliar processes in the Plan area specifically and in the UK generally, with no established track record of progression from the operational stage through to final restoration. This is in contrast to development for conventional gas resources, for which there is a well-established history in the Plan area.

2.21 The Authorities therefore consider that there is substantial evidence to justify distinguishing, in some elements of Policies M16, M17 and M18, between the specific criteria applying to development of conventional hydrocarbons (and to exploration for unconventional hydrocarbons where hydraulic fracturing is not involved), and those which apply to the appraisal and production of unconventional hydrocarbons generally (as well as all forms of hydrocarbon development involving hydraulic fracturing). The justification reflects relevant guidance and the potential for differing land use considerations and additional adverse impacts where the latter forms of development are involved. This

[4] Review of the Potential Public Health Impacts of Exposures to Chemical and Radioactive Pollutants as a Result of the Shale Gas Extraction Process, Public Health England, June 2014

results in a corresponding need for a tailored planning policy response. Identification of appropriate distinctions, with specific additional criteria, in the policies is therefore considered to be important in ensuring an effective approach to planning for these essentially new forms of development.

3.0) Definition of hydraulic fracturing used in the MWJP

3.1 A further consideration is the relationship between the restrictions in the spatial approach in Policy M16 part b) and the definition of 'associated hydraulic fracturing' applied by the Government for the purposes of the restrictions contained in the Hydraulic Fracturing (Protected Areas) Regulations 2016 (NEB06). Representations on behalf of the industry have suggested that this definition should be used for the purposes of the Plan and that the Plan should not draw distinctions which go beyond the use of this definition.

3.2 Associated hydraulic fracturing, as applied through the 2016 Regulations, is defined in Section 4B(1) of the Petroleum Act as the:

"hydraulic fracturing of shale or strata encased in shale which:

(a) is carried out in connection with the use of the relevant well to search or bore for or get petroleum, and

(b) involves, or is expected to involve, the injection of:

i) more than 1,000 cubic metres of fluid at each stage, or expected stage of the hydraulic fracturing, or

ii) more than 10,000 cubic metres of fluid in total"

3.3 The Authorities note that this definition does not make reference to any threshold criterion relating to hydraulic pressure. The Authorities have also taken into account the policy statement set out at Annex A to the Government response to consultation on Surface Development Restrictions for Hydraulic Fracturing (NEB07, see above), which was not referred to in the representations made by UKOOG et al. Under the heading "Operations which are not associated hydraulic fracturing", the statement says (at paragraph 2.4) that:

> *"Where a licensee is required (by their licence or a consent issued under it) to obtain the Secretary of State's consent before carrying out hydraulic fracturing which is not associated hydraulic fracturing, the Secretary of State will apply this policy as if that consent was a HFC".*

This suggests that protection of the areas identified in the Government's policy statement can still be appropriate in circumstances where associated hydraulic fracturing is not involved. The statement goes on to set out policy on surface development restrictions for hydraulic fracturing which build on the approach

taken in the 2016 Regulations by adding, as a matter of policy, to the protected areas covered by those Regulations. The Authorities consider that this justifies a broader approach to policy than applying restrictions to associated hydraulic fracturing only.

3.4 In any event, the Authorities do not consider that there is sufficient information available, at this very early stage of commercial interest in the exploration and development of unconventional gas resources in the Plan area, to allow an adequate understanding of how the volume thresholds contained in the definition of associated hydraulic fracturing would avoid the risk of significant adverse impacts from hydraulic fracturing in the Plan area through the licensing regime, including the potential for such impacts at volumes below that used to define associated hydraulic fracturing.

3.5 The only practical example to draw on so far in the Plan area, in a case relating to shale gas, is that of the development permitted by North Yorkshire County Council in 2016 for fracturing of a well at Kirby Misperton (KM8 well). The Hydraulic Fracture Plan[5] for that development, produced by Third Energy in May 2017, provides information on the volumes of fracture fluid to be used for each of the five proposed fracture zones. These are:

Zone A: 466.22 cubic metres

Zone B: 485.29 cubic metres

Zone C: 522.41 cubic metres

Zone D: 755.69 cubic metres

Zone E: 1,321.44 cubic metres

Total: 3,571.05 cubic metres

3.6 In this particular case, therefore, the development does meet the Government's definition of associated hydraulic fracturing. However, all but one of the individual fractures stages proposed are significantly below the 1,000 cubic metre threshold for individual fracture stages, and the total volume involved across all five stages is well under the 10,000 cubic metre total threshold. It is therefore clear from this example that there is a realistic potential for proposals to come forward, in the Plan area, involving hydraulic fracturing and giving rise to substantial land use planning issues, and community interest and concern, which do not meet the definition of associated hydraulic fracturing applied for the purposes of the 2016 Regulations.

3.7 It should be noted that the Authorities do not consider that the overall range or magnitude of planning issues and impacts requiring consideration, in the

[5] See Table 3-1 of Hydraulic Fracture Plan for Well KM8 Kirby Misperton Alpha Site, Third Energy (May 2017) https://www.third-energy.com/sites/default/files/Hydraulic%20Fracture%20Plan.pdf (LPA72)

example of the development referred to above, would be likely to have been materially less if the volume of fracture fluid to be used for Zone E fell just below the 1,000 cubic metre threshold and therefore the development as a whole did not meet the definition of associated hydraulic fracturing.

3.8 Equally, the Authorities consider that there could have been potential for a greater degree of overall impact to arise, through use of a larger number of individual fracture stages, each below the individual threshold and with a total volume remaining just under the 10,000 cubic metre threshold.

3.9 For these reasons, and taking into account also the wider definition of hydraulic fracturing set out in PPG, the Authorities do not consider that the hydrocarbon policies in the MWJP, including the spatial approach in Policy M16, should be based around only the definition of associated hydraulic fracturing.

3.10 The Authorities also note in this respect that PPG adopts its own definition of hydraulic fracturing. The section of PPG titled 'Planning for Hydrocarbon Extraction' contains an Annex (Annex A): *Shale Gas, coalbed methane and underground coal gasification*. Paragraph 129 of the Annex states:

What is hydraulic fracturing?

Hydraulic fracturing is the process of opening and/or extending existing narrow fractures or creating new ones (fractures are typically hairline in width) in gas or oil-bearing rock, which allows gas or oil to flow into wellbores to be captured.

3.11 This definition does not make reference to any threshold criteria relating to volumes or pressures of fracture fluid, or limit the definition specifically to shale gas, or to the type of strata in which the hydraulic fracturing would take place.

3.12 The Authorities consider that the PPG provides further support for the inclusion of policy in the Plan to cover hydraulic fracturing and not simply associated hydraulic fracturing. Restricting policy to associated hydraulic fracturing would leave an unjustified gap in policy having regard to national policy and the potential for significant land use issues to arise as a result of fracking which is not associated hydraulic fracturing.

3.13 It should be noted that MWJP paragraph 5.119 f) provides a clarification of the term 'hydraulic fracturing' for the purposes of the Plan. This states:

For the purposes of the Plan 'hydraulic fracturing' includes the fracturing of rock under hydraulic pressure regardless of the volume of fracture fluid used.

3.14 The Authorities consider that this term is generally consistent with the PPG definition of hydraulic fracturing. However, to ensure greater clarity on this point, the Authorities intend to propose a main modification to replace this term with the definition used in PPG:

5.119 f) ~~*For the purposes of the Plan 'hydraulic fracturing' includes the fracturing of rock under hydraulic pressure regardless of the volume of fracture fluid used.*~~ *Hydraulic fracturing is the process of opening and/or extending existing narrow fractures or creating new ones (fractures are typically hairline in width) in gas or oil-bearing rock, which allows gas or oil to flow into wellbores to be captured.*

4.0) Justification for Policy M16 b) ii)

4.1 As noted in the text of the MWJP at paragraph 5.120, in December 2015 a substantial number of new PEDLs were announced, covering significant areas within and immediately adjacent to the North York Moors National Park and Howardian Hills AONB and which overlap with a wide range of other sensitive environmental designations.

4.2 Mining operations and drilling at any depth would constitute 'development' as defined in the Town and Country Planning Act 1990[6] ('development' means the carrying out of building, engineering, mining or other operations in, on, over or under land, or the making of any material change in the use of any buildings or other land).

4.3 Development consisting of surface wells outside a National Park or AONB, with lateral drilling and hydraulic fracturing beneath the protected area, is not prohibited by the Onshore Hydraulic Fracturing (Protected Areas) Regulations 2016 where it would take place at a depth greater than 1,200m below ground level. Hydraulic fracturing beneath such areas, from a surface location outside the protected area, is not prohibited at all by the 2016 Regulations where the volume thresholds for fracture fluid used to define 'associated hydraulic fracturing' are not met.

4.4 The circumstances in the Plan area, particularly the overlap between PEDL areas and National Parks and AONBs, means that there is a high likelihood of proposals coming forward, during the life of the Plan, for lateral drilling under the National Park or AONB, from a surface location in close proximity to the designated area.

4.5 Where lateral drilling is proposed under the National Park, from a location outside the Park boundary, this would constitute a county matters straddling planning application (Town and Country Planning Act 1990, Schedule 1, paragraph 1(1) (i)). Such an application is treated as a single project, with applications submitted to both Minerals Planning Authorities for determination.

4.6 Such a development, as well as development involving lateral drilling under an AONB, particularly where hydraulic fracturing is involved, is likely to fall under the EIA regulations, even at exploration stage (PPG (Paragraph: 119 Reference

[6] Section 55 (1)

ID: 27-119-20140306) and may also be regarded as major development in combination with the wider surface impacts and development activity associated with it, depending on the circumstances of the case. The Authorities acknowledge that it would be appropriate to incorporate more flexibility, within the wording of Policy M16 b) ii) in relation to the need for application of the Major Development Test in any particular case and will put forward a further main modification to reflect this:

Policy M16 b) ii) *Sub-surface proposals for these forms of hydrocarbon development, including lateral drilling, underneath the designations referred to in i) above, will only be permitted where it can be demonstrated that significant harm to the designated asset will not occur. Where lateral drilling beneath a National Park or AONBs is proposed ~~for the purposes of appraisal or production~~ and is ~~this will be~~ considered to comprise major development it ~~and~~ will be subject to the requirements of Policy D04.*

4.7 When considering the potential impact of a development on the special qualities of a National Park or AONB, reference to their special qualities can be found in the relevant management plan for the area. Whilst the specific qualities relevant to each protected landscape may differ from one another, they will include qualities such as landscape and views, tranquillity, biodiversity and geodiversity and rare species and heritage, and it is the combination of these qualities that led to these areas being designated and protected as National Parks and AONBs. As such, development which would result in significant harm to the special qualities of a National Park or AONB will generally be resisted. This is reflected in the very strong national policy protection afforded to such areas. In this respect, the NPPF indicates that great weight should be given to conserving landscape and scenic beauty in National Parks and AONBs, which have the highest status of protection in relation to landscape and scenic beauty.

4.8 Examples of potential impacts on the National Park or AONB environment which could arise in association with lateral drilling from a location outside, but in close proximity to, the designated area, include both surface and sub-surface impacts;

- impacts on the water environment and consequent wider ecological impacts in such sensitive areas. Any impact on water quality through contamination of ground or surface water, such as from leakage of fracture fluid, could impact on hydrology or hydrogeology. This could be significant, for example, in terms of consequential impact on heath and moor habitats which are designated at international level as Special Protection Areas and Special Areas of Conservation across significant areas of the National Park, for both their vegetation and specific bird species they support;
- impacts on air quality as a result of emissions, which similarly could impact on sensitive ecological receptors within the protected area;

- offsite impacts from traffic movements which could need to utilise elements of the road network within the National Park or AONB;
- potential impacts from noise, vibration, lighting in relation to identified special qualities of the National Park or AONB including qualities such as tranquillity, dark night skies and a strong feeling of remoteness;

4.9 Other categories of sites or areas identified through Policy M16 b) ii) as warranting a high standard of protection in relation to sub-surface development are also, in some cases, potentially sensitive to impacts on ground and surface waters, particularly Protected Groundwater Source Areas (typically these are sources of water supplies for domestic consumption) and nature conservation designations (SPAs/SACs, SSSIs, Ramsar sites – many such designations in the Plan area are based on the interdependency between the nature conservation interest and associated ground and/or surface waters). Elements of the internationally and nationally important historic environment designations identified through the Policy could also, in some instances, be particularly sensitive to any ground movements as a result of seismic events induced through sub-surface development.

4.10 It is emphasised that Policy M16 b) ii) does not seek to prevent sub-surface development beneath these highly protected areas but requires it to be demonstrated that significant harm to the protected area does not occur. Development activity relating to unconventional hydrocarbons, other than coal mine methane, in the Plan area (and in the UK generally) is at a very early stage with no commercial scale development underway. It is important to ensure that the Plan promotes very high environmental standards, in line with Government policy, particularly where there is significant uncertainty about the exact scale, nature and location of development proposals which could come forward and the actual range of impacts and issues which could arise. In this respect the Authorities are not satisfied that there is evidence to preclude the potential for adverse impacts to occur.

4.10 In these circumstances the Authorities consider that the policy dealing with sub-surface development is sound, as is the policy relating to hydrocarbons development generally. It is consistent with national policy by seeking to balance the recognised benefits of hydrocarbons development with the need to maintain high standards of environmental protection for designated areas. This policy approach is of general application to designated areas and is not limited only to the protected areas identified specifically under the 2016 Regulations. The Authorities consider that the approach which UKOOG et al now appear to be suggesting would be unsound by not providing any adequate policy basis for determining proposals for sub-surface development; and note that in its hearing statement the industry itself advanced a policy for sub-surface development underneath or in close proximity to identified designated areas which required the avoidance of harm to those areas.

APPENDIX 1

Annotated extract of MWJP hydrocarbons definitions (paragraph 5.119) and Policy M16, with explanatory comments

NB The following MWJP text extract is the published plan text but incorporating changes introduced through the Addendum of Proposed Changes, July 2017.

Definitions

5.119 To ensure that the local policy approach to hydrocarbon development is as clear as it can be, it is helpful to define some key words and concepts that will be used by the Mineral Planning Authorities when implementing the Joint Plan:

a) 'Hydrocarbon development' includes all development activity associated with exploring, appraising and/or producing hydrocarbons (oil and gas), including both surface and underground development.

b) 'Surface hydrocarbon development' and 'surface proposals' includes use and/or development of the land surface for the purposes of the exploring, appraising and/or producing hydrocarbons.

c) 'Sub-surface hydrocarbon development' and 'sub-surface proposals' includes development taking place below the ground surface for the purposes of exploring, appraising and/or producing hydrocarbons.

Comment [RS1]: This distinction is based on the fact that the definition of development (Town and Country Planning Act 1990 (S.55 (1)) includes the carrying out of mining operations in, on, over or under land. The distinction, as subsequently applied through the Policy, also reflects the fact that, although certain issues may be common to both surface and sub-surface development, some planning considerations may be associated particularly with one or other form.

It also reflects distinctions drawn in legislation and policy relating to surface restrictions for hydraulic fracturing, as explained in the Supplementary Note.

d) 'Conventional hydrocarbons' include oil and gas found within geological 'reservoirs' with relatively high porosity/permeability.

e) 'Unconventional hydrocarbons' include hydrocarbons such as coal bed and coal mine methane and shale gas, as well as the exploitation of in situ coal seams through underground coal gasification.

Comment [RS2]: This distinction partly reflects Planning Practice Guidance which acknowledges the different geological settings within which conventional and unconventional hydrocarbons occur.

The distinction, as subsequently applied through the Policy, also reflects the fact that certain planning considerations may be associated particularly with development of conventional or unconventional resources: see the Introduction to and Section 2 of the Supplementary Note for further explanation.

f) For the purposes of the Plan 'hydraulic fracturing' includes the fracturing of rock under hydraulic pressure regardless of the volume of fracture fluid used.

Comment [RS3]: See Section 3 of Supplementary Note for further discussion of this definition.

g) In planning terms it is considered that relevant distinctions can be drawn between the specific nature and/or scale of activities associated with certain stages of development for conventional hydrocarbons and those used for unconventional hydrocarbons. These differences may include the potential for a larger number of well pads and individual wells, the volume and pressures of any fluids used for hydraulic fracturing processes and the specific requirements for any related plant and equipment and the management of related wastes.

Comment [RS4]: This distinction, as subsequently applied through the Policy, reflects Planning Practice Guidance and other evidence, which acknowledge particular matters, relevant to planning, associated with development of unconventional hydrocarbons. See Introduction and Section 2 of accompanying Supplementary Note for further explanation.

Policy M16: Key spatial principles for hydrocarbon development

Hydrocarbon development of the types identified below should be located in accordance with the following principles:

a)

Comment [RS5]: Part a) of Policy M16 provides greater locational flexibility for forms of hydrocarbon development which are expected to give rise to a lesser degree of environmental impact.

- **exploration, appraisal and production of conventional hydrocarbons, without hydraulic fracturing;**

Comment [RS6]: These forms of development are well-established in the Plan area and have been demonstrated to be capable of implementation without unacceptable impact, including where development has taken place within the National Park. A more flexible spatial policy is therefore justified, although relevant criteria in Policies M17 and M18, as well as M16 d), continue to apply as relevant.

- **exploration for unconventional hydrocarbons, without hydraulic fracturing:**

Comment [RS7]: Exploration for unconventional hydrocarbons, where hydraulic fracturing is not involved, will involve similar activity to that associated with exploration for conventional gas (see above). A more flexible spatial policy is therefore justified, although relevant criteria in Policies M17 and M18, as well as M16 d), continue to apply as relevant.

Proposals for these forms of hydrocarbon development will be permitted in locations where they would be in accordance with Policies M17 and M18 and, where relevant, part d) of this Policy.

b)

- **Exploration, appraisal and production of conventional hydrocarbons, involving hydraulic fracturing;**

- **Exploration for unconventional hydrocarbons, involving hydraulic fracturing;**

Comment [RS8]: Part b) of Policy M16 sets out a more restrictive spatial approach for forms of hydrocarbon development which are expected to give rise to a higher degree of environmental impact, compared with those forms addressed in Part a).

Comment [RS9]: The characteristics of development involving hydraulic fracturing, including the expectation of increased use of plant and equipment, greater traffic movements and potential for increased noise and other impacts, including cumulative impacts, indicates that the most sensitive locations in the Plan area warrant specific protection.
Such issues and impacts could arise where fracking is to be used to stimulate flow of gas from conventional wells and such activity has therefore been included within the more restrictive spatial approach imposed by this part of the Policy: see section 2 of accompanying Supplementary Note for further explanation.

Comment [RS10]: PPG acknowledges that hydraulic fracturing may be associated with the exploration for shale gas. Where this is the case a higher degree of environmental impact may be expected. This activity is therefore subject to the more restrictive spatial policy.

- **Appraisal and/or production of unconventional hydrocarbons (other than coal mine methane):**

Comment [RS11]: A range of forms of unconventional hydrocarbon resources are potentially present in the Plan area, including coal bed methane, and the underground gasification of coal. PPG and other evidence sources identify particular characteristics associated with such development, compared with development of conventional gas, for example the need for additional processes for dewatering and/or underground combustion and corresponding requirements for additional surface plant and equipment. Typically, development of these forms of unconventional gas can involve a need for multiple wells/well pads. These particular characteristics associated with this type of development give rise to corresponding potential for additional environmental impacts (see para. 2.4 to 2.8 of Supplementary Note), particularly where development is proposed in more environmentally sensitive locations. A more restrictive spatial approach is therefore justified.

Whilst exploration for unconventional resources, where hydraulic fracturing is not involved, may typically be a relatively short-term and relatively low impact activity, there is substantially greater potential for significant impacts at the appraisal and/or production stages, as a result of the additional timescales involved and the requirements for additional plant and equipment and associated site activity at these stages of development. This is reflected by including these latter forms of development within the spatial restriction set out in M16 Part b).

Although coal mine methane is also a form of unconventional gas, different spatial and planning considerations apply and such development, which is already taking place in the Plan area is not expected to give rise to the same character or magnitude of impact as for other forms of unconventional gas. Separate policy for the production of coalbed methane is therefore set out in M16 c).

i) Surface proposals for these forms of hydrocarbon development will only be permitted where they would be outside the following designated areas: National Park, AONBs, Protected Groundwater Source Areas, the Fountains Abbey/Studley Royal World Heritage Site and accompanying buffer zone, Scheduled Monuments, Registered Historic Battlefields, Grade I and II* Registered Parks and Gardens, Areas which Protect the Historic Character and Setting of York, Special Protection Areas, Special Areas of Conservation, Ramsar sites and Sites of Special Scientific Interest.

Comment [RS12]: This part of the Policy identifies those highly sensitive areas/designations where the more restrictive spatial approach for the forms of development set out in M16 b (1st, 2nd, 3rd bullets) apply. Impacts on such areas/designations are likely to be most significant where surface development is involved. This restriction takes into account national restrictions through the Protected Areas Regulations and associated government guidance, as set out in the Supplementary Note, and applied to the local circumstances of the Joint Plan area.

ii) Sub-surface proposals for these forms of hydrocarbon development, including lateral drilling, underneath the designations referred to in i) above, will only be permitted where it can be demonstrated that significant harm to the designated asset will not occur. Where lateral drilling beneath a National Park or AONBs is proposed for the purposes of appraisal or production, this will be considered to comprise major development and will be subject to the requirements of Policy D04.

Comment [RS13]: This recognises that it may be appropriate for sub-surface development (eg by lateral drilling) for the forms of hydrocarbon development referred to in M16 b) 1st, 2nd and 3rd bullet points to take place beneath these areas, where it can be demonstrated that significant harm will not occur. This is considered to represent an appropriate balance, proportionate to the nature of the impacts that could arise.

Comment [RS14]: Lateral drilling under the National Park would involve a straddling application, submitted to both the National Park and relevant mineral planning authority outside the Park. Such development, and also development involving lateral drilling under an AONB, is likely, particularly at appraisal or production stage, to constitute 'major development', requiring application of the relevant national and local policy tests. See Section 4 of Supplementary Note for further explanation.

iii) Surface and sub-surface proposals for these forms of hydrocarbon development will also be required to be in accordance with Policies M17 and M18. Surface proposals will also, where relevant, need to comply with Part d) of this Policy.

c) Coal mine methane:

Proposals for production of coal mine methane resources will be supported where any surface development would be located on industrial or employment land or within the developed surface area of existing or former coal mining sites.

Comment [RS15]: This reflects the specific circumstances associated with this form of unconventional gas, which is limited to areas of former coal mine workings, located in less environmentally sensitive parts of the Plan area and which is in itself generally a less intrusive form of development. See Section 2 of Supplementary Note.

d) All surface hydrocarbon development:

i) Where proposals for surface hydrocarbon development fall within a National Park or an AONB or associated 3.5km buffer zone identified on the Policies map, or are otherwise considered to have the potential to cause significant harm to a National Park and/or AONB, applications must be supported by a detailed assessment of the potential impacts on the designated area/s. This includes views of and from the associated landscapes from significant view points and an assessment of the cumulative impact of development in the area. Permission will not be granted for such proposals where they would result in unacceptable harm to the special qualities of the designated area/s or are incompatible with their statutory purposes in accordance with Policy D04.

Comment [RS16]: The focus of this part of the Policy is on visual/landscape impact on National Parks and AONBs and is therefore potentially relevant to all forms of surface hydrocarbon development.

ii) Surface hydrocarbon development will only be permitted where the undeveloped character of defined Heritage Coast will be protected.

Comment [RS17]: Heritage Coast is designated to maintain its undeveloped character and distinctive landscapes but is not subject to the same very high level of policy protection as National Park and AONBs. All forms of surface hydrocarbon development could impact on Heritage Coast and therefore fall within the scope of this part of the Policy.

e) Conversion of well pads and wells for further or alternative forms of hydrocarbon development:

Where proposals are brought forward for the conversion of an exploration well pad or individual well to one to be used for appraisal and/or production purposes, or for the conversion of a well pad or individual well used for conventional hydrocarbons to one to be used for unconventional hydrocarbons, such proposals shall be subject to the spatial principles set out in this Policy as relevant.

APPENDIX 2

Extract of references in PPG to distinctions between conventional and unconventional hydrocarbons

PPG Paragraph: 091 Reference ID: 27-091-20140306, which states:

Hydrocarbon extraction covers both conventional and unconventional hydrocarbons.

Conventional hydrocarbons are oil and gas where the reservoir is sandstone or limestone.

Unconventional hydrocarbons refers to oil and gas which comes from sources such as shale or coal seams which act as the reservoirs.

As an emerging form of energy supply, there is a pressing need to establish – through exploratory drilling – whether or not there are sufficient recoverable quantities of unconventional hydrocarbons such as shale gas and coal bed methane present to facilitate economically viable full scale production.

AUTHORITIES' COMMENT – this indicates an expectation of increasing development pressures relating particularly to unconventional sources of hydrocarbons. Potential resources of both shale gas and coal bed methane are known to be present in the Plan area. It is therefore appropriate that the Plan acknowledges and responds to this issue, in order to ensure that an appropriate balance between the Government's main objectives of encouraging exploration and development or resources whilst maintaining the very highest environmental standards.

PPG Paragraph: 095 Reference ID: 27-095-20140306, which states:

What is the exploratory phase of hydrocarbon extraction?

The exploratory phase seeks to acquire geological data to establish whether hydrocarbons are present. It may involve seismic surveys, exploratory drilling and, in the case of shale gas, hydraulic fracturing.

AUTHORITIES' COMMENT – This acknowledges that hydraulic fracturing can be relevant at the exploration stage in development of shale gas as a form of unconventional hydrocarbon. Government has made it clear via a Written Ministerial Statement (16 September 2015) that *exploration and testing of shale potential must and can be done whilst maintaining the very highest environmental standards*. It is generally acknowledged that hydraulic fracturing has the potential for significant environmental impacts. This view is also supported by the reference in **PPG (Paragraph: 119 Reference ID: 27-119-20140306)** which states: *Whilst all applications must be assessed on a case-by-*

case basis, it is unlikely that an Environmental Impact Assessment will be required for exploratory drilling operations which do not involve hydraulic fracturing. This suggests that Government considers that hydraulic fracturing at the exploration stage is more likely to give rise to significant environmental effects.

It is therefore appropriate that the Plan seeks to ensure a commensurately higher degree of environmental protection where this form of activity is involved, and that an equivalent standard of policy protection is available in circumstances where hydraulic fracturing is proposed in the context of development of conventional resources. This is reflected in the approach in parts a) and b) of Policy M16.

PPG Paragraph: 098 Reference ID: 27-098-20140306 which states:

How long does exploratory drilling last?

For conventional hydrocarbons, exploration drilling onshore is a short-term, but intensive, activity. Typically, site construction, drilling and site clearance will take between 12 to 25 weeks.

For unconventional hydrocarbons exploratory drilling may take considerably longer, especially if there is going to be hydraulic fracturing and, in the case of coalbed methane, removing water from the coal seam.

AUTHORITIES' COMMENT – This confirms that the duration of impacts associated with exploration phase of development of unconventional resources present in the Plan area can be longer than for conventional resources. This is a relevant factor in considering the degree of flexibility that maybe incorporated in policy for these forms of development.

PPG Paragraph: 100 Reference ID: 27-100-20140306 which states:

What does the appraisal phase involve?

The appraisal phase can take several forms including additional seismic work, longer-term flow tests, or the drilling of further wells. This may involve additional drilling at another site away from the exploration site or additional wells at the original exploration site. For unconventional hydrocarbons it may involve further hydraulic fracturing followed by flow testing to establish the economic viability of the resource and its potential productive life. Much will depend on the size and complexity of the hydrocarbon reservoir involved.

AUTHORITIES' COMMENT – This confirms that further hydraulic fracturing may be relevant at this stage of development of unconventional hydrocarbons. See comments relating to paragraph 095 and 098 above.

PPG Annex A Shale Gas, coalbed methane and underground coal gasification

It is noted by the Authorities that PPG contains a specific Annex A: *Shale Gas, coalbed methane and underground coal gasification* relating these forms of unconventional hydrocarbons, thereby indicating that they give rise to specific planning considerations to which planning authorities should have regard. Relevant references include:

Annexe A: paragraph 129 Reference ID: 27-129-20140306 which provides a definition of hydraulic fracturing:

What is hydraulic fracturing?

Hydraulic fracturing is the process of opening and/or extending existing narrow fractures or creating new ones (fractures are typically hairline in width) in gas or oil-bearing rock, which allows gas or oil to flow into wellbores to be captured.

Annex A: Paragraph 135 Reference ID: 27-135-20140306, which refers to the potential need for a relatively dense spacing of wells for coal bed methane development (eg within 500-1000m).

Annex A: Paragraph 137 Reference ID: 27-137-20140306 which refers to the potential need for de-watering over an extended period of time during coal bed methane development.

Annex A: Paragraphs 225 to 228, which states that Underground Coal Gasification may require drilling of several wells from potentially a number of well pads and the need for sequential development along seams and that that facilities to provide steam and possibly oxygen to regulate the combustion reaction will be required as well as, potentially, facilities to process the produced gas.

AUTHORITIES' COMMENT – These references suggest that development of other forms of unconventional hydrocarbons (besides shale gas) can give rise to particular issues and impacts, including the potential for cumulative impact through the need, or potential need, for multiple well pads and or wells, and/or the need for additional items of plant, equipment or processes not typically associated with development of conventional resources.

APPENDIX 3

DRILLING PROJECT COMPARISONS

The following table has been produced as supporting information to assist in the understanding of the principal material land-use planning differences between that which could reasonably be expected if one were dealing with gas extraction (both the appraisal and production stages) by conventional methods on the one hand, and methods such as hydraulic fracturing used to exploit unconventional gas reserves on the other.

The Royal Society and the Royal Academy of Engineering in their report *'Shale gas extraction in the UK: a review of hydraulic fracturing'* (June 2012) explain the process of hydraulic fracturing as follows:

> *"Once a well has been drilled and cased ('completed'), explosive charges fired by an electric current perforate holes along selected intervals of the well within the shale formation from which shale gas is produced ('production zone'). Pumps are used to inject fracturing fluids, consisting of water, sand ('proppant') and chemicals, under high pressure into the well. The injection pressure generates stresses in the shale that exceed its strength, opening up existing fractures or creating new ones. The fractures extend a few hundred metres into the rock and the newly created fractures are propped open by the sand.*
>
> *Additional fluids are pumped into the well to maintain the pressure in the well so that fracture development can continue and proppant can be carried deeper into the formation (API 2009). A well may be too long to maintain sufficient pressure to stimulate fractures across its entire length. Plugs may be inserted to divide the well into smaller sections ('stages'). Stages are fractured sequentially, beginning with the stage furthest away and moving towards the start of the well. After fracturing, the plugs are drilled through and the well is depressurised. This creates a pressure gradient so that gas flows out of the shale into the well.*
> *Fracturing fluid flows back to the surface ('flowback water') but it now also contains saline water with dissolved minerals from the shale formation ('formation water'). Fracturing fluid and formation water returns to the surface over the lifetime of the well as it continues to produce shale gas ('produced water')"*

The table below, though setting out examples whereby the two different techniques (i.e. development of conventional resources without hydraulic fracturing and development of unconventional resources involving hydraulic fracturing) may be distinguished from one another, is not to be taken as an exhaustive list of the differences, but a list of those elements to which the Authorities have had regard when formulating the relevant policies within the Plan.

IMPACT	DRILLING PROJECTS FOR CONVENTIONAL GAS	DRILLING PROJECTS FOR UNCONVENTIONAL GAS INVOLVING HYDRAULIC FRACTURING
RESIDENTIAL AMENITY IMPACTS	***Duration of development:*** The duration of the drilling of a well for the exploitation of conventional gas is likely to be shorter than that required in respect of unconventional gas extraction. Target formations for drilling conventional gas tend to be the geological strata of sandstones and limestones (source: BGS Mineral Planning Factsheet). Within the Vale of Pickering, the Kirkham Abbey Formation has been the principal target for conventional gas extraction within the Plan area. This formation lies at approximately 1,200 metres below ground level (approx. 4,000 ft). As such, the duration of the drilling of a well for the exploitation of conventional gas is likely to be shorter than that required in respect of unconventional gas extraction. Once a decision is made whether a commercially viable reserve of conventional gas has been proven, the production phase would see the installation of well-head gear and hook-ups to the gas grid and these would remain in place until such time as the reservoir has been depleted. These present minimal impacts both visually and a significant lessening of those impacts through what could be described as industrial-type activities on site such as the movement and operation of plant, machinery and equipment. Other than the occasional need to '*work over'* the well (which would tend to include the use of a smaller *'work over'* rig; smaller than the drill rig used to sink the well) for maintenance and other related activities, there would not be anticipated any sustained presence of	***Duration of development:*** The depth at which unconventional hydrocarbons are found below land within the Plan area and the nature of the processes used for their extraction mean that much longer time periods are involved in drilling and associated activities such as hydraulic fracturing and, thereby, potentially increasing the duration of any consequential environmental and/or residential impacts. Unconventional (or *'tight gas'*) is predicted to be found in the Bowland Shale (a deep water Carboniferous shale) some 3km (10,000ft) below ground level (source: *The Carboniferous Bowland Shale gas study: geology and resource estimation*, BGS, 2013); almost three times the depth to which previous conventional wells within the Plan area have been sunk. In the case of the Preston New Road (PNR) development in Lancashire, the first well is cited as being planned to be sunk to a depth of 3.5km (source: Officer Report to LCC Committee on 23rd June 2015). The Altcar Moss well site in Lancashire proposes a depth of 3.2km (source: Scoping Opinion request by Aurora Energy Resources, January 2018). The Bramleymoor case in Derbyshire proposes to be sunk to a depth of 2.4km (source: Officer Report to DCC Plg Cttee, dated 5.2.2018). By way of example, the timeframes involved in the drilling of a vertical well, the KM8 sunk to 10,000ft (3km) are provided below:

IMPACT	DRILLING PROJECTS FOR CONVENTIONAL GAS	DRILLING PROJECTS FOR UNCONVENTIONAL GAS INVOLVING HYDRAULIC FRACTURING
	significant pieces of plant and equipment such as drill rigs, cranes etc. Furthermore, the extent of the target reservoir in conventional gas extraction is larger than that with regards to unconventional gas extraction as the rock/formation where the gas is held is more permeable and the gas 'flows' more readily. The Plan area possesses four conventional gas fields (namely the Pickering, Marishes, Malton and Kirby Misperton gas fields). These were first discovered in 1985 and production started in 1995. There are two more gas fields, Ebberston South and Ebberston Moor, within the North York Moors National Park (source: Third Energy website on 06.04.18). Gas taken from these fields comes up to the surface through six production wells (two at Kirby Misperton, two at Great Habton (in the Malton field), and the remaining wells, one at Low Marishes and one at Pickering). Production from Ebberston Moor South is planned via underground pipeline to the existing Gas-fired Electricity Generating Station as Knapton. Of the wells within the Plan area, the existing wells have been subject to one or two '*side tracks'* or wells drilled directionally to reach target '*pockets'* of gas reserves.	• the construction time for the ½ hectare (5,000 sq metre) well pad cited as being six weeks (working Mon-Fri 7 til 7); • the mobilisation of the drill rig on the well site would take two week; • the duration of drilling was estimated to be between 6 weeks and 3 months; • well testing – 3 weeks; • the demobilisation of the drill rig would take a week Thus, in total, 18 weeks to 24 weeks (6 months) In addition to the drilling of the vertical well, there are further processes involved in the extraction of unconventional gas which include the perforation of the well followed by the pumping of a mixture of water, sand and additives at high pressure beyond the fracture limits of the formation/rock serve to provide another feature with which to distinguish between conventional and unconventional gas extraction. In respect of the KM8 proposal, the following timescales were stated: • ***pre-stimulation 'work over'*** – 2 weeks (this wouldn't be necessary if the well is not already pre-existing with the exception that the '*perforation*' of the well would be the same for a newly drilled well, the same as needed for a pre-existing well) The number of '*work overs'* anticipated in respect of unconventional gas extraction is likely to be significantly higher than that experienced within conventional wells by the reason of the '*tighter'* formations from where the gas is extracted and the greater the difficulties of stimulating the gas to flow. Depending upon the frequency of necessary '*work overs'*, the presence of '*work over'* rigs could be prolonged for

IMPACT	DRILLING PROJECTS FOR CONVENTIONAL GAS	DRILLING PROJECTS FOR UNCONVENTIONAL GAS INVOLVING HYDRAULIC FRACTURING
		significant periods of time longer than have, to date, been experienced within the Plan area. • ***hydraulic fracture stimulation / well test*** - 6 weeks. Each hydraulic fracture stimulation treatment is stated to be preceded by a series of '*mini-fracs*'. Each group of initial test fractures together with their associated the hydraulic fracture stimulation treatment ('*main frac'*) would not be expected to exceed five hours in duration. The Officer Report in respect of the PNR development (source: Officer Report to LCC Committee on 23rd June 2015) explains the timeframe associated with that particular project as follows: *"The development works (exploration and restoration) would have a proposed duration of 6 years from the start of construction works on site to the completion of the restoration activities. If the site moves into full production the decommissioning period would not take place."* This six year period only refers to the exploration and appraisal phases and not the production phase. In the event of commercially viable reserves of gas being found, then inevitably the duration of development would be extended depending upon how long it would take for the depletion of the gas within the target formation. The Officer Report then goes on to identify timeframes for specific activities at the PNR site as follows: • ***site mobilisation & construction*** – 2 months; • ***equipment mobilisation*** – 2 weeks; • ***well drilling*** - 5 months for the first well, then 3 months each for the remaining 3 wells.

IMPACT	DRILLING PROJECTS FOR CONVENTIONAL GAS	DRILLING PROJECTS FOR UNCONVENTIONAL GAS INVOLVING HYDRAULIC FRACTURING
		[Observation: thus, in the event of the use of the same rig for all four wells, a total of 1 year and 2 months is assumed to be the duration of drilling]. As earlier referred, given the depth to which the drilling needs to reach down, the duration of drilling is inevitably longer and, in respect of the example of the Preston New Road (PNR) development in Lancashire, the sinking of the initial well was stated within the Officer Report to take five months (source: Officer Report to LCC Committee on 23rd June 2015). However, experience has shown that this can be much longer in practice with the vertical pilot well taking approx. 10 months to reach 2.7 km (source: Cuadrilla website 06.04.18) The Officer Report then goes on to identify further timeframes for specific activities at the PNR site as follows: • ***hydraulic fracturing*** – on the basis of 3 hours per frac, and 30 to 45 fracs per well, each well is estimated to be subject to 2 months where hydraulic fracturing would take place [Observation: Thus, a total of eight months where hydraulic fracturing could potentially be taking place which is consistent with the stated duration of the presence of the coiled tubing tower for a period of 8 months] • ***initial flow testing*** – this is estimated to take 3 months per well • ***extended flow testing*** – this is estimated to take between 18 and 24 months per well • ***restoration*** – this is estimated to take between 7 and 9 months

IMPACT	DRILLING PROJECTS FOR CONVENTIONAL GAS	DRILLING PROJECTS FOR UNCONVENTIONAL GAS INVOLVING HYDRAULIC FRACTURING
		The Altcar Moss well proposal anticipates a similar period to the PNR development of five months for the duration of the drilling of the initial vertical well, followed by a further period of two months for the hydraulic fracturing operations to take place. The Altcar Moss proposal cites a 25 metre high coiled tubing tower, diesel powered generators, fluid storage tanks, proppant silos (reaching 13 metres in height), mixing tanks, fluid pumps, fluid separation and storage, diesel fuel storage, fixed and portable external lighting, a control room, office accommodation and welfare facilities as well as two cranes (although their heights are not stated). It is of particular note in respect of both the PNR and Altcar Moss examples where more than one vertical well is proposed, that there is a distinct possibility that multiples of larger structures such as, '*work over'* rigs, coiled tubing towers, proppant/sand silos and drill rigs may be present on a well pad concurrently with one another, increasing the attendant cumulative impacts of such development proposals, including residential amenity impacts. Furthermore, while a conventional well may well be completed with well-head valve gear remaining on-site and little else bar the occasional requirement to *'work over'* the well, wells sunk for the purpose of unconventional gas extraction are more likely to require many more re-visits to undertake further hydraulic fracturing to stimulate further gas extraction.

IMPACT	DRILLING PROJECTS FOR CONVENTIONAL GAS	DRILLING PROJECTS FOR UNCONVENTIONAL GAS INVOLVING HYDRAULIC FRACTURING
		The Bramleymoor case in Derbyshire (solely an exploration well) proposes a duration period of five years (source: Officer Report to DCC Plg Cttee, dated 5.2.2018). Site development work at this site is quoted as being for 3 months and the drilling, coring and suspension an additional 3 months. With regards the extent of the target formation, this is determined by the extent/'*reach*' of the fractures/fissures created by the hydraulic fracturing of the rock/formation which tend to be more limited. The consequent effect of this, therefore, is a greater number of wells and further the consequent prolonged duration of development on these particular sites subject to hydraulic fracturing. These additional wells can be *side-tracks*/lateral wells emanating from the *'parent'* vertical well, but even these can be limited by reason of both geology, depth and/or presence of geological faults. Therefore, once the *'saturation'* level in the number of possible side-tracks/lateral wells has been reached, then another '*parent'* vertical well would need to be sunk. In the case of the KM8 proposal, the extent of the '*reach*' of the fractures generated by the *'hydraulic fracture stimulation treatment'* has been estimated to extend 378 metres laterally and extend 65m both above and below the point of perforation i.e. 130 metres. This, in effect, is the extent of the '*reservoir*'. The lateral wells of the Altcar Moss well site are proposed to '*spread*'/'*reach*' a distance of 1.5km and those of the PNR site, 2.5km.

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		In the absence of target *'pockets'* and the fact the whole of the underlying strata of Bowland Shale is effectively the target formation, lateral wells would be drilled spreading out like the spoke of a bicycle wheel laid on its side and also at varying depths such that, visually it would resemble a vertical column of laid-down bicycle wheels emanating from which would be the lateral wells where hydraulic fracturing would take place along their horizontal lengths. This does not happen in the circumstance of conventional gas extraction and renders the two distinguishable from one another in this respect. The consequential impact of these multiple lateral wells would mean the prolonged duration of drill rigs and coil tubing towers situated on the well pads and thereby the prolonged duration of their attendant environmental impacts. Of particular note is reference within Appendix 1 to the Officer Report in respect of the Preston New Road development where it is explained that "*The coiled tubing and service rig would be used to occasionally service the wells. Well servicing which would take approximately a week per well*"; suggesting potential for their continued presence on site for a period of time that strays beyond the '*temporary*' and beyond into '*semi-permanent'*. Furthermore, not only would there be a plethora of lateral wells emanating from a single vertical well, the Preston New Road example in Lancashire serves to demonstrate the possibility of as many as four vertical wells that are capable of being accommodated on the well pad separated by varying distances of between 5 metres and 25 metres from one another (as described within Appendix 1 which accompanies the Officer Report for the Preston New Road development.

IMPACT	DRILLING PROJECTS FOR CONVENTIONAL GAS	DRILLING PROJECTS FOR UNCONVENTIONAL GAS INVOLVING HYDRAULIC FRACTURING
		In addition, from each of these four vertical wells are proposed to emanate between 30 to 45 stages which would be undertaken at intervals of 30 to 50m per stage i.e. beneath emanating from the four vertical wells would, in each instance, be in the region of 30 to 45 '*frac jobs*' resulting in total to a total of 180 fracking *'events*'. These fracking stages would take place along the length of the lateral wells that would extend beyond the well pad underground for a distance of some 2.5 kilometres. Cuadrilla states on its website that their modelling forecast results indicate *"over a 30 year period, a most likely volume of 6.5 billion cubic feet (Bcf) of gas would be produced from a 2.5km horizontal Bowland shale well"*. The Officer Report explains "*each fracturing stage would last for 3hours*". Operated consecutively (which they wouldn't be in reality) would amount to 22.5 days (on a 24/7 basis (which, again, in reality would not take place). There is a difference in the time estimations between the PNR and KM8 developments. The estimate time for undertaking each fracturing event within the KM8 proposals was 5 hours.
RESIDENTIAL AMENTIY IMPACTS	***Associated traffic movements:*** While traffic movements associated with conventional gas extraction involve the mobilisation/de-mobilisation of drill/work-over rigs to site, they do not involve the significant vehicle movements associated with operations involving hydraulic fracturing such as those hauling water to, and removal of waste water and solid waste from, the sites.	***Associated traffic movements:*** Hydraulic fracturing associated with the unconventional hydrocarbons will involve far greater traffic movements, as explained below by reference to different aspects of the development activity. ***Delivery of water*** – the smallest quantity of water to constitute a *'high volume hydraulic fracturing'* activity (defined as '*associated hydraulic fracturing'*), as specified within the Petroleum Act, would amount to the use of

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		10,000m^3 of water giving rise to over 300 loads for this element of a project alone; ***Construction of the well pad*** – the construction of the ½ hectare (5,000 sq metre) well pad for KM8 estimated 140 loads for the delivery of the stone (280 vehicle movements, 140 in and 140 out). The stone (Clean Type I aggregate would form a 300mm (0.3 metre) layer upon which the fracking equipment would sit. If this is factored upwards for the construction of a well site for unconventional gas drill pad, the number of loads could potentially increase four-fold. There would then be the requisite movements to and from the site of concrete for the drilling cellar construction(s) depending upon how many well heads are anticipated on the site. ***Works associated with the hydraulic fracturing stage*** – the KM8 development proposed 388 HGV movements in a six week period for equipment mobilisation and an additional 18 HGV, LGV and car movements each day for that six week period totalling 1,114 vehicle movements and averaging one every ten minutes. ***Waste water removal*** – the removal of waste water from the KM8 development, were it not possible/practicable to treat the waste water on-site, would mean an extra 470 HGV movements (i.e. 235 tankers off and 235 tankers returning to be filled with waste water). This should be noted to be an estimated total (1,645.55m^3) that is very much dependent upon the volume of flowback fluid returned to the surface. ***NORM removal*** – this would be dependent upon the volume of *'flowback'* fluid (water returning to the surface) deemed to be contaminated with NORM. Flowback fluid containing NORM and NORM-contaminated solid waste will have to be

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		transported off site to specialised waste management facilities licensed to handle such waste. ***Security fencing*** – At the Preston New Road site in Lancashire, security fencing to a height of 4 metres has been erected. Inevitably, the number of vehicles delivering and then involved in the removal of the fencing upon completion will very much depend upon the size of the well pad; ***Noise barrier*** – vehicles involved in bringing onto site the noise barriers which could be formed by temporary structures through a combination of scaffolding, shipping container placement and stacking and/or barriers such as noise abatement '*blankets*' both erection and dismantling. In respect of the KM8 development, the individual vehicle movements attributable to the noise barrier alone amounted to 72 with a vehicle movement frequency of one every ten minutes. ***Cellar construction*** – the cellar forms a containment area from which the wells can be drilled, whilst also housing the wellhead. The cellar is constructed from concrete rings, approximately 2.4m nominal diameter and 3m deep. Concrete deliveries would be needed to carry out this development which dependent upon the number of wells per pad anticipated could prolong the duration of the development. ***Mobilisation of the drill rig to site*** The Officer report for the PNR development explains "*During stage 1 (construction of the site), which would last approximately 2 months, there would be an average of 22 two way HGV movements per day (maximum of 48). During stage*

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		2 (mobilisation of rig, drilling of first borehole and demobilisation of rig) lasting five months, there would be an average of 14 two way HGV movements (maximum of 50). *For drilling of the subsequent three wells, the duration of the movements would be over a shorter period of three months but would equate to around 17 two way HGV movements per day. For hydraulic fracturing, (taking one to two months for each well) the average two way HGV movements would be around 10 per day. For the initial flow testing, (around three months), it is anticipated that the average two way movements would be around 5 per day. The extended flow testing would generate minimal HGV movements whilst the decommissioning and restoration of the site over approximately 2 months would generate an average of 22 two way HGV movements.* *The peak traffic flows would occur as a result of combined traffic associated with activities at more than one well. The total traffic numbers in the ES are based on such conditions. The peak traffic generated would be around 50 two way HGV movements per day which would occur for around one week on eight occasions over the life of the project"*
LANDSCAPE & VISUAL IMPACTS	Whilst conventional hydrocarbons development will involve visual impacts, these are not as significant in nature or duration as those which would be involved in unconventional hydrocarbons development involving hydraulic fracturing.	The different elements of activity involved in hydraulic fracturing would involve greater visual impacts not only through the heights of structures, but also through both their quantity (increased numbers of pieces of equipment) and their nature (varying types of structures) as set out below.

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	Height of the drill rig: By way of example, while in 2013 the KM8 well was planned to be drilled using a EDECO Rig 40 with a derrick height of 49m capable of drilling a well down to a stated depth of 2743m (9000ft) in order to explore the deeper formations (source: original KM8 application NY/2012/0338/FUL), other wells for conventional gas exploration purposes have used rigs of 36 metres in height at Lockwoods Field, Speeton (NY/2005/0003/FUL); at Bradshaw Field, Speeton (MIN3441); at Station Road Field, Speeton (MIN3443) and at Great Habton (NY/2012/0280/FUL), the height of the proposed drill rig was cited as being 33 metres).	***Height of the drill rig:*** There is evidence to suggest that drilling rigs for unconventional hydrocarbons development may potentially be taller by reason of the depths to which the drilling would have to reach down to the Bowland Shale beneath the Plan area. A shorter drilling rig would only be able to accommodate shorter lengths of drill pipe with which to go down to the depths of the shale and would take considerably more time than drilling to the depths of conventional gas resources. While a taller drill rig may shorten the duration of the presence of a drilling rig on-site, such a rig would, inevitably, have attendant potential adverse landscape and visual impacts. In the case of the KM8 proposal, taking into account that the well had already been sunk to depth, the height of the drill rig for the purpose of working over the well to prepare for the requisite works involved in hydraulic fracturing, i.e. the '*work over'* rig, was stated as being 37 metres (just over 121ft) (source: Officer Report to NYCC Plg Cttee on 23rd May 2016) The height of the drill rig for the purpose of drilling the initial vertical wells at Preston New Road was cited within the Officer Report as being 53 metres (source: Officer Report to LCC Committee on 23rd June 2015). Although, this was later reduced to 36 metres. The drill rig height in the case of the Altcar Moss well site in Lancashire has a stated maximum height of 60 metres (source: Scoping Opinion request by Aurora Energy Resources, January 2018). The Bramleymoor case in

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	Height of coil tubing tower: Coil Tubing Towers have not been experienced as having been utilised in conventional gas extraction projects in the Plan area. ***Height of the cranes used to manoeuvre the plant, machinery & equipment***: Given the fewer and less sizeable pieces of plant, machinery and equipment involved in conventional gas drilling projects, cranes are less likely to be utilised. ***Height of sand/proppant silos*** : Sand/proppant silos have not been experienced as having been utilised in conventional gas extraction projects; nor would they be expected to be.	Derbyshire proposes a drill rig up to 60metres in height (source: Officer Report to DCC Plg Cttee, dated 5.2.2018). ***Height of coil tubing tower:*** The Coil Tubing Tower utilised for the purpose of the KM8 development is stated as being 25 metres in height (source: Officer Report to NYCC Plg Cttee on 23rd May 2016); whereas, for the PNR development, such a tower was stated within the Officer Report as reaching 36 metres in height. ***Height of the cranes used to manoeuvre the plant, machinery & equipment***: The details that accompanied the KM8 proposal were described as involving a 50-tonne crane capable of reaching a height of 60 metres (196 ft). ***Height of sand/proppant silos*** : The PNR development proposed a sand silo zone of a height of 15 metres and the Altcar Moss development, proppant silos of 13 metres in height have been proposed.
LANDSCAPE & VISUAL IMPACTS	***External lighting:*** While external lighting would be required for safe working purposes, it is the duration of the utilisation of external lighting on site subject to hydraulic fracturing operations that distinguishes them from what has been experienced in respect of conventional well sites within the Plan area to date.	***External lighting:*** Lighting towers (each with a bank of four metal halide lamps each of 1,000W and powered by on-board generators) reaching a height of 8 metres (just over 26ft) were proposed as part of the KM8 development. Lighting would also be present on the derrick of the rigs to ensure that the block can be seen travelling up and down the mast and any coiled tubing towers are likely to also be lit for reasons of safe working practices. The KM8 coiled tubing tower was stated as being illuminated by four (4 no.)

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		metal halide lights each of 400W power to provide for visibility of the coil tubing injector.
LANDSCAPE & VISUAL IMPACTS	With the exception of the drill rig for the initial sinking of a conventional well, the necessary equipment, plant and machinery is distinguishable from the operations involving hydraulic fracturing in that conventional gas extraction would not involve the erection of proppant silos, the potential of multiple derricks of drill rigs, *'work-over'* rigs and coiled tubing towers and cranes etc. ***Typical pieces of plant, machinery and/or equipment*** The listed equipment for the drilling of the KM8 well includes: • Drilling Rig and associated equipment • Casing • Tubing • Site Office • Accommodation • Contractors Offices • Welfare Unit • Security Office • Telehandler • Skips and Waste Collection The listed equipment for the testing of the KM8 well includes: • Pipework • Storage Tanks • Ground Flare • Separator • Generator	The overall quantum of plant, machinery and/or equipment associated with unconventional hydrocarbons development is more significant, as identified below. ***Typical pieces of plant, machinery and/or equipment*** ***'work over' rigs*** - the height of the *'work over'* rig for the purpose of the hydraulic fracturing proposal at the KM8 well was stated as being 37 metres. This is consistent with the height of the '*work over*' rig proposed in the Altcar Moss development in Lancashire also stated as being 37 metres in height. The Bramleymoor case in Derbyshire proposes a '*work-over*' rig of 35metres in height (source: Officer Report to DCC Plg Cttee, dated 5.2.2018). ***Proppant silos*** – these can in the region of 13 to 15 metres in height; ***'Roadable water tankers'*** - in the case of the KM8 development, there were 19 roadable water tankers brought to the site with a purpose of holding the fresh water supply for undertaking the hydraulic fracturing operations. ***High pressure pumps*** – in the case of the KM8 development, the surface pressure required to hydraulically fracturing the target formations would range from circa 6,000psi to 7,000psi.

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	• Site Office • Welfare Unit Until such time as a decision is made on whether the well is commercially viable or not, the following equipment would be installed: • Wellhead • Production Tree • Choke • Cellar Barriers • Steps	The Environment Agency in its document, '*Monitoring and control of fugitive methane from unconventional gas operations'* (published August 2012) states that with specific regard to pressure "*the range of fluid pressures used in high volume hydraulic fracturing is typically 10,000–15,000 psi (700–1000 bar), and exceptionally up to 20,000 psi (1,400 bar). This compares to a pressure of up to 10,000 psi (700 bar) for a conventional well*". Perforation equipment such as perforation guns to create the pathways through the well bore into the target formation to allow for the flow down of the fracking fluid and the flow up of the '*flowback fluid'* and any gas that might be present. The listed equipment for the drilling of the PNR wells include: • well cementing equipment; • drilling materials and fluids including drilling muds; and, • wireline logging equipment; and, • tubular casings. During the actual hydraulic fracturing operations the initial drill rig would be demobilised and in its place would be sited a Coil Tubing Tower. In the case of the KM8 proposals, a Coil Tubing Tower reaching a height of 25 metres was chosen; however, in the case of the Preston New Road development, the chosen Coil Tubing Tower is explained within the Officer Report as reaching 36 metres in height and twinned with a Service Rig of the same height. The PNR site proposed six hydraulic fracturing pumps, a manifold unit, a blender unit, a high volume separator, monitoring cabin, generators, fuel storage and cranes. Silos that would be used to store the fracking sand would stand

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		some 15 metres in height and enclosed flare stacks (of 3 metre diameters) would stand 10 metres high. Other miscellaneous equipment would include site offices, welfare facilities and stores. It is of particular note in respect of both the PNR and Altcar Moss examples where more than one vertical well is proposed, that there is a distinct possibility that multiples of larger structures such as, '*work over*' rigs, coiled tubing towers, proppant/sand silos and drill rigs may be present on a well pad concurrently with one another, increasing the attendant cumulative impacts of such development proposals, including visual and landscape impacts.
LANDSCAPE & VISUAL IMPACTS	***Size of the well pad:*** The well pad upon which conventional wells sit are usually around one hectare in size (10,000m^2). The site preparation works would involve a range of typical construction vehicles including excavators, dump trucks, graders and compactors. The entire footprint of the well pad, once the topsoil has been removed, is covered by an impermeable membrane of High Density Polyethylene. This is heat welded to ensure integrity. Around the perimeter of the site is constructed a drainage ditch which again is lined with the HDPE membrane to collect surface water/fluid run-off and is not connected to any off-site watercourse.	***Size of the well pad:*** The size of well pads to accommodate wells for the purpose of unconventional gas extraction are likely to be significantly larger and, potentially, at least double the size of a conventional well pad so as to accommodate the associated plant, machinery and equipment (such as those referred to above) as well as making provision for the safe manoeuvring of heavy goods vehicles and the crane or cranes to manoeuvre the *'frack spread'*/ equipment into position. By way of example, the Preston New Road case has served to demonstrate that sites can be very much larger than the well pads that currently exist within the Plan area. The well pad (including the access track) at the Preston New Road site is cited as being 2.65 hectares (source: Officer Report to LCC Committee on 23rd June 2015). Unlike the KM8 case, where only the vertical well was planned to be '*fracked*', the four wells on the Preston New Road site

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		propose lateral wells reaching radial distances of 3km from the well pad (source: Officer Report to LCC Committee on 23rd June 2015). The larger well pads will inevitably utilise similar plant and machinery as for conventional gas well site construction such as excavators, dump trucks, graders and compactors, but their numbers and/or their duration on site would be dependent upon the size of the pads and the timeframe within which the construction project is proposed to work. As with well pads for conventional gas drilling, the entire footprint of the well pad, once the topsoil has been removed, is covered by an impermeable membrane of High Density Polyethylene (HDPE) which is heat welded to ensure integrity, and the site surrounded by a perimeter ditch; but, again, the duration of this activity is dependent upon the size of the pads and the timeframe within which the construction project is proposed to work.
ENVIRONMENTAL & SUSTAINABILITY IMPACTS	***Consumption of water in the process:*** Water consumption involved in conventional hydrocarbons development is much less significant than that associated with unconventional hydrocarbons development involving hydraulic fracturing ('*fracking*'). What is referred to as '*drilling mud*' is used to lubricate the drill bit when down the well and return any fragments of rock ('*drill cuttings*') to the surface. Estimated quantities of water consumed for KM8 are listed as: *(a) Initial requirements - c. 20,000 gallons* *(b) Daily operations - c. 10,000 gallons*	***Consumption of water in the process:*** The nature of unconventional hydrocarbons development involving fracking is likely to involve far greater volumes of water being consumed, with significant implications for traffic movements in the absence of any other means of transporting the requisite water. In addition to the required quantities of water for the actual drilling of the vertical wells in the first instance, there is, thereafter, the lateral/horizontal wells that spread out like the spokes of a bicycle wheel laid on its side, where further quantities of water are then consumed for undertaking the actual *hydraulic fracturing* process itself.

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	(c) Potable water - c. 1,000 gallons per week. As conventional drilling projects do not involve high volume high pressure hydraulic fracturing, the additional volumes of water consumed in that process, as described in the column on the right, would not arise; nor their associated vehicle movements.	If one were to consider the smallest quantity of water to constitute a *'high volume hydraulic fracturing'* activity (defined as '*associated hydraulic fracturing'*) (a *'frac job'*), as specified within the Petroleum Act, this would amount to the use of 1,000m^3 of water (the equivalent of 1 million litres or 219,969 imperial gallons) for each frac. The stated overall water requirement for the hydraulic fracturing process alone, distinct from that required for the drilling of the vertical well, amounts to 4,000m^3 (4 million litres or 880,000 gallons). In the case of the KM8 proposal, access to a water supply had been explained as being achieved via an existing pipeline and the PNR proposal is serviced via a water mains connection supply. However, there may be circumstances, particularly in large parts of the Plan area where distances from mains water supply connection would be likely to render the scheme cost prohibitive and the choice that then remains is tankering the water in by road haulage, which given the capacity of haulage tankers, could mean significant levels of traffic movements on the Plan area's roads; many of which do not comprise the principal or 'A' road network. The Officer Report for the PNR development refers to water consumption during hydraulic fracturing operations to be anticipated in the region of "*approximately 765m^3 of water per day (a maximum of one hydraulic fracturing stage will be carried out in a single day*)". This was later revised down to 600m^3 per day by reducing the proposed number of hydraulic fracturing stages and reusing flow back water to make up part of the fracturing fluid for the subsequent

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		fracturing stages. However, experience has shown with the KM8 development that while re-use of the '*flowback fluid*' had been intended, it was subsequently rejected by the operator (source: letter to the Environment Agency from Third Energy dated 9th October 2017) on the grounds of "*uncertainty as to the rate of flowback, potentially leading to increased duration of operation"* and *"only a small volume of the flowback water would be treated*". This, therefore, means the tankering off-site any *'flowback fluid'/'returned water'* with its attendant increases in traffic movements.
ENVIRONMENTAL & SUSTAINABILITY IMPACTS	***Generation of waste water:*** The '*drilling mud*' is generally disposed of to an off-site licensed waste site.	***Generation of waste water:*** The generation of waste water is significantly greater in light of the usage of water for the purpose of hydraulically fracturing the rock to extract the gas from the shale. There have been varying estimates of between 30% to 60% in respect of the amount of *'flowback fluid'/'returned water'* that would come to the surface after a *'frack job'* and these have been cited in applications to carry out hydraulic fracturing. The Officer Report in respect of the KM8 development refers to an estimate of between 30-50%; whereas the Officer Report in respect of the PNR development states "*about 10-40% of the injected fluid is predicted to return to the surface"* and the submitted Scoping Opinion request in respect of the Altcar Moss proposal cites 25% to 50%. With specific reference to the KM8 development, there were two options proposed in respect of waste water treatment; either treatment on-site or tankering off-site.

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		The explanation of the applicant company, Third Energy, conveyed within the Officer Report stated, *"the criteria for determining whether the flowback water will be treated and reused in subsequent hydraulic fracture treatments depends very much on actual flowback rates encountered post hydraulic fracture treatment. If flowback rates are slow, the time required to accumulate sufficient flowback fluid for treatment and reuse will increase significantly, impact on the overall duration of the hydraulic fracturing operation… If flowback water returns to surface at a suitable rate and assuming 50% is recovered, the amount of fluid to be treated by electrocoagulation is 1,645.55m^3. At 30% recovery, the fluid to be treated by electrocoagulation is reduced to 987.33m^3. It is not possible to predict what recovery rate and volume will be until after the first hydraulic fracture treatment (Zone E) is undertaken… The electrocoagulation process generates up to 10.97m^3 of treatment sludge (85% water and 15% solids) per 100m^3 of treated flowback water, although the volume of treatment sludge could be less and is based on the throughput volume of flowback water being treated"* It is clear though that, in the absence of any hydraulic fracturing having taken place to date, there is not enough data to ensure statistically significant results upon which to place any reliance.

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ENVIRONMENTAL & SUSTAINABILITY IMPACTS	***Generation of naturally occurring radioactive material (NORM):*** No reference has been found with respect to the generation of NORM in conventional gas drilling; however, the *'produced water'* (i.e. residual water that exists within the conventional gas reservoir) is likely to return to the surface with constituents components found within the target formation, but would not occur in the quantities likely to be generated with the hydraulic fracturing technique as discussed in the column on the right.	***Generation of naturally occurring radioactive material (NORM):*** The fluid returned to the surface once it's been down the well (i.e. *'flowback fluid'*) becomes contaminated by its time down within the reservoir. It brings back with it NORM, heavy metals and organic compounds and, while this is similarly the case in respect of conventional gas extraction, the volume is significantly greater as the amount is not only the *in situ* water present within the formation but also the additional fracking fluid sent down the well to bring the gas to the surface. Another difference between conventional vs. unconventional is that, for shale gas, all the water is produced immediately in the days after a '*frack job'* is undertaken, whereas within a conventional field it is produced continuously through the life of the field.

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