

Worcestershire Minerals Local Plan Background Document

Conventional and Unconventional Hydrocarbons (Oil and Gas, excluding Coal)

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1. Executive summary

- 1.1. Hydrocarbons, including oil and gas, are essential to the UK's economy and energy supply. However, these fossil fuel resources are finite, and minerals can only be extracted where they are found.
- 1.2. Geological features that contain hydrocarbons are normally located deep below the surface and are exploited using a number of methods. The UK has a long history of onshore and offshore oil and gas development, and new technology is increasingly allowing unconventional sources of hydrocarbons to be exploited.
- 1.3. One of these new methods that is gaining a lot of attention is hydraulic fracturing or "fracking" for shale gas. In addition to the concerns that accompany any mineral extraction proposal, there are a variety of environmental concerns that have been raised around shale gas extraction in particular. These include climate change impacts, seismic activity, and human health concerns.
- 1.4. There is a robust regulatory framework in place to control and monitor the oil and gas industry in the UK, and these developments are also subject to European Union law regarding the environment and water quality.
- 1.5. There is no history of oil and gas extraction in Worcestershire. Two exploratory boreholes were drilled in the county in 1967 and 1974, but no hydrocarbons were discovered. Nationally, there is a push to establish whether the UK has commercially viable deposits of shale gas (unconventional hydrocarbons) which can be extracted using fracking. The geological information we have does not indicate that Worcestershire is likely to be a prospective area for conventional or unconventional hydrocarbon extraction.

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3. Introduction to Oil, Gas, and Unconventional Hydrocarbons

- 3.1. This background paper provides an overview of conventional and unconventional oil and gas resources in Worcestershire, and the policy context and potential planning issues that might arise as a result of exploration and extraction.
- 3.2. Oil and gas ("fossil fuels") are primary sources of energy, and are collectively known as hydrocarbons. They are the principal sources of energy consumed in the UK, playing a critical economic role, and there is a national and local need for ongoing reliable supplies of hydrocarbons. Given the ever-increasing global reliance on and demand for these products, there are concerns about how long our supply will last as, like all minerals, oil and gas (including petroleum and natural gas liquids) are non-renewable.
- 3.3. The UK is highly dependent on oil and gas as primary sources of energy. Natural gas is used to generate electricity, and petroleum products derived from oil (including petrol, diesel and kerosene) are essential transport fuels. Oil and gas are also widely used for domestic heating and are important for a wide variety of industrial processes and manufacturing. There are millions of products that are made "from the chemical processing of oil and gas. Indeed, it is almost impossible to find any synthetic item where petroleum has not had any part in the process of its manufacture".¹
- 3.4. Conventional oil and gas developments are found across the UK, both onshore and offshore, where geological conditions allow. Oil and gas extraction is a localised activity: as with other minerals, oil and gas can only be extracted from where they occur naturally due to the underlying geology. As Worcestershire is a landlocked county, the focus of this paper will be on onshore oil and gas.
- 3.5. Increasing demand for energy and the need for improved energy security has led to technological advances which allow the exploration and extraction of "unconventional" oil and gas resources that were previously unrecoverable. There is Government support for these new technologies, including fracking, in the UK.
- 3.6. The term "unconventional" refers to the method of accessing and extracting the oil or gas, rather than the oil or gas itself being unconventional. Unconventional hydrocarbons include tight gas, shale gas and coal bed methane.
- 3.7. There are typically four main phases in the exploitation of an oil or gas resource:
 - Exploration
 - Appraisal

¹ British Geological Survey (2011) *Onshore Oil and Gas Minerals Planning Factsheet*.

- Development and production
 - Decommissioning, restoration and aftercare².
- 3.8. Planning permission is required for each phase of hydrocarbon extraction, although some initial seismic work may have deemed planning consent under Part 17 of Schedule 2 to the Town and Country Planning (General Permitted Development) (England) Order 2015.³
- 3.9. Currently, any organisation wishing to undertake a shale gas development must submit its planning applications to local Mineral Planning Authorities under the Town and Country Planning Act 1990. However, the government is consulting on changing this regime, so that planning permission for the production phase is considered through the Nationally Significant Infrastructure Project process.⁴
- 3.10. The exploratory, appraisal and production phases of oil and gas development can only take place in areas where the Oil and Gas Authority has issued a Petroleum Exploration and Development Licence. Such licenses were previously issued by the Department of Energy and Climate Change⁵.

Planning for Oil and Gas in Worcestershire

- 3.11. Worcestershire County Council has a statutory duty to produce a Minerals Local Plan (MLP) to deliver and manage minerals development. The current Hereford and Worcester MLP was adopted in 1997 and needs to be updated to reflect current policy, practice and guidance. The new Minerals Local Plan will replace the existing Minerals Local Plan and will be a Development Plan Document which is used to guide new development and determine planning applications.
- 3.12. The adopted Plan contains brief mentions of coal and oil in Worcestershire but, at the time of adoption, there was no interest in exploiting either of these resources. At the time that plan was produced, preliminary geological surveys had shown no evidence of viable oil resources in the county. The plan states that "in the event of significant oil deposits being discovered, a review of the relevant aspects of the plan will be undertaken to take account of the changed circumstances".⁶ In the light of

² Department of Energy and Climate Change (2013) *Onshore oil and gas exploration in the UK: regulation and best practice* [online] Available from the [government publications website](#) [Accessed 27.09.2018]

³ Ministry of Housing Communities and Local Government (2014) National Planning Practice Guidance: Minerals: When is planning permission required for the extraction of hydrocarbons? Paragraph: 093 Reference ID: 27-093-20150415, Revision date: 15 04 2015 [online] Available from the PPG website [Accessed 27.09.2018].

⁴ Department for Business, Energy and Industrial Strategy (July 2018) *Initial consultation on the timings and criteria for including major shale gas production projects in the Nationally Significant Infrastructure Project regime*.

⁵ Department for Business, Energy and Industrial Strategy (2017) *Guidance on fracking: developing shale gas in the UK* [online] available from the [BEIS website](#) [Accessed 27.09.2018].

⁶ The County of Hereford and Worcester (1997) *Minerals Local Plan*, p.6.

technological advancement, new data, and policy changes at the national level, the Council considers it important to revisit the available data to develop a robust evidence base to support the policies in the emerging MLP.

Conventional Oil and Gas in the UK

- 3.13. The oil and gas industry is well-established in the UK, with exploration and production having begun in the mid-1800s.
- 3.14. 'Conventional' onshore oil and gas usually refers to resources which are located in relatively porous sandstone or limestone rock formations, and conventional extraction methods generally involve drilling a borehole down to the porous rock where the oil or gas has accumulated. The "source rocks" of these reservoirs are usually underlying shale. Oil and gas is normally pumped out of the ground using beam pumps (also known as 'nodding donkeys').
- 3.15. One of the best-known sources of oil and gas in the UK is a formation called the Kimmeridge Clay, which is found offshore in the North Sea and extends across southern England to the south coast in Dorset. The Kimmeridge reserves have been exploited since the early 1970s⁷.
- 3.16. Concerns about supply disruptions during the First World War spurred the first systematic search for onshore oil supplies in the UK, but it has been the offshore oil and gas reserves discovered in the North Sea since the 1960s that have had the largest economic impact. Onshore exploration expanded again in the 1980s following reforms to the production licensing system and global price increases.

Unconventional hydrocarbons in the UK

- 3.17. Unconventional hydrocarbons is a term that is used to refer to a number of types of oil and gas including tight gas, shale gas and coal bed methane. The term "unconventional" refers to the methods of extraction rather than the hydrocarbons themselves, which are the same as those extracted using conventional methods.
- 3.18. Sometimes referred to as 'alternative fossil fuels', this category includes a number of formerly inaccessible hydrocarbon reserves. New technologies - or old technologies applied in new ways - have allowed these reserves to be commercially exploited. These include gas recovered from active or abandoned coal mines (coal mine methane), methane recovered from undisturbed coal seams (coal bed methane), gas recovered from mudrocks and shales via fracking (shale gas or tight gas), or gas recovered by burning underground coal seams in situ which produces a synthetic gas (syngas) through a process called underground coal gasification.

⁷ British Geological Survey (2011) *Onshore Oil and Gas Minerals Planning Factsheet*.

- 3.19. Both coal mine methane and coal bed methane are already produced in the UK on a small scale, and exploration for further prospects is ongoing. Exploration licenses have previously been taken out on parts of the South Staffordshire and Wyre Forest coalfields, both of which extend into the northern part of Worcestershire. However, BGS data indicates that these areas are "unlikely to contain coalbed methane in commercial quantities".⁸ No areas in Worcestershire are shown on the government's map of onshore licences and prospective areas, with the nearest license area being on the border of Staffordshire, Shropshire, and Telford & Wrekin.⁹ Coal bed methane and underground coal gasification are covered in the 'Coal Mining in Worcestershire' background paper.¹⁰
- 3.20. There are no underground coal gasification operations in the UK, and current government policy does not support its development.¹¹

Shale gas and hydraulic fracturing in the UK

- 3.21. The first UK well to (accidentally) encounter shale gas was drilled in West Sussex in 1875¹², but it wasn't until the 1980s that further work revealed more details of the UK's shale gas potential.
- 3.22. There are two technologies that have made the current interest in shale gas possible: directional drilling and hydraulic fracturing ("fracking"). Neither of these technologies is strictly new, but in combination they allow formerly inaccessible sources of gas to be extracted commercially.
- 3.23. Directional drilling - one of the key technologies necessary for shale gas exploration - has been assisting UK operators recover difficult deposits economically since the 1970s, especially at the Wytch Farm onshore/offshore field in Dorset¹³.
- 3.24. Hydraulic fracturing is not a new technology: "the first hydraulic fracturing of onshore conventional UK wells was done in the late 1950s, and it has

⁸ BGS/DETR (1999) *Mineral Resource Information for Development Plans, Herefordshire and Worcestershire: Resources and Constraints*.

⁹ Department of Energy & Climate Change (July 2014) *Map of Onshore Licences, SEA Areas and Prospective Areas* [online] available on the www.gov.uk [Accessed 27.09.2018].

¹⁰ Available on the Worcestershire Minerals Local Plan [background documents webpages](#).

¹¹ In a written government question and answer on coal gasification (no. 56962), Dr Thérèse Coffey MP, Parliamentary Under-Secretary at the Department for Environment, Food and Rural Affairs, stated that "The Department for Business, Energy & Industrial Strategy (BEIS) commissioned a report from Atkins into the greenhouse gas implications of underground coal gasification to inform Government policy about its development in the UK. The report was peer reviewed by academics and industry. The report finds that emissions from underground coal gasification would be too high to be consistent with our commitment to a low-carbon future. The Government is therefore minded not to support the development of this technology in the UK". The statement is available on the [Parliament website](#) [Accessed 03.10.2018].

¹² Selley, R (2012) *UK shale gas: The story so far in Marine and Petroleum Geology*, 31:1, pp100-109 [online] Available on the [journal website](#) [Accessed 28.09.2018].

¹³ Cuadrilla (undated) Horizontal wells [online] Available on the [Lancashire County Council website](#) [Accessed 26.09.2018].

been a common field operation to increase flow rates since then".¹⁴ Offshore wells and coal bed methane operations are also commonly fractured to improve flow rates (though this is not always necessary for all coal bed methane sites).

- 3.25. There has been some exploration for shale gas in the UK, but to date none is being produced. We don't have enough geological information about the deposits underlying Worcestershire to know whether they might be prospective for shale gas.

Other issues: Underground carbon capture and storage

- 3.26. Underground carbon capture and storage is another issue that is gaining attention nationally. This is covered in a separate chapter below.

4. Economics of Oil and Gas

- 4.1. In the UK, fossil fuels remain the dominant source of energy supply, but now account for 80.1 per cent, a record low level¹⁵. Gas is one of the key pillars of the UK's energy mix, accounting for over 30 per cent of the UK's energy production and second only to oil¹⁶.
- 4.2. Oil and gas produced in the UK (both onshore and offshore) had a value of £23.95 billion in 2014.¹⁷ In terms of production from the UK continental shelf, an industry report states that, in 2016, £17 billion worth of oil and gas was produced.¹⁸
- 4.3. The 1980s build-up of North Sea oil and gas sites allowed the UK to become self-sufficient in the supply of these minerals and by 1999 the UK was a major exporter of oil and gas. Production of both onshore and offshore oil and gas has been in decline since then. The UK became a net importer of gas in 2004, and of oil in 2010¹⁹.
- 4.4. Onshore oil and gas operations are generally small by offshore standards, so the cost required to develop them is also comparatively smaller and they remain commercially attractive. As the price of oil and gas remains high, this is likely to remain true for some time. However, the major oil companies, which previously dominated onshore production, have gradually been giving way to smaller independent operators as costs have risen across the sector and the size of new onshore discoveries have fallen²⁰.

¹⁴ Department of Energy and Climate Change (December 2015) *Onshore oil and gas exploration in the UK: regulation and best practice* [online] [Accessed 27.09.2018] Available on the [gov.uk website](http://gov.uk).

¹⁵ Department for Business, Energy and Industrial Strategy (July 2018) *Digest of United Kingdom Energy Statistics 2018*.

¹⁶ Department for Business, Energy and Industrial Strategy (July 2018) *Digest of United Kingdom Energy Statistics 2018*.

¹⁷ British Geological Survey (2016) *United Kingdom Minerals Yearbook 2015*.

¹⁸ The UK Oil and Gas Industry Association Limited (2017) *Economic Report 2017*.

¹⁹ British Geological Survey (2011) *Onshore Oil and Gas Minerals Planning Factsheet*.

²⁰ British Geological Survey (2011) *Onshore Oil and Gas Minerals Planning Factsheet*.

- 4.5. The United Kingdom Onshore Operators Group (UKOOG) is the trade organisation for companies exploring for and producing crude oil and natural gas onshore in the UK.

Local context: history of oil and gas extraction in Worcestershire

- 4.6. BGS records show that two exploratory boreholes for hydrocarbons have been drilled in Worcestershire. These are known as Collington 1 (near the village of Collington on the border between Herefordshire and Worcestershire in the north-west of the county) and Netherton 1 (near Elmley Castle in the south of the county). The Oil and Gas Authority's map of onshore oil and gas activity also shows a borehole at Kempsey, south of the city of Worcester. This borehole, known as Kempsey 1, dates from 1979²¹.
- 4.7. Collington 1 was drilled in 1967 to a depth of 1,720m and was subsequently abandoned because no hydrocarbons were discovered. Netherton was drilled in 1974 to a depth of 2,327m and was also abandoned because no hydrocarbons were discovered²². The borehole at Kempsey dates from 1979, and we have no information on why this was abandoned. There are no records of oil or gas development in this location. To the best of our knowledge, no further exploratory wells have been drilled in the county.
- 4.8. The British Geological Survey *Herefordshire and Worcestershire Resources and Constraints* document concluded that "the prospects for discovery of oil and gas in Herefordshire and Worcestershire are very low. [Two] exploration wells have been drilled in the county, none of which discovered oil or gas. The lack of source rocks in the Worcester Basin indicates that it is not prospective for oil and gas".²³
- 4.9. The Worcestershire Archive and Archaeology Service was consulted to see whether there were any further records of hydrocarbon exploration or extraction in the area. This search did not turn up any additional information about historic oil exploration.
- 4.10. Officers are anecdotally aware that seismic surveys have been undertaken in the county at various times but the county council does not have any information on the findings of these surveys. Unfortunately the licensing process does not require operators to share their findings from seismic surveys with the Council.

²¹ Oil and Gas Authority, *Map of onshore oil and gas activity*, available online [here](#).

²² BGS/DETR (1999) *Mineral Resource Information for Development Plans, Herefordshire and Worcestershire: Resources and Constraints*.

²³ BGS/DETR (1999) *Mineral Resource Information for Development Plans, Herefordshire and Worcestershire: Resources and Constraints*.

Current oil and gas operations in Worcestershire and future potential

- 4.11. There are no current oil or gas operations in Worcestershire.
- 4.12. Though previous BGS data indicated that the Worcester Basin does not contain appropriate source rocks for oil and gas development, the geological requirements for unconventional development may be different from conventional onshore operations. The Worcester Basin was identified in the Department of Energy and Climate Change's Strategic Environmental Assessment document as an area under consultation in the 14th licensing round, but no areas of the county have a licence.

5. Oil and Gas and unconventional hydrocarbon geology and extraction

Geological Context

Conventional Oil and Gas

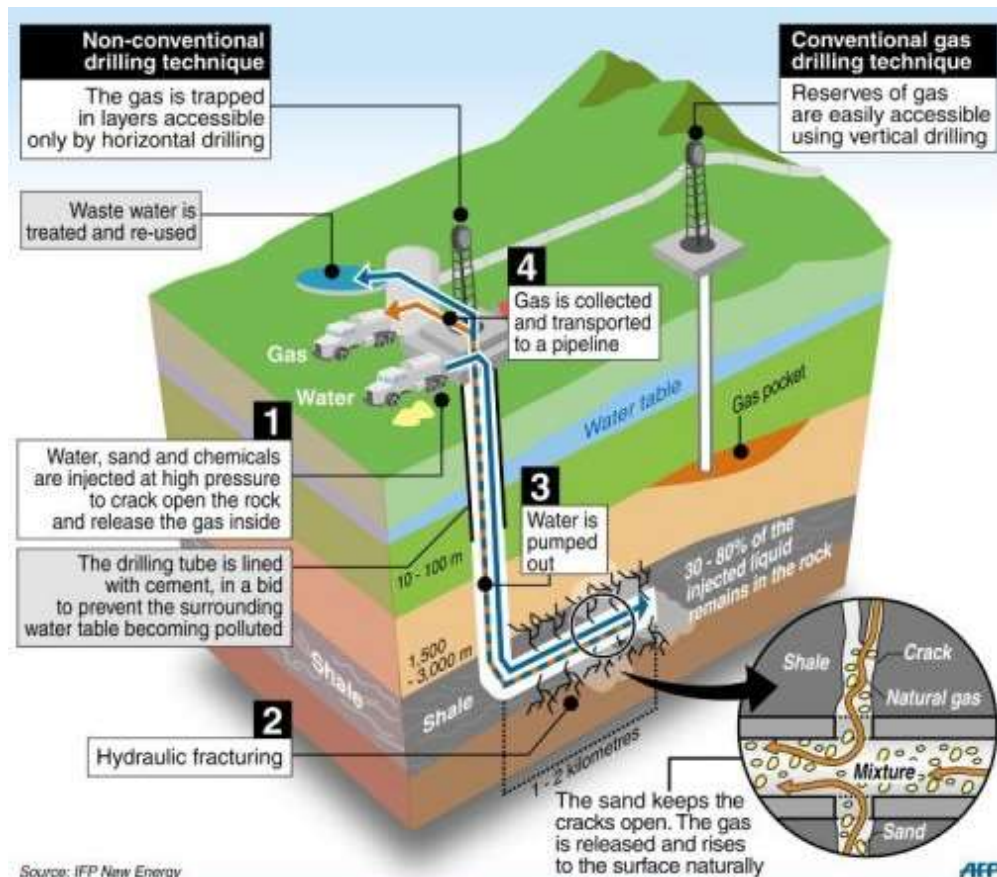
- 5.1. Commercially viable fossil fuels are typically found accumulated in geological structures and reservoir rocks beneath the earth's surface.
- 5.2. Oil is normally obtained from relatively fine-grained sedimentary rocks including sandstones and shales. These are known as 'reservoir rocks' or 'source rocks', and are formed over long geological periods after the rocks are buried and the temperature and pressure on them increases. Once formed, the hydrocarbons can migrate through naturally occurring fractures and pores in the rock above and form large reservoirs in areas where impermeable 'cap rocks' form a seal²⁴.
- 5.3. Onshore oil and gas are usually found in reservoir rocks located between 800m and 1,200m below the surface, and are typically extracted through boreholes²⁵.
- 5.4. Potential source rocks are found in many parts of the UK, however to date there have been no oil or gas deposits found within Worcestershire.

Unconventional Hydrocarbons

- 5.5. Reservoir rocks for unconventional hydrocarbons can be limestones, sandstones, shales, or coal with low porosity. Limestones and sandstones typically contain tight gas, while shales are the source of shale gas. Coal seams may be exploited for coal bed methane or coal mine methane.
- 5.6. In the case of shale gas, extraction normally involves hydraulic fracturing which allows the gas to flow from the small spaces in the rocks to the well, effectively extracting the gas from the source rocks themselves rather than from a reservoir as in conventional extraction.
- 5.7. Shale and tight gas are usually found in rocks located between 1,500m and 3,000m below the surface.

²⁴ British Geological Survey (2011) *Onshore Oil and Gas Minerals Planning Factsheet*.

²⁵ British Geological Survey (2011) *Onshore Oil and Gas Minerals Planning Factsheet*.



Source: IFP New Energy

Figure 1: This illustration shows the differences between conventional and non-conventional drilling techniques. Note the difference in depth, method, and size of above-ground plant. (Photo: IFP New energy)

Extraction

- 5.8. Minerals are only able to be worked where they are found and those locations are predetermined by the underlying geology. This means that borehole locations are relatively fixed, and reserves of all mineral types, including oil and gas, are limited.
- 5.9. Taking the view that any mineral working must be restored, mineral extraction is considered a temporary land use, even though it might take place over a long time.
- 5.10. The government identifies four main phases in the development of shale gas and oil²⁶:
- 1) Exploration
 - 2) Moving into production
 - 3) Production
 - 4) Decommissioning and restoration

²⁶ Department for Business, Energy & Industrial Strategy (2017) *Guidance on fracking: developing shale gas in the UK* [online] available on the government webpages [Accessed 27.09.2018].

- 5.11. A large amount of preparatory work is normally undertaken prior to oil and gas extraction, as it is important to ensure that the deposit is commercially viable before drilling begins. There are several stages to this:
- Seismic surveys to determine the extent of the deposits;
 - Mapping and analysis of seismic data;
 - Secondary seismic surveys (if necessary);
 - Exploratory well (or wells) drilled to conclusively determine the presence and quality of the deposit;
 - Production phase (which may require drilling additional wells).
- 5.12. There are also a number of stages that must be passed before exploratory drilling can begin, as set out by government²⁷:
- 1) Petroleum Exploration and Development Licence issued by the Oil & Gas Authority
 - 2) Operator secures landowner consent for exploration well
 - 3) Environment Agency assesses risk to water, air quality, and how waste will be managed
 - 4) Planning permission from local authorities, who seek views from the local community
 - 5) Specialist inspectors from the Health and Safety Executive scrutinise the well design to ensure it is safe
 - 6) Final Oil & Gas Authority checks to ensure controls are in place to protect against seismic activity
 - 7) A Hydraulic Fracturing Consent licence is obtained from BEIS, confirming that fracking may proceed.
- 5.13. Planning permission is required for each phase of hydrocarbon extraction, although some initial seismic work may have deemed planning consent under Part 17 of Schedule 2 to the Town and Country Planning (General Permitted Development) (England) Order 2015.²⁸
- 5.14. The production phase typically involves two stages: primary recovery, when the oil or gas flows to the surface due to natural pressure and is then pumped using beam pumps. Secondary or enhanced recovery takes place after the natural pressure is depleted and involves injecting water or natural gas into the reservoir at a constant rate to maintain pressure.
- 5.15. Depending on whether the source is conventional or unconventional, there may also be some variations in the exploration and extraction process.

²⁷ Department for Business, Energy & Industrial Strategy (2017) *Guidance on fracking: developing shale gas in the UK: What happens before a company can explore for shale gas?* [online] available on the [government webpages](#) [Accessed 27.09.2018].

²⁸ Ministry of Housing Communities and Local Government (2014) National Planning Practice Guidance: Minerals: When is planning permission required for the extraction of hydrocarbons? Paragraph: 093 Reference ID: 27-093-20150415, Revision date: 15 04 2015 [online] Available from the PPG website [Accessed 27.09.2018].

Exploration

- 5.16. The exploration phase involves the collection of detailed geological information using sophisticated geophysical methods. These normally include seismic surveys and exploratory wells.
- 5.17. 'Reflection seismic surveying' is a technique which captures a detailed image of subsurface geological strata allowing engineers to determine whether any are likely to trap oil or gas. These surveys work by sending sound waves into the ground and recording the way they are reflected back from major rock boundaries in the earth. Onshore, this is done by driving large lorries along long 'lines' (usually existing roads, but occasionally across fields). The lorries are equipped with vibration pads which send sound waves into the earth at predetermined points to create a grid of data. The reflections are collected using strategically placed "geophones". Once the data are processed, detailed maps of the subsurface geology are produced which allow the engineers to determine whether and where exploratory wells should be drilled. The time spent and level of disturbance at any one site during this phase is relatively small, as this type of survey can cover many kilometres in one day²⁹.
- 5.18. "If this process identifies [geological] structures which may contain commercial quantities of hydrocarbons, an exploration well is drilled in an attempt to conclusively determine the presence or absence of oil or gas. Oil drilling rigs are generally capable of drilling through several thousand meters of rock. They require a power source to rotate the drill and drive the pumps [...] Onshore drilling is a short lived but intensive activity which may carry on 24 hours per day".³⁰ During drilling, a rig will be present on site for the duration.
- 5.19. For conventional development, construction, drilling and site clearance at this phase can take between three and six months.
- 5.20. For unconventional oil and gas developments, exploratory drilling may take longer, especially if there will be hydraulic fracking. In these cases, exploratory drilling may take two-six months, and may involve drilling a number of small diameter wells which will be fractured to determine if shale gas is present in commercial quantities.

*Appraisal (testing)*³¹

- 5.21. Appraisal takes place once an operator has determined the presence of oil or gas, but still requires more information about the extent of the deposit, its characteristics, or whether the resource is economically viable. This phase can take several forms, including further seismic testing, flow tests, or even drilling more wells. At this point, there is little difference between

²⁹ British Geological Survey (2011) *Onshore Oil and Gas Minerals Planning Factsheet*.

³⁰ British Geological Survey (2011) *Onshore Oil and Gas Minerals Planning Factsheet*.

³¹ This section is based on Hampshire County Council's *FAQ – Onshore oil and gas (conventional and unconventional (including 'fracking')) development in Hampshire* (August 2018; Version 16) document which is available on the [Hampshire County Council website](#) and is used here with their kind permission.

conventional and unconventional hydrocarbon exploration, though in the case of shale gas, drilling and testing exploration boreholes may take longer.

- 5.22. The length of time it takes to complete this stage depends on the size and complexity of the oil or gas reservoir involved. For conventional deposits, surface operations tend to last four to six months, with on-site activity gradually diminishing as longer term-flow testing concludes. For unconventional deposits, this phase may involve hydraulically fracturing wells before flow testing them. Fracking will normally require an additional planning consent and a full Environmental Impact Assessment.

*Production*³²

- 5.23. If an exploration well locates a significant amount of oil or gas, and if further testing shows that the deposit is commercially viable, then a development may move into the production phase. The production phase begins when the operator submits a pad development plan (also called a field development plan) to the Oil & Gas Authority for consideration³³.
- 5.24. Currently, any organisation wishing to undertake a shale gas development must submit its planning applications to local Mineral Planning Authorities under the Town and Country Planning Act 1990. However, the government is consulting on changing this regime, so that planning permission for the production phase is considered through the Nationally Significant Infrastructure Project process.³⁴
- 5.25. Production normally involves drilling a number of wells. It may involve re-using wells drilled at the exploratory or appraisal phase, or the development of new wells on new sites. Rigs will be required to drill any further boreholes required at this stage.
- 5.26. Once initial drilling is complete, the surface activity will diminish substantially as wells start to produce oil or gas.
- 5.27. For wells that are hydraulically fractured, 'fracking' takes place at the start of development to release the oil or gas from the source rocks to allow its extraction. It does not typically continue during the production phase, though some wells require re-fracking at intervals of 3-5 years³⁵ to ensure steady production.

³² This section is based on Hampshire County Council's *FAQ – Onshore oil and gas (conventional and unconventional (including 'fracking')) development in Hampshire* (August 2018; Version 16) document which is available on the [Hampshire County Council website](#) and is used here with their kind permission.

³³ Oil & Gas Authority (October 2017) *Guidance Notes for Onshore Field Development Plans, Field Development Plan Addendums and Cessation of Production*.

³⁴ Department for Business, Energy and Industrial Strategy (July 2018) *Initial consultation on the timings and criteria for including major shale gas production projects in the Nationally Significant Infrastructure Project regime*.

³⁵ Campaign to Protect Rural England (2013) *Fracking Explained* [Online] Available from the [CPRE website](#) [Accessed 27.09.2018]

- 5.28. The size of the production pad may vary on a site-by-site basis depending on geology and surface conditions. For conventional developments, the well pad will usually be around two hectares in size. Well pads for wells that will be hydraulically fractured may be larger. Typically, one pad will contain a number of vertical wells and associated horizontal lateral wells, but it may be necessary to construct a number of well pads across a productive area. Associated equipment such as pipelines and processing facilities may also be required and will be subject to additional planning permissions.
- 5.29. The length of the production phase depends on the nature of the resource being exploited and the planning permission(s) and associated consents. The productive life of an oil or gas field can be up to 20 years.

Decommissioning and restoration

- 5.30. Once production has finished, wells are made safe for abandonment, associated facilities and site infrastructure is dismantled and sites are restored according to the restoration plan agreed with the mineral planning authority.
- 5.31. Decommissioning and restoration may take place after any of the phases described above. The section below on *Potential for Restoration* gives more detail on restoration.

6. Policy context for oil and gas extraction

National Planning Policy Framework

- 6.1. The National Planning Policy Framework (NPPF) sets out policies on the development of mineral resources. It states that "It is essential that there is a sufficient supply of minerals to provide the infrastructure, buildings, energy and goods that the country needs"³⁶ and that "When determining planning applications, great weight should be given to the benefits of mineral extraction, including to the economy."³⁷ Oil and gas are essential for the country's energy supply, but authorities must also ensure that there are no unacceptable adverse effects from extraction on the natural or historic environments or on human health and amenity.
- 6.2. The NPPF also requires that minerals planning authorities should, among other things, "provide for restoration and aftercare at the earliest opportunity, to be carried out to high environmental standards".³⁸
- 6.3. In addition, the NPPF requires planning policies to "provide for the extraction of mineral resources of local and national importance".³⁹ Minerals of local and national importance are defined as "Minerals which are necessary to meet society's needs, including [...] oil and gas (including conventional and unconventional hydrocarbons)".⁴⁰ The NPPF also stipulates that minerals planning authorities should "adopt appropriate policies so that known locations of specific minerals resources of local and national importance are not sterilised by non-mineral development where this should be avoided (whilst not creating a presumption that the resources defined will be worked)".⁴¹

Planning Practice Guidance

- 6.4. The government's web-based national Planning Practice Guidance (PPG) contains further detail on the minerals planning policies contained in the NPPF in an extensive *Planning for Hydrocarbon Extraction* section, as well as guidance on issues that apply to all minerals sites.
- 6.5. The chapter on Hydrocarbon Extraction details the phases of extraction, the mineral planning and planning application/development management

³⁶ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 203.

³⁷ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 205.

³⁸ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 205(e).

³⁹ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 204(a).

⁴⁰ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, Annex 2: Glossary.

⁴¹ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 204(c).

process, environmental impact assessments and restoration. It also contains several annexes, one of which focuses on 'unconventional' hydrocarbons: shale gas, coal bed methane and coal seam gas.

- 6.6. The PPG states that 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 production⁴²".
- 6.7. Issues which must be addressed at all mineral sites include amenity, dust, noise, stability and restoration and aftercare.
- 6.8. For amenity, the key issues are proximity to occupied properties and the impacts on the local community. For sites where fracking takes place, the UK Onshore Operators Group has published a Community Engagement Charter, which sets out a series of commitments to open communication and also promises a financial contribution to affected communities⁴³. This is discussed in more detail in the *Community and Amenity Impacts* section below.
- 6.9. For dust and noise emissions, the PPG requires that an assessment be carried out. This assessment should identify all potential sources of the nuisance, and for each source, consider the procedures and mitigation measures that may be necessary. For noise, this assessment should be in accordance with the Noise Policy Statement for England. In the case of dust, health impacts must be considered, and in both cases the impacts on site neighbours and sensitive facilities must be taken into account⁴⁴.
- 6.10. The PPG states that seismic surveys are "essential to understand the structure under the earth's surface and be able to predict the depths of the key target formations".
- 6.11. If mineral planning authorities are in a petroleum licence area, they need to include the licence areas on their policies maps, and set out criteria-based policies for each of the exploration, appraisal and production phases of hydrocarbon extraction.⁴⁵ The Oil and Gas Authority's web-based onshore interactive map shows that there are no petroleum licence areas within Worcestershire.

⁴² Ministry of Housing, Communities and Local Government (2014) *National Planning Practice Guidance: Minerals: What are conventional and unconventional hydrocarbons?* Paragraph: 091 Reference ID: 27-091-20140306, Revision date: 06 03 2014 [online] Available from the [PPG website](#) [Accessed 27.09.2018].

⁴³ UK Onshore Operators Group (2013) *Community Engagement Charter* [online] Available from the [OOG website](#) [Accessed 03.10.2018]

⁴⁴ Ministry of Housing, Communities and Local Government (2014) *National Planning Practice Guidance: Minerals: What are conventional and unconventional hydrocarbons?* Paragraphs 019-032, Revision date: 06 03 2014 [online] Available from the [PPG website](#) [Accessed 27.09.2018].

⁴⁵ Ministry of Housing, Communities and Local Government (2014) *National Planning Practice Guidance: Minerals: What are mineral planning authorities expected to include in their local plans on hydrocarbons?* Paragraph: 106 Reference ID: 27-106-20140306, Revision date: 06 03 2014 [online] Available from the [PPG website](#) [Accessed 27.09.2018].

- 6.12. Finally, restoration of mineral sites is a priority in the NPPF, and its importance is reflected in the detailed information contained in the PPG. Restoration and aftercare should incorporate, at a minimum, an overall restoration strategy, information about soil resources and hydrology and how soils and overburden materials will be handled during excavation, an assessment of the agricultural land classification (where the land is agricultural) and a landscape strategy. Applicants must also provide an outline strategy of their commitments for the five-year aftercare period⁴⁶. Key issues for restoration are covered in the *Planning Issues: Potential for restoration* section below.

Local planning policies

- 6.13. The Adopted Minerals Local Plan from 1997 forms part of the existing Development Plan. Only policies 1,2,5,6 and 7 have been "saved" by the Secretary of State. None of these policies pertain specifically to oil and gas. Policy 6, *Extraction of Minerals other than Aggregates*, refers exclusively to surface extraction, and states that "The likelihood of underground mining in the County is remote and does not justify the formulation of a specific policy in this Plan".⁴⁷
- 6.14. There were no preferred areas for oil and gas extraction in Worcestershire identified in the 1997 plan, and the plan deems the likelihood of oil extraction in the county to be remote:
- "A number of preliminary geological surveys have been carried out in those sectors of the County which have been released for prospecting by the Government [...] to date there is no evidence to suggest the presence of oil in the county. In the event of significant oil deposits being discovered, a review of the relevant aspects of the Plan will be undertaken to take account of the changed circumstances"*⁴⁸.
- 6.15. The saved policies in the adopted Minerals Local Plan (1997) will all be superseded by the emerging Minerals Local Plan.

City, District, and Borough Local Plans

- 6.16. Policies contained in city, district and borough local plans do not typically mention oil, gas, or unconventional hydrocarbons. They often contain policies on climate change, including long-term targets to reduce carbon emissions through the use of renewable energy sources. Local plans also set out the amount of development planned for each area which will

⁴⁶ Ministry of Housing, Communities and Local Government (2014) *National Planning Practice Guidance: Minerals: Restoration and after care*, Paragraph: 146 Reference ID: 27-146-20140306, Revision date: 06 03 2014 [online] Available from the [PPG website](#) [Accessed 27.09.2018].

⁴⁷ The County of Hereford and Worcester (1997) *The County of Hereford and Worcester Minerals Local Plan* p.52.

⁴⁸ The County of Hereford and Worcester (1997) *The County of Hereford and Worcester Minerals Local Plan* p.6.

contribute to increased demand for oil and gas products in the short to medium term.

6.17. Other policies in these plans address protecting green open space, green infrastructure and amenity, all of which may be impacted by applications for oil and gas extraction. Though oil and gas facilities are often small compared to large quarrying operations, restoration plans for these sites may also contribute to achieving these types of objectives.

- 6.18. There are several local plans in the county:
- Borough of Redditch Local Plan No.4
 - Wyre Forest Core Strategy
 - Bromsgrove District Plan
 - South Worcestershire Development Plan

All of these plans emphasise the importance of moving towards a low-carbon economy, and support the use of renewable energy. None specifically refers to oil, gas or hydrocarbon development.

There are also parts of two AONBs in the county: the Cotswolds and the Malvern Hills. The Cotswolds AONB Management plan does not specifically mention conventional or unconventional hydrocarbon development, though the Cotswolds Conservation Board has produced a briefing paper on unconventional gas prospectivity in the AONB which concludes that "From information available at present the Board considers that the Cotswolds AONB and its setting can be seen as at low risk from exploration and exploitation of unconventional gas. However, this is a topic for which new evidence and guidance is forthcoming and will need to be kept under review".⁴⁹ The Malvern Hills AONB Management Plan does discuss fracking, and states that "The Government has identified Eastnor [in Herefordshire] as an area that may see some fracking. There are no proposals yet and working in this area may be technically difficult and costly. Any proposals will need to be considered on their own merits, based on a thorough assessment of impacts".⁵⁰ It should be noted that the Eastnor area does not appear on the latest interactive mapping of licence areas.

Regulatory framework

- 6.19. The oil and gas industry in England is regulated by several bodies:
- The Oil and Gas Authority (OGA);
 - The Environment Agency (EA);
 - The Health and Safety Executive (HSE); and
 - The Mineral Planning Authority, (Worcestershire County Council).

It is also subject to European Union regulations including Environmental Impact Assessment (EIA).

⁴⁹ Cotswolds Conservation Board (undated) *Briefing Paper: Unconventional gas prospectivity of the Cotswolds AONB and its setting*.

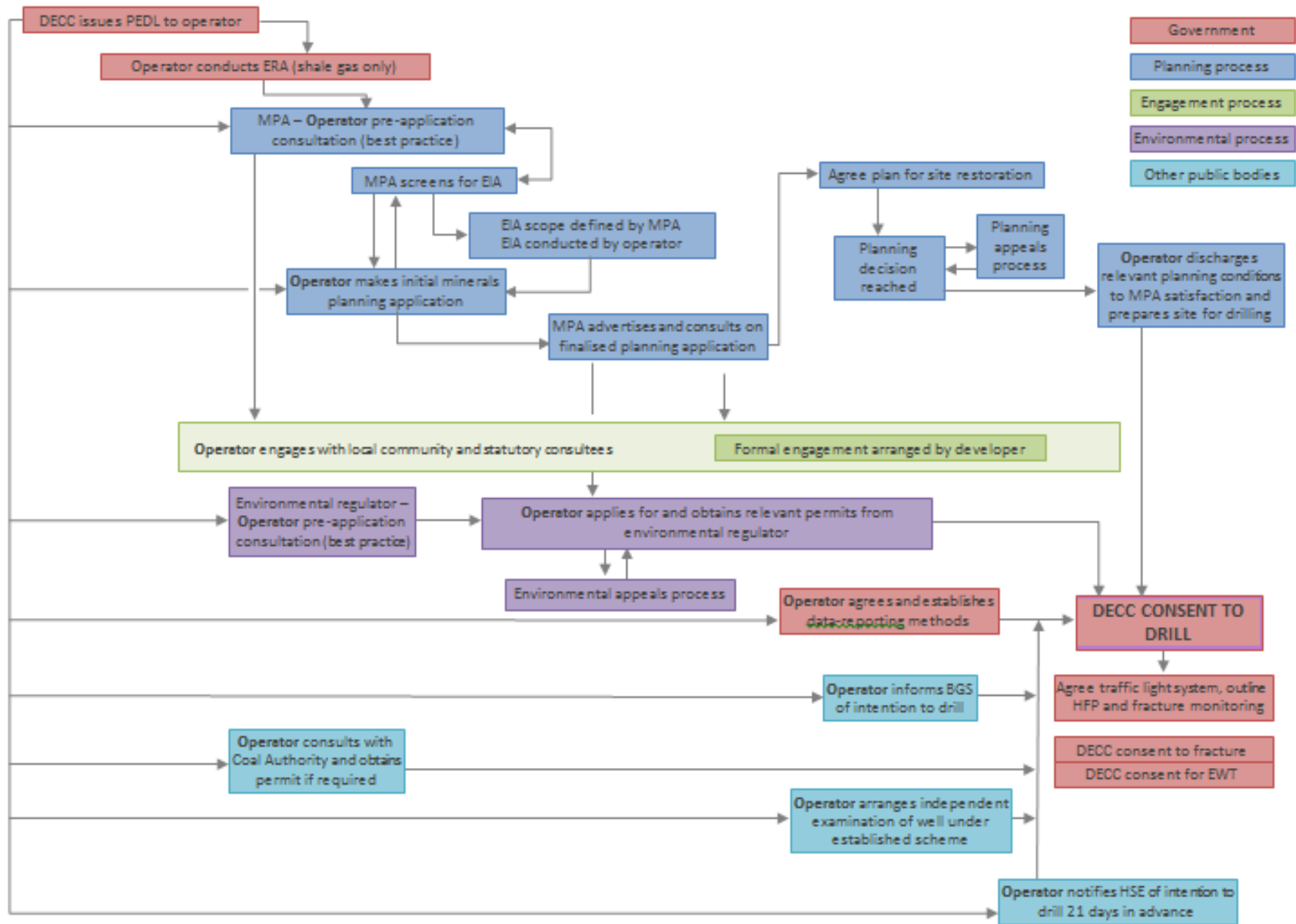
⁵⁰ Malvern Hills AONB Partnership (April 2014) *Management Plan 2014-2019, The development of fracking in the AONB*.

- 6.20. In order to begin any exploration for oil and gas, a licence from OGA is required, as well as a number of other permits and consents.
- 6.21. The EA has published guidance documents and regulations which are designed to reduce risks to people and the environment. All operators must also comply with a comprehensive set of health and safety regulations on well design, construction, operation and monitoring to minimise the risk of leaks. All oil and gas operations (including shale gas) must be carried out in accordance with best practice and standards established by the industry body, the UK Onshore Operators Group in consultation with BEIS, the EA and the HSE.
- 6.22. The industry has also instituted an additional safeguard in the form of the 'Well Examination Scheme' which requires operators to appoint an independent well examiner for the complete lifecycle of the project. The well examiner reviews the proposed and actual well operations to ensure they meet the operator's policies and procedures, comply with regulations and follow industry good practice⁵¹.
- 6.23. As noted previously, planning permission is required for each stage of extraction, although some initial seismic surveying that is part of the exploration phase may fall under Permitted Development rights.
- 6.24. Public consultation is also required at several stages in the process.
- 6.25. Before drilling, operators must have obtained or done the following:
- A petroleum licence from BEIS (via the OGA)
 - Permission from the Coal Authority if required
 - Received planning permission from the MPA
 - Completed an Environmental Impact Assessment (if required)
 - Obtained the appropriate environmental permits from the EA
 - Notified the HSE of the well design and operation plans
 - Ensured a complete examination of well design and construction by an Independent Well Examiner
 - Served notification on the EA of an intention to drill in accordance with Section 199 of the Water Resources Act, 1991
 - Apply to BEIS(OGA) for consent to drill, including submission of a hydraulic fracking plan if required
 - Advised the British Geological Survey

A flow chart illustrating in more detail the regulatory processes that an operator must follow in order to successfully begin drilling can be found on the next page. Note that this is based on guidance from the former Department for Energy and Climate Change⁵², whose responsibilities now rest with the Department for Business, Energy and Industrial Strategy (BEIS). References to DECC therefore now relate to BEIS and/or the Oil and Gas Authority.

⁵¹ UK Onshore Operators Group (2013) *Fact sheet on onshore oil and gas regulation* [Online] Available from the [OOG website](#) [Accessed 28.09.2018]

⁵² Department of Energy and Climate Change (2013) *Onshore oil and gas exploration in the UK: regulation and best practice* [online] Available from the [government publications website](#)



Oil and Gas Licences⁵³

- 6.26. Licences for onshore drilling and exploration are granted by the Department for Business, Energy and Industrial Strategy (BEIS), via the Oil and Gas Authority (OGA). BEIS issues Petroleum Exploration and Development Licences (PEDL), giving a company or a group of companies (a joint venture) exclusive rights to explore for, and develop, the resource in a particular geographic location. Licences allow a company to pursue a range of exploration activities for conventional or unconventional gas, subject to planning permission and the necessary associated consents.
- 6.27. Worcestershire County Council does not issue licences for oil and gas development.
- 6.28. The terms of the PEDL licences require approval of the choice of operator. The checks carried out on operators cover their:
- technical competence;
 - capability to supervise, manage and undertake the proposed operations; and
 - the scope of their relevant insurance coverage.
- 6.29. If and when an operator is approved for a licence, the operator is given the responsibility for managing all activity in the PEDL. No method for drilling is specified in the initial licence, as it only conveys exclusivity in an area for the licensee.
- 6.30. Licences do not give consent for drilling or any other operations or development. Potential operators will also need to obtain the following before any development can commence:
- Consent from the landowner;
 - Planning permission for each stage of development (explorations, appraisal and production) from the MPA (in Worcestershire this is Worcestershire County Council);
 - Regulatory consents (such as from the Environment Agency); and
 - Any additional consents (including well consent) from the OGA for drilling operations.
- The OGA will also consider the view of the Health and Safety Executive in reaching the final decision on licences.
- 6.31. Now that opportunities for unconventional oil and gas are being explored in the UK, it is conceivable that existing licences may be re-examined for their potential for unconventional resources.
- 6.32. Licensing rounds to date have not presented any new geological information that changes our previous assumptions about the potential for

⁵³ This section is based on Hampshire County Council's *FAQ – Onshore oil and gas (conventional and unconventional (including 'fracking')) development in Hampshire* (August 2018; Version 16) document which is available on the [Hampshire County Council website](#) and is used here with their kind permission.

Worcestershire to contain viable deposits of oil or gas. However, we will keep close watch on any developments that might affect Worcestershire.

European Union Directives

- 6.33. EU Directives are transposed into national legislation through a number of regulations. These cover several areas which affect oil and gas extraction including waste, recycling, water, habitats, and sustainability.
- 6.34. Strategic Environmental Assessment (SEA) is required by EU directive for certain qualifying plans and programmes. The goal of SEA is to increase the consideration of environmental issues during the development of strategic documents, and they are intended to guide decision making.
- 6.35. The European Environmental Impact Directive has been enshrined in national legislation through The Town and Country Planning (Environmental Impact Assessment) Regulations 2017. Environmental Impact Assessments occur at the project level, through the production of an 'Environmental Statement'. The Planning Practice Guidance states that "Significant environmental impacts are best addressed through consideration of an Environmental Statement which will have to accompany nearly all planning applications for new mineral working. Statutory regulators must be consulted as part of the Environmental Impact Assessment process. This ensures that the mineral planning authority has sufficient information on all environmental matters at the time the planning decision is made".⁵⁴
- 6.36. The Habitats Directive protects plants, animals and 'habitat types' which may include designated landscapes, and is a primary piece of European nature conservation policy.
- 6.37. Air quality, safety, water quality and pollution are all also subject to EU directives that are expressed in statutory requirements and national policy.

Environment Agency

- 6.38. The Environment Agency handles the permitting system for many EU directives in the UK. These are collectively known as "Environmental Permitting Regulations" (EPR) and are determined by national legislation and policy. They primarily cover environmental protection and waste management.
- 6.39. The Water Framework Directive protects surface and ground water. Water use is also regulated under the EPR by Water Abstraction Licences. The water needed for oil and gas development may be obtained from the local water supply company or taken from surface or groundwater sources. If an operation plans to "take more than 20 cubic metres [of water] a day, you

⁵⁴ Ministry of Housing, Communities and Local Government (2014) *National Planning Practice Guidance: Minerals: How and when are the details of any significant environmental impacts best addressed?* Paragraph: 011 Reference ID: 27-011-20140306, Revision date: 06 03 2014 [online] Available from the [PPG website](#) [Accessed 27.09.2018].

are likely to need an abstraction licence from the Environment Agency".⁵⁵ Licences will only be granted where a supply is deemed by the EA to be sustainable.

7. Planning issues arising from oil and gas extraction

- 7.1. The NPPF requires the emerging Minerals Local Plan to provide a policy framework that will ensure that the environmental, amenity and other impacts from any oil and gas extraction in the county are acceptable. Potential impacts and other planning issues are detailed below.
- 7.2. Actual impacts will vary depending on the location of the site, and even a small site located within a designated area may have the potential to be more damaging to landscapes, habitats and species than a large operation in an undesignated area that is less sensitive⁵⁶.
- 7.3. As the scale of an operation largely determines the amount of road traffic, as well as the amount of noise, dust, and vibration caused, these issues must be handled on a site-by-site basis for each individual application.

Environmental Impacts

- 7.4. The UK has over 60 years' experience regulating onshore (and offshore) oil and gas extraction activity, and these activities are not deemed to be inherently unsafe. The Royal Society and Royal Academy of Engineering were commissioned by the government to carry out an independent review of the scientific and engineering evidence relating to the technical aspects of the risks associated with fracking in the UK. This report concluded that "the health, safety and environmental risks associated with hydraulic fracturing as a means to extract shale gas can be managed effectively in the UK as long as operational best practices are implemented and enforced through regulation"⁵⁷.
- 7.5. The report continues to state that the "most likely causes of possible environmental contamination include faulty wells, and leaks and spills associated with surface operations. Neither cause is unique to shale gas. Both are common to all oil and gas wells and extractive activities".⁵⁸

⁵⁵ Environment Agency (2014) Guidance: Water management: abstract or impound water [online] Available from the [government's water webpages](#) [Accessed 28.09.2018].

⁵⁶ Thompson, A. et al. (2004) *Planning for the Supply of Natural Building and Roofing Stone in England and Wales (The Symonds Report)*

⁵⁷ Royal Society and Royal Academy of Engineering (2012) *Shale gas extraction in the UK: a review of hydraulic fracturing, p.4* [online] Available from the [Royal Society website](#) [Accessed 28.09.2018].

⁵⁸ Royal Society and Royal Academy of Engineering (2012) *Shale gas extraction in the UK: a review of hydraulic fracturing, p.4* [online] Available from the [Royal Society website](#) [Accessed 28.09.2018].

- 7.6. It is therefore imperative that the Minerals Local Plan supports the robust regulation that is already in place in order to ensure that there are no unacceptable adverse impacts from these operations.

Water Resources⁵⁹

- 7.7. The risk of water contamination associated with oil and gas development is low, provided operations follow industry standards and comply with regulations. It is important that any oil or gas development does not have a significant impact on water resources, particularly when these feed into local water supplies. Water resources and potential impacts on local water availability are very important considerations in the planning process, even though this issue is covered under other regulatory regimes.
- 7.8. The Environment Agency protects water resources as part of its role as environmental regulator (as discussed in the *Regulatory Framework* section above). Before any gas or oil operation starts in the UK, operators must submit details of their plans to the EA for assessment of risks and the acceptability of issuing permits. If proposals are considered to have the potential to contaminate ground water (either directly or indirectly), the EA may find the risk to the environment unacceptable and would not grant a permit. A permit may be issued if the risk can be limited by, for example, the design of the well, monitoring, or limiting the concentration of chemicals.
- 7.9. For unconventional oil and gas development with associated 'fracking', water is an essential part of the process, as it is injected at pressure into the shale rock to help with the gas extraction process. Water use is greatest at the production stage. As a result, the fracking process is likely to use significant volumes of water, although the government does not consider the amount to be exceptional compared to other industrial or leisure activities. The amount of water required during the drilling and production phases of operation is much lower than during the fracking stage.
- 7.10. Water used for hydraulic fracturing is normally mixed with sand and additives to reduce friction. In the UK, it is a legal requirement to disclose fully the composition of fracking fluid additives.
- 7.11. Fracking takes place at such a great depth that the risk of fractures extending into aquifers is negligible⁶⁰, and these resources can be further protected by:
- Ensuring the casing around the wellhole is of an adequate standard;

⁵⁹ This section is based on Hampshire County Council's *FAQ – Onshore oil and gas (conventional and unconventional (including 'fracking')) development in Hampshire* (August 2018; Version 16) document which is available on the [Hampshire County Council website](#) and is used here with their kind permission.

⁶⁰ Royal Society and Royal Academy of Engineering (2012) *Shale gas extraction in the UK: a review of hydraulic fracturing* [online] Available from the [Royal Society website](#) [Accessed 28.09.2018].

- Ensuring adequate distance (and type of rock) between the fracking activity and groundwater;
- Ensuring the chemicals and the quantities used are harmless to the water supply;
- Controlling the storage and disposal of waste (including waste water) from sites.

7.12. Waste water is also regulated by the EA, and operators must obtain environmental permits for the disposal of these fluids and have an agreed waste management plan in place.

*Seismic Activity and Subsidence*⁶¹

7.13. Concerns have been raised about subsidence due to unconventional oil and gas development. However, unlike coal mining, shale gas production does not remove large quantities of rock from under the ground. There are no documented cases of fracturing operations causing subsidence at the surface.

7.14. There are also concerns that fracking can cause seismic activity (earthquakes). Globally, there are no documented cases of shale gas operations (at any phase of development) causing tremors large enough to cause damage to infrastructure on the surface, or to cause injury. This includes the small (2.2 magnitude) earth tremor which occurred near Blackpool in April 2011.

7.15. Following the Blackpool tremors, fracking was temporarily suspended in the UK while an independent review was carried out. The review concluded that the tremors may have been caused by the unconventional gas extraction activities nearby. As a result, a series of safeguards were recommended to prevent a similar situation occurring in the future.

7.16. These new safeguards are required for all fracking operations, and require operators do the following before permission is granted:

- Have procedures to monitor, report and mitigate seismic activity;
- Undertake an assessment of the geological risks including the location of any known faults;
- Submit a Hydraulic Fracturing Plan to BEIS including documenting information about all stages of the development;
- Undertake other detailed risk assessments required by BEIS, including control and mitigation measures for fracture containment and for any potential induced seismic activity.

7.17. Where fracking is taking place, real-time seismic monitoring is required and must comply with a 'traffic-light' warning protocol which requires operations to stop immediately if a seismic event of greater than 0.5 magnitude is detected. A 0.5 tremor is well below the energy level that

⁶¹ This section is based on Hampshire County Council's *FAQ – Onshore oil and gas (conventional and unconventional (including 'fracking')) development in Hampshire* (August 2018; Version 16) document which is available on the [Hampshire County Council website](#) and is used here with their kind permission.

could be felt at the surface. Please refer to the graphic below for a visual representation of the warning system.



Figure 3: Traffic light monitoring system for seismic events related to fracking.⁶²

Dust and air quality

- 7.18. Dust is an important air quality issue that arises from most mineral operations. The NPPF requires that any unavoidable noise, dust and particle emissions and any blasting vibrations are controlled, mitigated or removed at source, and the PPG provides detailed guidance on acceptable dust levels.
- 7.19. Dust is not a major concern for oil and gas extraction because, apart from setting up the site, there is no handling or breaking of soils involved in the process. However, there may be some dust impacts resulting from the construction of the well pad and from vehicle movements during the life of the site. There is also the possibility of negative impacts on the wider environment including heritage, ecology, agriculture and designated nature conservation sites.
- 7.20. Good site management can help reduce the impacts of dust at the source. The PPG requires a dust assessment study to be carried out, and sets out five key stages to such studies.
- 7.21. The severity of dust impacts can depend on the types and sensitivities of nearby receptors. Special care must be taken to ensure that facilities that are sensitive to dust are not unduly impacted by mineral workings. Dust

⁶² Department for Business, Energy and Industrial Strategy (2017) *Guidance on fracking: developing shale gas in the UK* [online] available from the [BEIS website](#) [Accessed 27.09.2018].

impacts arising from extraction can be mitigated through the following means⁶³:

- Using dust filters on equipment where possible,
- Restricting dust-creating activities to certain times or locations,
- Using water sprays and wheel-washes,
- Protecting materials and active work areas from wind.

- 7.22. Natural gas must sometimes be "flared" or "vented" which can also lead to concerns about air quality. Both flaring and venting release greenhouse gases into the atmosphere.
- 7.23. The oil and gas industry strives to avoid flaring and venting wherever possible, as these can be harmful to the environment and to avoid wastage of the valuable gas resource.
- 7.24. In the UK, natural gas can only be vented or flared when necessary for safety reasons, for example to remove gas from the system safely prior to plant maintenance or if there is a problem with the facility. In some cases, natural gas is flared during the exploration phase if it is not economically viable to build the infrastructure to make use of it long-term.
- 7.25. Site operators must monitor air quality and share their results with the Environment Agency and the Health and Safety Executive when appropriate, and they must be able to demonstrate that their activities have not led to air pollution levels higher than those set out in their environmental permits.

*Climate Change and Resilience*⁶⁴

- 7.26. The Council's Minerals and Climate Change background paper outlines some of the key climate change sustainability issues for the minerals sector and areas in which the minerals industry can contribute to sustainability targets. These include energy efficiency and renewable energy, transportation and other emissions, flood mitigation, habitat creation and biodiversity⁶⁵.
- 7.27. There are concerns that oil and gas development will contribute towards climate change through greenhouse gas emissions. As there is a long history of conventional oil and gas development in the UK, the carbon footprint associated with the practices is better known.
- 7.28. However, the potential carbon footprint of unconventional oil and gas development is not yet known due to the limited activity in this area to

⁶³ Arup Environmental/Ove Arup & Partners (1995) *The Environmental Effects of Dust from Surface Mineral Workings*. Report on behalf of the Department of the Environment.

⁶⁴ This section is based on Hampshire County Council's *FAQ – Onshore oil and gas (conventional and unconventional (including 'fracking')) development in Hampshire* (August 2018; Version 16) document which is available on the [Hampshire County Council website](#) and is used here with their kind permission.

⁶⁵ Worcestershire County Council (2013) *Minerals and Climate Change Background Paper* [online] available from the Worcestershire Minerals Local Plan [background documents webpages](#).

date. Though unconventional hydrocarbon development (specifically shale gas) has been proposed as a "bridge" to help the UK transition away from coal-based energy⁶⁶, there is some concern that the potential benefits of shale gas extraction may be offset by methane leakages and undermined by the slow development process, which means that shale gas production won't come online in time to offset the effects of coal in the UK power generation mix⁶⁷. One of the conditions of licencing is that all oil and gas operators must minimise the release of these gases.

- 7.29. There are also concerns that the development of the shale gas industry will undermine the delivery of renewable energy. The government is committed to meeting a legally binding target to cut emissions by at least 80% by 2050, and to meeting renewable energy targets. The government has stated that it will not allow shale gas production to compromise the focus on boosting renewables, nuclear and other low-carbon technologies. However, the Government considers gas to be the cleanest fossil fuel, and part of the answer to climate change as a bridge in the UK's transition to a green future, especially as the country moves away from the use of coal. There is an expectation that gas generation will continue to play a major role in electricity provision over the coming decades alongside low-carbon technologies.

Community and Amenity Impacts

- 7.30. There can be significant community and amenity impacts as a result of oil and gas development. Community impacts can be especially acute as there is considerable public resistance to oil and gas development, especially fracking. This is recognised as a significant issue by the UKOOG, which has produced a Community Engagement Charter which ensures financial commitments to affected communities.
- 7.31. This Charter promises to
- Provide benefits to local communities at the exploration/appraisal stage of £100,000 per well site where hydraulic fracturing takes place, and
 - Provide a share of proceeds at production stage of 1% of revenues, allocated approximately two thirds to the local community, and one third at the county level⁶⁸.
- 7.32. It also promises ongoing engagement with communities from an early stage in the process, and regular monitoring and evaluation of the engagement process.

⁶⁶ Lawson, R. et al (2014) Briefing Paper: *Shale Gas: Four myths and a truth* [online] Available from the [e3g library online](#) [Accessed 02.10.2018]

⁶⁷ London Lawson, R. et al (2014) Briefing Paper: *Shale Gas: Four myths and a truth* [online] Available from the [e3g library online](#) [Accessed 02.10.2018]

⁶⁸ UK Onshore Operators Group (2013) *Community Engagement Charter* [online] Available from [the UKOOG website](#) [Accessed on 01.05.2014]

- 7.33. Many community and amenity impacts are also addressed through the planning system in the form of planning conditions. The following sections detail some of the issues that must be considered at the application stage.

Traffic and Transport

- 7.34. Oil and gas extraction will almost inevitably cause some traffic impacts. Issues will be most acute near the extraction site, as "more distant transport movements are generally dissipated within the whole transport system⁶⁹". It is possible to mitigate traffic issues, and any future applications would need to assess the potential transport implications.
- 7.35. The noise from traffic can be effectively reduced through natural screening using trees and hedgerows or temporary earth bunds or acoustic fencing, but these should be carefully considered to ensure they are appropriate to wider landscape and green infrastructure requirements.
- 7.36. To keep local traffic to a minimum, the use of other means of transport including rail, private roads and waterways should be considered. For oil and gas, pipeline infrastructure is also important.
- 7.37. Some traffic impacts can be mitigated by imposing conditions around working hours for sites, but there may be some periods during oil and gas development when 24-hour access is required.

Noise

- 7.38. Noise is an inevitable consequence of mineral workings. It is an important health and safety consideration for employees in the sector, and becomes an issue for the surrounding area when it disrupts or disturbs people outside the site boundary.
- 7.39. The NPPF requires that any unavoidable noise is "controlled, mitigated or removed at source", and requires the establishment of "appropriate noise limits for extraction in proximity to noise sensitive properties".⁷⁰ However, it also states that planning policies developing noise limits should "recognise that some noisy short-term activities, which may otherwise be regarded as unacceptable, are unavoidable to facilitate minerals extraction".⁷¹
- 7.40. Noise can be created during site preparation, drilling, and during the transportation of material around and off the site. It can be of particular concern during drilling operations which may continue 24 hours a day.
- 7.41. In addition to setting noise limits, there are a number of other ways to mitigate the noise impacts caused by oil and gas extraction:

⁶⁹ British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.

⁷⁰ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 205(c).

⁷¹ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 204(g).

- Limiting working hours
 - Taking care with reversing alarms
 - Switching off machinery when not in use
- 7.42. Site design is also an important factor for managing noise impacts, and planted screens and bunds may assist with noise management in addition to addressing dust and visual impacts (though in some cases the bunds themselves may cause a nuisance).

Visual Impacts

- 7.43. Any large minerals extraction operation will have visual impacts on the landscape, as will any large associated buildings or machinery. Any mineral working must consider the effect it will have on the surrounding area, both during working phases and in the final restoration scheme. Oil and gas developments are often relatively small in size (1-2 hectares per well pad), but in areas where there are a number of wells, the cumulative visual impact of these may be substantial.
- 7.44. One of the main visual impacts of oil and gas developments is the drilling rig and well. These can be up to 45 metres high, which is higher than a 10-storey building. In a very flat landscape with little forest cover, these could be intrusive features.
- 7.45. Careful siting of well pads is possible through the use of modern drilling technology, and this must be considered at the application stage.
- 7.46. Planting of tree screens, hedgerows or other vegetation may help mitigate some of the visual effects of a development as well. Topsoil, subsoil, and other overburden that must be removed prior to extraction may be used to construct bunds or mounds around the site that could help reduce the visual impact (as well as contribute to noise and dust mitigation) of the site and ensure that the materials are retained on site for use in site restoration.
- 7.47. However, any mitigation of visual impacts must also be handled sensitively to ensure that they do not become intrusive features in their own right. For example, in a very flat landscape, bunds may be out of keeping with the surrounding area and be more intrusive than simply leaving the working site unscreened.

Protected sites and designated landscapes

- 7.48. National and international protected area designations afford a high degree of protection from development, including mineral development. Local sites can also be designated for a variety of purposes including nature and geological conservation, and the County Council regards these sites as material considerations. The Green Infrastructure approach adopted by the council is founded in the idea that it is possible to successfully safeguard the natural environment and sites of historical

importance as well as manage the impacts of mineral development through comprehensive restoration plans.

- 7.49. We don't have enough information about prospective oil and gas in Worcestershire to know whether designated landscapes would be disproportionately affected by potential development.
- 7.50. Fracking in certain designated areas is restricted under legislation. Section 50 of The Infrastructure Act 2015 states that the Secretary of State may not issue a hydraulic fracturing consent unless s/he is satisfied that various conditions are met, including that "The associated hydraulic fracturing will not take place within other protected areas". "Other protected areas" are defined under Regulation 3 of The Onshore Hydraulic Fracturing (Protected Areas) Regulations 2015⁷² as "areas of land at a depth of less than 1,200 metres beneath [inter alia] an area of outstanding natural beauty". This means that the likelihood of fracking within the Cotswolds or Malvern Hills AONBs is greatly reduced. Worcestershire does not include any of the other types of protected area referred to in the legislation.

Green Belt

- 7.51. The north eastern part of Worcestershire lies within the Green Belt. Kidderminster, Bromsgrove and Redditch are completely surrounded by Green Belt and the area between Worcester and Droitwich is also designated as Green Belt. National policy on mineral working in Green Belt land will apply here.
- 7.52. The NPPF states that there should be no inappropriate development in the green belt, but that mineral extraction is not inappropriate provided it preserves the openness of the Green Belt and does not conflict with the purposes of including land within it⁷³.
- 7.53. We do not currently have any information about the geological potential of Worcestershire's Green Belt land for oil or gas. The nature of particular deposits will determine the configuration of any site proposed within the Green Belt.

Potential for Restoration

- 7.54. Mineral extraction is ultimately a temporary land use, and old mineral sites can present excellent opportunities for restoration and for biological, geological and cultural conservation. The NPPF requires planning policies to "ensure that worked land is reclaimed at the earliest opportunity, taking

⁷² It should be noted that this is a draft item of legislation and has not yet been made as a UK Statutory Instrument.

⁷³ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework, paragraph 146(a)*.

account of aviation safety, and that high quality restoration and aftercare of mineral sites takes place".⁷⁴

- 7.55. The nature of onshore oil and gas sites is such that they are often fairly small (1-2 hectares), though there may be a group of sites of that size within a local area depending on the geology of the deposit.
- 7.56. Operators are required to include a restoration and aftercare plan with their application to the MPA. Once drilling is complete, wells "may be suspended to allow for future testing. If it is concluded that there is no petroleum present or not in commercial quantities then the well will be abandoned, in accordance with the latest Oil and Gas UK standard"⁷⁵.
- 7.57. Restoration of oil and gas sites typically involves the removal from the site of all equipment that was brought in to conduct the operations. Health and Safety regulations come into play at this stage as well, as the Health and Safety Executive (HSE) must be notified when a well is abandoned to ensure that the process complies with legislation and that there is no unplanned escape of fluids⁷⁶.
- 7.58. The heavy involvement of Natural England and the RSPB in conservation efforts with aggregate quarries has led to a focus on biological and ecological conservation opportunities for quarries. Much of the best practice guidance for quarry restoration applies to large-scale sand and gravel sites that are able to progressively return large areas of former workings to productive use and contribute to biodiversity or habitat creation targets. There is much less information available that specifically deals with oil and gas sites.
- 7.59. Due to the nature of oil and gas extraction, i.e. via a well that produces over a long period of time, phased or rolling restoration may prove difficult. However, there will likely be opportunities to contribute to the county's Green Infrastructure goals during the operational phase of development.
- 7.60. The County Council would usually expect sites to be cleared completely during decommissioning, and any boreholes to be made safe. Any alternative restoration would need to be expressly justified and would usually need a specific planning permission for any subsequent use or development. We would also expect any restoration plan to tie in to our Green Infrastructure priorities. Restoration options for these sites should result in acceptable landforms that are sympathetic to their surroundings and in keeping with the landscape character of the area.

⁷⁴ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework, paragraph 204(h)*.

⁷⁵ Department of Energy and Climate Change (2013) *Onshore oil and gas exploration in the UK: regulation and best practice* [online] Available from the [government publications website](#) [Accessed 27.09.2018]

⁷⁶ Department of Energy and Climate Change (2013) *Onshore oil and gas exploration in the UK: regulation and best practice* [online] Available from the [government publications website](#) [Accessed 27.09.2018]

Historical Conservation

- 7.61. The historical aspects of minerals extraction may fit into one of several categories: archaeological remains on the site (including the remains of other historical workings in the same location which require preservation); the impact of the development on the settings of listed buildings, monuments or other sites; and changes to historic landscape character.
- 7.62. Like minerals, archaeological remains can only be extracted from where they occur. As these remains are irreplaceable once they have been removed, it is critical to take proper care with their handling. Archaeological remains on oil and gas sites may be found in the topsoil, subsoil, or overburden, and are most likely to be found during construction of the well pad.
- 7.63. Each of these categories presents unique circumstances for site restoration. In the case of archaeological remains, discoveries may ultimately be removed from the site altogether after excavation and therefore not have any implications for the site's restoration plan. However, if remains are deemed nationally significant, best practice might demand that they be preserved in situ. A restoration plan for a site that impacts the setting of a listed building might be dedicated to improving that setting and enhancing the historic landscape character, leaving it in better condition than it was found, or in a state that better reflects the historical context in which the building was originally found.
- 7.64. If the preliminary work for a project has identified archaeological issues, a full archaeological assessment (which would normally form part of the Environmental Impact Assessment) may be required. This may be sufficient, but in some cases, further work might be required or there may be a requirement to preserve any new finds in situ during the work where appropriate.
- 7.65. Restoration plans for oil and gas sites will also need to consider potential impacts on the settings of listed buildings, ancient monuments, or other sites, as well as potential changes to the landscape character.

Geological Conservation

- 7.66. Geological conservation generally involves maintaining an exposure of interesting strata after a quarry has been abandoned. The nature of oil and gas extraction is such that no exposures usually become or remain visible, as all of the activity takes place beneath the surface. While the wider site area could in theory conceal notable exposures, the potential for geological conservation as part of a restoration plan for an oil or gas site is fairly limited, and restoration options that incorporate geoconservation aspects may be limited to educational resources.

Safeguarding Mineral Deposits

- 7.67. The NPPF requires that planning policies "adopt appropriate policies so that known locations of specific minerals resources of local and national importance are not sterilised by non-mineral development where this should be avoided (whilst not creating a presumption that the resources defined will be worked)".⁷⁷ It also requires that appropriate facilities which support minerals production and processing be safeguarded.
- 7.68. Safeguarding is a key aspect of sustainable development, as it ensures that non-renewable resources are conserved for the use of future generations⁷⁸. The most recent guidance on this issue is provided in the 'Minerals' section of the PPG, which states that "there is normally no need to create mineral safeguarding areas specifically for extraction of hydrocarbons given the depth of the resource, the ability to utilise directional drilling and the small surface area requirements of well pads"⁷⁹.

⁷⁷ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 204(c).

⁷⁸ Wrighton, C. E., McEvoy, F. M., and Bust, R. (2011) *Mineral Safeguarding in England: Good practice advice* British Geological Survey: Open report

⁷⁹ Ministry of Housing, Communities and Local Government (2014) *National Planning Practice Guidance: Minerals: Should mineral planning authorities be safeguarding areas for the extraction of hydrocarbons?* Paragraph: 108 Reference ID: 27-108-20140306, Revision date: 06 03 2014 [online] Available from the [PPG website](#) [Accessed 27.09.2018].

8. Carbon Capture and Underground Storage

- 8.1. Underground structures, including man-made and natural spaces, have the potential to be used for a wide variety of storage and disposal purposes. There can be concerns about the stability, pollution and safety of such developments, and geologically these spaces must be stable and secure for them to be considered.
- 8.2. There are numerous examples of underground structures being used for document, waste, water, and hydrocarbon storage. The underground storage of natural gas may also be possible. This is a complex issue but we have no geological information that indicates that Worcestershire would be prospective for this type of underground storage.
- 8.3. There is growing interest in the long-term potential for the injection and storage of carbon dioxide (CO₂) underground to contribute to reducing greenhouse gas emissions and climate change. The NPPF states that minerals planning authorities should "encourage underground gas and carbon storage and associated infrastructure if local geological circumstances indicate its feasibility".⁸⁰
- 8.4. Carbon capture and storage consists of three steps:
 - Capturing and compressing CO₂;
 - Transporting compressed CO₂ to a storage location by pipeline;
 - Isolating the CO₂ for the long term⁸¹.

There are now 17 large-scale CCS facilities in operation globally, with five more under construction. There are not yet any operational projects in the UK, although approval was gained in 2017 for a project to transport and store CO₂ under the North Sea.⁸²

- 8.5. CO₂ changes from a gas to a liquid at temperatures and pressures equal to being stored at depths of about 800m. Liquid CO₂ takes up much less space than gas, and storage of this liquid may take place in porous reservoir rocks, coal seams, or oil and gas fields. Because both liquid and gas CO₂ is less dense than water, underground storage requires a cap that will seal and isolate the CO₂ from escaping. Ideal geological conditions include a porous and permeable storage rock below 800m with a cap rock that has very low permeability and forms a geological barrier⁸³.
- 8.6. There is no detailed or specific regulatory framework for underground CO₂ storage as of yet. It seems likely that the Environment Agency, with their

⁸⁰ Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 209(c).

⁸¹ British Geological Survey (2008) *Underground Storage* Minerals Planning Factsheet, p14.

⁸² London School of Economics/Grantham Research Institute on Climate change and the Environment (May 2018) *What is carbon capture and storage and what role can it play in tackling climate change?*

⁸³ British Geological Survey (2008) *Underground Storage* [Online] Available from the [BGS website](#) [Accessed 02.10.2018]

corresponding responsibilities for water management, pollution control and waste regulation, would be heavily involved in their eventual development. We do not have enough geological information to know whether Worcestershire might be considered prospective for this type of development. The Minerals Local Plan will include policies that would enable applications for planning permission to be assessed.

9. Conclusions

- 9.1. Oil and gas are essential to the UK economy and energy sources. The UK has a long history of oil and gas extraction and the government is currently pursuing policies in favour of hydraulic fracturing.
- 9.2. There have been concerns expressed about the environmental and health effects of fracking on communities.
- 9.3. It is important that the emerging Minerals Local Plan contains robust policies to enable the assessment of proposals for development if they come forward. The policies should ensure that there are no unacceptable adverse effects on the environment or human health due to any future oil and gas extraction in the county.
- 9.4. The restoration of oil and gas sites presents opportunities to contribute to the strategic restoration goals and the Green Infrastructure priorities embedded in the emerging Minerals Local Plan.
- 9.5. There has been no oil or gas production in Worcestershire to date, and the geological information that we have available indicates that this is unlikely in the near future.

Appendix 1: Glossary

Appraisal: A process whereby a site operator gathers more information about the extent of an oil or gas deposit, its characteristics, and/or its economic viability.

Beam pump: The main visible portion of a reciprocating piston pump in an oil well used to mechanically lift liquid out of the well, also known as a "nodding donkey" or a "pump jack".



Figure 4: Beam Pump. (Photo copyright Richard Croft, Creative commons Attribution - ShareAlike 2.0 licence)

Borehole: A long, narrow shaft in the ground. May be vertical or horizontal, and may be used for a number of purposes.

Coal bed methane: A form of natural gas extracted from coal beds.

Decommissioning: To remove from service, deactivate, shut down, dismantle.

Directional Drilling: the practice for drilling non-vertical wells or boreholes. Normally steerable from a rig at the surface, wells can be made to follow a prescribed path from vertical to horizontal, or diagonally along shallow arcs.

Energy security: this term refers to an uninterrupted supply of energy sources at an affordable price. Originally coined in the 1970s to refer to oil security, the term has broadened and now encompasses a more comprehensive understanding of a variety of energy sources, associated infrastructure and power generation.

Flaring: the controlled burning of natural gas.

Fossil Fuels: Fuels formed by natural processes of decomposition and compression over millions of years. These contain a high percentage of carbon, and include coal, petroleum and natural gas.

Fracking: See **Hydraulic Fracturing**.

Hydraulic Fracturing: A mining technique which uses a liquid mixed with sand and chemicals injected into a borehole at high pressure to create small fractures (usually smaller than 1mm in width) which allow liquids or gases to flow to the well. Once the pressure is removed from the well, the grains of sand serve to hold the fractures open. Also called "fracking".

Hydrocarbons: Any organic compound made entirely of hydrogen and carbon. Found in crude oil, natural gas, coal, and plants.

Natural Gas: A fossil fuel consisting mainly of methane, a hydrocarbon gas.

Nodding donkey: See **Beam Pump**.

Reserves: The part of a mineral resource which has been fully evaluated and appraised and is deemed commercially viable to work. The extent of reserves can only be determined after a detailed appraisal process, and the capital involved in taking a site to this point can be substantial. In the context of planning, the term "reserves" should be further restricted to minerals with legal access and for which valid planning permission for extraction also exists (i.e. "permitted reserves"). Therefore reserves must also meet geological and economic criteria, but also accessibility based on legal permission to extract the mineral. Permitted reserves form a small part of total mineral resources⁸⁴.

Reservoir rocks: A permeable sub-surface rock that contains hydrocarbons. Generally sedimentary rocks, including shales, sandstones and carbonates, these must be both porous and permeable.

Resources: Natural concentrations of minerals of a sufficient size that are or may become of potential economic interest due to their inherent properties. The status of a resource in economic terms may change over time as markets decline or expand, transport links and distribution networks change and as extraction and processing technology improves. "Resources that might previously have remained unworked, because of their poor quality [...] are increasingly being considered as potential sources of supply⁸⁵" and this is particularly the case with unconventional hydrocarbons.

Restoration: A process whereby a former mineral extraction site is returned to beneficial after-use. Though oil and gas extraction may take place over a long period of time, it is ultimately a temporary or intermittent land use, and once the site is exhausted, it will no longer be useful for mineral extraction

⁸⁴ British Geological Society (undated) *What is the difference between resources and reserves?* [online] Available from the BGS website [Accessed 03.10.2018]

⁸⁵ British Geological Society (undated) *What is the difference between resources and reserves?* [online] Available from the BGS website [Accessed 03.10.2018]

and an after-use will have to be established. This is often referred to as "restoration", even though sites are not always returned to their original use or condition. For example, it may be more appropriate for low-grade agricultural land to be 'restored' as a lake or nature reserve rather than returned to agriculture.

Seismic Survey: A form of geophysical survey that measures the earth's properties by means of physical principles. Similar to an ultrasound, it measures the properties of sub-surface materials by measuring their response to artificially-generated vibrations.

Shale Gas: A natural gas, primarily methane, found in shale rock.

Source rocks: A sedimentary rock in which hydrocarbons form or are capable of forming.

Tight gas: Natural gas that is produced from reservoir rocks with very low permeability, such that hydraulic fracturing is required to make them economical. Though shale has low permeability and low porosity, shale gas is usually considered separately, as tight gas most commonly refers specifically to sandstone and limestone. In general, the same technology used to extract shale gas can be used to extract tight gas.

Venting: the controlled release of natural gas without burning.

Worcester Basin: A sub-surface geological valley or "graben" which runs north-south, mainly comprising Permian and Triassic sandstones. Please refer to the map on the next page.

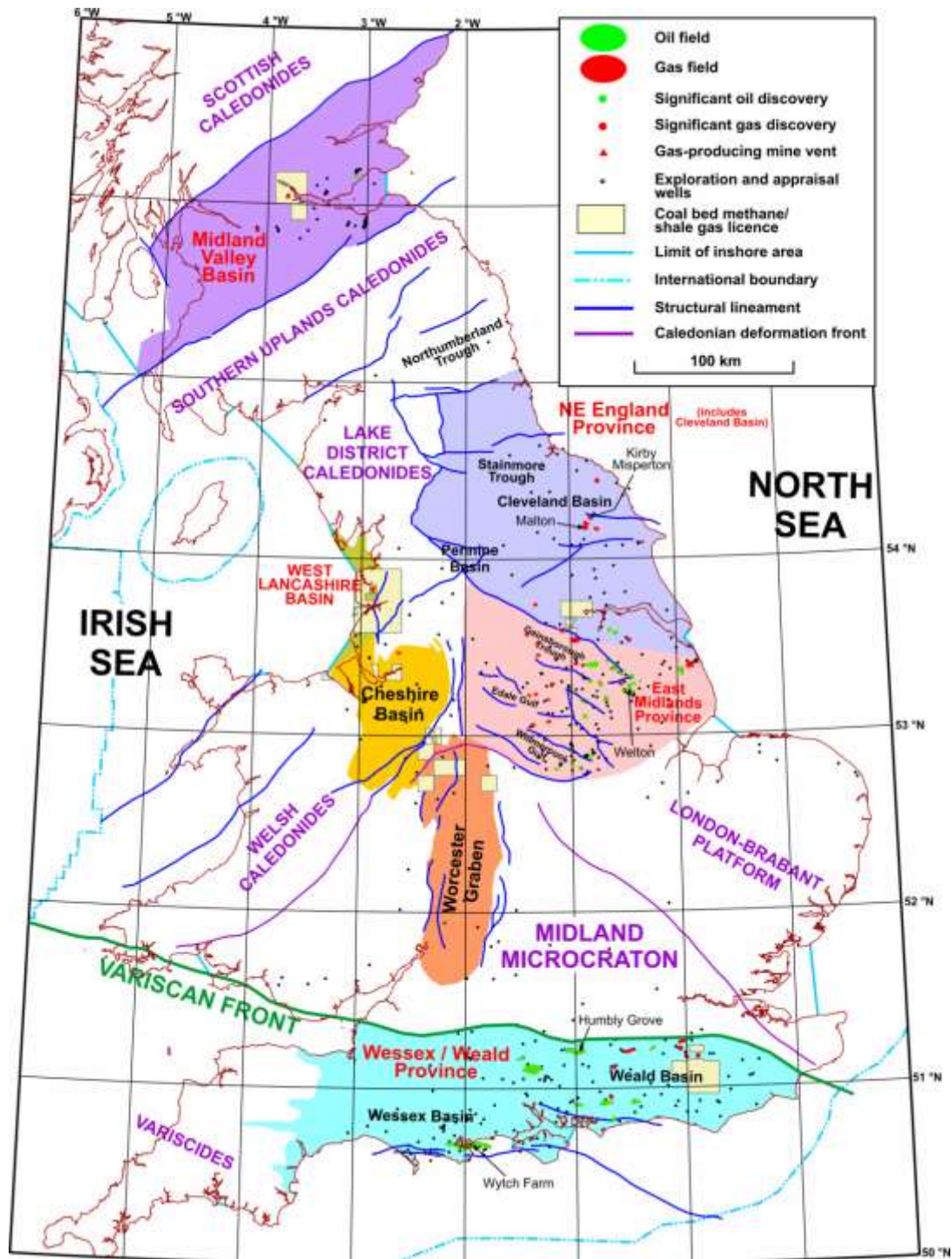


Figure 5: Map showing the main UK onshore hydrocarbon "provinces", showing the location of the Worcester Basin or Graben. (DECC 2012)

Appendix 2: Additional Resources

There is a wealth of information about oil and gas extraction in the UK available online. The following represents a list of some of the most comprehensive and useful websites:

British Geological Survey

*Mineral Planning fact sheets on **Onshore Oil and Gas** and **Alternative Fossil Fuels** available for download on the [BGS website](#). There is also a [Herefordshire and Worcestershire mineral resources and constraints map](#).*

Hampshire County Council

Hampshire County Council has produced an excellent FAQ document on oil and gas extraction, including unconventional hydrocarbons, which is available on the [Hampshire County Council website](#).

Government and Industry Websites

The [Oil and Gas Authority website](#) contains extensive information about the process and regulation of oil and gas extraction:

The [UK Onshore Operators Group website](#) presents an industry-focused perspective on the industry.

Campaign to Protect Rural England

CPRE has a number of documents on shale gas available on [their website](#).