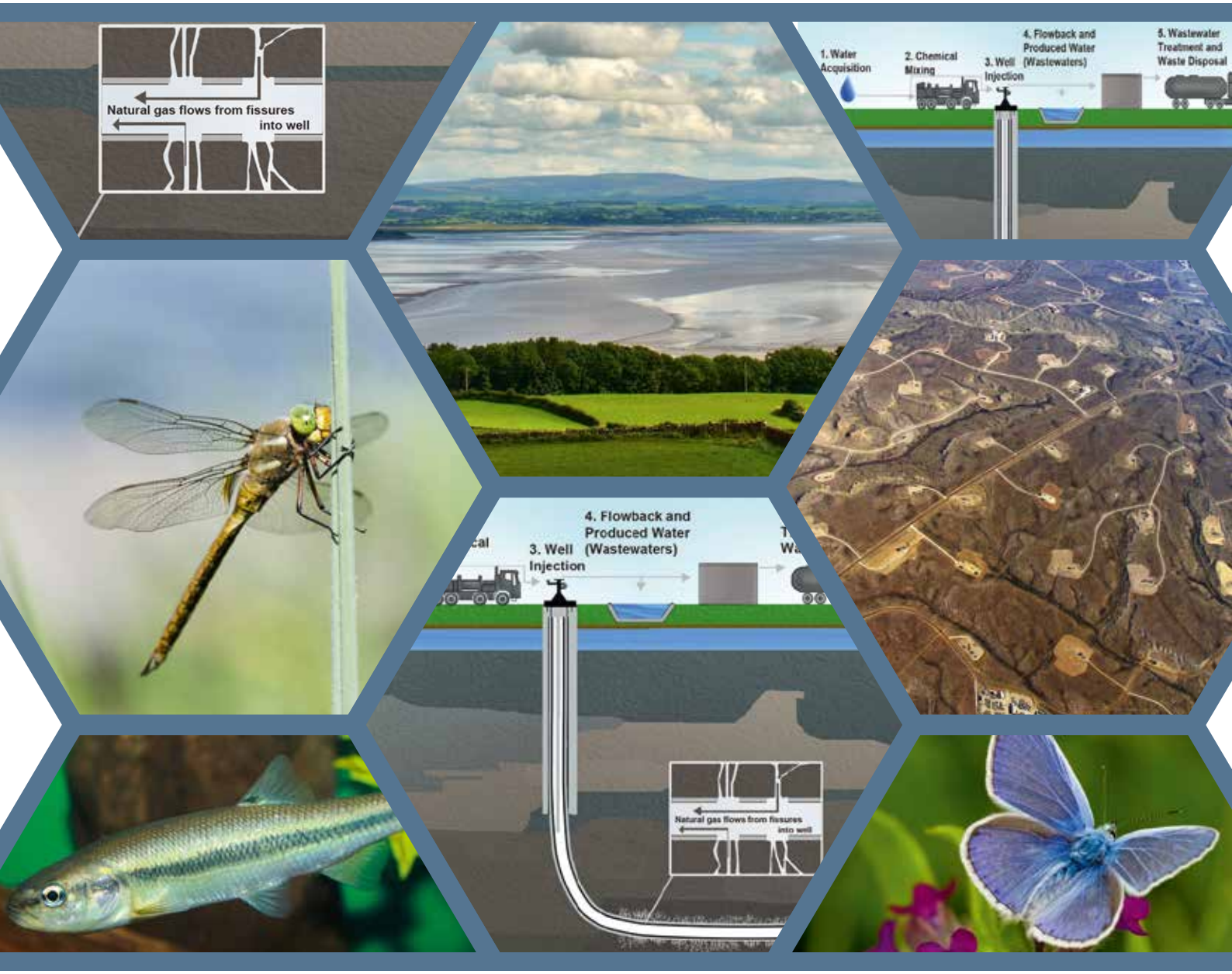
CHEMTrust

Protecting humans and wildlife from harmful chemicals

BRIEFING

FRACKING POLLUTION: HOW TOXIC CHEMICALS FROM FRACKING COULD AFFECT WILDLIFE AND PEOPLE IN THE UK AND EU



June 2015

This briefing was produced by CHEM Trust, a UK-based charity working at UK, EU and International level to protect humans and wildlife from harmful chemicals.

This briefing accompanies a detailed report, *"Chemical Pollution from Fracking"* which is available at: **www.chemtrust.org.uk/frackingreport**

CHEM Trust's particular concerns relate to chemicals with hormone disrupting properties, persistent chemicals that accumulate in organisms, the cocktail effect and the detrimental role of chemical exposures during development in the womb and in early life. CHEM Trust strongly supports the conservation of biodiversity and believes in the importance of wildlife protection. Furthermore, monitoring wildlife populations can provide vital insights into contaminant related threats to human health.

For more about our work, including our regularly-updated blog, see **www.chemtrust.org.uk**

Further copies of this briefing, and the full report, can be downloaded from **www.chemtrust.org.uk/fracking**

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Cover photos clockwise from top left, Diagram of fracking process [Credit US Environmental Protection Agency-Wikimedia Commons], Morecambe Bay Estuary [Credit Kevin Eaves- Shutterstock.com], Brown Hawker dragonfly Aeshna grandis [Credit Lydeke Bosch- Shutterstock.com], Jonah oil and gas site, Wyoming, USA [Credit EcoFlight], Creek chub Semotilus atromaculatus [Credit Brian Gratwicke-Wikimedia commons], Common blue butterfly Polyommatus icarus [Credit Radka Palenikova- Shutterstock.com]

Summary

High volume hydraulic fracturing or 'fracking', is a controversial technology used for extracting oil or gas resources which are trapped in shale rocks, coal seams and similar deposits. In the US, where fracking is carried out extensively, there are many examples of fracking causing chemical pollution leading to health and environmental impacts.

Due to our concerns about fracking, CHEM Trust commissioned a detailed examination of the impacts of fracking with respect to chemical pollution; the detailed report *"Chemical Pollution from Fracking"* is available at: **www.chemtrust.org.uk/frackingreport**

This briefing summarises the *"Chemical Pollution from Fracking"* report, discussing some of the latest developments and includes our recommendations for the future.

Fracking operations require large numbers of wells, and need substantial volumes of water and chemicals. This chemical use, combined with the substances that flowback from underground, makes fracking a potentially significant source of air, land and water pollution.

In addition, fracking operations also generate substantial noise and air pollution from vehicles and other equipment. Note that in this briefing we use the term 'fracking' to cover the entire process of shale gas exploration and production.

Our key recommendations are:

1) **All chemicals used in fracking must be disclosed**, with no provision for commercial confidentiality.
2) **Stronger EU regulation of fracking is required**, ensuring that Environmental Impact Assessments (EIA) are required for all sites, chemical use is controlled and transparent, effective monitoring is obligatory and wastewater management is safe, including an absolute ban on disposal of wastewater by re-injection into the ground.
3) **Regulations must protect the environment and people even when fracking wells are no longer used**, including financial bonds to cover clean-up costs.
4) **Effective monitoring and enforcement is essential to ensure that regulatory controls are followed**. This means that regulators must have the resources to carry out these functions; this is a particular concern in the UK where the Environment Agency (EA) is experiencing substantial budget cuts.

In CHEM Trust's view there should be an EU-wide moratorium on fracking until all our recommendations (see end of briefing) are in place.

CHEM Trust's focus is on the toxic effects of pollutants, and so this briefing and our position excludes consideration of fracking's effects on climate change and its potential to cause earthquakes.

There is further information for those involved in campaigning against fracking available from our website, **www.chemtrust.org.uk/frackingcampaign**

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1. What is fracking?

High-volume horizontal hydraulic fracturing, or 'fracking' is a way of releasing oil or gas resources that are trapped in shale rocks, coal seams and deposits. This technology has been developed to a commercial scale in the US over the past 20 years. It involves drilling deep wells both vertically and horizontally, and then pumping large volumes of 'fracking fluid' into the well at high pressure (see Figure 1). Note that in this briefing we use the term 'fracking' to cover the entire process of shale gas exploration and production.

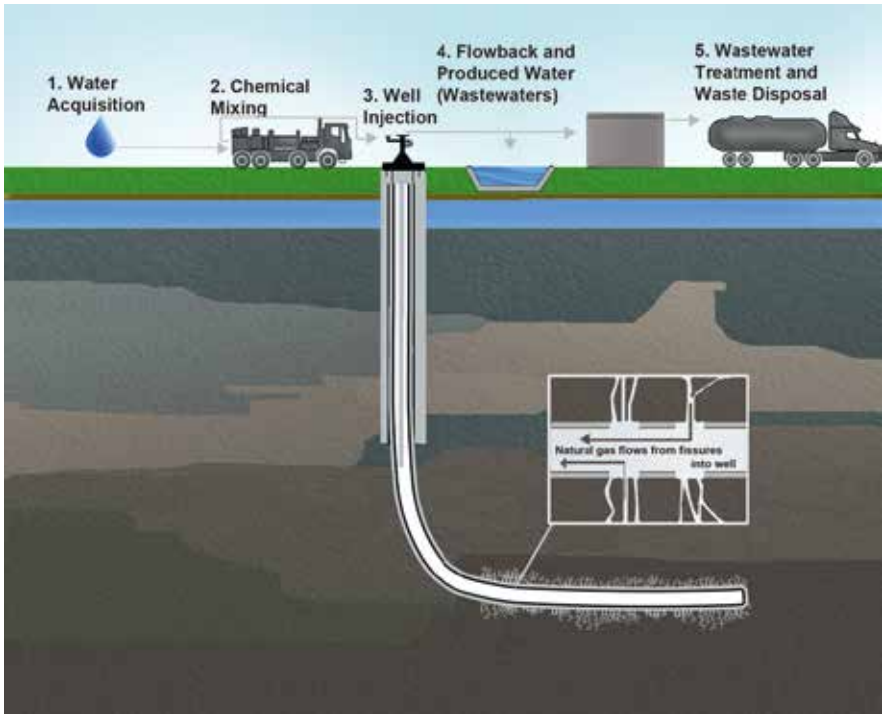

Figure 1:
Diagram of fracking process [Credit US Environmental Protection Agency/Wikimedia Commons]

Fracking fluid is a mixture of water, sand and chemicals, and when pumped into the well at high pressure it causes the shale to fracture and the sand to flow into the crevices, keeping them open. When the pressure is released, gas or oil flows to the surface, along with initially large volumes of wastewater or 'flowback' from the fracking process.

A similar process can be used to extract coal bed methane (CBM), releasing the methane associated with coal deposits by drilling horizontal wells, fracturing the coal and draining the seams. CBM also produces large volumes of contaminated wastewater. Shale oil, shale gas and coal bed methane are collectively called unconventional oil and gas (UOG) resources.

It's worth noting that each fracking operation, which may be repeated dozens of times for each well, requires a large amount of water. The Institute of Civil Engineers estimated that 10,000 to 25,000m^3 of water would be required for each well.[1] This water demand, in itself, could have substantial environmental impacts. For example, not only drying out certain habitats, but also the increased water extraction from rivers could exacerbate the impact of other pollutants (e.g. from agriculture or sewage works) due to reduced dilution.

2. Fracking: a source of pollution

Fracking presents greater cumulative risks to public health and the environment than conventional drilling due to: (i) the chemicals required; (ii) the large volumes of water involved; (iii) the additional contaminants in the flowback; (iv) the need for many transport movements; and (v) the larger number of wells needed to reach a similar level of production.

As the United Nations Environmental Program (UNEP) has stated, in its review of shale gas: *"[Hydraulic] fracking may result in unavoidable environmental impacts even if [unconventional gas] is extracted properly and more so if done inadequately."* [2]

UNEP: "[Hydraulic] fracking may result in unavoidable environmental impacts even if [unconventional gas] is extracted properly and more so if done inadequately." [2]

The scale of commercial fracking shouldn't be underestimated. For example, it has been estimated – based on data from the petrochemical company INEOS - that this one company is planning over 1000 fracking wells in the central belt of Scotland alone.[3]

There have been many cases of pollution from fracking in the US, from a range of causes. A frequent one is the failure of the well casings in the upper part of the well (see examples below).

Jonah oil and gas site, Wyoming, USA [Credit EcoFlight]

2.1 Water and land pollution from fracking

The main potential pathways of water and land pollution during fracking are:

- Accidental spillages during the mixing and transport of drilling and fracking chemicals and water prior to injection into the well.
- Leaks from failure or inadequacy of well casings in the upper part of the well. A large number of pollution incidents in the US have been due to this sort of failure[4], which has allowed methane and fracking chemicals to migrate into groundwater, drinking water or nearby properties, sometimes causing explosions, evacuations and necessitating the replacement of water supplies.[5]
- Fissures in rock, potentially accentuated by the fracking process, leading to contamination of important groundwater reserves, potentially contaminating drinking water, springs etc.
- Leaks from storage and treatment of the large volumes of flowback water produced.
- Leaks from transport of flowback water.
- Inadequate treatment of flowback prior to discharge, and leaks from re-injection of flow back into the ground (where permitted).

Flowback contains the substances added to facilitate fracking, combined with salts, hydrocarbons, heavy metals and naturally occurring radioactive materials (NORM) present in the rock. Flowback waters should be treated before any release into the environment. In the UK this has so far been done by taking the flowback to a sewage treatment works by tanker.

The substantial volumes of fracking fluids and flowback involved in UOG production are potentially significant pollutants of air, groundwater, surface water and soil.

What chemicals are used in fracking?

Fracking fluids are about 91-95% water, 5-9% sand and less than 0.5% chemical additives. Because the volumes of water involved are huge, this small proportion of chemicals adds up to significant quantity, perhaps totalling many tonnes in each operation.

The sand is a proppant, designed to keep rock fractures open, while the other additives include scale inhibitors and acids to prevent blockages, gelling agents to help carry the sand, biocides to prevent bacterial growth, friction reducers to increase pumping efficiency, surfactants (detergents) to aid penetration, clay stabilisers and "breakers" which reduce viscosity and help fluid recovery.

Different wells use different mixtures of chemicals, and these mixtures may also change over time. This makes it impossible to predict which chemicals will be used where and when. CHEM Trust strongly believes that there should be full disclosure of chemicals being used or planned to be used in fracking. This should include the full disclosure of the chemicals present in proprietary mixtures, with no ability to claim commercial confidentiality.

"CHEM Trust strongly believes that there should be full disclosure of chemicals being used or planned to be used in fracking"

A 2011 study in the US, which questioned 14 major fracking companies, found they used many toxic chemicals, such as benzene, naphthalene, methanol, ethylene glycol, caustic soda and formaldehyde. It also found 279 products contained at least one chemical that manufacturers deemed a trade secret.[6] The *"Chemical Pollution from Fracking"* report gives more details about the chemicals used in fracking, see Chapter 4.

Hormone disrupting chemicals

CHEM Trust is particularly concerned about the use of hormone (or endocrine) disrupting chemicals, chemicals that can disrupt the sensitive hormonal control systems in our bodies and those of wildlife leading to negative impacts on reproduction, neurodevelopment, behaviour and metabolism. Such chemicals have also been linked to hormonally driven cancers (e.g. breast, prostate and testicular cancers) and coronary heart disease.

In the US, researchers examined the properties of chemicals used in fracking and found many were known to be hormone disrupting or reproductive toxicants.[7] A separate study tested fracking chemicals and surface and groundwater near fracking sites for hormone-related activities. The scientists found a range of hormone disruption related activities in fracking chemicals, and in the surface and groundwater samples, including imitation and blocking of male and female hormones.[8]

2.2 Air pollution from fracking

Fracking is a source of air pollution, including:

- Evaporation from fracking fluids – including any stored flowback.
- Emissions from the flaring and treatment of gas.
- Diesel fumes from the constant running of pumps, generators, compressors and from heavy vehicles transporting large volumes of water and wastewater to and from the fracking site.

3. Impacts of fracking on human health

3.1 Pollution risks to local people from fracking

Fracking is a concern to local people because of the potential for air and water pollution. Noise is also likely to be an issue in many cases.

In a letter recently published by the British Medical Journal, 20 high-profile doctors, pharmacists and public health academics said the "inherently risky" fracking industry should be prohibited in the UK on "public health and ecological grounds."[9]

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Preliminary studies in the US have shown that there is a higher incidence of skin conditions and upper respiratory problems in communities living close to fracking operations.[10] In a provisional study in Australia, 58% of people living close to fracking operations reported health problems including coughs, tight chests, rashes, difficulty sleeping, joint pains, muscle pains, nausea and vomiting.[11]

3.2 Chemical risks to workers from fracking

The UK Trades Union Congress (TUC) has raised concerns over the health and safety of those employed in fracking operations in the UK. Their briefing states that the biggest health risks lie in potential explosions, exposure to the hydrocarbons and other chemicals in fracking fluid, including biocides, and exposure to silica, which is linked to serious illness, including lung cancer.[12]

Hormone disrupting chemicals used in fracking fluid have a range of toxic properties which could be relevant to workers, including reducing sperm counts, affecting menstrual cycles and impairing fertility. Heavy metals like lead and arsenic, which are found in flowback, also affect fertility and are associated with a greater risk of miscarriage or stillbirth.[13]

4. The implications of fracking on wildlife and the countryside

Fracking poses a range of threats to wildlife and the countryside, including potential pollution of watercourses, land-take and disturbance from fracking-related operations. There are also reports of damage to livestock on farms[14].

4.1 Wildlife impacts of pollution incidents in the US

Experience from the US has shown that pollution from fracking can have devastating impacts on wildlife. For example, spills of fracking fluids have killed fish (including creek chubs and blacknose dace), salamanders and frogs.[15]

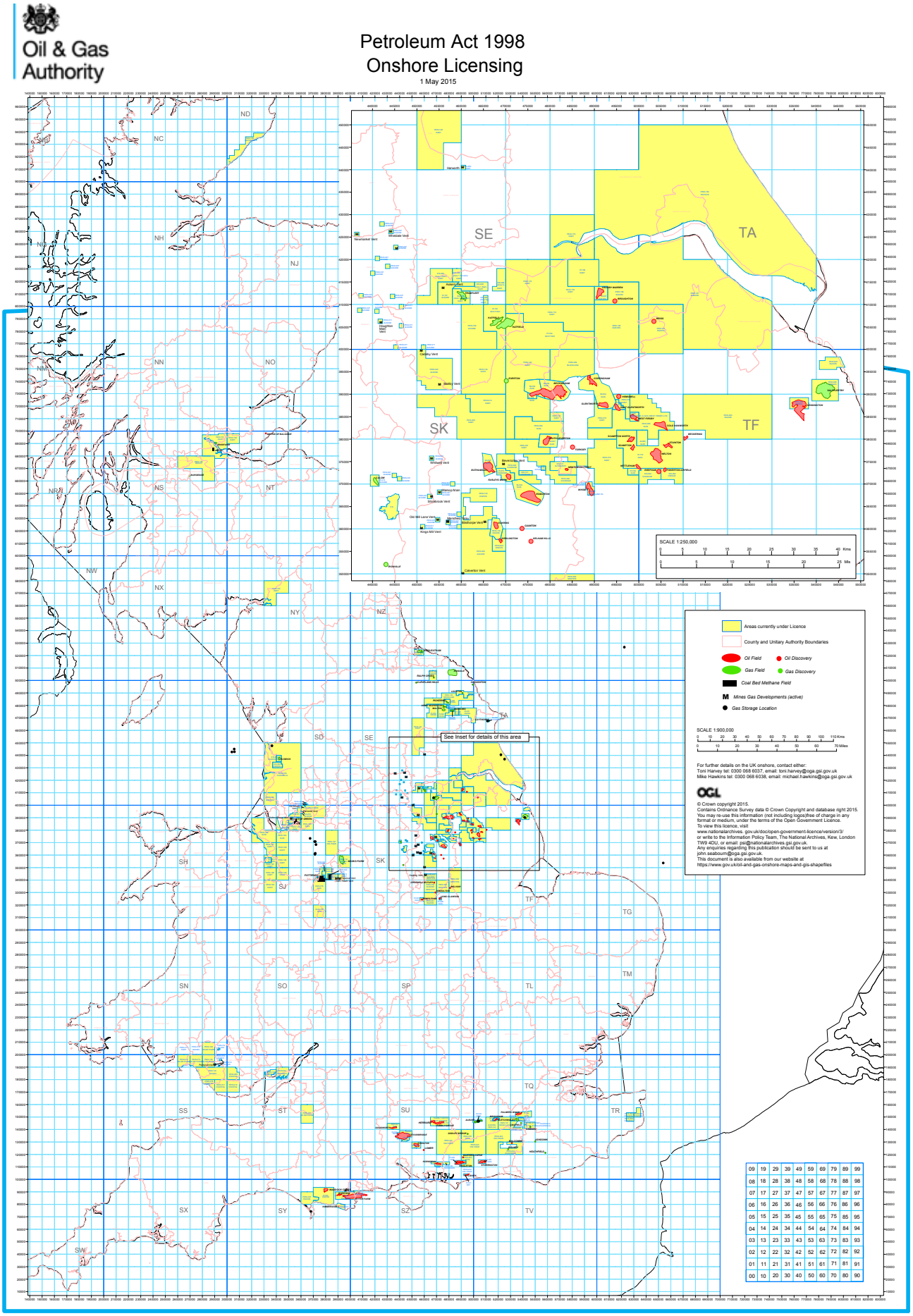
A fracking-related fire and spill in Ohio, USA, is estimated to have killed over 70,000 fish – showing the scale of damage that fracking accidents can cause.[16]

Creek chub *Semotilus atromaculatus*
[Credit Brian Gratwicke/Wikimedia commons]

4.2 UK Wildlife sites under threat

A large amount of the UK has been defined as available for fracking exploration, though the Infrastructure Act 2015 has restricted fracking within certain protected areas. Figure 2 shows a map showing the areas where exploration licenses have been granted, as of 1st May 2015. A much wider area of the country is available for licensing, see the interactive map available on the gov.uk site.[17]

Figure 2: On shore licences for oil and gas in the UK



Map showing onshore licences for oil and gas in the UK [Credit Gov.uk; latest version: https://www.gov.uk/oil-and-gas-onshore-maps-and-gis-shapefiles

Fracking company Cuadrilla has drilled exploratory wells in Lancashire and there are fears that if fracking goes ahead it could harm wildlife in the River Wyre estuary, a site of special scientific interest (SSSI) which is only a few kilometres away. The concerns are based both on the impacts of extracting water for fracking, and the potential impacts from pollution.

Morecambe Bay Estuary [Credit Kevin Eaves/ Shutterstock.com]

The Wyre estuary forms part of Morecambe Bay, a wetland of international importance under the Ramsar convention. This wetland hosts 11 wading bird species of international importance and four species of national importance and also includes a large area of salt marshes and reed beds and meadows which provide habitats for bees and northern marsh orchids, common blue butterflies and brown hawker dragonflies. The local farmland is also an important feeding ground for overwintering birds.[18]

Hawker dragonfly *Aeshna grandis* [Credit Lydeke Bosch/ Shutterstock.com]

Common blue butterfly *Polyommatus icarus* [Credit Radka Palenikova/ Shutterstock.com]

4.3 A threat to rare species in the UK

The Royal Society for the Protection of Birds (RSPB), with the aid of other wildlife charities in the UK, investigated the likely impacts of shale gas or oil development on British wildlife.[19]

They concluded that many different aspects of fracking could negatively affect wildlife, in addition to pollution and reduction in available water resources. The significant land required by a large number of wells, and the noise and other disturbance created by fracking activities - which may be 24 hours per day at times - are both likely to have a negative impact on wildlife.

The RSPB believes that fracking could have negative impacts on some of the UK's rarest species, like the Barbastelle bat, which could particularly suffer due to light pollution. The bat is found on the Sussex Weald which is currently vulnerable to fracking operations.

Barbastelle bat *Barbastella barbastellus* [Credit Hugh Clark / Bat Conservation Trust]

5. Can regulation solve the problem?

Strong, fully enforced, regulation should reduce the impacts of fracking and reduce the risk of pollution. However, pollution has occurred in the US, despite US states having legislation and regulation designed to protect the environment.

Given that fracking could result in many thousands of wells across the EU, the challenge for regulators is considerable.

Will regulators in all relevant Member States be able to ensure:

- That all these wells will be constructed to a sufficiently high standard to avoid pollution?
- That all chemicals are being used safely?
- That there will be no pollution from the flowback water?
- That all the wells' integrity will continue to be monitored once officially closed, as substantial amounts of contaminated water are likely to remain in the well?

Furthermore, the issue is not just one of regulation, but also independent monitoring and enforcement of this regulation. Without this even stringent regulations will have little impact.

> ***"the UK government played a key role in ensuring that no EU regulatory changes were proposed"***

It is clear that such monitoring is required; for example, in Denmark in May 2015, the regulator stopped Total drilling its first exploratory shale gas well, accusing it of using an unauthorised chemical, though drilling later re-started after new assurances regarding chemical handling.[20]

In the UK, and in many other countries around the EU, cuts in public spending are reducing the capacity of regulators to do their job effectively. Other EU countries, particularly newer Member States, may not have effective environmental – or worker safety - regulators.

5.1 Will EU regulations prevent pollution?

The core of environmental regulation across Europe is provided by EU-level legislation agreed by the Governments of EU Member States and Members of the European Parliament. National or regional legislation may then be added to this by individual governments.

As a result of the expected growth in fracking, the European Commission started a range of research projects to examine whether the EU regulatory system was adequate to prevent pollution. The impact assessment produced during this process concluded that improvement of existing EU regulations would be beneficial,[21] but the UK government played a key role in ensuring that no EU regulatory changes were proposed,[22] and instead the Commission adopted a non-binding recommendation in January 2014[23].

The non-binding recommendation encourages EU Member States to adopt minimum principles, which include: reducing health and environmental risks by conducting a strategic environmental assessment (SEA) and an environmental impact assessment (EIA), involving the public in consultations, protecting water quality and monitoring and treating flowback. However, without revised and binding EU legislation, few of these voluntary recommendations are likely to be enforced by Member States.

The role of the EU's REACH chemicals legislation

The main law controlling chemical use in Europe is REACH, and it was identified in the European Commission's studies as not properly addressing the use of chemicals in fracking.[24]

As a result of this realisation, the European Chemicals Agency (ECHA) has recently announced that a 'use category' for chemicals used in fracking will be introduced for REACH registration from 2016.[25] Companies selling chemicals for use in fracking will have to specify this use category in their REACH registration dossiers. This should provide more transparency about which chemicals are used in fracking, via the European Chemical Agency's (ECHA) public database of registration information[26]. However, this database won't provide information on which chemicals are being used at specific sites.

REACH also, in most cases, obliges those using hazardous chemicals that are registered within REACH to ensure that their use is covered by an 'exposure scenario', which details how a chemical should be used in order to ensure that risks are 'adequately controlled'. This exposure scenario should be produced by either the chemical producer, the distributer or the end user, and can be viewed by government regulators – though the public has no general right of access.

In the case of fracking, an exposure scenario should, for example, include how flowback should be treated to ensure risks from the chemical are adequately controlled. It is unclear whether exposure scenarios are adequate at the moment, particularly given that an industry-led process to draft industry guidance on exposure scenarios for fracking has not yet led to publication of a final document.[27] Without full transparency of exposure scenarios it is not possible to analyse their quality.

In CHEM Trust's view all exposure scenarios relating to chemicals used in fracking should be publicly available. This will allow others to assess the suitability of the chemicals being used, and whether they are being used in accordance with the exposure scenario.

In addition, the analysis of chemical risks relating to fracking should consider the impacts of leakage from the well and from above ground piping, storage and transport, as these are clearly foreseeable risks.

5.2 Will UK regulators be able to protect people and wildlife?

In recent years the previous UK Coalition Government has been strongly pro-fracking, with the Prime Minister, David Cameron, saying the government was going "all out" for shale gas.[28] The Chancellor of the Exchequer, George Osborne, has given fracking companies the 'most generous tax breaks in the world'[29] and a leaked letter to Cabinet colleagues has shown him asking them to fully support a fast track for fracking in the UK.[30] The new Conservative government is expected to continue with the same pro-fracking approach.

The UK Infrastructure Act 2015[31] will halt fracking in - though not under or near - certain (not yet fully defined) wildlife and groundwater related protected areas. This is likely to include National Parks and Areas of Outstanding Natural Beauty. Both Scotland and Wales have put a moratorium on fracking, but a vast amount of England remains available for fracking.[32]

All fracking sites, whether exploratory or producing, require Petroleum Exploration and Development Licences, planning permission, well construction notification and approval and environmental permits. But they do not require an Environmental Impact Assessment (EIA) despite this being part of the Commission's recommendation. During the parliamentary debate on

the Infrastructure Act 2015, environmental groups had asked to include a requirement for EIAs, but this was not included in the final Act.

UK regulation of fracking is complex and split between a number of regulators. For example, in England these include the Environment Agency (EA), Health and Safety Executive (HSE), the Minerals Planning Authority, the British Geological Survey and the UK Department of Energy and Climate Change (DECC). A new "Oil and Gas Authority" now regulates the licensing of onshore oil and gas sites in the UK, and large areas of the country are now licensed for exploration, see figure 2.

5.3 Concerns for the future

CHEM Trust is not only concerned about the current regulation of fracking, but also what may happen in the future. Given the scale of operations that the fracking industry would like put in place across Europe, it is vital that effective environmental and human health protection policies, adequately tailored to the particular threats of fracking, are enshrined in law.

Particularly worrying issues for the future include:

1) A strong lobby from many parts of business for 'better regulation', which frequently means deregulation or at least regulatory delays. Such a lobby could lead to a government removing regulatory requirements. For example, it could be conjectured that the UK might reduce the controls on treatment and disposal of flowback fluid, increasing risks to the public and the environment.

2) On-going cuts in regulatory authorities, such as the EA in England, including loss of staff and redeployment of staff towards other priorities such as flooding. This will reduce their capacity to identify failures and enforce licence conditions in important regulatory areas such as fracking.

3) If the UK were to leave the EU it would mean that some or all of the agreed EU laws regulating fracking would no longer apply here. If the UK were to end up with a similar status as Norway, for example, the REACH chemical regulations would still apply (as these are part of the EU internal market for products). However, EU Regulations controlling the drilling site might not apply, as these are not part of the EU Internal Market legislation. That said, it's worth noting that Norway & other countries in the European Economic Area (EEA) have decided to follow the Water Framework Directive.[33]

6. Conclusions

Fracking has the potential to have a massive impact on the countryside and those who live in it – be it people, livestock or wildlife. The potential scale of fracking operations is huge, creating major water pollution risks from the large amount of chemicals used, and wastewater generated. Alongside the water pollution risks, there are also serious risks of local air pollution and land pollution.

In CHEM Trust's view there should be an EU-wide moratorium on fracking until all our recommendations (below) are in place.

CHEM Trust's focus is on the toxic effects of pollutants, and so this briefing and our position excludes consideration of fracking's effects on climate change and its potential to cause earthquakes.

There is further information for those involved in campaigning against fracking available from our website, see:
www.chemtrust.org.uk/frackingcampaign

6.1 Recommendations

Regulations

- The European Commission's January 2014 recommendations on fracking need to be turned into legislation. Without effective and legally binding legislation designed to deal with fracking, then people and wildlife in the EU are not going to be properly protected.
- All fracking operations, including exploration, should be covered by Environmental Impact Assessments.
- It is clear that faulty wells are a major pollution risk, therefore the quality of well construction and safety standards must be strongly regulated and enforced.
- The toxic and possibly radioactive waste from fracking will require careful disposal and should be addressed specifically in EU regulations. In particular, underground disposal of wastewaters (e.g. through re-injection) should be banned.
- Companies undertaking fracking should have to deposit bonds sufficient to cover any future compensation claims and to pay for clean up at the end of the life of the well. A failure to have sufficient resources in restoration bonds for the clean up of opencast coal mines is now creating a major social and environmental crisis in Scotland.[34]

Chemical disclosure

- There must be full public disclosure of all the chemicals used, with adequate data on their hazard profiles, and clear, publicly available, assessment of all the potential health and environmental effects. There should be no opportunity for industry to withhold chemical identities based on claimed commercial confidentiality.
- Manufacturers and distributers of chemicals must produce and communicate human and environmental exposure scenarios for fracking substances. These

exposure scenarios should be publicly available, and must make clear what are the assumptions made in calculating adequate control, for example, with respect to the storage and fate of flowback.

- In addition, the analysis of chemical risks relating to fracking (including exposure scenarios) should consider the impacts of leakage from the well and the above ground piping, storage and transport, as these are clearly foreseeable risks.

Monitoring

- Under the supervision of a regulator, operators of fracking wells should undertake extensive air, land and water monitoring in the vicinity of their sites prior to, during and after the operation. This is to ensure that clear baselines are set and any subsequent pollution is apparent.
- There should be detailed and ongoing inspection of operations by independent experts in geology and ground water protection, to ensure safe well construction and proper disposal of all chemicals, including contaminated water, muds and other wastes.
- There must be systems in place to identify emerging chronic or acute health effects in workers, residents, livestock and wildlife.
- Even when wells are exhausted and sealed, they remain a threat to ground waters and must be monitored. Operators need to commit resources to ensure that any future problems are identified and can be remediated.

Regulators

- The regulation and monitoring of a large number of fracking wells will be a challenge for regulators. There must be sufficient staff and resources to do this job effectively. This is a particular concern in the UK, where the staffing of regulators such as the EA has been reducing in recent years.
- It is also vital that regulators have sufficient expertise in the full range of issues relevant to fracking, including, for example, the safety of wells.

Location

- The vulnerability of ground waters to pollution from fracking should be recognised and there should be no operations in groundwater source protection zones.
- There should be no fracking on, near, or underneath, key wildlife sites, including Natura 2000 sites (both Special Areas of Conservation (SACs) and Special Protection Areas (SPAs), and in the UK, National Parks and Sites of Special Scientific Interest (SSSIs).
- Local communities should be involved in any decisions on fracking in their area; see the Friends of the Earth position on fracking for more information on this and other issues.[35]

Water supply

- Regulators must forbid fracking where there is insufficient water available for the fracking operation, or if extracting this water will negatively affect wildlife or people.

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