CIWEM Chartered Institution of Water and Environmental Management

Shale Gas and Water 2016 Summary Report

An independent review of shale gas extraction in the UK and the implications for the water environment

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Laura Grant, Policy Adviser

Alastair Chisholm, Head of Policy and Communications

In compiling this review CIWEM has consulted widely with its membership and technical panels, hosted a national conference on shale gas and met with the key stakeholders from the government, regulators, shale gas and water industries and civil society groups.

This report provides an update to the January 2014 report *Shale Gas and Water*.

The full report can be found at *www.ciwem.org/shalegas*

CIWEM Chartered Institution of Water and Environmental Management

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- Brings members from all over the world together under common policy and technical issues
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Summary Report

Purpose

The use of water in hydraulic fracturing to unlock natural gas trapped in shale formations has brought the water-energy nexus to the fore. In 2014 CIWEM published a review of the implications for the water environment with ten recommendations for action. Although exploration has not progressed in the UK during this time, there have been considerable developments in legislation, policy and regulation.

This report provides an update for 2016, reviewing the latest publicly available evidence to assess the likely viability, scale and timing of shale gas exploitation in the UK. From consultation with experts, it then considers if an industry of any significant scale were to develop, what the implications of hydraulic fracturing of shale would be for water resources, water treatment and the water environment. In this context, the report also considers the suitability of the current and expected future regulatory requirements for mitigating the industry's potential impacts on the environment.

This report does not consider in detail whether shale gas can be a sustainable, bridging energy source for the UK as part of a longer-term programme of decarbonisation, nor does it assess the robustness of UK Government's wider energy policy. These issues and wider environmental issues, such as the release of fugitive emissions and induced seismicity, are examined in a separate policy position statement by CIWEM

CIWEM's Position

Environmental risks of shale gas extraction

Extracting shale gas via hydraulic fracturing and directional drilling generally poses greater environmental challenges than conventional methods of gas extraction. The environmental risks include water resource requirements, the potential contamination of ground and surface waters with methane or other pollutants used in, or mobilised by the drilling and hydraulic fracturing process, the release of fugitive methane to the atmosphere, localised air pollution, landscape and visual amenity intrusion and the potential consequences of induced seismicity. A robust regulatory regime is required to mitigate risks and to improve general public confidence in what is presently a highly controversial process.

The development of shale gas in the UK

Two years on from CIWEM's initial report, little progress has been made in terms of wells drilled, and this has been largely from delays and rejections to planning applications. However we consider that this has been of benefit, as in the interim there has been time for new legislation to be developed, the industry has collaborated and developed guidelines and the regulators have produced standard rules and guidance on best available techniques to minimise environmental harm.

The UK Government has expressed a commitment to facilitate exploration for shale gas and is putting in place a regulatory regime which it hopes will provide appropriate safeguards to

communities, employees and the environment, whilst at the same time avoiding obstruction to the industry to a level that would discourage interest in this exploration. Exploration involving drilling is necessary to properly understand the size of the shale gas resource and, in the event that this is sufficiently large, how economically viable gas extraction might be. Until such exploration has taken place, a reliable estimate of the likely size and nature of any subsequent production industry is extremely uncertain.

The viability of shale gas as an economically extractable fuel resource for the UK centres upon the following key issues:

- **Resource size** with the need for sufficiently large and appropriate gas-bearing shale formations to make exploration and exploitation worthwhile as a means of providing an indigenous source of gas.
- **Extraction technology** that enables extraction to be economically viable and a skilled workforce and service sector to enable the gas to be safely secured.
- **Environmental regulation** to ensure a streamlined system that does not threaten the environment nor restrict an industry from developing.
- **Public acceptance** providing a social licence to operate for the shale gas operators. Acceptance of the visual and physical disruption associated with the drilling process in particular, especially where there might be a high density of shale gas well pads.
- **Economics** of extraction and the commodity price to be sufficiently attractive to enable a profitable industry to develop.

This report looks at each of these aspects in depth and concludes that delays in the planning and permitting process remains a barrier to the quick development of an extensive industry in the UK. A greater concern may be the ability to achieve an economically attractive return in light of higher production costs and falling oil prices. Innovation in technologies for wastewater treatment is also likely to be required to bring costs down.

It is important to emphasise that despite the extensive UK media coverage of the issue of shale gas extraction in recent years and the often vociferous nature of opposition from a growing number of local pressure groups, the activity, even at this very early exploration stage, is embryonic in the UK. In addition and for various reasons which are discussed in this report, the expansion of any industry, in the event of promising exploration outcomes, will almost certainly not be quick.

It is equally important to emphasise that whilst politicians may wish to draw favourable comparisons with experiences in the United States of America (US), the observed dramatic downward pressure on wholesale gas prices experienced there is unlikely to be seen in the UK. Likewise, because of factors such as population density, associated local opposition, geology, technological advancement and a more robust regulatory regime, any industry will look quite different to that in the US and what is commonly depicted by opposition groups with very large fields of drilling pads causing widespread landscape impact. It will need to be a well-run industry, operating with a high level of transparency, suitably involving stakeholders at all levels and employing best available techniques in order to minimise disruption.

Impacts on the water environment

An understanding of the likely size of any shale gas industry, together with its geographical focus is essential in order to appreciate the impact of this activity on the water environment. However, despite the absence of this picture, we can identify the key risks and assess impacts across a likely scale. We can also recognise the priorities for information sharing and disclosure and make recommendations for where improvements in current industry and regulatory practice should be considered.

Water use

The process of extracting shale gas is carried out in stages, with water required during the drilling and hydraulic fracturing stages. When compared to the lifetime of a shale gas well, the period for water demand is quite short and focussed at the early stages of the well's development. There are a number of factors affecting the water use of an individual well and therefore estimates are wide ranging. A typical volume of water used in the hydraulic fracturing process is between 10-20 Ml per shale well over a five to seven week period.

To understand a more regional picture with multiple sites, UK research has suggested that for 1000 wells, the estimated peak demand is 2.2 Ml per day. For comparison United Utilities in the North West currently supply around 1,750 Ml per day of drinking water in a normal year. Therefore in the context of regional water supply it constitutes a small fraction of what a single water company might be asked to supply. The water industry does not for the time being appear concerned about its ability to supply a shale gas industry as a customer during the exploration stages as suggested by their Water Resource Management Plans. There are other options for supply, such as direct abstraction, should supply from a water company not be appropriate.

However should a significantly sized production industry develop, there may be local consequences in some catchments in the south east which are already water stressed. In these cases it will be up to the water companies to decide if they are able to supply the water or the relevant environmental agency if it is to be abstracted. Where water stressed catchments and shale gas licence areas coincide, operators will need to be aware of the risk that there may be reduced volumes available in the future. The likelihood of water shortages may increase and such incidences may restrict the industry's operations.

There is the potential for drilling and fracturing processes to be timed as to when volumes of water are available. Furthermore, research is ongoing into hydraulic fracturing techniques that use less water and methods to increase the proportion of flowback water that could be treated and reused directly on site. Recycling and good onsite management is important to ensure that water efficiency is addressed. Where there are multiple companies operating in a particular area, collective water supply and reuse systems could provide efficiencies.

It is therefore considered that water supply issues will be local and early engagement by shale gas companies with the environment agency and water companies is essential to establish the nature of any risks and manage them accordingly. CIWEM considers companies should continue to work to improve the accuracy of their water consumption and production estimates and communicate these with water companies.

Water pollution

A frequently expressed public concern associated with shale gas operations is that contamination of groundwater could occur. This may result from a catastrophic failure or loss of integrity of the wellbore, or if methane or contaminants can travel from the target fracture through subsurface pathways to an aquifer. There is also the potential for pollution of the local land and water environment if the returned water from the hydraulic fracturing process is not appropriately contained, managed, and treated prior to eventual disposal. Any material spilt on or applied to the ground has the potential to reach the water table.

Risks to groundwater quality from mobilisation of methane and other contaminants, are generally considered to be low where target shales exist at considerable depths below aquifers and contaminants would be required to migrate many hundreds of metres between source rock and sensitive overlying groundwater. New regulations restrict hydraulic fracturing to below 1200 metres in source protection zone 1 to protect public drinking water supply. This is also the case in National Parks, the Broads, Areas of Outstanding Natural Beauty and World Heritage sites. Elsewhere the Environment Agency has stated it will object to shale gas extraction infrastructure or activity where the activity would have an unacceptable effect on groundwater, or if it is close to sensitive receptors it will adopt the precautionary principle through planning or permitting controls.

Where the source rocks are shallower and regulations permit, the risk of contamination of water resources and the environment is to be thoroughly assessed during the planning and permitting stages. Current regulation requires operators to produce a hydrogeological assessment conducted by a specialist expert at the planning and permitting stages and when submitting an intention to drill a borehole. This will evaluate any risks to groundwater from substance used or released from drilling and well stimulation activities.

Risks to groundwater from wellbore failure must continue to be seriously considered by all appropriate regulators and construction closely monitored to ensure that best practice is followed. There needs to be high clarity and transparency about the methods used to continually verify well integrity throughout the exploration, production and decommissioning phases, with all permit-specified data placed rapidly in the public domain, and interpreted by the regulator. Rigorous well testing can help to identify any potential problems that can then be repaired before operations re-commence.

CIWEM considers the most significant risk relates to the management of flowback and produced water. Any negligence associated with storage, transportation and operations resulting in spills represent the greatest threats to surface water, as well as to groundwater. Good pollution prevention practice will be essential during exploratory phase as well as the construction, production and decommissioning phases. These can be effectively managed through robust best practice and there is no reason why this should not be achievable. Close monitoring and scrutiny by regulators, allied to strict enforcement, will continue to be essential to ensure that the industry acts in an appropriately responsible manner. The Environment Agency also expects operators to demonstrate best available techniques to protect groundwater in their permit applications.

In order to establish the current condition of the water environment and successfully identify where contamination may have occurred, either as a result of shale gas-related activities or

others, good baseline data are required. Experience from the US and Australia shows that without good baseline data, it is hard to scientifically establish a cause of contamination and this fosters conjecture, commonly leading to a polarised discussion lacking in robust evidence. It is important that before shale gas activities commence, baseline data for appropriate contaminants are obtained for soil, ground and surface waters that are potentially at risk.

In the early phases of development of UK-relevant techniques it will be reasonable for the regulators to require intensive monitoring data from the operators to verify the safety and integrity of the techniques. Data quality specifications, laboratory inter-calibration and quality assurance systems will be essential to establish trust. It should be expected that, once the operators have demonstrated the suitability and low risk of pollution from fracking techniques, the level of monitoring data may safely be reduced.

Water treatment

Flowback and produced water will need to be treated before being returned to the environment. The technologies required will depend on the contaminants present and these in turn will reflect the local geology and the composition of the fracturing fluid. Specialist commercial treatment facilities will need to be used where the wastewater is not of a composition that is acceptable at public wastewater treatment plant permits.

Treatment and reuse of produced and flowback water is an area where technology is rapidly developing and may enable on-site treatment by the time an industry is in any way mature in the UK. Otherwise, a supply-chain of specialist treatment facilities will need to develop to meet market need where this cannot already be provided by larger public and industrial wastewater treatment sites.

Reuse of flow back and produced water arguably represents the most sustainable process in terms of water resource use and also reduces the risks associated with transporting waste. Reusing and recycling of produced waters also acts to reduce the volumes of water and waste ultimately requiring final treatment and disposal. The re-injection of flowback and produced water must be carefully regulated to ensure that there are no cases of induced seismicity. The final guidance on re-injection for reuse and disposal is expected in early 2016.

Public acceptance

CIWEM considers that the importance of clear, open stakeholder engagement from all parties cannot be overstated with an issue which is subject to such passionate debate. Water lies close to the majority of concerns expressed by stakeholders in this discussion and it is important that all parties properly understand the impacts of the current exploration industry as well as those that are likely to require management were a moderately sized extractive industry to develop.

Given the proximity of any industry to local populations in the UK and the ability of opposition groups to mobilise against risks they perceive to be unacceptable, any UK shale gas industry will need to be an exemplar of good practice, alongside those bodies which govern and regulate it. It is important that the public are reassured that regulation is fit for purpose and that transparency is displayed at all levels in order to establish trust.

Finally, in updating this report we have been pleased to observe that the UK is moving in the right direction with regulations being developed that protect the water environment and several stakeholders working collaboratively to establish baseline studies, guidance and best practice. Many of the ten recommendations we first set out have now been implemented or are in train. However, this does not preclude the need for continual scrutiny and diligence by all parties concerned and further research and practice in the areas highlighted below.

Progress since CIWEM's 2014 recommendations

	Recommendations	Progress
1	**Government departments and agencies should actively promote informed understanding among stakeholders using clear scientific evidence, transparency and consistent messages, across a range of media and forums. Government Ministers should ensure that their messages on shale gas are consistent with those of the departments.**	The relevant Government departments and agencies have made considerable progress to improve public understanding. DECC and the regulators have produced a wealth of material and guidance to this aim. However there is still some inflammatory language being used by some senior Parliamentarians. A series of Government 'u turn' announcements on protected areas has undermined some public trust, although generally the outcome has been welcomed as improving environmental protection. The change to allow the intervention of Secretaries of State in determining planning appeals is likely to cause deepened public concern with the erosion of localism.
2	**The industry should ensure it complies with the UK Onshore Oil and Gas (UKOOG) community engagement charter so that the public are involved within the planning process with adequate notice and information. The production of guidance for local communities on what they can expect and where they can and cannot influence would be helpful.**	The industry, through UKOOG, has committed to conducting early stage environmental risk assessments to be discussed with local communities and Environmental Impact Assessments associated with sites that include hydraulic fracturing. These commitments have been put in place for planning applications submitted for three sites in Lancashire and North Yorkshire. Yet public opposition in these areas remains strong. Building public trust is still a key issue for the industry to ensure it has a social licence to operate. UKOOG has also published further guidelines for the industry on addressing public health and

		establishing environmental baselines which will be helpful in building the integrity of the industry.
3	**Further collaboration between the agencies involved in advising and regulating the industry is required. As regulation is developed for the appraisal and production phases, a rationalised and integrated system of risk assessment should be included to avoid confusion, increase public engagement and reduce delays.**	The Oil and Gas Authority (OGA) has been set up as an executive agency of DECC, although regulatory responsibility still sits between a number of agencies. It is possibly too early to assess the work of the OGA and how it will work with the others involved in regulation. The Environment Agency is working on sector guidance for permitting and best available techniques (BAT) for the industry where these are available. It has also established standard rules permits to reduce delays. The industry has produced draft guidelines on Environmental Risk Assessment and Environmental Impact Assessment, which it expects to complete in early 2016. These should be independently scrutinised to ensure that they adequately protect health and the environment.
4	**CIWEM believes water and sewerage companies should become statutory consultees in the shale gas planning process regardless of whether they continue to provide and treat water for the industry. They must be engaged with early and provided with the right information to meet their duties.**	It is welcome that this has been recognised and progressed through the *Infrastructure Act 2015* and implemented in *The Town and Country Planning (Development Management Procedure (England) Order 2015*. It will now be for shale gas and water companies to build relationships and make sure that this is put into practice, particularly as the industry moves into the production phase.
5	**The importance of baseline monitoring cannot be overstated. Regulators must ensure that an environmental baseline is fully established before any commencement of drilling activity and this should include both deep and shallow aquifers for radio-nuclides and other contaminants. Full details of the environmental monitoring programme should be disclosed.**	The British Geological Survey (BGS) has completed a national baseline methane survey and is undertaking comprehensive baseline monitoring at two proposed sites in Lancashire and one in Yorkshire. It is welcome that this is independent from the industry and the findings should be used to update baseline monitoring guidelines and used at all sites in the future. Draft Environment Agency guidelines set out that a site condition report is required before commencement of operations.

		UKOOG published baseline monitoring guidance for soil, air and water before and during operations in 2015 with which all of its Members must comply.
6	**The long-term monitoring of relative conditions to the environmental baseline in the vicinity of the well and nearby receptors throughout the lifetime of the well will be important to detect any contaminants. In developing production guidance, parameters on the frequency, locations and time scale of measurements should be included.**	The *Infrastructure Act 2015* now requires appropriate arrangements for the monitoring of emissions of methane into the air for the duration of the permit. The Environment Agency has produced draft guidance for operational monitoring on a wide range of aspects. It considers it best practice to undertake groundwater monitoring even if it not required by a permit. The BGS comprehensive baseline study should be used as a strong evidence base against which to any future changes in environmental condition can be assessed and future monitoring programmes designed.
7	**The protection of groundwater must be made a priority and the environmental regulator should continue to adopt the precautionary principle where there is insufficient certainty to protect groundwater. Operators should provide the environmental regulator with a detailed risk assessment to examine the relationship between the shale and the aquifer including a thorough evaluation of geological and hydrogeological setting.**	The *Infrastructure Act 2015* prohibits hydraulic fracturing anywhere at a depth of less than 1000 metres. New provisions set out in the *Onshore Hydraulic Fracturing (Protected Areas) Regulations 2015* restrict hydraulic fracturing to take place below 1200metres in Source Protection Zone (SPZ) 1. This should provide a reasonable buffer to protect the groundwater from contamination by methane and other contaminants, although a more effective requirement may be for the operator to demonstrate that there is no connectivity. It is welcome that the Environment Agency now requires the completion of a hydrogeological assessment to be undertaken by a suitably qualified person in its latest draft guidance. Outside of the restricted areas the risk of contamination from the loss of well integrity still requires consideration. Best available techniques will need to be applied by operators to ensure returned waters are appropriately contained, managed, and treated prior to eventual disposal. CIWEM considers

		mismanagement is one of the greatest risks for contamination of the environment.
8	**Further research is needed into hydraulic fracturing with lower quality waters and also waterless techniques to minimise water use and thus requiring less subsequent treatment.**	The service industry continues to work on lower water quality solutions internationally. The UK should identify what it can learn from this, particularly as the industry enters the production phase.
9	**Research and development is needed in water treatment and decontamination technologies that exhibit reduced energy consumption, as well as into onsite and mobile treatment solutions that reduce the risks of transporting waste.**	The Natural Environment Research Council (NERC) in the UK and the United States National Science Federation (NSF) are jointly looking at scientific and technological innovation to improve understanding and mitigate potential environmental impacts. There is also work being undertaken by the EU Commission Joint Research Centre in this area. CIWEM, UKOOG, WaterUK and British Water have established an initiative to bring together key stakeholders to consider the whole life management of water issues, including mobile treatment solutions and water sourcing. Most of these initiatives are in their infancy and there is still much to learn from abroad and progress.
10	**The reuse of hydraulic fracturing fluid on site is the preferred option of the industry and the regulator. Given that there is common ground between the industry and regulator, they should work closely together to identify optimum solutions.**	The environmental regulators have been looking to develop best available techniques for the management of flowback fluid and re-injection. The Environment Agency's final sector guidance to be published in early 2016 is likely to suggest that the reinjection of flowback and produced water will be allowed for the purposes of re-fracture. A groundwater permit and in some cases a radioactive substances permit will be required. Re-injection for disposal may be allowed in certain circumstances. CIWEM considers the risks from contamination and induced seismicity must be adequately assessed for any re-injection activity through the groundwater permit and hydrogeological assessment.


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