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A Best Practice Regulatory Proposal for Shale Gas Production

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ABSTRACT

Unconventional gas reserves are typically characterised by relatively low permeability, making these reserves more challenging — technically and commercially — to exploit than conventional gas reserves. The production of shale gas, an unconventional gas, is expanding worldwide. Most activity is occurring in the United States, while the industry is gaining momentum in other countries (for instance, Canada) or poised to begin (for instance, Australia and the United Kingdom).

The rapid and increased interest in shale gas, along with the special characteristics of shale gas production, poses a number of challenges for industry regulators. These characteristics include the techniques of vertical drilling and hydraulic fracturing. The challenges associated with shale gas production raise a number of risks, particularly to the environment.

Compared to other countries, the United States' regulatory regime is complex. The complexity is due to having to 'catch-up' to the rapid increase in shale gas activity and the interaction and tension between federal and state governments. In contrast, Western Australia's response has been to review the State's regulatory regime for conventional gas and account for unconventional gas production where it was considered necessary. While Western Australia's approach is not optimal, it is coherent and anticipatory.

There have been two dominant regulatory responses by jurisdictions to address the challenges associated with shale gas production. The first is to adopt a 'business as usual approach', which involves applying existing regulation for conventional gas to shale gas production. The second response is to adjust the regulation for conventional gas in an attempt to account for shale gas production. Both responses are rejected by the thesis — an unacceptable level of risk will result if either is used. Rather, a response in the form of fresh regulation is needed.

To address the challenges and risks of shale gas production, the thesis proposes a best practice framework for the regulation of shale gas production. The framework has numerous features, which come together in a purposeful way to establish the framework. Fundamental to the framework is the goal of meeting a number of

regulatory objectives; the objectives reflect important values that require protection.

A strength of the framework is the producer and regulator having a clear understanding of the regulatory purpose, which improves their ability to prioritise and engage, thereby increasing the probability that a coherent, as opposed to a 'patchwork', regulatory regime will result. The framework permits flexibility, so that the unique characteristics of the production site can be taken into consideration in order to meet the objectives. If the objectives of the framework are met, then best practice has been achieved.

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My appreciation of my supervisors, Winthrop Professor Richard Bartlett and Professor John Chandler for their wisdom and guidance during the writing of this thesis and my studies generally. At times my confidence waned, however, their belief in me was a tremendous help.

Thank you to my partner Niels for his loyalty and understanding, without which I would have been incapable of moving from my native New Zealand to study fulltime, and coping with the subsequent sense of isolation.

DEDICATION

Mary Cochrane (February 1915 – June 2012)

To my Nana (OB), you lived a full and contented life, which you shared with me, thank you. You said just before you died 'we are good mates'; yes we were. I love you and miss you, Simon (LS).

PART I INTRODUCTION & THESIS

> *The emerging trend of shale gas extraction poses some new challenges to existing regulatory regimes worldwide, with most of the applicable regulatory regimes not explicitly covering unconventional gas resources. Particularly regarding water resources, there are some serious negative impacts and a lack of regulation concerning shale gas extraction.*[1]

The production of shale gas is growing at unprecedented levels. The growth is due to advances in technology and a decline in conventional gas reserves, which have made the production of shale gas commercially viable. Shale gas is a type of unconventional gas. Other well-known types of unconventional gas are coal seam gas (CSG) and tight gas. The focus of this thesis is the regulation of shale gas production.[2] Shale gas offers a plentiful supply of energy for domestic use and exporting. There are flow on effects, such as energy security, employment and economic growth. Evidence is building that production comes at a price as shale gas production has a number of challenges different from conventional gas. The challenges need to be managed to mitigate a variety of risks, many having environmental implications. The importance of effective management is increasingly gaining the attention of government and interest groups, with a particular focus upon what the role of regulation should be.

The premise of the thesis is that a new regulatory response for shale gas production is required. The approach of using existing regulation for conventional gas is unsatisfactory, as is the approach of modifying existing regulation. A regulatory framework is needed, comprising a number of regulatory objectives. The goal of the framework is to ensure that shale gas production is undertaken consistent with the objectives. There are a number of regulatory features that combine in a purposeful way to establish the framework. The combination accounts for the challenges and activities of shale gas production, including any factors of the production site. If the

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[1] Leonie Reins, 'The Shale Gas Extraction Process and Its Impacts on Water Resources', (2011) 20(3) Review of European Community & International Environmental Law 300, 300.

[2] Also referred to as 'shale gas development', 'development', and 'production'.

goal of the regulatory framework[3] is achieved, so is best practice.

Part II of the thesis provides a preliminary understanding of shale gas. The Part begins with an overview of conventional and unconventional gas, and then focuses specifically upon shale gas. Special attention is given to the shale reserves of North America and Western Australia. The Part concludes with a discussion on why shale gas has become increasingly attractive to producers,[4] whilst acknowledging that some of the reasons are subject to criticism.

The primary techniques used in shale gas production and the significant challenges they pose are examined in Part III. The challenges include those arising from the activities of horizontal drilling and hydraulic fracturing (activities that are particularly associated with shale gas), water related issues, and cumulative impacts. These challenges play an influential role in the design of the framework proposed by the thesis. Part IV defines what regulation is (although regulation can be regarded as an elusive concept). A practical definition of regulation is a means intended to influence, through various mechanisms, the behaviour of actors, regardless of whether they are individuals or organizations, to function in a way that is consistent with specific community objectives — including social and environmental. The principal regulatory approaches are explored, referencing the relevance of each approach to shale gas production where possible. The analysis is a prelude to which regulatory approach, or approaches, will be incorporated into the proposed regulatory framework. At the conclusion of Part IV, three concepts frequently associated with any regulatory approach are examined: regulatory burden, unintended consequences and the precautionary principle.

The complexities between jurisdictions are compared in Part V. The United States, being experienced in shale gas production and with a regulatory regime that is complex, is compared to Western Australia, where the industry is in its infancy and has taken steps to prepare its regulatory response. The Western Australian response is less complex than that of the United States. Minimizing complexity is a

[3] The regulatory framework is also referred to as the ‘proposed regulatory framework’ or ‘framework’.

[4] The term ‘producer’ includes ‘operator’, ‘proponent’ and ‘developer’.

characteristic embraced by regulators[5] and producers as it reduces regulatory burden; however, a reduction in complexity must not be at the expense of achieving the regulatory objectives.

The two regulatory responses most common to regulating shale gas production are problematic. The business-as-usual response, where the regulation of conventional gas production is simply applied to shale gas, is insufficient. The approach fails to appreciate that the production of shale gas and its ensuing risks are sufficiently different to justify a different regulatory arrangement. An alternative response is to adjust or modify the conventional gas regulatory regime. The attractions of adjusting the existing regime are the ability to leverage the experience of conventional gas production, its perceived cost-effectiveness, and the belief that the level of regulatory burden is acceptable. A weakness is that any adjustments to the regime will be unduly influenced by the experience of conventional gas production, particularly because of its history and dominance. Another weakness is that the response fails to recognize the exogeneity problem. In Part VI, both responses are rejected — neither can adequately address the challenges specific to shale gas production.

Part VII begins with the focal point of the framework: the regulatory objectives. The objectives are qualities considered so important that they require protection, and the goal of the framework is to achieve these objectives. The objectives also provide direction and a common purpose, something that will be beneficial to the regulator and the producer. The framework is made up of a number of regulatory features. Supporting the objectives are several regulatory approaches, including one that relies upon a management plan. The plan outlines to the regulatory agency how the producer intends to operate in a manner that is consistent with the objectives. The approaches are complemented by a regulatory method, being a modified version of precautionary risk regulation. The method assesses the appropriateness of the proposed management plan and minimizes subjective decision-making by the regulatory agency. In addition to applying the precautionary risk regulatory method, threat ranking is used as another form of regulatory assessment method. Threat ranking is a systematic process, which provides quantified information to the regulatory agency.

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[5] The term ‘regulator’ may also be referred to as ‘regulatory agency’.

The proposed regulatory framework has other features. There are the activities ordinarily undertaken as part of producing shale gas and which the framework must manage. The execution of the activities will be complemented by specific factors, which identify the unique qualities of the production site — for example, its geological profile.

The framework has a number of traits — flexibility and durability, for example — which enable the framework to be applied to different locations and assist the framework in meeting the demands of a rapidly evolving industry. Supporting the traits is a strong preference that the federal government is not part of the framework (assuming the jurisdiction is federated), meaning the regulator is not subject to the vagaries of two forms of government.

Other considerations of the framework address the attributes of a regulatory agency, including how the agency should be funded, and the importance of its independence.

When the features of the framework are combined in a purposeful manner, the need for the regulator to respond in an ad hoc and reactive way is diminished, reducing the risk of 'patchwork' regulation and providing the conditions for the achievement of the regulatory objectives.

The research was conducted through the examination of primary source literature. The literature included court judgments, legislation, and regulations; secondary source materials, such as journal articles, other academic papers, regulatory documents, government reports, industry documentation, and literature from 'concerned' third parties — in particular, parties with environmental interests.[6]

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[6] For example, the literature included university publications (eg Harvard and Penn State); periodic publications (eg Washington University Law Quarterly); a non-partisan research body (the United States Congressional Research Service); regulators (eg Department of Mines and Petroleum (Western Australia) and the United States Environmental Protection Agency); think tanks (eg Organization for Co-operation and Development); and legislation (eg the United States Safe Drinking Water Act and the Clean Water Act, and Western Australia's Petroleum and Geothermal Energy Act — including the associated *Petroleum (Environment) Regulations 2012* (Western Australia). Examples of 'pro-industry' or 'grass roots' material are the Canadian Society for Unconventional Resources; the Canadian Association of Petroleum Producers; the Council of Canadians; the Clean Air Council; and the Pennsylvania

Third party literature, which may be described as ‘grass roots’ or ‘pro-industry’, has also been relied upon, notwithstanding that some may see this as imprudent due to the issue of credibility and the perception of bias. The rationale for relying upon these sources is twofold. First, it is evident that they occupy a place in the debate over shale gas production; while often being strongly partisan, they still provide useful insights. Second, gate keeping is occurring, which has the potential to ‘shut out’ certain views, and where the more resourced are able to frame the debate.

Environmental Council.

PART II NATURAL GAS & THE INCREASING INTEREST IN UNCOVENTIONAL GAS

1 Introduction

Natural gas is a combustible and varying mixture of hydrocarbon gases formed mostly of methane, but also ethane, propane, butane, pentane and other gases.[7] Natural gas can be classified as conventional or unconventional, with methane being the predominant gas in both. Conventional and unconventional gas reserves are distinguished by their respective permeability, which is the key difference as it influences the manner, ease and cost associated with extracting the resource.[8] As conventional gas is more permeable, making it easier to extract and therefore a more commercial proposition, producers have focused primarily on this gas.

Due to technological advances, shale gas can be extracted commercially; however, it remains more complex and costly to extract than conventional gas.

North America, in particular the United States, provides a useful insight to shale gas production. The United States is the largest producer of shale gas. There is a degree of uncertainty regarding the extent of the United States' reserves; nevertheless shale gas will play a major role in meeting the nation's energy needs. Less certain is the role shale gas will have in Canada. The industry is still in its infancy compared to the United States, although a number of provinces have commenced development. Should development continue, it could make up the possible shortfall Canada will experience in its conventional natural gas production.

Shale gas is appealing because it has a number of uses, including electricity generation and the management of greenhouse gases. However, these uses do attract

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[7] NaturalGas.org, *Overview of Natural Gas: Background*, <http://www.naturalgas.org/overview/background.asp>.

[8] Canadian Association of Petroleum Producers, *Natural Gas: Conventional & Unconventional* <http://www.capp.ca/CANADAINDUSTRY/NATURALGAS/CONVENTIONAL-UNCONVENTIONAL/Pages/default.aspx>.

controversy and are not without their challenges. The increased appeal of shale gas, despite its relative difficulty to extract, gives rise to a number of problems, particularly those that are legal in nature. How does a jurisdiction effectively regulate the activities and challenges of shale gas production?

A sound understanding of shale gas is required so that the relevant issues are identified for consideration in the framework. The purpose of this Part is to provide context and begin to develop the required understanding; Part III provides specific detail on the activities and challenges associated with shale gas production.

2 Key characteristics of conventional gas

2.1 Natural gas formations

There are different theories as to how natural gas is formed; however, it is generally accepted that most natural gas is formed from the immense pressure on organic matter trapped beneath the earth's surface — with high temperatures possibly playing a role as well. Natural gas that has risen towards the earth's surface over time and become trapped as gas formations within deposits of porous, sedimentary rock by overlying impermeable layers of rock is referred to as conventional gas. Unconventional gas is natural gas that has formed within impermeable rock formations or migrated to a rock formation that has since become impermeable. Unconventional gas is effectively trapped within a rock formation rather than by an overlying one. Hence, the key difference between the two forms of natural gas is the extent to which the gas is located in permeable rock. Because conventional gas is found in more permeable and porous rock formations, it is easier and more cost-effective to extract than unconventional gas.[9]

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[9] Susan L Sakmar, 'The Future of Unconventional Gas: Legal, Policy and Environmental Challenges to the Development of North American Shale Gas' (Paper presented at 29th USAEE/IAEE North American Conference, Calgary, Canada, 14–16 October 2010) 2 <http://www.usaee.org/usaee2010/submissions/OnlineProceedings/Sakmar_Paper_Shale%20Gas.pdf>; Department of Mines and Energy, *What is the Difference between Conventional and Unconventional Gas?* (3 September 2012) Northern Territory Government <http://www.nt.gov.au/d/Minerals_Energy/index.cfm?header=What%20is%20the%20difference%20between%20Conventional%20and%20Unconventional%20Gas?>; NaturalGas.org,

2.2 Development of conventional gas

Conventional gas production is such that producers can target deposits trapped in sand and rock formations with little 'technological prompting'. That is, the gas is more straightforward and cheaper to extract, making conventional gas the primary focus of the oil and gas industry since the industry's inception.

Vertical drilling is the long-established mode of drilling for conventional gas and is generally the principal means of extraction by allowing the gas to flow into the wellbore and ultimately to the land surface. Vertical drilling is less expensive than horizontal drilling,[10] which is the principal means of drilling for unconventional gas.

Conventional reservoirs can yield up to 95 per cent of the natural gas that is in the reservoir; however, for unconventional gas the recovery rate is around 20 per cent.[11] While conventional gas deposits have historically been the most practical and relatively straightforward to exploit, changing circumstances are making the exploitation of unconventional gas reserves increasingly economic.

3 Unconventional gas

3.1 A working definition of unconventional gas

While there is no single definition of unconventional gas, it is widely accepted that gas that resides in reservoirs of permeability of less than 1 millidarcy (mD)[12] and

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Overview of Natural Gas: Background above n 7; ibid.

[10] Taha Murtuza Husain et al, 'Economic Comparison of Multi-Lateral Drilling over Horizontal Drilling for Marcellus Shale Field Development' (Final Project Report, Penn State University, 5 January 2011) 12 <http://www.ems.psu.edu/~elsworth/courses/egee580/2011/Final%20Reports/fishbone_report.pdf>.

[11] Mike Johnson, Jim Davidson and Paul Mortensen, 'A Perspective on Canadian Shale' (Report, World Energy Council, 2009) 9 <http://www.worldenergy.org/documents/congresspapers/248.pdf>.

[12] Centre for Global Energy Studies, *What is unconventional gas?* (21 Jul 2010) <http://www.cges.co.uk/news/624-what-is-unconventional-gas>.

which cannot be extracted through conventional means constitutes unconventional gas. To extract unconventional gas, specific techniques such as horizontal drilling, hydraulic fracturing and multilateral wellbores are required to stimulate flow rates to levels that are economic.[13] Geoscience Australia encapsulates the characteristics of unconventional resources:

> Unconventional resources are natural resources that require greater than industry-standard levels of technology or investment to exploit [essentially due to them being trapped in reservoirs with low permeability that produce dry natural gas][14]. In the case of unconventional hydrocarbon resources, additional technology, energy and capital has [sic] to be applied to extract the gas.[15]

The most common types of unconventional gas are shale, tight gas, and CSG:[16]

1. Shale gas is natural gas that has not migrated to a reservoir rock because it is trapped within an impermeable layer of rock, giving rise to its low permeability characteristics.

2. Tight gas is found within reservoir rocks with very low porosities and permeability.[17] Generally, the standard definition for a tight gas reservoir is a rock with matrix porosities of 10 per cent or less and permeabilities of 0.1 mD

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[13] This commentary is adapted from Kent Perry and John Lee, 'Unconventional Gas Reservoirs — Tight Gas, Coal Seams, and Shales' (Working Document No 29, National Petroleum Council, 21 February, 2007) 5 <http://www.npc.org/study_topic_papers/29-ttg-unconventional-gas.pdf>.

[14] Ibid 4.

[15] Geoscience Australia, *Unconventional Petroleum Resources* (31 May 2012) <http://www.ga.gov.au/energy/petroleum-resources/unconventional-resources.html>.

[16] Advanced Resources International, *Unconventional Gas* <http://www.adv-res.com/unconventional-gas-nonconventional-resources.asp>; Geoscience Australia and Australian Bureau of Agricultural and Resource Economics, 'Australian Energy Resource Assessment (Chapter 4)' (Report No 70142, Geoscience Australia, 1 March 2010) 87 <http://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=70142> and <https://www.ga.gov.au/image_cache/GA17052.pdf>.

[17] Leslie Haines (ed), 'Tight Gas' (Supplementary Report, Oil and Investor, March 2006) 4 <http://www.oilandgasinvestor.com/pdf/TightGas.pdf>.

or less, exclusive of fracture permeability. Tight gas can be further contrasted with 'ultra-tight' gas reservoirs, which have in situ permeabilities as low as 0.001 mD.[18]

3. CSG is found in coal seams, where it is bonded to coal particles as opposed to having migrated to a reservoir. CSG is extracted through well drilling. The initial part of CSG production often involves the extraction of water to reduce pressure so as to liberate the gas. If the pressure within the seam is high, the gas may flow without the need for prompting.[19]

3.2 Techniques for producing unconventional gas

The techniques of horizontal drilling and hydraulic fracturing are not new; however, they have not played a dominant role in the production of conventional gas given their purpose was to extend the economic life of an existing well as opposed to being the technology applied during the course of a well's standard economic life — as is the case for unconventional gas:

> Although hydraulic fracturing has been used for decades, producers only began combining it with horizontal drilling to exploit unconventional gas resources — notably, vast shale deposits — as recently as 2002–03, initially in Texas.[20]

The horizontal drilling and the extraction methods, including hydraulic fracturing, required to develop unconventional gas are more complex than when applied to conventional gas production. The Pennsylvania Environmental Council (PEC) notes:

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[18] Ali Sharif, 'Tight Gas Resources in Western Australia' (Article, Petroleum in Western Australia Magazine, September 2007) 28 <http://www.dmp.wa.gov.au/documents/Tight-gas___Resources_in_Western_Australia.pdf>.

[19] Department of Environment and Resource Management, *About Coal Seam Gas* (1 April 2013) Queensland Government <http://www.ehp.qld.gov.au/management/coal-seam-gas/index.html>.

[20] Matthew Bramley, 'Is Natural Gas a Climate Change Solution for Canada?' (Report, David Suzuki Foundation and the Pembina Institute, 2011) 11 <http://www.davidsuzuki.org/publications/downloads/2011/DSF-Pembina-NatGas-web.pdf>.

> The mechanical and technical requirements of drilling and gas operations at the unconventional Marcellus Shale wells are more costly and intricate, and have higher potential risk [to the environment] than conventional extraction efforts typically employed in the past.[21]

Unlike conventional gas, developing unconventional gas requires multiple points of contact with the reservoir, involving repeated well digging and hydraulic fracturing.[22]

4 Shale gas

4.1 Characteristics of shale gas

Shale is a clastic fine-grained sedimentary rock that forms from the compaction of successive depositions of clay and other mineral particles that are commonly called 'mud'. The composition places shale in a class of sedimentary rocks known as 'mudstones'. Shale is different from other mudstones because it is laminated, which means that the rock comprises multiple thin layers, and fissile, where the rock splits into thin sheets along the laminations.[23]

The exact geochemistry of the shale differs from one formation to another.[24] The gas can be stored in natural fractures or pore spaces within the shale play.[25] The sediments in shale formations are less permeable than concrete, and the natural gas is in effect 'trapped' unless prompted. For the shale gas to be released there must be enough trapped gas to generate the pressure required for the gas to travel through

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[21] Christopher Hall et al, 'Developing the Marcellus Shale: Environmental Policy and Planning Recommendations for the Development of the Marcellus Shale Play in Pennsylvania' (Report, Pennsylvania Environmental Council, July 2010) 5 <http://www.pecpa.org/sites/pecpa.org/files/downloads/Developing_the_Marcellus_Shale_0.pdf>.

[22] ParisTechReview, *Unconventional Gas: A Reasoned View from France* (28 June 2011) Natural Gas Europe <http://www.naturalgaseurope.com/reasoned-view-france>.

[23] geology.com, *Shale* <http://geology.com/rocks/shale.shtm>.

[24] Leonie Reins, above n 1, 300.

[25] 3Legs Resources, 'An introduction to shale gas' (Report, June 2011) 1 <http://www.3legsresources.com/media/A%20guide%20to%20shale%20gas.pdf>.

pores that are 1000 times more restrictive than those in conventional sandstone reservoirs.[26] While unconventional gas resources are more challenging to develop than conventional gas resources, there are countries with a history of developing the resource, particularly shale gas, and countries with shale gas resources that are in various stages of preparing for a marked increase in shale gas production throughout the world. The United States, Canada and Western Australia are examples. The United States has the longest history of production and is the world's largest producer, Canada's production is increasing, and Western Australia is estimated to have relatively large reserves, with a modest degree of industry activity, at this time.

4.2 The United States

The United States has an extensive history of producing natural gas from shale formations, with the first producing well being completed in 1821 and production continuing throughout the 20th century.[27] It was not until the 21st century that production increased substantially: 'industry has been witnessing an extraordinary acceleration of unconventional gas production, driven by the exploitation of a few shale gas plays.'[28]

The proportion of shale gas in the United States' energy mix is thought to be increasing rapidly, mainly due to the discovery of economically feasible ways of exploiting shale gas. It is estimated by industry analysts that the greater part of new gas energy reserves will be from shale gas. 'Shale gas rose from less than 1% of

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[26] National Energy Board/Office national de l'energie (Canada), 'Understanding Canadian Shale Gas' (Energy Brief, November 2009) 1 <http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/ntrlgs/prmrndrstndngshlgs2009/prmrndrstndngshlgs2009nrgbrf-eng.pdf>.

[27] Ground Water Protection Council and ALL Consulting, 'Modern Shale Gas Development in the United States: A Primer' (Report, US Department of Energy, Office of Fossil Energy and National Energy Technology Laboratory, April 2009) 13 <http://www.netl.doe.gov/technologies/oil-gas/publications/EPreports/Shale_Gas_Primer_2009.pdf>.

[28] Florence Gény, 'Can Unconventional Gas Be a Game Changer in European Gas Markets?' (Report, Oxford Institute for Energy Studies, December 2010) 11 <http://www.oxfordenergy.org/wpcms/wp-content/uploads/2011/01/NG46-CanUnconventionalGasbeaGameChangerinEuropeanGasMarkets-FlorenceGeny-2010.pdf>.

domestic gas production in the United States in 2000 to over 20% by 2010.'[29]

The United States Energy Information Administration (US EIA) has assessed the United States' technically recoverable shale gas resources at 665 trillion cubic feet (tcf).[30] Technically recoverable resources (TRR) are the volumes of oil and gas that can be produced with current technologies and do not take into account costs, pricing or other economic factors that may limit oil and gas production. It is estimated that the United States has produced approximately 37 tcf, and 'the Marcellus leads the way in remaining natural gas reserves with an estimated 369 tcf ...'[31]

Caution is needed when relying upon estimates of shale gas as large-scale production of the resource is relatively new. As production increases, so does the drilling activity, which provides more information, resulting in the estimates being revised up or down.[32] The uncertainty is no surprise to some, especially those who have been sceptical from the outset about the initial estimates. They believe that experience to date shows that approximately only 10 per cent of each shale gas field will prove to be recoverable, because of wells having a rapid decline rate and becoming commercially unviable within a few years, as opposed to a few decades.[33]

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[29] Paul Stevens, 'The "Shale Gas Revolution": Developments and Changes' (Briefing Paper, Chatham House, August 2012) 2. <http://www.chathamhouse.org/sites/default/files/public/Research/Energy,%20Environment%20and%20Development/bp0812_stevens.pdf>.

[30] Penn State Extension, 'Latest Update on Shale Oil and Gas Assessments Worldwide' (Online Article, College of Agriculture Sciences, Penn State, 17 June 2013) <http://extension.psu.edu/natural-resources/natural-gas/news/2013/06/latest-update-on-shale-oil-and-gas-assessments-worldwide>.

[31] Ibid.

[32] For example, reserves for 2012 were estimated to be 42% lower than that estimated for 2011 (482 tcf of recoverable shale gas from an estimate of 827 in 2011). PennEnergy *US shale gas reserve estimates plummet* (26 January 2013) <http://www.pennenergy.com/articles/pennenergy/2012/01/u-s--shale-gas-reserve.html>.

[33] Matt Ridley, 'The Shale Gas Shock' (GWPF Report No 2, The Global Warming Policy Foundation, April 2011) 13 <http://www.marcellus.psu.edu/resources/PDFs/shalegas_GWPF.pdf>.

Conventional gas resources are measured using specific scientific assessment methodology — the same methodology is difficult to apply to unconventional gas. Assessments of unconventional gas resources are made more difficult by the heterogeneity of the rock formations, their extremely low permeability, and the uncertainty over how much volume of reservoir will be connected to the production well. Relatively robust quantification requires geological modelling and examination of the production behaviour of several wells by correlation to other known resources.[34]

An important improvement will be a robust and standardized measurement process. With unconventional resources playing an increasing role in energy supply, the more urgent it has become to devise the process.[35]

While there are uncertainties with respect to their extent, there are several shale formations in production in the United States, with more coming into production, making it probable that shale gas will play a greater role in energy consumption for a number of decades.[36] The United States Environmental Protection Agency (US EPA) has stated that natural gas is pivotal to meeting the country's future energy needs, noting that the resource has numerous economic, security enhancement, and environmental benefits; part of the US EPA's focus is to undertake work that enables the United States to increase production for domestic use in a way that is safe and

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[34] Robert Priddle (ed), 'World Energy Outlook [Part C — Prospects for Natural Gas]' (Study, International Energy Agency, 2009) 396 <http://www.worldenergyoutlook.org/media/weowebsite/2009/WEO2009.pdf>.

[35] Ibid. For a useful presentation on estimating potential hydrocarbon recoveries from unconventional gas plays see Scott Reeves, 'Unconventional Gas Resources to Reserves — A Predictive Approach' (Paper presented at Rocky Mountain Geology & Energy Resources Conference, Denver, Colorado, 9–11 July 2008) <http://www.adv-res.com/pdf/Rocky%20Mountain%20G%20&%20E%20Resources%20Conference.pdf>.

[36] School of Public Policy, 'Marcellus Shale Gas Development: Reconciling Shale Gas Development with Environmental Protection, Landowner Rights, and Local Community Needs' (Report, University of Maryland, July 2010) 24 <http://www.ela-iet.com/EMD/MARCELLUS_SHALE_GAS_DEVELOPMENT.pdf>.

responsible.[37]

4.2.1 The increasing significance of shale gas in the United States

Approximately nineteen geographic basins in the United States are recognized commercial sources of shale gas. Examples include the Barnett Shale in the Fort Worth Basin, the Marcellus Shale (and others) in the Appalachian Basin, and the New Albany Shale in the Illinois Basin.[38] The potential of these sources may be high. The Marcellus Shale could become the second largest natural gas field in the world, holding the equivalent to the energy content of approximately 87 billion barrels of oil, which is sufficient to meet worldwide demand for around three years.[39] The United States Federal Administration believes shale gas will have a very important role in domestic energy production in the years ahead.[40]

The growing dominance of shale gas in the United States has altered the energy setting, with consequences for global energy supply. Should shale gas production maintain its current path, the United States may move from being a liquefied natural gas (LNG) importer to an LNG exporter.[41] In 2008 the United States imported 13 per

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[37] United States Environmental Protection Agency 'EPA Releases Update on Ongoing Hydraulic Fracturing Study' (News Release, 21 December 2012) <http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/4af0024955d936ef85257adb0058aa29%21OpenDocument>.

[38] Halliburton, 'US Shale Gas: An Unconventional Resource. Unconventional Challenges' (White Paper, July 2008) 1 <http://www.halliburton.com/public/solutions/contents/shale/related_docs/H063771.pdf>.

[39] Timothy J Considine, Robert Watson and Seth Blumsack, 'The Economic Impacts of the Pennsylvania Marcellus Shale Natural Gas Play: An Update' (Report, Department of Energy and Mineral Engineering, College of Earth and Mineral Sciences, Pennsylvania State University (24 May 2010) iv <http://marcelluscoalition.org/wp-content/uploads/2010/05/PA-Marcellus-Updated-Economic-Impacts-5.24.10.3.pdf>.

[40] The Obama Administration, 'Blueprint for a Secure Energy Future' (Strategic Document, The White House, Washington, 30 March 2011) 9 <http://www.whitehouse.gov/sites/default/files/blueprint_secure_energy_future.pdf>.

[41] EuropeUnconventionalGas.org, *Unconventional Gas in the United States* <http://www.europeunconventionalgas.org/home/unconventional-gas/unconventional-gas-in-the-united-states>.

cent of its natural gas supply — a figure that is anticipated to fall to one per cent by 2035.[42]

> The exploitation of shale gas ignited a genuine revolution in the United States. In a country that only recently witnessed massive investment in terminal infrastructure to receive imports of liquefied natural gas the Americans now find themselves sitting on enormous reserves.[43]

4.2.2 Employment opportunities and revenues

The rapid increase in shale gas production prompted some analysts to predict that by 2011 between 50–60 per cent of new reserves growth would be sourced from shale gas reservoirs.[44] The implication being:

> [United States] employment in natural gas rose 17 percent from 2006 to 2008, representing one in four net new jobs created during that time throughout the entire US economy. Natural gas supports an estimated 2.8 million US jobs, and over 30 states are home to more than 10,000 natural gas jobs each. A 2009 Penn State study concluded that the Marcellus shale could generate $13.5 billion in economic value per year, $1.4 billion in state and local tax revenue, and almost 175,000 jobs

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[42] KPMG Global Energy Institute, 'Shale Gas — A Global Perspective' (Report, KPMG International, December 2011) 6 <http://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Documents/shale-gas-global-perspective.pdf>.

[43] ParisTechReview, above n 22.

[44] Ground Water Protection Council and ALL Consulting Modern Shale Gas Development, above n 27, 10.

by 2020 — in Pennsylvania alone.[45]

In 2009 despite the United States being in deep economic recession, Marcellus gas producers spent a total of $US4.5 billion to develop Marcellus Shale gas resources, which is estimated to have generated $US3.9 billion worth in value added activities, $US389 million in state and local tax revenues, and more than 44,000 jobs.[46]

4.3 Shale gas in Canada

Canadian production of conventional natural gas is waning and the decline is expected to continue over the next few years. Although the potential for shale gas production is still being evaluated, assessments point to 573 tcf of TRR.[47]

Large-scale commercial production of shale gas in Canada is pending; however, companies are exploring for and developing shale gas resources in Alberta, British Columbia, Quebec, and New Brunswick. In time, Canada will reflect qualities experienced by the United States, such as 'progressively increased efficiencies for shale gas recovery as industry optimizes its well completion and production practices.'[48]

Canada's National Energy Board (NEB) reports that the development of shale gas

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[45] Frank Verrastro and Conor Branch, 'Developing America's Unconventional Gas Resources — Benefits and Challenges' (A Report of the CSIS Energy & National Security Program, Center for Strategic and International Studies, December 2010) 2 <http://csis.org/files/publication/101209_Verrastro_UncontentionalGas_Web.pdf> citing Timothy Considine et al, 'An Emerging Giant: Prospects and Economic Impacts of Developing the Marcellus Shale Natural Gas Play' (Study, Department of Energy and Mineral Engineering, Pennsylvania State University, University Park, Pa, July 2009) <http://www.alleghenyconference.org/PDFs/PELMisc/PSUStudyMarcellusShale072409.pdf>.

[46] Timothy J Considine, Robert Watson and Seth Blumsack, above n 39.

[47] Analysis & Projections, 'Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States' (Report, United States Energy Information Administration, United States Department of Energy, 13 June 2013) I–2 <http://www.eia.gov/analysis/studies/worldshalegas/>.

[48] Ibid I–9.

and other unconventional resources will assist supplies of natural gas to the North American market for decades ahead.[49]

4.4 Shale gas in Western Australia

The interest in shale gas in Western Australia has been relatively modest, although awareness is picking up, which in part is due to the finding that the geological conditions are similar to the United States and Canada. The US EIA has estimated that Western Australia holds 288 tcf of shale gas.[50] While the quantity of shale gas may be only half of what the United States is estimated to have, Western Australia's reserves are relatively large on a per capita basis.

The US EIA reports that TRR of shale gas in Australia are 437 tcf[51] where 'one tcf is approximately equivalent to Australia's annual domestic gas usage'.[52] Western Australia is estimated to hold the fifth largest reserves of shale gas in the world,[53] with the Canning Basin in Western Australia estimated to have the highest

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[49] KPMG Global Energy Institute, above n 42, 9.

[50] Department of Mines and Petroleum, 'FAQ' (Frequently Asked Questions, Government of Western Australia, April 2012) 2 <http://www.dmp.wa.gov.au/documents/Unconventional_Gas_in_WA_FAQ.pdf>. It is unclear whether the estimate is based on TRR.

[51] Today in Energy, *Shale Oil and Shale Gas Resources Are Globally Abundant* (14 June 2013) United States Energy Information Administration <http://www.eia.gov/todayinenergy/detail.cfm?id=11611>.

[52] Commonwealth Scientific and Industrial Research Organisation, *Australia's Shale Gas Potential* (31 August 2012) <http://www.csiro.au/Outcomes/Energy/Energy-from-oil-and-gas/Shale-gas-potential.aspx>.

[53] Ibid.

recoverable resources in Australia, with TTR of 229 tcf.[54]

Western Australia is well placed geographically to potential markets, although it is unlikely to take advantage of the Chinese economy in the way Australia's eastern states have with CSG. China has the world's largest TRR, which are estimated to be 1115 tcf.[55] There is a degree of optimism over the extent of Western Australia's industry: 'based on interstate and international experience, it is likely that a successful onshore gas industry would employ several thousand people in construction, operations, infrastructure and service sectors.'[56]

Commercialization is yet to be realized, with no applications for projects requiring hydraulic fracturing before the Department of Mines and Petroleum (DMP) (Western Australia's responsible lead regulator) and the DMP expecting that shale gas will remain in the exploration and proof of concept phase for a number of years.[57]

Commercialization may be promoted through assistance from the Department of Petroleum Engineering (Shale Gas Industrial Consortium) at Curtin University (consortium). The consortium is undertaking the work partnering with different interest groups, including industry. The consortium's primary goal is to undertake sweet spot mapping in locations that are likely to have a high potential for shale gas production within the Perth and Canning Basins. The initiative is aligned with ensuring that energy needs in the years ahead are met, which cannot be achieved

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[54] Alex Cull et al, 'Australia: Unconventional Series — The Shale Gas Revolution Comes to Australia' (Online Article, Norton Rose Fulbright, 19 August 2011) <http://www.mondaq.com/australia/x/143146/Renewables/Unconventional+series+The+shale+gas+revolution+comes+to+Australia>; The DMP has tabulated the estimated shale gas reserves in Western Australia for the Canning and Perth Basins in *Investment Opportunities Shale Gas* (February 2013) <http://www.dmp.wa.gov.au/documents/Investment_Opportunities_-_Shale_Gas.pdf>.

[55] Analysis & Projections, above n 47, 15.

[56] WA Onshore Gas, *Securing economic growth* <http://waonshoregas.info/securing_economic_growth>.

[57] Department of Mines and Petroleum, 'DMP sets record straight for shale and tight gas' (Online Article, Government of Western Australia, 29 May, 2013) <http://www.dmp.wa.gov.au/7105_17715.aspx>.

effectively if the understanding of Australia's shale gas potential is poor.[58]

5 Why developing unconventional gas is becoming increasingly viable and appealing

The increasing focus upon shale gas represents a significant change as shale plays were traditionally disregarded by producers in their pursuit of the larger and less intensive opportunities provided by conventional resources which gave faster returns on their investments.[59] There are a number of factors contributing to the increased appeal of shale gas, including the often-mentioned advances in technology.

5.1 Increased access to gas plays through technological advances

Unconventional gas resources have recently been extracted by modifying techniques that increase considerably the amount of rock that is in contact with the well, thereby improving flow rates. In recent years, producers have developed, or improved, technology capable of producing larger volumes of shale gas at lower costs.[60] In particular, the use of horizontal drilling in conjunction with hydraulic fracturing has enhanced the ability of producers to make a commercial return.

Producing shale gas has been described as a technology-driven activity, because achieving gas production from essentially unproductive rock needs technologically

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58 Department of Petroleum Engineering, 'Shale Gas Consortium' (Notice, Curtin University) <https://petroleum.curtin.edu.au/local/docs/ugrg/Shale.pdf>.

59 Maximilian Kuhn and Frank Umbach, 'Strategic Perspectives of Unconventional Gas: A Game Changer with Implications for EU's Energy Security' (Strategy Paper, Vol 01 No 1, European Centre for Energy and Resource Security (EUCERS), Department of War Studies, King's College London, 1 May 2011) <http://www.kcl.ac.uk/sspp/departments/warstudies/research/groups/eucers/strategy-paper-1.pdf>.

60 Matthew Bramley, above n 20, 3.

intensive processes.[61]

In the 1970's a joint approach between the United States Federal Government and private operators was established. The partnership helped cultivate technology that later became crucial to the production of natural gas from shale rock, including horizontal wells, multi-stage fracturing and slick-water fracturing.[62] An early example where technological advancements in hydraulic fracturing and horizontal drilling made shale gas economic is the production of the Barnett Shale in northeast Texas. The advancement was a consequence of Mitchell Energy and Development Corporation experimenting during the 1980's and 90's with technology and practices, and lead ultimately to deep shale gas production becoming a commercial reality.[63] Consequently the Barnett Shale became the largest single producing natural gas play in North America, but was surpassed by the Haynesville Shale in 2011. These early successes built confidence in the industry, encouraging prospective producers in other locations to proceed.[64]

5.2 Diverse applications

Conventional and unconventional natural gas together make up the second largest source of energy consumed in the United States after petroleum.

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[61] Mike Johnson, Jim Davidson and Paul Mortensen, above n 11, 1.

[62] United States Energy Information Administration, 'Review of Emerging Resources: US Shale Gas and Shale Oil Plays' (Report, US Department of Energy, July 2011) 4 <http://www.eia.gov/analysis/studies/usshalegas/pdf/usshaleplays.pdf>.

[63] United States Energy Information Administration, 'World Shale Gas Resources: An Initial Assessment of 14 Regions outside the United States' (Report, US Department of Energy, 5 April, 2011) 4 <http://www.eia.gov/analysis/studies/worldshalegas/>.

[64] Kenneth B Medlock III, Amy Myers Jaffe and Peter R Hartley, 'Shale Gas and US National Security' (Policy Paper, James A Baker III Institute for Public Policy, Rice University, July 2011) 20 <http://www.bakerinstitute.org/publications/EF-pub-DOEShaleGas-07192011.pdf>; Stevens notes in Paul Stevens, 'The "Shale Gas Revolution": Hype and Reality' (Report, Chatham House, September 2010) 13 <http://www.chathamhouse.org/sites/default/files/public/Research/Energy,%20Environment%20and%20Development/r_0910stevens.pdf> that by 2008 up to 2,600 of the 2,710 wells were horizontal.

Natural gas is unique among other energy sources because it plays a role in a number of sectors of the United States economy:

> … coal, nuclear and hydro are used almost exclusively in the power sector. Petroleum is primarily used for transportation, and only secondarily as an energy source and petrochemical feedstock in the industrial sector. Hydro and nuclear power are used solely for electricity generation. Natural gas, by contrast, is used as a fuel in the residential, commercial, power and industrial sectors, and as a chemical feedstock.[65]

5.3 Increased prospects for electricity generation

The United States is the world's largest economy. Its electricity generation is predominantly coal-fired, producing approximately 45 per cent of the country's output.[66] Coal's dominance may not be guaranteed. Natural gas, with an emphasis upon an increased supply of unconventional gas, will have an increased role in electricity generation, with shale likely to undergo the largest production increase:[67]

> Moving electricity generation from coal to natural gas provides a near-term affordable solution to security of supply concerns. Natural [shale] gas is not as clean as wind or nuclear power [sic], but it is far cheaper, available today and reliable. Clean coal is very expensive, unproven and up to twenty years away.[68]

The perceived comparative advantages of unconventional gas over coal include the following:[69]

- 'Cycling' — where natural gas has the ability to scale rapidly up or down the

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[65] Energy Project, 'Shale Gas: New Opportunities, New Challenges' (White Paper, Bipartisan Policy Center, January 2012) 9 <http://www.bipartisanpolicy.org/sites/default/files/BPC%20Shale%20Gas%20Paper.pdf>.

[66] World Coal Association, *Total World Electricity Generation by Fuel (2009) [Source: IEA 2010]* <http://www.worldcoal.org/coal/uses-of-coal/coal-electricity>.

[67] Frank Verrastro and Conor Branch, above n 45, 8.

[68] ShaleGasInfo.eu, *Issues and Policy* <http://www.shalegasinfo.eu/index.php/en/info/issues-a-policy.html>.

[69] Frank Verrastro and Conor Branch, above n 45, 8.

amount of electricity generated (whether renewable or not), which helps manage peak demand

- 'Clean' energy — natural gas reduces carbon dioxide emissions by having a more favourable chemical composition than oil and coal as natural gas is 30 per cent less carbon-intensive than oil and 50 per cent less than coal. Also, emissions of mercury, sulphur and nitrogen oxides are negligible compared with those of other hydrocarbon fuels[70]

- Affordability — assuming the natural gas supply is able to meet anticipated growth in demand, natural gas is a cost-effective alternative for electricity generation, particularly when the environmental toll of coal is taken into account, and

- Complementary — generators powered by natural gas are suited to play a complementary role in a generation mix that includes renewables, wind and solar power. Gas plants are easier to turn on and off than coal plants, allowing power utilities to use them to manage variable generation from renewable energy. The variable capacity is referred to as a 'balancer' where natural gas is used to compensate for reductions in intermittent electricity production from renewables.[71]

While shale gas production does provide promise, like all fuels, shale gas poses challenges as resource extraction and refining pose significant environmental hurdles, especially in an era of carbon constraints.[72] For example, despite the optimism and flourish of current activity to develop the resource, shale gas will not provide a universal answer to the disadvantages of coal fire powered electricity generation. Rather, for the United States, as may be the case for most countries,

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[70] The statement that natural gas is relatively clean is drawn from Paul Stevens, 'The "Shale Gas Revolution": Hype and Reality' above n 64, 4. The statement is made in the context of natural gas being relatively clean, not that it is advantageous for electricity generation per se.

[71] Frank Verrastro and Conor Branch, above n 45, 9.

[72] Frank A Verrastro et al 'The Geopolitics of Energy — Emerging Trends, Changing Landscapes, Uncertain Times' (Report, CSIS Energy and National Security Program, October 2010) 5 <http://csis.org/files/publication/101026_Verrastro_Geopolitics_web.pdf>.

increased production of all forms of energy will be needed.[73]

5.4 A bridging or permanent role, and greenhouse gases

5.4.1 Role

With traditional energy sources in decline, or becoming less reliable, which was reflected by the volatility in world oil prices in 2008, and the increased capacity to tap into unconventional gas, some are viewing unconventional gas as a bridging fuel:[74]

> Newly discovered gas shales (where natural gas is found) are totally changing the market. There's a lot of talk about using gas as a bridge fuel to cleaner technologies or making it an integral part of energy generation in this country.[75]

Shale gas could be a 'bridge' fuel as is it is domestically available and relatively clean, and a country can rely upon it as it transitions from traditional sources of energy to renewables.[76] In reality this may not occur, as a country with substantial reserves may have little incentive to seek alternative sources of 'greener' energy. There is the possibility that the reserves could delay the transition as the sense of urgency to seek alternatives is reduced.

Some argue that the properties of natural gas mean it should be seen as a 'permanent' pillar of the United States' energy strategy and not just a temporary

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73 Ibid x.

74 Ernest J Moniz et al, 'The Future of Natural Gas' (Interdisciplinary MIT Study No 4, Massachusetts Institute of Technology (MIT), 6 June 2011) iii <http://mitei.mit.edu/system/files/NaturalGas_Report.pdf>.

75 Cheryl Campbell, *Natural Gas: Bridging the Gap between Fossil Fuels and Renewable Energy* College of Engineering and Applied Science, University of Colorado <http://www.colorado.edu/engineering/profile/natural-gas-bridging-gap-between-fossil-fuels-and-renewable-energy>.

76 Definition adapted from Hannah Wiseman, 'Regulatory Adaptation in Fractured Appalachia' (Research Paper No. 08-10, The Centre for Global Energy, International Arbitration, and Environmental Law, The University of Texas School of Law, 1 November 2010) 103 <http://eidmarcellus.org/wp-content/uploads/2011/08/SSRN-id159495212.pdf>.

solution while waiting for the clean energy revolution. By substituting natural gas into energy intensive sectors such as electricity and transportation 'we can fuel a growing economy while mitigating emissions of carbon into the earth's atmosphere.'[77]

5.4.2 Greenhouse gases

Natural gas could become an energy source that has the lowest carbon tangible emissions of all fossil fuels[78] but also provides an economic dividend. Per unit of energy, natural gas produces about half the quantity of greenhouse gases as coal and up to three quarters the amount of petroleum — with the price being set for carbon emissions, the greenhouse advantages of unconventional gas will take on an economic value.[79]

Is natural gas really 'green', given hydraulic fracturing emits gas? A 2011 study estimated that, when all the shale losses were accounted for over the lifecycle of a well, 3.6 to 7.9 per cent (on average) of the well's production was emitted to the

[77] Roger Cooper, 'Natural Gas Reconsidered' (Policy Memo, Progressive Policy Institute, July 2011) 5 <http://progressivefix.com/wp-content/uploads/2011/07/07.2011_Cooper_Natural-Gas-Reconsidered-1.pdf>.

[78] IHS Cambridge Energy Research Associates, 'Fueling North America's Energy Future: The Unconventional Natural Gas Revolution and the Carbon Agenda' (Special Report, IHS Cambridge Energy Resources Associations, 2010) ES-5 <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43227/1296-ihs-cera-special-report.pd>.

[79] School of Public Policy, above n 36, 8.

atmosphere in the form of methane[80] — highlighting the importance of accounting for all phases of shale gas production (including use) if an accurate measure of shale gas' green credentials is to be achieved. This compares unfavourably with conventional gas where it was estimated that 1.7 to six per cent was emitted in the form of methane, which means that over its productive lifecycle, a shale gas well emits at least 30 per cent more methane than a conventional gas well, challenging the notion that shale gas is truly a bridging fuel to manage global warming.[81] The United Kingdom's Department of Energy and Climate Change has referred to the disquiet over potential methane emissions:

> CO_2 emissions from combustion of shale gas contribute to climate change in exactly the same way as from combustion of conventional gas, but methane emissions from the production process, if not properly controlled, can result in significant additions to greenhouse gas emissions.[82]

Based on a standard coal fired power plant, when natural gas is compared with coal, the former's carbon dioxide emissions are lower, approximately, by a factor of three,

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[80] A Cornell University Study (2012) concluded that hydraulic fracturing releases up to 8% of the extracted methane directly into the atmosphere, with the methane contributing to 44% of global warming, the reasons being: size of the fracking wells and their mode of operation; wells involving hydraulic fracturing requiring more time to drill before being capped; more ventilation being needed; and the potential effect of flow back waste. See Andrew Michler, *Updated Cornell Study Shows Fracking Causes More Global Warming than Coal* (17 April 2012) <http://inhabitat.com/updated-cornell-study-shows-fracking-causes-more-global-warming-than-coal/>. However the conclusion is not without its critics: see Mark Drajem *Cornell Researcher Rebuts Colleagues on Fracking Leaks* Bloomberg Businessweek (10 July 2012) <http://www.businessweek.com/news/2012-07-10/cornell-researcher-rebuts-colleagues-on-fracking-leaks>.

[81] Robert W Howarth, Renee Santoro and Anthony Ingraffea, 'Methane and the Greenhouse-Gas Footprint of Natural Gas from Shale Formations — A Letter' (2011) 106(4) *Climatic Change Journal* 679, 685 <http://www.springerlink.com/content/e384226wr4160653/fulltext.pdf?MUD=MP>.

[82] Department of Energy & Climate Change, 'Gas Generation Strategy' (Strategy Paper, Department of Energy & Climate Change, United Kingdom Government, December 2012) 56 [5.20] <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65654/7165-gas-generation-strategy.pdf>.

when natural gas is being used for electricity generation in the United States.[83] But the comparison with coal is only part of the picture. The potential of shale gas to have an effective role in a low carbon economy is tempered when seen in the context of current and medium term conventional gas production in regions other than North America, where production and use is relatively high. Even if shale gas is used as a substitute for other fossil fuels in the United States, there is nothing stopping those fossil fuels being used by other countries, potentially causing a global increase in carbon emissions:

> Put directly, whilst world demand for fossil fuels remains high, any new sources of fossil fuel (even if relatively low in carbon per unit of useful energy) will be purchased, combusted and consequently add to the global emissions burden.[84]

The unconventional resources of the European Union may be too small to have a discernible influence on the level of natural gas resources over the next 20 years. As the greenhouse gas emissions from unconventional gas are higher than conventional gas, environmental imperatives will be placed on unconventional projects — raising their costs and delaying their full implementation.[85]

Shale gas production may not only lead to the emission of more greenhouse gases, it also runs the risk of:

- Giving the false impression to customers that the global natural gas supply is secure when this is disputable, meaning measures that encourage the reduction in natural gas usage, such as price increases, efficiency measures

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[83] Daniel P Schrag, 'Is Shale Gas Good for Climate Change?' (2012) 141(2) *Dædalus, Journal of the American Academy of Arts and Sciences* 72, 73 <http://schraglab.unix.fas.harvard.edu/publications/128_Schrag.pdf>.

[84] Ruth Wood et al, 'Shale Gas: A Provisional Assessment of Climate Change and Environmental Impacts' (Research Report, The Tyndall Centre, University of Manchester January 2011) 51 <http://www.tyndall.ac.uk/sites/default/files/tyndall-coop_shale_gas_report_final.pdf>.

[85] Stefan Lechtenböhmer et al, 'Impacts of Shale Gas and Shale Oil Extraction on the Environment and on Human Health' (Study, Directorate General for Internal Policies, Policy Department A: Economic And Scientific Policy, European Parliament 2011) 11 <http://europeecologie.eu/IMG/pdf/shale-gas-pe-464-425-final.pdf>.

and substitution might not be pursued,[86] and

- Deferring the significant expenditure required to develop technologies that are zero (or low) carbon emitters: 'If money is invested in shale gas then there is a real risk that this could delay the production and deployment of such technologies.'[87]

5.5 Influencing geopolitical power

The United States shale gas reserves could assist in reducing the geopolitical power wielded by the dominant, and often politically unstable, petroleum producing nations (the 'petro-power' countries). By significantly reducing these producing nations' role in the global energy supply chain by substituting with shale gas, the United States and its aligned countries could reduce their vulnerability and enhance their geopolitical positions.[88] However, the outcome is not guaranteed; international relations and politics are susceptible to a number of factors, including instability and changing allegiances between countries.

The extent of the United States' shale gas reserves could mean that the United States can avoid or at least mitigate two problems that are generally associated with having to rely substantially on foreign sources of energy. First, a multi-billion dollar outflow of United States wealth to foreign (and potentially rival) interests is avoided, which helps manage the United States' balance of payments and, second, the United States' energy security is enhanced, which promotes political and economic resilience, including the ability to plan.[89] Countries allied to the United States could access the natural gas that was previously imported by the United States. Indirectly, the United

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[86] Ibid.

[87] Ruth Wood et al, above n 84, 6.

[88] Kenneth B Medlock III, Amy Myers Jaffe and Peter R Hartley, above n 64, 13.

[89] Nathaniel Freeland, 'The Strategic Importance of Shale Gas' (Issue Paper, Center for Strategic Leadership, US Army War College, August 2011) 1 <http://www.csl.army.mil/usacsl/publications/IP16_11.pdf>.

States would affect these countries' ability to access energy:[90]

> Should the shale gas momentum in the US be sustained in the longer term, the reduced requirement in the American market for LNG will provide European markets with the potential option of additional sources of supply.[91]

6 Conclusion

Unconventional gas is difficult to define. However, an important characteristic is its relatively low permeability in rock, meaning it cannot be extracted through conventional techniques. There are three common types of unconventional gas, each with its unique characteristics, with shale gas being the focus of the thesis.

Due to the challenges of its extraction, shale gas has not been widely commercialized until relatively recently. However, there are two countries with a history of commercialization, these being the United States and, to a lesser extent, Canada.

It is difficult to estimate a country's shale gas reserves, although the United States is considered to have vast quantities. It is likely that shale gas will have a very important role in meeting the future energy needs of the country and have the potential to grow the economy. Canada's production of shale gas is growing, although on a smaller scale than in the United States. However, there may be potential for the industry to expand as interest is growing and money is being invested. Western Australia's reserves are considered high, especially on a per capita basis, with the level of commercial activity being modest to date, but with the potential to expand considerably in the future.

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[90] Wade Hoxtell, Michael LaBelle and Cillian O'Donaghue, 'Dialogue Shale Gas: A Game Changer for European Energy Security?' (Conference Report of 9th Transatlantic Energy Governance Dialogue, Central European University, Budapest, 12–13 May 2011, Central European University, The Global Public Policy Institute and The Brookings Institution, 2011) 8 <http://www.globalenergygovernance.net/fileadmin/media/events/2011/event_2011_TEGD-9-conference-report.pdf>.

[91] Peter Kiernan, 'The Shale Gas Phenomenon: Altering the Western Discourse on Energy Geopolitics' (2010) 3(2) *Analytical Journal* 35, 40 <http://www.analyticalmk.com/files/04-2010/journal_06.pdf>.

There are a number of reasons why shale gas is becoming increasingly appealing, although some of the reasons are questionable. The ability of the gas to fuel a wide spectrum of the economy is an obvious one. However, whether shale gas can be a bridging fuel, play a permanent role in energy supply, or have the capacity to reduce greenhouse emissions is uncertain. The various views regarding the capacity of the gas may be overly optimistic and ignore the possibility that countries with access to considerable reserves of traditional energy sources may not transition to shale gas as they have little incentive to do so. It is also unclear whether shale gas over its lifecycle is 'green', given its emissions of methane are higher than conventional gas. Finally, shale gas production has the potential to enhance the resilience of a producing country's economy and make it less susceptible to the vagaries of geopolitics. However there is unpredictability: political instability, the state of the global economy, and changing allegiances between countries make it difficult to predict how the increased supply of shale gas will play out nationally and internationally.

Large-scale industrialization of shale gas is relatively new and many of the potential opportunities for the gas have only been identified recently. The rapid increase in shale gas could lead to production operating in the absence of suitable regulation. To develop a framework, an understanding of shale gas production is needed. The aim of this Part was to commence the understanding. Part III provides specific detail on the activities and challenges associated with shale gas production.

PART III TECHNIQUES & CHALLENGES OF PRODUCING SHALE GAS

7 Introduction

> *The industry is completely different in terms of monitoring or regulating because it is not like a single, stationary factory or refinery [therefore, it is heterogeneous]. I don't think public-health researchers or the regulatory agencies have gotten their hands around that problem.*[92]

The rapid, large-scale rise of shale gas production presents a number of challenges. The challenges relate to key activities of production, including horizontal drilling, hydraulic fracturing, well spacing, water considerations, and cumulative impacts.[93] It is these challenges that this Part explores.

8 The process of horizontal drilling

Horizontal drilling allows for the extraction of unconventional gas that in the past would not have been feasible, either technically or economically. Horizontal drilling involves drilling a vertical well to a certain depth and then drilling laterally to access a larger portion of the gas reservoir.[94] A number of these directional wells can be drilled from a single well so that there is little or no evidence on the surface that such

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[92] Susan McClure, 'Marcellus Shale Natural Gas: From the Ground to the Customer' (Study Guide No 1 from 'Marcellus Shale Natural Gas Extraction Study', The League of Women Voters of Pennsylvania, 2009–2010) 47 <http://www.bfenvironmental.com/pdfs/Marcellus_Shale_Study_Guide_Parts_1-5.pdf>, quoting Roxana Witter, Colorado School of Public Health, Denver, Colorado in Chris Vaughn, *Air-quality tests raise questions about natural gas wells in the Barnett Shale* (4 October 2009) Star Telegram <http://tech.groups.yahoo.com/group/safepipelines/message/14578>.

[93] Energy Resources Conservation Board, 'Unconventional Gas Regulatory Framework — Jurisdictional Review' (Report No 2011–A, 28 January 2011) 5–6 <http://www.ernstversusencana.ca/wp-content/uploads/2012/12/2011-03-02-ERCB-unconventional-gas-report-2011-A.pdf>.

[94] Susan L Sakmar, 'The Future of Unconventional Gas' above 9, 3.

drilling has occurred; rather, the drilling rig resembles a vertical well. The purpose of horizontal drilling is to increase contact with the gas-bearing shale formations.[95] This increased contact may reduce costs and environmental disturbance.[96]

The process involves drilling a well from the surface to a point — the 'kick-off point' — just above the target gas-bearing shale formation. Special tools are then used to drill a curved section so that the well bore intersects the reservoir — the 'entry point' — at a near-horizontal inclination.[97] Drilling continues along this horizontal trajectory for one to two kilometres, with the intention of exposing the wellbore to as much of the reservoir as possible.[98]

During the drilling process, and at its end, a series of casings are run into the well and cemented to seal the well bore. The purpose of the sealing is to prevent water flooding the well and protect surrounding groundwater from contamination by drilling and reservoir fluids. The production casing is then perforated using explosives along the horizontal wellbore where shale will be subjected to hydraulic fracturing.[99] 'Each perforation is isolated in sequence so that only a single section of the well is hydraulically fractured[100] at a given time'.[101]

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95 NaturalGas.org, *Onshore Drilling* <http://www.naturalgas.org/naturalgas/extraction_onshore.asp>.

96 Anthony Andrews et al 'Unconventional Gas Shales: Development, Technology, and Policy Issues' (Report, Congressional Research Service, 30 October 2009) 17 <http://www.fas.org/sgp/crs/misc/R40894.pdf>; NaturalGas.org, *Onshore Drilling* above n 95.

97 Lynn Helms, 'Horizontal Drilling' 35(1) *DMR Newsletter* 1, 1 <https://www.dmr.nd.gov/ndgs/newsletter/NL0308/pdfs/Horizontal.pdf>; New York State Department of Environmental Conservation, *Marcellus Shale* <http://www.dec.ny.gov/energy/46288.html>.

98 Mike Johnson, Jim Davidson and Paul Mortensen, above n 11, 7.

99 Anthony Andrews et al, above n 96, 24.

100 See Section 9.1 'The technique of hydraulic fracturing'.

101 Mark Zoback, Saya Kitasei and Brad Copithorne, 'Addressing the Environmental Risks from Shale Gas Development' (Briefing Paper No 1, Worldwatch Institute, July 2010) 4 <http://www.worldwatch.org/system/files/BP1.pdf>.

8.1 Horizontal drilling intersects vertical fractures

The Canadian Society of Unconventional Resources describes horizontal drilling as:

> A drilling procedure in which the wellbore is drilled vertically to a kick-off depth above the target formation and then angled through a wide 90 degree arc such that the producing portion of the well extends horizontally through the target formation.[102]

The usefulness of horizontal drilling can be illustrated in its application to gas shale formations such as the Marcellus, which have natural fractures or vertical 'joints'. Vertical drilling will not intersect many vertical fractures. However, with horizontal drilling, 'the wellbore in the shale is perpendicular to the most common fracture orientation, which allows it to intersect a much greater number of fractures.'[103]

The same principle can be applied to vertical fractures that result from hydraulic fracturing along a horizontal well bore. This can result in more efficient drilling as one horizontal well may extract the same quantity of gas as four or more vertical wells for the same producing shale formation.[104]

8.2 The extent of disturbances

The reduction in the number of wells results in fewer well pads, production facilities, roads and pipelines within an area. This has the effect of reducing surface disturbance and interference with the overall natural landscape, and can help

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[102] Canadian Society of Unconventional Resources, 'Understanding Water and Unconventional Resources' (Information Booklet) 22 <http://www.csur.com/sites/default/files/Understanding_Water_final.pdf>.

[103] Lisa Sumi, 'Shale Gas: Focus on the Marcellus Shale' (Report, Oil & Gas Accountability Project/Earthworks, May 2008) 7 <http://www.marcellus.psu.edu/resources/PDFs/Focusonthemarcellus.pdf>.

[104] West Virginia Surface Owners' Rights Organization, *Why Multiple Horizontal Wells from Centralized Well Pads Should Be Used for the Marcellus Shale* (August 27 2012) <http://www.wvsoro.org/resources/marcellus/horiz_drilling.html>.

manage other impacts such as noise and traffic volumes.[105]

However, horizontal drilling may disturb the surface in other ways, raising the prospect that the reduction in surface disturbance may be overstated. Horizontal drilling usually has multiple wells drilled from a common pad, which has a greater contiguous surface area, resulting in more surface runoff from one location.[106]

8.3 Well spacing

A country with a petroleum industry is likely to have legally enforceable well spacing rules. These rules help with the management of the reserves by preventing multiple drilling of a specific well in any given area. The area is commonly known as a drilling spacing unit (DSU). The regulator may also direct that drilling takes place from within a prescribed measurement, sometimes called the target area, within a DSU. Wells must be drilled within the target area to avoid penalties.[107]

It is possible that over time wells could be drilled on all available spacing units (often referred to as 'infilling'), where the spacing unit requirements become driven by the needs of production, rather than what the regulator initially considered appropriate: 'In most cases, state regulatory agencies initially define allowable spacing units. This

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[105] J Daniel Arthur and Bobbi Jo Coughlin, 'Hydraulic Fracturing Considerations for Natural Gas Wells of the Fayetteville Shale' (Paper, ALL Consulting, 2008) 8 <http://all-llc.com/publicdownloads/ALLFayettevilleFracFINAL.pdf>; J Daniel Arthur, Brian Bohm and Mark Layne, 'Hydraulic Fracturing Considerations for Natural Gas Wells of the Marcellus Shale' (Paper presented at the Ground Water Protection Council Annual Forum, Cincinnati, Ohio, 21–24 September 2008) 13 <http://www.dec.ny.gov/docs/materials_minerals_pdf/GWPCMarcellus.pdf>.

[106] un-naturalgas.org, *How about horizontal drilling?* <http://www.un-naturalgas.org/hydraulic_fracturing_a-z.htm#horizontal%20drilling>.

[107] Michael Laffin and Katie Jamieson, *ERCB Alters Alberta Well Spacing Framework* (25 November 2011) Blakes <http://www.blakes.com/English/Resources/Bulletins/Pages/Details.aspx?BulletinID=1418>.

often results in wells being spaced closer together over time.'[108] Initially, there is no need to have additional wells as the gas is relatively easy to extract and the producer is resigned to complying with the regulatory requirements. Assuming the regulatory requirements are fit for purpose, the early phases of production will be carried out with a well density that is suitable. Nonetheless, if a producer can demonstrate to the regulatory authority that more wells are required to extract as much of the gas as possible, then down-spacing is likely to be approved, resulting in a well density that may be unacceptable. The experiences of the Barnett, Fayetteville and other shale formations have shown a trend over time from larger to smaller spacing units. The spacing history is likely to be replicated by the Marcellus Shale.[109]

Well spacing is an emerging issue, particularly in North America.[110] The issue is attracting more attention because:[111]

- Optimal well spacing must be achieved for the efficient and systematic production of unconventional gas

- Unconventional gas requires greater well density than conventional density to achieve commercial returns, and

- Regulatory authorities are allowing greater density, even though their regulatory standards would not ordinarily permit such — possibly creating adverse effects on the environment.

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[108] National Park Service, 'Potential Development of the Natural Gas Resources in the Marcellus Shale — New York, Pennsylvania, West Virginia, and Ohio' (Report, US Department of the Interior, December 2008) 5 <http://www.nps.gov/frhi/parkmgmt/upload/GRD-M-Shale_12-11-2008_high_res.pdf>.

[109] Ibid.

[110] See, eg, Michael Laffin and Katie Jamieson, above n 107. The Energy Resources Conservation Board (ERCB), the regulator for Alberta, Canada, recently amended the regulations relating to well spacing in its Oil and Gas Conservation Regulations.

[111] Energy Resources Conservation Board, 'Unconventional Gas Regulatory Framework — Jurisdictional Review' above n 93, 5.

8.4 Costs

While horizontal drilling increases access to a shale play, it does so at a greater financial cost than a vertical well. The cost of drilling a horizontal well in North America is between five and ten million United States dollars,[112] although the cost of drilling will be influenced by the nature of the technology needed, the additional time it takes to drill and, in some instances, hydraulic fracturing being applied over several days to one well.[113] The increased cost of drilling a horizontal well does not lead to more gas being extracted. For shale gas, producers might only recover 20 per cent of the gas compared with conventional reservoirs, where it is possible to recover more than 90 per cent.[114]

9 Hydraulic fracturing

9.1 The technique of hydraulic fracturing

Hydraulic fracturing is described as a 'drilling process', which technically it is not. Fracturing is used after the horizontally drilled hole is completed. Hydraulic fracturing is a well stimulation process used to maximize the extraction. By undertaking the process, gas can 'escape'.[115]

Shale gas wells have a propensity to produce at a lower pressure and have lower production rates than conventional gas wells. Due to the low production rates, a greater number of wells are likely to be needed to produce a certain volume of gas.[116] Each well requires hydraulic fracturing as shale gas is tightly trapped in exceedingly

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[112] Mike Johnson, Jim Davidson and Paul Mortensen, above n 11, 11.

[113] National Energy Board/Office national de l'energie (Canada), above n 26, 11.

[114] Ibid 14.

[115] American Society of Civil Engineers, *Policy Statement 539 — Hydraulic Fracturing* (20 July 2012) <http://www.asce.org/Public-Policies-and-Priorities/Public-Policy-Statements/Policy-Statement-539---Hydraulic-Fracturing/>.

[116] Mary Griffiths, 'Protecting Water, Producing Gas — Minimizing the Impact of Coalbed Methane and Other Natural Gas Production on Alberta's Groundwater' (Report, Pembina Institute, April 2007) 2 <www.pembina.org/pub/1434>.

small spaces within the reservoir rock, meaning that the gas will not flow up the well. Not all fracturing operations are the same. The design of an operation is regularly determined by individual characteristics[117] such as the formation, including its 'tightness', the resource, and the capacity for the formation to release the gas under changing pressure without prompting.[118]

Hydraulic fracturing involves injecting fluids consisting of water, sand and chemicals at high pressure. Water and sand comprise 98 to 99.5 per cent of the fluid, with chemical additives making up the remainder. Formulations vary depending upon the characteristics of the well.[119] The process involves not only well stimulation but also a number of other activities, including the acquisition of source water, well construction and waste disposal.[120]

The volume of potentially toxic substances, even at less than one per cent of the total volume of fluid, can be very high.[121] These substances are chemicals that alter the characteristics of the water to minimize friction. Fracturing fluid may flow back, where it is pumped to holding tanks or pits. Disposal options for flow-back include

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[117] Jennifer Goldman and Lisa Sumi, 'How Fracturing Works' (Fact Sheet, Earthworks, 2 February 2009) 1 <http://www.earthworksaction.org/files/publications/Fracking_Facts.pdf>.

[118] Hannah Wiseman, 'Untested Waters: The Rise of Hydraulic Fracturing in Oil and Gas Production and the Need to Revisit Regulation' (2009) 20 *Fordham Environmental Law Review* 115, 119 <http://ssrn.com/abstract=1595092>.

[119] FracFocus, *Hydraulic Fracturing: The Process* <http://fracfocus.org/hydraulic-fracturing-how-it-works/hydraulic-fracturing-process>.

[120] Office of Research and Development, 'Hydraulic Fracturing Research Study' (Fact Sheet, United States Environmental Protection Agency, June 2010) 1 <http://www.epa.gov/safewater/uic/pdfs/hfresearchstudyfs.pdf>.

[121] Ken Costello, 'Hydraulic Fracturing: Placing What We Know Today in Perspective' (Paper, National Regulatory Research Institute, October 2011) 5 <http://www.nrri.org/pubs/gas/NRRI_Hydraulic_Fracturing_Oct11-16.pdf>.

discharge into surface water or underground injection.[122]

The fluid that does not recede comprises sand and other agents, which hold open the fractures. The fluid is often referred to as a proppant as it 'props' open the fractures made by hydraulic fracturing, allowing gas to flow.[123] The newly opened or enlarged fractures may extend several hundred feet from the well.

Hydraulic fracturing alters the accessible surface area open to free the shale gas and, therefore, is essential to the extraction of shale gas in quantities that are commercially viable.[124] Without hydraulic fracturing, the process of extracting the gas would be so excruciatingly slow that commercialization would not be possible.

9.2 The Importance of hydraulic fracturing in the United States

Hydraulic fracturing technology has been in existence for some time. The first commercial application of hydraulic fracturing for the purpose of stimulating the production of oil or gas is estimated to have occurred in the United States around the middle of the 20th century.[125] In the decades since, hydraulic fracturing has been used on more than one million producing wells, and is now applied annually to approximately 35,000 wells of all types. The importance of hydraulic fracturing to the United States was highlighted in a report prepared for the American Petroleum

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[122] United States Environmental Protection Agency, *Hydraulic Fracturing Background Information* (Wednesday, 9 May 2012) <http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydrowhat.cfm>.

[123] Hannah Wiseman, above n 118, 4.

[124] Canadian Association of Petroleum Producers, 'The Facts on Natural Gas' (e-Newsletter 'Upstream Dialogue', 2011) 15 <http://www.capp.ca/getdoc.aspx?DocId=217568&DT=NTV>.

[125] FracFocus, *Hydraulic fracturing: A Historic Perspective* <http://fracfocus.org/hydraulic-fracturing-how-it-works/history-hydraulic-fracturing>.

Institute,[126] (although the likely economic impact of a proposal to regulate hydraulic fracturing is disputed).[127] The report found that if the technology were to be eliminated there would be a decrease of around 79 per cent of wells completed. As a result, by 2014 the United States would experience a 45 per cent reduction in natural gas production, with reductions continuing during the forecast period, resulting in a 57 per cent decrease in gas production by 2018. Due to the country's emerging reliance on unconventional resources, where over 95 per cent of gas wells are ordinarily reliant upon hydraulic fracturing, the effect on production would be significant.[128] While hydraulic fracturing is not without risks,[129] some commentators believe that, in light of what is known, the financial cost to the United States of not developing its shale gas resources is likely to be high compared to the risks posed by the increased fracturing.[130] Given that approximately 90 per cent of wells in the United States involve hydraulic fracturing, some are less optimistic: 'Scientists are worried that the chemicals used in fracturing may pose a threat either underground or when waste fluids are handled and sometimes spilled on the surface.'[131]

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[126] Global Insight, 'Measuring the Economic and Energy Impacts of Proposals to Regulate Hydraulic Fracturing' (Report No 1, Prepared for American Petroleum Institute, 2009) 2 <http://s3.amazonaws.com/propublica/assets/natural_gas/ihs_gi_hydraulic_fracturing_task1.pdf>.

[127] Ernie Niemi and Paul Thoma, 'Potential Economic Impacts of Regulations to Rein-In the External Costs of the American Oil and Natural Gas Production Industry — A Critique of Recent Reports.' (Report prepared for the Natural Resources Defense Council, ECONorthwest, 2009) 4 <http://docs.nrdc.org/energy/files/ene_09091001b.pdf>.

[128] Global Insight, above n 126, 2. The results of the study are compared with production levels in a reference case, which is based on existing regulations, and with the production levels that would come from existing wells alone ('no drilling').

[129] This is discussed in Part III 'Techniques & Challenges of Producing Shale Gas'.

[130] Ken Costello, above n 121, iv

[131] ProPublica, *What is Hydraulic Fracturing?* <http://www.propublica.org/special/hydraulic-fracturing-national>.

10 Water related issues

10.1 The role of water

Throughout the drilling process, water, along with custom-designed water-based fluids, serves a number of different roles. These include:[132]

- Lubrication
- Circulation of the drilled-up rock from out of the bore hole, and
- The containment of formation fluids within the bore hole.

In addition to these roles, there are those associated with the preparation of the well, which is often referred to as 'completing' the well by hydraulic fracturing. For instance:[133]

- Pressurizing the well to fracture the rock, and
- Conveying the proppant (such as sand) into the formation to maintain the fractures that have been opened.

Substantial amounts of water are required for the drilling and stimulation of a shale gas well. A single stage fracture treatment, being the total volume of the sub-stages, requires more than 500 000 gallons (1 892 000 litres), which approximates to 76 per cent of the water required to fill an Olympic size swimming pool. Wells that experience numerous treatments expend several million gallons.[134] A Marcellus Shale

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[132] Canadian Society of Unconventional Resources, above n 102, 2.

[133] Ibid.

[134] Ground Water Protection Council and ALL Consulting, above n 27, 58.

fracturing operation needed up to 10 million gallons of water.[135] Water and its relationship to hydraulic fracturing is illustrated by the following: 89 per cent of water used in developing the Barnett Shale is for fracturing, while 10 per cent is for drilling. The sources of water are approximately evenly divided between groundwater (56 per cent) and surface water (43 per cent), with less than one per cent being from reused and recycled sources.[136]

Some dispute that shale gas production uses excessive amounts of water. They argue that while up to 5 million gallons per well could be used, these water requirements are not large in comparison with those of other industries, such as power generation:

> Gas drilling in Pennsylvania uses less than 60 million gallons per day, compared with 1,550 used in public water systems, 1,680 used in industry and 5,930 used in power generation in the state (US Geological Survey). A single shale gas well uses in total about the same amount of water as a golf course uses in three weeks.[137]

10.2 Water issues: access and effective management

The principal driver determining the nature of water management and responsible disposal arising from hydraulic fracturing is linked to the fluid requirements for a successful hydraulic fracturing operation:

> All phases of water management ultimately depend on the requirements the frac fluid properties need for fracturing success. These requirements are the result of the

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[135] Lisa Sumi, 'Environmental Concerns and Regulatory Initiatives Related to Hydraulic Fracturing in Shale Gas Formations: Potential Implications for North American Gas Supply' (Report prepared for the Council of Canadians, Earthworks, 21 September 2010) 5 <http://canadians.org/sites/default/files/L-Sumi-Report.pdf>. The quantity of water needed is likely to vary, depending where the well is located on the shale play. A Canadian conventional well has been reported to use considerably less water — 50,000 gallons. In the Horn River Basin of Canada, the hydraulic fracturing of a single horizontal unconventional gas well may require up to 26 million gallons.

[136] Tom Hayes, 'Shale Gas Water Management Consortiums: Marcellus and Barnett Regions' (Paper presented at GWPC Water/Energy Symposium, Pittsburgh, PA, 27 September 2010) 9–10 <http://www.gwpc.org/sites/default/files/event-sessions/3Hayes_Tom.pdf>.

[137] Matt Ridley, above n 33, 22.

> geology, the operating environment, the frac design, the scale of the development process, and the results required for total project success.[138]

Given the important role water plays, easy access to water and effective water management are becoming important issues for those involved in the production of shale gas.[139] These two issues are broadly characterized by the following activities:

- Supplying water for well construction without undermining local water resources

- The containment and recovery of fluids (waste water) from the wells, and

- Wastewater management.[140]

With the increase in shale gas production, water has become the greatest discernible environmental concern associated with shale gas production.[141] The increase and the associated environmental concerns prompted the US EPA to announce in March 2010 that it would study the potential adverse impact that hydraulic fracturing may have on drinking water.[142] 'The purpose of the study is to assess the potential impacts of hydraulic fracturing on drinking water resources, if any, and to identify the driving

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[138] American Petroleum Institute, 'Water Management Associated with Hydraulic Fracturing' (Guidance Document No HF2, June 2010) 10 <http://www.shalegas.energy.gov/resources/HF2_e1.pdf>.

[139] Peter Rowley, 'Meeting the challenge of unconventional gas' (Article, ERM Foundation, 30 April 2010) <http://www.erm.com/Analysis-and-Insight/Articles/Meeting-the-challenge-of-unconventional-gas/>.

[140] Partially informed and interpreted from Daniel J Soeder and William M Kappel, 'Water Resources and Natural Gas Production from the Marcellus Shale' (Fact Sheet No 2009-3032, US Geological Survey, May 2009) 4 <http://pubs.usgs.gov/fs/2009/3032/pdf/FS2009-3032.pdf>.

[141] IHS Cambridge Energy Resources Associations, above n 78, ES-5.

[142] Office of Research and Development, 'Hydraulic Fracturing Research Study' above n 120, 1.

factors that may affect the severity and frequency of such impacts.’[143]

The US EPA issued a progress report in December 2012; the final report is scheduled for release in 2014. The study’s intention is to inform stakeholders, such as the public and decision-makers, ‘at all levels with high-quality scientific knowledge that can be used in decision-making processes.’[144] This may explain why the EPA has designated the report as a ‘Highly Influential Scientific Assessment’, which is therefore subject to an independent and external peer review, along with ad hoc expert input.[145]

The study’s scope is broad and includes the lifecycle of water in hydraulic fracturing, being:[146]

- Water acquisition
- Chemical mixing
- Flow-back and produced water (waste waters),and
- Wastewater treatment and waste disposal.

10.2.1 Supply of water

Water for drilling and hydraulic fracturing of the wells frequently comes from surface water bodies such as rivers and lakes. The water can come from groundwater and re-used produced water too, being water that is trapped in underground formations that is brought to the surface with the natural gas. The water comprises mostly salty water contained within the shale formation, and is considered waste. Ordinarily, shale gas that is producing is located in areas where there is sufficient water. Where there is

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[143] Office of Research and Development, ‘Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources: Progress Report’ (Report, Environmental Protection Agency, December 2012) 1 <http://www2.epa.gov/hfstudy/study-potential-impacts-hydraulic-fracturing-drinking-water-resources-progress-report-0>. The purpose of the study was finalized after March 2010, which is why it is referred to in the December 2012 progress report.

[144] Ibid 4.

[145] Ibid.

[146] Ibid 9.

insufficient water or there is a competing interest for the use of the water, such as an increasing population and industry, it can be challenging to source adequate supplies.[147] Water may be delivered in tanker trucks or through purpose-built waterlines. The water may not arrive at one time; rather, water can be delivered over a number of days or weeks, being stored in onsite tanks or designated lined pits.

10.2.2 Containment and recovery of fluids

Water above and below the ground faces the threat of contamination by hydraulic fracturing. While there is momentum to increase the use of natural gas in the United States, the shift needs to be managed carefully so that clean drinking water supplies are preserved. The preservation will be a significant challenge as drinkable water is frequently sourced from freshwater streams, lakes and groundwater aquifers.[148]

The integrity of the well is an important factor for the containment of fluids. Should the cement or casing fail, the water sources will be compromised as gas in subsurface formations[149] can migrate from the wellbore through bedrock and soil, ultimately reaching water sources.[150]

If the annulus, the space between two concentric objects (such as between the wellbore and casing) where fluid can flow, is improperly sealed, gas, fracturing fluids and formation water containing high concentrations of dissolved solids may make contact outside the wellbore. Should contact be made outside the wellbore, the surrounding environment will be detrimentally affected. An incident similar to this

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147 Ground Water Protection Council and ALL Consulting, above n 27, 65.

148 Michael Berkowitz 'Toxic Chemicals on Tap — How Natural Gas Drilling Threatens Drinking Water' (Report, Environment America Research and Policy Center, November 2009) 2 <http://www.eenews.net/public/25/13089/features/documents/2009/11/04/document_gw_02.pdf>.

149 Often referred to as 'stray' gas

150 Notice of Final Rulemaking Department of Environmental Protection Environmental Quality Board 25 *Pa. Code,* Chapter 78 Oil and Gas Well Cementing and Casing (29 September 2010) <http://www.pabulletin.com/secure/data/vol41/41-6/239.html>.

occurred in Ohio in 2007.[151]

The migration of contaminants is a risk of drilling. Challenges associated with hydraulic fracturing may not be unique, but rather universal to natural gas drilling:

> Occasionally, a cement job has an incomplete bond with the walls of the well, and that can be big trouble, because contaminants can then leak into water supplies. *But this has no direct connection to hydraulic fracturing* ...[152]

If there is a no direct link to hydraulic fracturing, there could be an *indirect* one. The migration of contaminants is a result of shale gas producers not drilling properly due to substandard cementing. If the activities posing a risk to water are not new to the natural gas industry, today's hydraulic fracturing is considerably different to that performed in the past. Contemporary wells are a lot deeper and involve greater volumes of water, with fluids being injected under higher pressure into rock with less permeability, and with greater volumes of water remaining underground.[153]

10.2.3 Wastewater management

While a sizeable portion of fracturing fluid is pumped back to the surface once the hydraulic fracturing is completed, research shows that between 25 and 60 per cent of the fluids stay underground, and industry representatives have reported that as much as 50 per cent of the fracturing compounds may be trapped underground.[154]

Groundwater and potential contaminants can travel rapidly through fractures in

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[151] Mark Zoback, Saya Kitasei and Brad Copithorne, above 101, 8. In Ohio, a well of around 4,000 feet was not properly sealed, permitting gas to move from the shale layer through the annulus into an underground source of drinking water.

[152] Ann Davis Vaughan and David Pursell, 'Frac Attack: Risks, Hype, and Financial Reality of Hydraulic Fracturing in the Shale Plays' (Report, Reservoir Research Partners and Tudor Pickering Holt & Co, 8 July 2010) 11 <http://tudor.na.bdvision.ipreo.com/NSightWeb_v2.00/Handlers/Document.ashx?i=2ac12b4d442943a090b8b0a8c8d24114> (emphasis not added).

[153] Ibid 12.

[154] Earthworks, 'Frack Fluids: Injected and Left Behind' (Fact Sheet) <http://www.earthworksaction.org/files/publications/FS_LeftBehind_lowres.pdf>.

rocks. Fractured rocks are often randomly spaced without following the contours of the surface — posing challenges in finding and mitigating the contaminates.[155]

The importance of effective wastewater management is more apparent given water can contain organic and inorganic chemicals, and naturally occurring radioactive material (NORM). NORM is generally found in drill cuttings and produced water. NORM is evident in areas where sediments build up or where precipitates accumulate as scale on pipes, storage tanks, and other surface equipment and process vessels:[156]

> These pollutants [produced water] can be dangerous if they are released into the environment or if people are exposed to them. They can be toxic to humans and aquatic life, radioactive, or corrosive. They can damage ecosystem health …[157]

Producers reuse or re-inject the wastewater. However, a substantial amount will still require disposal. Other producers use treatment plants, which can be an acceptable option 'as long as those plants are properly equipped to remove the chemicals and the total dissolved solids in the fluid and radioactivity levels are within reason';[158] otherwise streams and rivers will still be at risk of being polluted, leading to the contamination of drinking water resources and the destruction of ecosystems.

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[155] United States Environmental Protection Agency, 'Getting up to Speed: Ground Water Contamination' (Guide) 2 <http://www.epa.gov/region1/students/pdfs/gwc1.pdf>.

[156] J Daniel Arthur et al, 'Evaluating the Environmental Implications of Hydraulic Fracturing in Shale Gas Reservoirs' (Paper, ALL Consulting, 2008) 20 <http://www.all-llc.com/publicdownloads/ArthurHydrFracPaperFINAL.pdf>; Rebecca Hammer and Jeanne Van Briesen, 'In Fracking's Wake: New Rules are Needed to Protect Our Health and Environment from Contaminated Wastewater' (Report No D:12-05 A, Natural Resources Defense Council, May 2012) 65 <http://www.nrdc.org/energy/files/Fracking-Wastewater-FullReport.pdf>.

[157] Rebecca Hammer and Jeanne Van Briesen above n 156, 1.

[158] Jon Campbell, 'Hydrofracking: Most NY Treatment Plants Not Equipped to Handle Wastewater' (Online Article, pressconnects.com, 15 March 2011) <http://www.pressconnects.com/article/20110315/NEWS01/103150384/Hydrofracking-Most-N-Y-treatment-plants-not-equipped-handle-wastewater?nclick_check=1>.

According to Environmental America,[159] the stakes are potentially high should water contamination occur: 'If fracking were to degrade the New York City watershed [the city's source of drinking water] with sediment or other pollution, construction of a filtration plant would cost approximately $6 billion.'[160]

A wastewater management process needs to have the capacity to deal with the fluid (flow-back water) that emerges out of the top of the shale well relatively shortly after fracturing. Essentially this is fracturing fluid that has been injected into the well that comes to the surface when the drilling pressure is reduced. Most of the flow back occurs in the first seven to ten days, with the remainder occurring over a three to four week time period. Any fluid left will be absorbed in the shale formation.[161] Flow-back is frequently contaminated with depleted fracturing fluid, chemicals and substances existing in the shale.[162] For example, the hydraulic fracturing in the Marcellus Shale has flow-back water consisting of clays, chemical additives, dissolved metal ions and total dissolved solids (TDS).[163] Decades of shale gas production on the Marcellus

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[159] Environmental America is a multi-state-based environmental advocacy organization.

[160] Tony Dutzik, Elizabeth Ridlington and John Rumpler, 'The Cost of Fracking — The Price Tag of Dirty Drilling's Environmental Damage' (Report, Environment America Research & Policy Center Fall, 2012) 2 <http://www.environmentamerica.org/sites/environment/files/reports/The%20Costs%20of%20Fracking%20vUS.pdf>.

[161] Penn State Extension, 'Marcellus Shale Wastewater Issues in Pennsylvania — Current and Emerging Treatment and Disposal Technologies' (Fact Sheet, College of Agricultural Sciences, Pennsylvania State University, April 2011) 1–2 <http://extension.psu.edu/water/marcellus-shale/waste-water/current-and-emerging-treatment-and-disposal-technologies-1/marcellus-shale-wastwater-issues-in-pennsylvania-current-and-emerging-treatment-and-disposal-technologies/view>; Erich Schramm *What Is Flowback, and How Does it Differ from Produced* Water*?* (24 March 2011 Energy and Environmental Research of Northeastern Pennsylvania Clearinghouse <http://energy.wilkes.edu/pages/205.asp>.

[162] Andrea Shramko et al, Analytical Characterization of Flowback Waters in the Field' (Paper presented at 16th Annual Petroleum & Biofuels Environmental Conference (IPEC), Houston, Texas, 3–5 November 2009) 2 <http://ipec.utulsa.edu/Conf2009/Papers%20received/Shramko_106.pdf>.

[163] Erich Schramm, above n 161.

could produce TDS loadings, resulting in significant levels of pollution.[164]

There is a point when flow-back water becomes produced water, frequently referred to collectively as 'wastewater'. When this transformation occurs is not obvious, but it is linked to the rate of return measured in barrels per day (bpd) and by looking at the chemical composition of the water. Flow-back water produces higher flow rate over a shorter period of time, while produced water has a lower flow rate but over a much longer period.[165] What is contained in produced water can vary from site to site due to factors such as location and the type of hydrocarbon present.[166]

The amount of water produced is the largest of any by-product, with the volume fluctuating during the life of the reservoir.[167] In the past, produced water was dealt with in a manner convenient to the producer, which could have been the least expensive option. The approach is different today and influenced by a number of factors:[168]

- Location of the site
- Regulatory requirements

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[164] Emily A Collins, 'New Withdrawals, New Impairments as Pennsylvania Develops the Marcellus Shale' (Working Paper No 2010-34, University of Pittsburgh, October 2010) 5 <http://ssrn.com/abstract=1699731> quoting Environmental Quality Board, 'Wastewater Treatment Requirements — Order' (Notice of Final Rulemaking No 25 PA. CODE CH. 95, Pennsylvania Department of Environmental Protection, 2010) 3 and Table-Results of TDS Assimilative Capacity Analyses: at 42 <http://files.dep.state.pa.us/PublicParticipation/Advisory%20Committees/AdvCommPortalFiles/WRAC/Preamble%20TDS%20Final%20Rulemaking%20to%20WRAC.pdf>.

[165] Erich Schramm, above n 161.

[166] John A Veil et al, 'A White Paper Describing Produced Water from Production of Crude Oil, Natural Gas and Coal Bed Methane' (White Paper, National Energy Technology Laboratory, US Department of Energy, January 2004) 42 <http://www.circleofblue.org/waternews/wp-content/uploads/2010/08/prodwaterpaper1.pdf>.

[167] National Energy Technology Laboratory, *Introduction to Produced Water* <http://www.netl.doe.gov/technologies/pwmis/intropw/index.html>.

[168] John A Veil et al, above n 166, 42.

- Availability of technology and technical feasibility, and
- Availability of equipment and infrastructure.

Depending on the factors present, a number of options, including underground injection, discharge and beneficial reuse, are available.

Within the Marcellus Shale plays of Pennsylvania, some operators are managing produced water derived from a well that has already been subject to hydraulic fracturing by combining the produced fluids with fresh water to produce frack water for a 'fresh' well.[169] Depending upon the quantity of produced water recovered from a fracked well, the volume of fresh water that needs to be sourced may be less than the volume required in the new well as the former type of water can be a substitution for the latter.[170]

The presence of wastewater has prompted the United States to make it unlawful to discharge this waste directly into waterways. The US EPA has initiated a rulemaking process to establish discharge standards for wastewater. The rulemaking process is a step towards the US EPA strengthening its oversight of hydraulic fracturing, rather than relying upon the states to regulate wastewater discharges.[171]

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[169] Environmental and Regulatory Subgroup of the Operations and Environment Task Group, 'Evolving Regulatory Framework' (Paper No 2-6, National Petroleum Council North American Resource Development Study, 15 September 2011) 7 <http://www.npc.org/Prudent_Development-Topic_Papers/2-6_Evolving_Regulatory_Framework_Paper.pdf>.

[170] For instance 'if the volume of produced water recovered from a previously fraced well is 25% of the volume of frac water needed, the gas company would need to obtain only 75% of the total frac fluid volume from a new water supply. In such cases, the volume of water withdrawn from new supply sources is less than the volume used in the new well.': at ibid.

[171] United States Environmental Protection Agency, 'EPA Initiates Rulemaking to Set Discharge Standards for Wastewater from Shale Gas Extraction' (Fact Sheet, October 2011) <http://water.epa.gov/scitech/wastetech/guide/upload/shalereporterfactsheet.pdf>; Nicholas Kusnetz, EPA Plans to Issue Rules Covering Fracking Wastewater' (Online Article, ProPublica, 20 October 2011) <http://www.propublica.org/article/epa-plans-to-issue-rules-covering-fracking-wastewater>.

The rulemaking may address risks identified in a survey conducted by the Environmental Working Group. The survey found some states and federal regulatory agencies did not track fluids used in hydraulic fracturing and, in a few instances, seemed to misinterpret the federal *Safe Drinking Water Act 1974* (SDWA), meaning a producer could be fracturing without the required permit.[172]

For shale gas to become a key energy source, producers need to meet the challenges associated with water. A management strategy that is effective in addressing the challenges, without making production uneconomical, will provide the optimal outcome.[173]

11 Cumulative impacts

11.1 Definition

Cumulative impacts are the combined effects of humans that may, over time, lead to serious threats to the environment. Single impacts may be insignificant; cumulative impacts, however, build up, from one or more sources, often compromising resources, including the natural environment.[174]

The adverse effects resulting from cumulative activity may get to a point where they exceed the limits the environment can cope with. The impacts rarely combine in a predictable way, but rather are challenging due to 'interactions, synergism, compounding, feedback loops, and other mechanisms that create uncertainty but

[172] Dusty Horwitt, 'Drilling around the Law' (Report, Environmental Working Group, 20 January 2010) 3 <http://static.ewg.org/files/EWG-2009drillingaroundthelaw.pdf>.

[173] Veolia Water Solutions & Technologies, *Shale Gas Water Treatment Strategies* Veolia Water <http://www.vwsoilandgas.com/medias/articles/shalegaswatertreatmentstategies.htm>.

[174] Office of Federal Activities, 'Consideration of Cumulative Impacts in EPA Review of NEPA Documents', (Guidance, Environmental Protection Agency, May 1999) 1 <http://www.epa.gov/compliance/resources/policies/nepa/cumulative.pdf>.

also suggest crosscutting, preventive solutions.'[175]

11.2 The challenge

Managing the impacts of shale gas production — both short-term and cumulative — upon communities, pre-existing land-use, fauna, and ecological systems is an emerging challenge for regulators and producers.

In its Ninety-Day Report (dated 18 August 2011) the Secretary Energy Advisory Board (SEAB) Shale Gas Production Subcommittee (the subcommittee) stated that all levels of the United States government needed to apply more effort in scrutinizing cumulative impacts, including applying a holistic approach, where possible, as opposed to discrete permitting, as the latter focused on individual activities and failed to connect the relevant issues.[176]

Frequently, the economic impact of proposed shale gas production is assessed through the use of input/output models, which are reliant upon estimating the economic contribution the proposal may make, including job creation. The approach treats each well as a separate investment node. Problems arise as the approach fails to acknowledge that there are cumulative effects upon the community caused by multiple wells, such as increased demand upon public services and social disruption.[177]

Cumulative impacts vary in nature, sometimes depending upon the location of the wells. Where transportation of water is required, many truck trips are needed. Multiple trips create multiple effects, such as pressure upon water resources,

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[175] Cumulative Impacts Project, *About the Cumulative Impacts Project* <http://www.cumulativeimpacts.org/about.html>.

[176] Shale Gas Subcommittee, 'Ninety-Day Report' (Report, Secretary of Energy Advisory Board, 11 August 2011) 25 <http://www.shalegas.energy.gov/resources/081111_90_day_report.pdf>.

[177] See also Susan Christopherson and Ned Rightor, 'How Should We Think about the Economic Consequences of Shale Gas Drilling?' (Working Paper, Cornell University, May 2011) 28 <http://www.greenchoices.cornell.edu/downloads/development/marcellus/Marcellus_SC_NR.pdf>.

compromised air quality, noise, and strained infrastructure.[178] Adding to the complexity, cumulative impacts increase disproportionally in quantity or force by successive additions, and the impacts can occur even when individual producers undertake their activities within the minimum regulatory requirements.

11.3 Recognizing the challenge

The sub-committee of the SEAB recognized the importance of managing cumulative impacts by rating them as one of the four major areas of concern arising from shale gas. The subcommittee recommended that jurisdictions have greater regard to the combination of impacts from multiple drilling, production and delivery activities[179] and then 'make efforts to plan for shale development impacts on a regional scale.'[180]

Similarly, the Pinchot Institute for Conservation convened the 'Assessing the Environmental Effects of Marcellus Shale Gas Development: The State of Science' workshop.[181] The workshop highlighted the importance of understanding and addressing cumulative impacts arising from shale gas production. A report from the workshop explored the impacts on aquatic resources. It found that the loss of forest area and the impact of chemicals could damage ecosystem services, being the watershed stream network, through nutrient removal, compromising fisheries, reducing water quality and limiting recreational use. The report noted that very little information was available on the topic, and concluded that a cumulative impact assessment to aquatic resources was needed.[182] It is challenging to undertake a cumulative impact assessment in the absence of full information. Science in

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[178] Earthworks, *Hydraulic Fracturing 101* <http://www.earthworksaction.org/issues/detail/hydraulic_fracturing_101>.

[179] Such as impacts on air quality, traffic, noise, visual pollution.

[180] Shale Gas Subcommittee, above n 176, 3.

[181] Pinchot Institute for Conservation, *Assessing the Environmental Effects of Marcellus Shale Gas Development: The State of Science* <http://www.pinchot.org/gp/EffectsofMarcellusShale>.

[182] Jerry V Mead et al, 'The Marcellus Shale Play — Impacts to Stream Ecosystems and Potential Regulation of Intensity of Mining' (Presentation, Patrick Center for Environmental Research, Academy of Natural Sciences, Drexel University) 19 <http://www.pinchot.org/uploads/download?fileId=955>.

particular will have a critical role in determining the cumulative effects of shale gas production on the natural environment, and upon human health. If the effects are to be estimated with accuracy and credibility, then the scientific information needs to be sufficient and accessible to numerous parties, including regulators, producers, affected landowners, and public interest groups.[183]

Not all cumulative impacts are the same. The impacts need to be differentiated on a number of grounds, including that:[184]

- Cumulative impacts cannot be properly understood or managed simply by focusing on the activities of individual wells, and
- The assessment of cumulative impacts, and the development of management strategies, requires an understanding of the system or receiving environment, in which they occur.

If the regulator is to assist with managing cumulative effects then:[185]

- Shortcomings of sectoral mandates need to be recognized, so that the risk of making decisions in isolation of the values that exist outside the sector are recognized
- The merit of a 'one application' approach needs revisiting as it fails to reflect the incremental impacts of shale gas production, which manifest cumulatively

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183 V Alaric Sample and Will Price, 'Assessing the Environmental Effects of Marcellus Shale Gas Development: The State of Science' (Workshop Summary, Academy of Natural Sciences and Pinchot Institute for Conservation, 1 April 2011) 3, found at <http://www.pinchot.org/gp/EffectsofMarcellusShale>.

184 Daniel Franks et al, 'Cumulative Impacts — A Good Practice Guide for the Australian Coal Mining Industry' (Guide, Centre for Social Responsibility in Mining and Centre for Water in the Minerals Industry, Sustainable Minerals Institute, University of Queensland, 2010) 46 <http://commdev.org/files/2648_file_CSRM_20SMI_20Good_20Practice_20Guide_20document_20LR.PDF>.

185 Steven A Kennett and Michael M Wenig, 'Alberta's Oil and Gas Boom Fuels Land-Use Conflicts — But Should the EUB Be Taking the Heat?' (*Resources* Newsletter Article No 91, Canadian Institute of Resource Law, 2005) 6 <http://dspace.ucalgary.ca/bitstream/1880/47049/1/Resources91.pdf>.

- The regulator needs to understand the limitations of its mandate, including the land it does not have control over and the uses that are undertaken on this land, and

- Thresholds need to be understood. Thresholds can assist decision makers in assessing whether the incremental impacts of a proposed production are within realistic limits, and whether mitigation steps are required.

11.4 Managing cumulative impacts can be good business practice

While managing short-term and cumulative impacts of shale gas production is challenging, improved processes for managing cumulative impacts can make for good business through enhancing relationships between producers and local communities, and the promotion of planning, which can improve the chance of production success.[186]

11.4.1 Social Licence

The management of cumulative impacts plays a vital role in assisting industry and government in reconciling the potentially competing interests between industry and communities, and achieving a 'social licence to operate'. Social licence has a number of facets. It involves more than a producer going through the motions in meeting its obligations: 'You don't get your social license by going to a government ministry and making an application or simply paying a fee ... It requires far more than money to truly become part of the communities in which you operate.'[187]

Social licence involves producers securing a broad-based ongoing acceptance and support from stakeholders such as affected farmers, local communities, businesses

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[186] Daniel Franks et al, above n184, 5.

[187] Pierre Lassonde (President of Newmont Mining Corporation), quoted in SociaLicense.com, *The Social License to Operate* <http://socialicense.com/index.html>.

and politicians.[188] A social licence requires producers and government to accept the responsibility to protect community interests and environmental values from the negative impacts of resource production while at the same time maximizing any opportunities that may arise. This may be achieved by working with the public from the outset, maintaining ongoing communication and having the capacity to maintain a balance between social, economic and environmental considerations arising from the production.[189] At its core, a social licence involves recognizing that third parties have a 'right to know', which is inextricably linked to the demand for increased public scrutiny so that a producer's practices can be scrutinized and challenged. Pursuing a social licence means the shale gas industry accepts that it is operating within a definite context, involving a network of players, whose interests may or may not coincide. For example, the agriculturalist's sense of a 'right to know' may be driven by commercial imperatives that require a 'clean environment' so that the agriculturalist can grow produce; while the environmentalist's 'right to know' is driven by the need to preserve the environment for future generations, requiring a 'clean environment' as well. Reconciling the various interests is an important component of the licence.

The importance of achieving and maintaining a social licence is becoming increasingly evident to producers. There is a growing awareness that unmitigated harmful impacts of industrial activity have the ability to delay or prevent the production of shale gas resources due to community concerns. This is the same for governments. They are beginning to realize that if they are to capitalize on the opportunities of developing natural resources, the conditions in local communities and environments need to be given due consideration and managed effectively during all phases of the project.[190] The potential gain to the resource sector and its relationship to communities through an increased focus upon cumulative impacts have been noted by the Australian mining industry: 'Proactive and collaborative

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[188] Curtis Campbell, 'Shale Gas Issues Yield to Adroit Community Relations Efforts' (2011) 238(1) *Pipeline & Gas Journal* <http://pipelineandgasjournal.com/shale-gas-issues-yield-adroit-community-relations-efforts>.

[189] Bruce March, 'Taking Steps to Responsibly Develop Canada's Oil and Gas' [Winter 2011] *Imperial Oil — The Review* 4, 4 <http://www.imperialoil.ca/Canada-English/Files/imperial_review2011_chairman.pdf>.

[190] Daniel Franks et al, above n 184, 5.

management of cumulative impacts can benefit regional environments and communities and contribute to industry's social licence to operate.'[191]

12 Conclusion

Due to technical advancements, particularly in horizontal drilling and hydraulic fracturing, shale gas is an economic boon for countries that have relatively large reserves. Shale gas production is an example of industrial ingenuity, but it is also associated with a number of challenges, many of which relate to the natural environment.

Horizontal drilling is more effective than vertical drilling for shale gas. One horizontal well can extract the same quantity of gas as a number of vertically drilled wells. Whether horizontal drilling reduces surface disturbance is arguable. If a reduction is achieved then this will lessen the surface runoff. Well spacing is familiar to the industry. However, the activity is beginning to attract further attention from regulatory agencies as well density can increase over time in favour of the producer and is higher than in conventional production.

Horizontal drilling is accompanied by hydraulic fracturing, the latter being a well stimulation process to enhance gas extraction. Critical to drilling and environmental protection are the casings that seal the well bore. Casings stop water from entering the well and flooding it, and protect the water from pollutants.

Water is an important aspect of hydraulic fracturing because the water is likely to comprise contaminates. The composition highlights the importance of an effective water management regime, which includes wastewater. The management is potentially complex, but important to achieve. A template approach will be unsuitable, as a number of variables must be considered, the nature of which depends on the specific characteristics of the production site.

Shale gas production has a number of activities. These activities interact with each other and the natural environment in unforeseen ways — are referred to as cumulative impacts. These impacts give rise to particular issues for the producer and

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[191] Ibid.

the regulatory agency as a lack of predictability affects their ability to implement mitigation steps. Understanding and addressing these impacts will contribute significantly to the protection of the environment and the achievement of a social licence to operate.

The various activities of shale gas production means that the framework will need to comprise particular features**.** A framework based upon a restrictive regulatory approach will be too rigid, making the framework incapable of addressing the various challenges posed by a rapidly emerging industry. A framework with a regulatory approach that gives producers, within regulatory limits, the responsibility for developing their own response is more suitable. The producer will have the capacity to address the challenges and activities of shale gas production, including the particular variables of a production site.

PART IV REGULATION — A GENERAL OVERVIEW

13 Introduction

Shale gas production has a number of activities that have the potential to cause harm. These activities need to be managed to prevent or minimize the harm. Regulation is a tool that can assist as it is intended to promote desirable behaviour, thereby minimizing detriment.

Regulation can be used in different contexts, which makes the concept challenging to define.[192] According to Baldwin and Cave, regulation can be defined in a number of ways.[193] It may be beneficial to view regulation mostly as a function of government, which places requirements upon organizations and citizens through various instruments.[194] Regulation is intended to influence the behaviour of actors, whether they are individuals or organizations (both public and private), in order to promote specific community objectives — including those objectives that relate to social and environmental concerns.[195]

> It is the supervision of a private or professional activity in the interests of the public as a whole, their welfare, their rights and their future, where those elements would be at risk were there no regulation. After that uncontentious statement, there come

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[192] Department of Treasury and Finance, 'Victorian Guide to Regulation (Guide, Government of Victoria, Australia, August 2011) <http://www.dtf.vic.gov.au/CA25713E0002EF43/WebObj/VictorianGuidetoRegulationJuly2011/$File/VictorianGuidetoRegulationJuly2011.pdf>.

[193] Robert Baldwin and Martin Cave, *Understanding Regulation — Theory, Strategy, and Practice* (Oxford University Press, 1999) 1-2.

[194] Organisation for Economic Co-operation and Development, 'The OECD Report on Regulatory Reform: Synthesis' (Report, 1997) 6 <http://www.oecd.org/dataoecd/17/25/2391768.pdf>.

[195] Taskforce on Reducing the Regulatory Burden on Business, 'Regulation Taskforce Issues Paper (Attachment B)' (Issues Paper, Australian Government, 25 October 2005) 1 <http://www.regulationtaskforce.gov.au/__data/assets/pdf_file/0004/69727/issuespaper.pdf>.

> the subdivisions and principles of regulatory activity, which are the subject of much academic writing and business interest …[196]

The mechanisms used to influence behaviour include rules, expectations and codes of conduct. The regulations are often backed up by an authority that has the power to promote compliance and enforce the regulations through the imposition of some form of sanction if considered necessary.

Regulatory types can be placed into three broad categories, where one or more types can be relied upon at any one time:[197]

- Economic regulations — these relate to market decisions (such as pricing, and competition) and market entry or exit. The regulations are intended to promote efficiency

- Social regulations — their focus is upon the public interest, where the economic implications of social regulations are likely to be secondary. Examples of the public interest include human health and the environment; and

- Administrative regulations — being paperwork and administration, often referred to as 'red tape', where public agencies require information (for example, application and reporting requirements, and completing a taxation return).

There are a number of regulatory approaches. For illustrative purposes, the approaches are part of a continuum. At one end are the prescriptive approaches, where the government, through the regulatory agency, specifies what must be complied with and where there is very little scope for discretion to be exercised by the regulated. Command and control regulation is an example. Generally these approaches are an earlier form of regulation. At the other end of the continuum are the more recent approaches, where the government adopts a 'hands-off' approach, permitting the regulated to develop their own ways of meeting the regulatory

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[196] Baroness Deech of Cumnor, 'Regulating the Regulators' (Speech delivered at Gresham College, City of London, 23 May 2012) 1 <http://www.gresham.ac.uk/lectures-and-events/regulating-the-regulators>.

[197] Organisation for Economic Co-operation and Development, above n 194, 6.

objectives. By satisfying the objectives, compliance is achieved. For hands-off regulation, the path to compliance is left to the industry to determine, and there is very little prescription, along with non-intrusive oversight by the regulatory agency. Along the continuum are other regulatory approaches, acknowledging that not all approaches, such as risk-based regulation, readily reside within the continuum. The selection of the regulatory approach is influenced by the regulatory goals that need to be achieved and how much control and influence the government wishes to have.

14 Possible regulatory approaches

The following is a précis of a number of regulatory approaches that could be used as the basis of the proposed regulatory framework. Those relevant to the framework are identified, with more than one regulatory approach ultimately being adopted.

14.1 Self-regulation and co-regulation

A traditional model of self-regulation is one that focuses upon professional groups developing and self-enforcing their professional rules, which have been commonly arrived at for the mutual benefit of members. The professional group may adopt self-regulation to maintain professional reputation and ethical standards or avoid the imposition of government regulatory intervention.[198]

The essence of self-regulation involves significant industry participation in the development and implementation of the regulatory arrangements, including self-regulatory organizations (SROs) meeting what is required:[199]

> Industry collectively administers a solution to address citizen or consumer issues, or

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[198] R S Khemani and D M Shapiro, 'Glossary of Industrial Organisation Economics and Competition Law' (Glossary, Organisation for Economic Co-Operation and Development, 1993) 73 <http://www.oecd.org/dataoecd/8/61/2376087.pdf>.

[199] Jillian Segal, 'Institutional Self-Regulation: What Should Be the Role of the Regulator?' (Speech delivered at the National Institute for Governance Twilight Seminar, Canberra, 8 November 2001) 2–3 <http://www.asic.gov.au/asic/pdflib.nsf/LookupByFileName/NIGConf_081101.pdf/$file/NIGConf_081101.pdf>.

other regulatory objectives, without formal oversight from government or regulator. There are no explicit ex ante legal backstops in relation to rules agreed by the scheme (although general obligations may still apply to providers in this area).[200]

The definition does not preclude the notion of 'enforced' self-regulation, which is self-regulation being subject to a form of governmental oversight. If the regulatory regime is a creature of statute and that statute establishes a network of SROs or requires that any self-regulatory initiative (such as a code of practice) gains the pre-approval of a designated governmental agency, then this would constitute enforced self-regulation.[201]

While self-regulation may have its advantages, including leveraging off the knowledge and expertise of the SROs more effectively, and the potential to be flexible and adaptable, there are weaknesses.[202] Those subject to the self-regulation may be perceived as a 'closed shop', where they apply the regulatory requirements (which they developed) with less transparency than required by other types of regulation. The regulatory requirements may be deliberately modest to achieve a competitive advantage over competitors.[203] Careful consideration is required to ensure that the approach is appropriate in the circumstances. If the approach is applied to an industry where the consequence of non-compliance is serious, the industry needs to

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[200] Ofcom (Office of Communications) 'Identifying Appropriate Regulatory Solutions: Principles for Analysing Self- and Co-Regulation' (Statement, 10 December 2008) 7 <http://stakeholders.ofcom.org.uk/binaries/consultations/coregulation/statement/statement.pdf>.

[201] Robert Baldwin and Martin Cave, above n 193, 34.

[202] Ian Bartle and Peter Vass, 'Self-Regulation and the Regulatory State — A Survey of Policy and Practice' (Research Report No 17, Centre for the study of Regulated Industries, School of Management, University of Bath October 2005) 2, 7 <http://www.bath.ac.uk/management/cri/pubpdf/Research_Reports/17_Bartle_Vass.pdf>.

[203] Elizabeth Nielsen, 'Regulation, Co-regulation, or Self Regulation — What Is the Best Approach?' (Presentation to Copolco Workshop, Prague, Czech Republic, 17 May 2004) 4 <http://www.google.com.au/url?sa=t&rct=j&q=coregulation&source=web&cd=4&sqi=2&ved=0CDgQFjAD&url=http%3A%2F%2Fwww.iso.org%2Fiso%2Flivelinkgetfile%3FllNodeId%3D21969%26llVolId%3D-2000&ei=yOKEUP61FsiRiQeg2oCgCw&usg=AFQjCNGepRpb6PlWphmpN_r-CzHz8VRLEQ&sig2=9iGdC4E_5-T6WGN_dcTMNQ&cad=rjt>.

be subject to a more rigorous approach. Challenges can occur when an industry has been self-regulated for a long time, possibly since its inception. The industry resists regulatory change, particularly legislative. Industry lobbyists claim that a government takeover is occurring, to the detriment of industry and its stakeholders. Stewarding a shift from the 'lightest' form of regulation to one that is more rigorous is particularly confronting. The sense of handing control over to a regulator (government) is more acute for an industry that is used to the freedom of self-regulation.

A variant of self-regulation is co-regulation. A co-regulatory approach involves the combination of both self and statutory regulation, where the relevant public authority and industry work together to administer and achieve the objective(s).

> Co-regulation may be distinguished from self-regulation in that it involves some degree of explicit government involvement. In other respects it shares similar characteristics, typically involving an industry and government working together to develop standards to govern the behaviour of the relevant market.[204]

With co-regulation, factors such as the nature of the industry, its past performance, and perceived risk will influence the allocation of responsibilities, but usually the regulatory agency has the legal authority to compel compliance with the objectives. The involvement by the regulator may decrease over time, often when the perceived level of risk is acceptable, upon which co-regulation begins to approximate self-regulation, potentially blurring the boundaries.[205] The reasons why self, enforced and co-regulation are unsuitable for the regulation of shale gas production are closely aligned to the weaknesses referred to above.

The relative 'light touch' of self-regulation means there is the potential for the industry to prioritize its private interests over the public interest.[206] Certain activities may be easy to 'fudge' as there is little regulatory oversight to compel compliance.

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[204] Department for Business Innovation & Skills, *Co-regulation*, United Kingdom Government <http://webarchive.nationalarchives.gov.uk/+/http://www.dius.gov.uk/policies/bre/better-regulation-framework/alternatives-to-regulation/choose-the-alternative/co-regulation>.

[205] Ibid.

[206] Ian Bartle and Peter Vass, above n 202, 38.

Shale gas production causes public anxiety about its safety, which strongly suggests self-regulation is unsuitable, and that an independent regulatory agency is needed. Without the agency, the public would find the regulatory arrangements unsatisfactory, and the establishment of a social licence to operate would be very unlikely.

With co-regulation, the level of government involvement over time tends to diminish, which is incompatible with the nature of shale gas production. How would government know when the risk level is acceptable, justifying its retreat, or when its involvement needs to increase once more?

14.2 Command and control regulation

Command and control (C&C) regulation concentrates on managing activities and potential risks by specifying how an organization will administer its activities: ‘Command and Control is about focusing the efforts of a number of entities (individuals and organizations) and resources, including information, toward the achievement of some task, objective, or goal.’[207]

To help meet the regulatory requirements, the regulated has to meet standards set by the regulatory agency. A standard is a mandated level of performance that is enforceable in law, and where the regulated has little say over the parameters within which the activities will be considered legally acceptable. As an approach for environmental regulation, C&C regulation does have its strengths, especially in the initial stages of regulatory intervention ‘preferred when the initial reduction in the amount of pollutant significantly benefits society, while continued reduction doesn't

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[207] Jodi Short, ‘Governing Without Commands or Controls: The Emergence of Self-Regulation as Reform and Justification’ (Paper presented at the annual meeting of the American Sociological Association, New York, New York, 11 Aug 11 2007) 11 <http://www.irle.berkeley.edu/culture/papers/short07.pdf>, quoting David S Alberts and Richard E Hayes, ‘Understanding Command and Control’ (Publication, US Department of Defense Command and Control Research Program, 2006) 32 <http://www.dodccrp.org/files/Alberts_UC2.pdf>.

offer as much benefit (The Marginal Benefit of reduction is highly inelastic)'.[208]

While C&C regulation has the capacity to set limits, and show that the government and regulator are acting decisively and unambiguously with the force of law at their disposal,[209] C&C regulation has its disadvantages, including being:

- Increasingly outmoded, given it is:
    - Challenging to comprehend and administer
    - Heavy handed on those being regulated
    - Difficult for an industry experiencing change (for example, transitioning to a greener economy) as C&C regulation has a tendency to be inflexible and not forward looking[210]
    - Remote from the concerns of relevant communities, and administered by unaccountable bureaucrats,[211] and
    - Problematic to include quality systems or input from experts,[212] and
- Focused upon problems only after the fact and failing to deal with root causes

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[208] Experimental Economics Center, Andrew Young Center at Georgia State University, *Benefits and Drawbacks of Command-and-Control EconPort* <http://www.econport.org/content/handbook/Environmental/pollution-control-revised/Traditional-Pollution-Techniques/Traditional-methods-sub-page.html>.

[209] Robert Baldwin and Martin Cave, above n 193, 35.

[210] James New and Marco Matteini (eds), 'Introduction to Energy Regulation' (Training Package, United Nations Industrial Development Organization and the Renewable Energy and Energy Efficiency Partnership) Module 3 of 'Training Manual on Sustainable Energy Regulation and Policymaking for Africa' s 7.1, 3.16 <http://www.unido.org/fileadmin/media/documents/pdf/training_manual_on_sustainable_energy_regulation_and_policymaking_for_Africa.pdf>.

[211] Jodi Short, 'The Paranoid Style in Regulatory Reform' (Georgetown Public Law Research Paper No. 11-10, Georgetown University Law Center, 12 January 2011) 39–40 <http://ssrn.com/abstract=1739015>.

[212] Elizabeth Nielsen, above n 203.

(an 'end-of-pipe' emphasis).[213]

C&C regulation's limitations have meant that there is a move towards alternative regulatory approaches. For example, the United Kingdom Government is implementing a new framework that is intended to help identify the most effective approach to achieve the desired policy outcomes. The framework emphasizes the importance of ensuring that alternative approaches to regulation are canvassed, where the 'traditional "command and control" regulation is seen as the last, not first, resort.'[214]

The application of C&C regulation to the shale gas industry would be problematic. The 'end-of-pipe' focus means that potentially serious incidents would occur, only to be addressed after the fact. A deficient wastewater management method could lead to the pollution of a waterway; with remedial action taking place once the harm has been done. C&C regulation has the propensity to be detached from relevant communities, heightening suspicion about the industry. Equally important, C&C regulation has the propensity to encourage legalism, where layer upon layer of inflexible rules impinge unnecessarily upon industry, stifling managerial innovation and decision-making: 'there is what is dubbed the 'regulatory ratchet', whereby regulatory rules grow rather than recede because revisions of regulations are infrequent; work on new rules tends to drive out attention to old ones ...'[215]

The relative difficulty of applying quality systems or using advice from experts would be problematic to the producer, which may wish to adopt these resources to help manage the complexity of shale gas production. For instance, how would a producer know whether its practices meet regulatory expectations if there is an inability to assess the quality of its practices?

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[213] Jodi Short, 'The Paranoid Style in Regulatory Reform' above n 211, 39–40.

[214] Better Regulation Executive, 'Reducing Regulation Made Simple — Less Regulation, Better Regulation and Regulation as a Last Resort' (Publication, United Kingdom Government, December 2010) [23] <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/31626/10-1155-reducing-regulation-made-simple.pdf>.

[215] Robert Baldwin and Martin Cave, above n 193, 37.

14.3 Risk-based regulation

Regulation that is risk-based may enhance the overall welfare of the public as its basis can better afford protection from hazards and gain efficiency from the services that government provide.[216] The principal goal is to achieve more safety at less cost through substituting prescriptive, deterministic regulations with goal-oriented, probabilistic ones, which are based on the criteria of cost-effectiveness and the minimization of individual risks.

A risk-based approach involves the application of a systematic framework (evidence-based assessment) to prioritize the activities that potentially pose the greatest risk. The resources of the regulator, primarily inspection and enforcement, are then targeted to those risks identified in the assessment.[217] For risk-based regulation to be effective, limited resources need to be allocated where the most risk is anticipated, which is dependent on the right intelligence being in place.[218] Underlying the approach is that the regulator is technically competent and is able to exercise

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[216] Gregory Bounds, 'Challenges to Designing Regulatory', Chapter 1 of 'Regulatory Policy — Improving the Governance of Risk' (OECD Publication, Organisation for Economic Co-Operation and Development (OECD), 2010) 15 <http://www.planejamento.gov.br/secretarias/upload/Arquivos/seges/arquivos/OCDE2011/OECD_Risk.pdf>.

[217] Deborah Peterson and Sally Fensling, 'Risk-Based Regulation: Good Practice and Lessons for the Victorian Context' (Paper presented at the Victorian Competition and Efficiency Commission Regulatory Conference, Melbourne, 1 April 2011) 2 <http://www.vcec.vic.gov.au/CA256EAF001C7B21/WebObj/20110328-Risk-basedregulation-DPIpaperforVCECconference/$File/20110328%20-%20Risk-based%20regulation%20-%20DPI%20paper%20for%20VCEC%20conference.PDF>.

[218] Regulatory Reform Committee, *Themes and Trends in Regulatory Reform — The Implications of the Financial Crisis for Regulation* (21 July 2009) United Kingdom Parliament, [23] <http://www.publications.parliament.uk/pa/cm200809/cmselect/cmdereg/329/32906.htm>.

exemplary discretion.[219]

Risk-based regulation can make the risks from shale gas production transparent and the ranking of the risks possible. Ranking of the risks will determine the level of risk tolerance a society finds acceptable.[220]

Risk-based regulation has its limitations. The most significant relates to the core of the approach: determining what is an acceptable risk and acceptable cost. For example, in the environmental field it seems that the approach favours business attributes (such as job creation) rather than environmental attributes (such as air quality) because it is easier for business to prove costs (quantitative) than an environmentalist to demonstrate benefits (qualitative). There will always be competing considerations that need to be weighed up — the key is that this is undertaken credibly, including the ability to recognize qualitative factors.[221]

> According to Baldwin and Cave, the first regulatory challenge faced by regulators consists in the identification of risks that need to be reduced — not only on the basis of priority, *but also in a way which would be approved by the public.*[222]

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[219] John Rimington, Jim McQuaid and Vladimir Trbojevic, 'Application of Risk Based Strategies to Workers Health and Safety Protection — UK Experience' (Report, Ministry of Social Affairs and Employment, 15 May 2003) 19 <http://www.risk-support.co.uk/SZW-published_report.pdf>.

[220] Thomas Flüeler and Hansjörg Seiler, 'Risk-Based Regulation of Technical Risks: Lessons Learnt from Case Studies in Switzerland' (2003) 6 (3) *Journal of Risk Research* 213, 228 <https://www1.ethz.ch/uns/people/associated/thomasfl/publ/Risk_Based_Regulations.pdf>.

[221] Bridget M Hutter, 'The Attractions of Risk-Based Regulation Accounting for the Emergence of Risk Ideas in Regulation' (Discussion Paper No 33, London School of Economics and Political Science, May 2005) 8 <http://webfirstlive.lse.ac.uk/researchAndExpertise/units/CARR/pdf/DPs/Disspaper33.pdf>.

[222] Marianne Ojo, 'Responsive Regulation: Achieving the Right Balance between Persuasion and Penalisation' (Paper, Centre for European Law and Politics, University of Bremen, 19 March 2009) 11 <http://mpra.ub.uni-muenchen.de/14170/1/MPRA_paper_14170.pdf>, quoting Robert Baldwin and Martin Cave, above n 193, 142 (emphasis added).

Risk-based regulation has the potential to play an important role in the framework, given its focus is goal orientated, drawing upon the knowledge and experience of the producer, whilst simultaneously focusing upon risk minimization. These attributes provide the 'cover' needed across the actual and potential hazards of shale gas production. The approach is conducive to establishing a social licence as it promotes openness between the regulator and third parties as the latter is given the opportunity to participate in identifying the risks and the extent to which these should be tolerated.

The limitations of risk-based regulation may be mitigated by the regulatory agency applying a checklist (template) with issues being identified and weighted, consistent with publicly available criteria, which is used by the regulator in its decision-making. This would help the regulator exercise discretion and judgment with rigour, consistency, and fairness. It could be that greater weighting is given to the risks that the public are concerned about, such as the impact increased traffic will have upon the ambience of their community. While the actual weighting might be controversial, consultation and ongoing review would help manage any concern.

14.4 Performance-based regulation

Performance-based regulation may be adopted to avoid the weaknesses of 'traditional' regulatory approaches such as C&C.[223] The move away from prescriptive to performance-based regulation is more appropriate in complex or rapidly changing areas, where the most appropriate ways of achieving particular objectives may not be obvious to policy makers or are likely to alter over time or across producers. Determining the key principles and objectives in legislation and allowing discretion in how they are put into effect would be an appropriate way to regulate in these

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[223] Stephen D Sugerman, 'Let's Try Performance-Based Regulation to Attack our Smoking and Obesity Problems' (Transcript Magazine Article, School of Law, University of California, Berkeley, Summer 2005) 1 <http://www.law.berkeley.edu/faculty/sugarmans/Lets%20try%20Performance%20Based%20Regulation.pdf>.

circumstances.[224] Furthermore, as the emphasis of performance-based regulation is not upon legislated prescriptive standards, which is the basis of C&C regulation, it is more straightforward to draft the regulations.

However, the discretionary nature of performance-based regulation may lead to the need for a high level of guidance and uncertainty in the sense that:[225]

- It may be unclear whether the steps taken to comply actually satisfy the regulation's outcomes or objectives, and
- The reasons leading to a prosecution for alleged non-compliance may be subjective.

Given a performance-based approach is particularly useful in complex or rapidly evolving areas, the approach would suit shale gas production. The potential for uncertainty due to the discretionary nature of the decision-making and the lack of clarity regarding whether industry is complying may be overstated. The regulatory objectives can reduce uncertainty by providing an *aide-mémoire* to the exercise of discretion and the perceived lack of clarity.

14.5 Management-based regulation

Management-based regulation is available to entities to mitigate certain severe events. Management-based regulation, unlike long-established C&C regulatory strategies, requires entities to undertake their own review and decision-making, and formulate internal regulation about how to achieve event mitigation.[226]

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224 Regulation Taskforce, 'Rethinking Regulation — Report of the Taskforce on Reducing Regulatory Burdens on Business' (Report, Australian Government, January 2006) 160 <http://www.regulationtaskforce.gov.au/__data/assets/pdf_file/0007/69721/regulation-taskforce.pdf>.

225 Department of Treasury and Finance, above n 192, 27.

226 Cary Coglianese, 'Reducing Risk with Management-Based Regulation', (Participant Notes presented at Columbia-Wharton/Penn Roundtable on 'Risk Management Strategies in an Uncertain World', IBM Palisades Executive Conference Center, Palisades, New York, 12–13 April 2002) 2

Management-based regulation is most useful where the desired performance of regulated firms is hard to measure. It 'may also be appropriate in settings where there is a high degree of heterogeneity among firms, which makes it difficult for a regulator to specify an appropriate technology-based regulatory standard.'[227]

Management-based regulation may be perceived as 'performance-based', even though it is not, because it involves planning and management practices intended to achieve a certain type of outcome; for instance, no unauthorized discharge into waterways. Like performance-based regulation, management-based regulation is 'light-handed' in the sense that it provides flexibility and discretion to the regulated entity. Performance-based regulation requires an obligation to achieve or avoid certain outcomes; management-based regulation requires:

> … only that firms engage in certain *management practices* that *are designed to achieve (or avoid) the outcome*. The achievement or avoidance of the outcome is not what is mandatory under a pure management-based regulation; the establishment of management practices is. [228]

Management-based regulation appears to have similar qualities to self-regulation, because of the focus upon internal systems — giving flexibility to the producer to determine the most efficient and effective means to limit their risk. However, management-based regulation is government imposed, often with legal obligations requiring the regulated entity to participate, which is not the case with self-regulation.[229]

The approach requires the development of management plans that are consistent

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<http://www.ldeo.columbia.edu/chrr/documents/meetings/roundtable/pdf/notes/coglianese_cary_note.pdf>.

[227] Ibid.

[228] Cary Coglianese, 'Management-based Regulation: Implications for Public Policy' in Gregory Bounds and Nikolai Malyshev (eds), 'Risk and Regulatory Policy — Improving the Governance of Risk' (OECD Publication, Organisation for Economic Co-Operation and Development (OECD), 2010) 159, 166 <http://www.planejamento.gov.br/secretarias/upload/Arquivos/seges/arquivos/OCDE2011/OECD_Risk.pdf> (emphasis added).

[229] Ibid 165–6.

with criteria, where the plans require the regulated to outline how they intend to achieve the criteria. The regulators may require approval of the plans, and, where necessary, work with the regulated in developing the plans. In some instances, the regulated must submit records of compliance, which can be substantiated through auditing.[230]

Management-based regulation acknowledges that producers are likely to have better quality information regarding risks and the possible ways to manage or eliminate them. Where the ideal performance of the producers is not easy to quantify, and there is a high level of heterogeneity amongst producers, the plan is a means to address the site-specific challenges, given the plan's flexibility. When the regulatory agency has approved the plan, it can become legally enforceable, depending upon the requirements of the regulation.

No two shale gas production sites are the same, with the producers, not the regulatory agency, holding most of the knowledge, making the production conducive to a bottom- up regulatory approach. In contrast, a prescriptive approach is based upon imposing much of the regulatory detail from the top, meaning it is unsuitable to manage the variability, challenges and innovative nature of shale gas production.

14.6 Meta-regulation

Meta-regulation aims to enhance the self-regulatory capacity of organizations to achieve more than is legally required for regulatory compliance.[231] For example, meta-regulation demands that regulated sites of activity, such as workplace sites, engage with relevant internal and external stakeholders to develop risk management

[230] Cary Coglianese and David Lazer, 'Management-Based Regulation: Prescribing Private Management to Achieve Public Goals' (2003) 37(4) *Law & Society Review* 691, 4 <http://iris.lib.neu.edu/cgi/viewcontent.cgi?article=1000&context=comp_info_sci_fac_pubs>.

[231] Fiona Haines 'Regulatory Failures and Regulatory Solutions: A Characteristic Analysis of Meta-regulation' (Conference Paper presented at Proceedings, Annual Meeting, Law and Society Association, Baltimore, Maryland, 2006) 1 <http://dtl.unimelb.edu.au/R/U6V8IAH6NHKNDN8T1PA8UR3JVUVEKDY6K8PCRPEQF7PIVQMFPX-01506?func=dbin-jump-full&object_id=67730&local_base=GEN01&pds_handle=GUEST>.

strategies (the ‘self-regulatory efforts’) that become, through formal endorsement such as registration or licensing, the regulatory requirements for that site.

A variant is to make the implementation of appropriate internal mechanisms a condition of the applicant being granted a licence or an approval. A common example of this form of meta-regulation is the environmental management systems and local community consultations that an environmental regulator requires from the applicant before approval.[232] The role of the regulator is to ‘meta-regulate’ by monitoring and assessing the self-regulatory efforts to determine whether these are acceptable.

Meta-regulation is consistent with the view that it is desirable for government not to have a ‘hands on’ approach to regulating, but rather the focus of regulating is on establishing the goals for specified policy outcomes and monitoring the observance of those goals. It is the regulated entity that develops the tools to reach the required level of compliance as mandated by the regulator.[233]

While meta-regulation may be a sophisticated response that builds upon the self-regulatory potential of an organization, it does have a number of vulnerabilities, including:

- A tendency to place a lot of importance upon the role of an organization’s internal compliance system, which means such a system might act as a façade that masks non-compliance,[234] and
- Selectively addressing risks and making promises that regulation can provide

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[232] Christine Parker, ‘Meta-Regulation: Legal Accountability for Corporate Social Responsibility?’ (Legal Studies Research Paper No. 191, Faculty of Law, Monash University, 3 November 2006) 20–1 <http://ssrn.com/abstract=942157>.

[233] Fiona Haines, above n 231, 1.

[234] Kimberly D Krawiec, ‘Cosmetic Compliance and the Failure of Negotiated Governance’ (2003) 81 *Washington University Law Quarterly* 487, 487 <http://scholarship.law.duke.edu/cgi/viewcontent.cgi?article=2674&context=faculty_scholarship>.

> ‘win-win’ outcomes to what are likely to be complex social problems.[235]

Meta-regulation is an option for the regulation of shale gas production as it gives the producer the scope to develop a compliance strategy intended to meet the regulator’s goals, assuming there is an alignment with the activities and challenges of production.

The potential downside is the approach’s preoccupation with internal compliance systems. It is questionable whether shale gas production is conducive to such systems. The systems are better suited to a static firm or factory, where they can be embedded in the organization’s ‘production line’, as opposed to the scope, breadth, variability, and site-specific characteristics of shale gas production.

14.7 Which regulatory approach is better at mitigating the challenges posed by shale gas production?

There are numerous challenges associated with shale gas production. No single regulatory approach is likely to be able to account for all of these, particularly when all approaches are likely to have their imperfections:

> There is no ideal regulatory model, but success as an open, innovative competitive economy requires a low cost, low risk regulatory system that also reduces health, safety and environmental risks and protects other public interests.[236]

Industry representatives agree that there is no ideal regulatory model as shale is local, that is, no two shale plays are the same. ‘A key characteristic of shale gas is that no two operations are the same. Thus shale plays differ and even wells on the same play differ.’[237] Geological differences influence why states have different practices for

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[235] Fiona Haines, above n 231, 1–2.

[236] Alan Hardacre, ‘Better Regulation — What Is at Stake?’ (Training Paper, European Institute of Public Administration, 2008) 3 <http://www.eipa.eu/files/repository/eipascope/20080905132115_SCOPE2008-2_1_AlanHardacre.pdf>, quoting Scott Jacobs, ‘RIA: Benefits and Applications’ (Workshop on Good Regulatory Practice, World Trade Organization, Geneva, 18–19 March 2008).

[237] Paul Stevens, ‘The “Shale Gas Revolution”: Developments and Changes’ above n 29, 10.

protecting the environment.[238] Shale gas production is heterogeneous more than homogenous, yet there is the temptation to have a one-size-fits-all attitude towards regulation, with little or no capacity for flexibility to account for variations.

15 Regulatory burden, unintended consequences and the precautionary principle

15.1 Regulatory burden

While regulation can assist with achieving the community's objectives, it can also impose unnecessary compliance burdens on the regulated, often referred to as 'regulatory burden', which can be passed on to the public. The benefits resulting from the regulation must outweigh any burdens that arise.[239]

> ... the costs and risks of regulation may sometimes outweigh its intended benefits. To avoid any unnecessary costs to society associated with the introduction of excessive, inefficient or ineffective regulation, best practice principles have been established.[240]

Regulatory costs that can be justified will be considered to be a necessary aspect of the regulatory process. If they cannot be justified — for example, the financial cost is disproportionate to what is needed to maintain the objectives — then the cost imposes a regulatory burden.

Frequently the same actors incur the regulatory costs of any regulatory regime. The government will incur the cost of administering the regulation, the extent of which

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238 Peter Behr, 'Safety of Shale Gas Wells up to States — And the "Cement Job"' (Online Article, Midwest Energy News, 2 October 2012) <http://www.midwestenergynews.com/2012/10/02/safety-of-shale-gas-wells-up-to-states-and-the-cement-job/>.

239 Better Regulation Office, 'Guide to Better Regulation' (Guide, NSW Department of Premier and Cabinet, NSW Government, November 2009) 7 <http://www.dpc.nsw.gov.au/__data/assets/pdf_file/0009/16848/01_Better_Regulation_Guide_October_2009.pdf>.

240 Department of Treasury and Finance, above n 192, 5.

depending upon any fees and levies imposed to recoup expenditure. There will be costs to the producer. These are usually direct: resource costs associated with regulatory compliance, the financial outlay of changing practices, and stakeholder management. Furthermore:

> To the extent that regulation constrains the actions of the regulated, there will be private costs of regulation. These private costs are considered when estimating the net social benefit/cost of regulation, but not counted as direct costs of regulation.[241]

Regulatory burden is inevitable in most industrial sectors as it is a form of intervention imposed upon actors who are transacting with the least interference possible ('free enterprise'). However, the nature of the challenges of shale gas production means it is especially susceptible to regulatory imposition. For example, effective water management is becoming a dominant factor in shale gas production and is a key focus of regulators. Similarly, cumulative effects have prompted significant interest, necessitating regulators to understand that the shale gas production is not operating in isolation from other considerations, such as the social licence to operate, and the natural and human environment.

A way of minimizing regulatory burden is to ensure that the framework is focused upon nothing more than is reasonably required to achieve the regulatory objectives. In particular, the focus will require the effective management of the shale gas activities and associated factors. In doing so, the regulatory costs will be able to be justified and considered essential to the regulatory process.

15.2 Unintended consequences

All regulation, irrespective of the approach taken, poses the risk of producing unintended consequences, positive or negative. Unintended consequences are the results of action that are at variance from the anticipated outcome. To minimize the chance of unintended consequences, the regulatory agency should not only understand the visible effect of the regulation, but should also take into account those effects that it is obliged to anticipate, that is, those that are reasonably

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[241] George Barker, 'A Framework for Regulatory Decision-Making under Uncertainty' (Working Paper No 2, Centre for Law & Economics, Australian National University, 2008) [3.3] <http://150.203.86.5/cle/Papers/Regulation_and_Uncertainty_Conference%20.pdf>.

foreseeable.[242] The regulatory agency must anticipate the effects, which any responsive agency is required to do, and, through its mandate, ensure that appropriate mitigating steps are taken. For example, in an attempt to mitigate the impact upon communities of the increased vehicle movements associated with shale gas production, the regulator may limit the number and frequency of vehicles that pass through these communities. A number of vehicles will have to use alternative transport route, requiring longer travelling distances.

The visible effect of the regulation is fewer vehicles travelling through designated communities on any one day. However, the regulatory agency needs to anticipate and consider other consequences of the regulatory intervention, including:

- The development may take longer to complete, yet communities might prefer an increase in vehicle traffic if it meant that production would be completed sooner
- There is greater burden upon the producer, its employees and contractors (greater expense to the companies, longer working hours for employees and contractors)
- There is greater use of fossil fuels, leading to increased air pollution, and
- Fewer opportunities for local businesses to 'cash in' on the increased activity.

15.3 The precautionary principle

An increase in human activity that has the potential for unpredictable, uncertain and catastrophic consequences was a significant factor in the development of the precautionary principle. The precautionary principle is not easy to define; many of the statements relating to the principle have the following premise: 'When the health of humans and the environment is at stake, it may not be necessary to wait for

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[242] Christopher J Coyne 'Unintended Consequences — How Regulation Changes Behaviour' [2009] July–August *Fraser Forum* 16, 16–17 <http://www.ccoyne.com/Unintended_Consequences_-_Fraiser.pdf>.

scientific certainty to take protective action.'[243]

Decision-makers are required to foresee the likelihood of damage, rather than react to it after the event.[244] It is based upon a 'better safe than sorry' philosophy where the principle is intended to provide pre-damage control of risks through the provision of anticipatory measures.[245]

The precautionary principle may not be explicitly stated in legal or policy instruments, although it could be implicit. For example, the United States *Clean Water Act 1977* (CWA) establishes rigorous goals intended to achieve its sole objective to 'restore and maintain the chemical, physical and biological integrity of the Nation's waters'.[246] The inclusion of the CWA objective was considered significant at the time and promoted extensive debate as to how it should be quantified. In 1975 the US EPA convened a forum on the 'Integrity of Water', which a number of experts from various disciplines attended, to help determine what the objective might mean in practice. With use of 'restore', 'maintain' and 'integrity' of an environmental value, it is possible to see how the objective would not preclude decision makers from using precautionary measures to promote and maintain water integrity. [247]

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[243] Science & Environmental Health Network *Precautionary Principle — Frequently Asked Questions* <http://www.sehn.org/ppfaqs.html>.

[244] Jon Nevill, *The Precautionary Principle* (2004) Only One Planet <http://www.onlyoneplanet.com/Precautionary_principle.htm>.

[245] World Commission on the Ethics of Scientific Knowledge and Technology, 'The Precautionary Principle' (Report, United Nations Educational, Scientific and Cultural Organization (UNESCO), 2005) 30 <http://unesdoc.unesco.org/images/0013/001395/139578e.pdf>.

[246] Joel Tickner, Carolyn Raffensperger and Nancy Myers Tickner, 'The Precautionary Principle in Action' (Handbook, Science and Environmental Health Network) 3 <http://www.mindfully.org/Precaution/Precaution-In-Action-Handbook.htm#ii>, quoting the US Clean Water Act.

[247] Office of Water and Hazardous Materials, 'The Integrity of Water' (Proceedings of a Symposium, United States Environmental Protection Agency, Washington DC, 10–12 March 1975) <http://nepis.epa.gov/Adobe/PDF/P1004625.PDF>.

The United Nations Conference on Environment and Development (UNCED), having met in June 1992, developed the Rio Declaration on Environment and Development. The declaration has a number of principles. Principle 15 has been relied upon as a starting point to garner the precautionary principle's meaning. Principle 15 provides that if the environment is to be protected, a precautionary approach is to be used by nation states, and where there are threats of serious or irreversible damage, a lack of complete scientific certainty is not to be used to justify postponing measures to prevent environmental degradation.[248]

The principle is no longer limited to potential risks to the natural environment; rather it applies to any human activity that has the prospect of causing serious or irreversible harm. The relevant policy development for environmental and natural resource areas that are susceptible to scientific uncertainty can be assisted by clarifying precautionary decision-making processes and the role of the precaution generally.[249]

In 2005 the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) developed what it refers to as a working definition of the precautionary principle. For COMEST, the principle applies to situations where human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain. In such circumstances, actions shall be taken to avoid or diminish that harm, where:

- *'Morally unacceptable harm'* includes harm that is threatening to human life

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[248] United Nations Environment Programme, *Rio Declaration on Environment and Development* <http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=78&ArticleID=1163>; Chris W Backes and Jonathan M Verschuuren, 'The Precautionary Principle in International, European and Dutch Wildlife Law' (1998) 9(1) *Colorado Journal of International Environmental Law and Policy* 43 <http://arno.uvt.nl/show.cgi?fid=4977>.

[249] Annette Weier and Paul Loke, 'Precaution and the Precautionary Principle: Two Australian Case Studies' (Staff Working Paper, Productivity Commission, Australian Government, September 2007) xi <http://www.pc.gov.au/__data/assets/pdf_file/0005/67271/precautionaryprinciple.pdf>.

or health, or is serious and essentially irreversible, or inequitable,[250] and

- *'Actions'* should be proportionate to the harm they seek to avoid or diminish. Participatory process is used to select the action.[251]

15.3.1 The implications of the precautionary principle

The precautionary principle has its critics. The United States Chamber of Commerce believes the regulatory implications of the principle are generally negative. The Chamber believes there is a lot of uncertainty regarding global warming and climate. The precautionary principle requires the application of the worst-case scenario, which involves restricting the use of carbon-based fuels. In doing so, the Chamber believes this is equivalent to adopting a policy of risk avoidance, constituting a departure from their preferred approach of determining a specific regulatory issue, applying sound science, and undertaking a cost benefit analysis and risk assessment.[252]

Others focus upon the precautionary principle's lack of clarity and precision as grounds for criticism; its generality is both a source of strength and weakness.[253] It is advantageous because it prevents inflexibility (prescription) in its application, enabling the precautionary principle to be applied to a number of contexts. Its disadvantage is that it provides little guidance to regulators and other decision makers.

There are two potential roles for the precautionary principle: the first is a 'justification' role where the principle is used to support the case that the nature of shale gas production necessitates a regulatory response which specifically addresses

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[250] World Commission on the Ethics of Scientific Knowledge and Technology, above n 245, 14.

[251] Ibid.

[252] Environment, Technology & Regulatory Affairs Division, *Precautionary Principle* United States Chamber of Commerce <http://www.uschamber.com/issues/regulatory/precautionary-principle>.

[253] Linda Cameron, 'Environmental Risk Management in New Zealand — Is there Scope to Apply a More Generic Framework?' (Policy Perspectives Paper 06/06, New Zealand Treasury, July 2006) 11 <http://www.treasury.govt.nz/publications/research-policy/ppp/2006/06-06/05.htm>.

such production; the second is where the precautionary principle itself is part of the regulatory approach. The two roles are not mutually exclusive.

15.3.2 The precautionary principle and risk

The precautionary principle may be associated with risk-based regulation as the approach is based upon a structured methodology involving risk assessment, risk management and risk communication. These activities can show knowledge gaps and uncertainties, indicating whether there are sufficient grounds for invoking the principle.[254]

Whether there is capacity for the risk-based approach and the precautionary principle to complement each other may be open to question as the Productivity Commission[255] staff also suggest that the precautionary principle is a response to the intrinsic difficulties faced by decision makers confronted with uncertainty (as distinct from risk). The differences between risk and uncertainty are important for decision-making as risk can be applied to conventional cost-benefit analysis and risk management. In contrast, these tools are not amenable where there is uncertainty, because a lot of the information needed for analysis is unavailable or unreliable.[256] However, acknowledging the realities 'on the ground', the staff members reported that 'decision-makers with responsibility for managing environmental resources or safeguarding human health have little practical alternative but to deal with uncertainty within some form of risk management framework.'[257]

The European Union (EU) considers that the use of the precautionary principle is a component of risk management in situations when the level of scientific uncertainty prevents a complete assessment of risk. The precautionary principle also applies

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[254] Thomas Flüeler and Hansjörg Seiler, above n 220, 14.

[255] The Productivity Commission is the Australian Government's independent research and advisory body on a range of economic, social and environmental issues affecting the welfare of Australians. Its role, expressed simply, is to help governments make better policies in the long term interest of the Australian community' (Australian Commonwealth Government). <http://www.pc.gov.au/>.

[256] Annette Weier and Paul Loke, above n 249, 2.

[257] Ibid 3.

when decision-makers believe that the preferred level of protection may be in danger, [258] however, relying on the precautionary principle is not an excuse for shunning the principles of risk management.[259]

16 Conclusion

Shale gas may seem to be an infinite resource, providing a continuous source of energy and financial returns. Producers have an inclination to be self-interested, which, in the industrial context, manifests itself in the form of profit maximization. Within the shale gas industry, profit maximization is very likely to be detrimental to those things society values, whether it is human health or the environment.

This Part discussed a number of regulatory approaches, each of which is intended in influence behaviour. Concepts that are closely aligned with the approaches were discussed too: regulatory burden, unintended consequences, and the precautionary principle, including its link to risk. The discussion will provide a backdrop for the forthcoming parts, principally Part VII, where the framework is put forward. Every approach has its limitations, meaning there will be imperfections affecting the framework's capacity to protect the regulatory objectives:

> These imperfections and limitations are the primary motivation for regulation — to promote economic efficiency, environmental sustainability, morality, and the general welfare of the public. The same imperfections and limitations, however, also guarantee the imperfect nature of regulation.[260]

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[258] Commission of the European Communities, 'Communication from the Commission on the Precautionary Principle Brussels (Communications No COM(2000) 1, Brussels, 2 February, 2000) 13 <http://ec.europa.eu/dgs/health_consumer/library/pub/pub07_en.pdf>.

[259] Ibid 18.

[260] Barak Orbach, 'What is Regulation?' (Online Article, Yale Journal on Regulation Online, 11 March 2013) <http://jreg.commons.yale.edu/what-is-regulation/#note-133-48>.

PART V The United States and Western Australia

17 Introduction

In the United States and Western Australia there is no one regulatory initiative that is specifically tailored to shale gas production. Western Australia's regulatory regime is less complex and more coherent than that of the United States, where a number of laws at the federal, state and local levels provide for a complex set of arrangements, [within the context of the Unites States Constitution].[261] Within the United States, each applicable state implements many of the federal laws through agreements and planning arrangements endorsed by the relevant federal agencies. Another approach is the system of 'cooperative federalism', where federal agencies develop nationwide standards and permitting requirements, and delegate to the states the authority to administer the regulatory programmes.[262] The US EPA administers the majority of the federal regulation. When it comes to development on federally owned land, the Bureau of Land Management (BLM) primarily manages the land.

A significant challenge for the United States has been the rapid increase of shale gas production, which the current regulatory regime for natural gas has been expected to manage. A 'patchwork' of regulation has developed, leading to an incoherent regime. States with a strong history of oil and gas production tend to apply less onerous regulatory requirements because their industry has acquired a form of privileged status, making the state more able to take advantage of the situation. A state with little or no history tends to apply a cautious approach to regulation, potentially to its economic disadvantage, going so far as to contemplate a moratorium.

The relative lack of complexity in Western Australia is due, in part, to the State being in the early stages of producing shale gas, which has given Western Australia the opportunity to undertake an independent review of its regulatory regime. The review has assisted in addressing the challenges of the natural resources industry, including

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[261] Ground Water Protection Council and ALL Consulting Modern Shale Gas Development, above n 27, ES-2 and ES-3.

[262] David B Spence, 'Federalism, Regulatory Lags, and the Political Economy of Energy Production' (2013) 161 *University of Pennsylvania Law Review* 431, 470 <http://www.pennumbra.com/issues/pdfs/161-2/Spence-161-U-Pa-L-Rev-431.pdf>.

shale gas production. Western Australia is also a jurisdiction where its shale gas reserves are confined within state boundaries and there are fewer regulatory requirements from federal government.

Western Australia's regulatory regime has two regulatory approaches, providing a basis for achieving the regulatory objectives. The United States relies upon regulatory approaches as well. However, as its regulatory regime is complex and has a propensity to change, the approaches are difficult to identify. These characteristics risk the United States' regime failing to meet its objectives, which, like its approaches, are not apparent.

This Part presents the respective regulatory regimes of the United States and Western Australia, including the implications these regulations have for the two jurisdictions and the proposed regulatory framework.

18 Federal regulation — United States

This Chapter provides an account of a number of pieces of federal legislation in the United States. Despite the importance of the legislation, in many instances the producer is either exempt from the laws or the regulatory obligations are less onerous than one might expect. When there are exemptions, the states may have the capacity to 'fill the regulatory gap'. Nevertheless, the potential remains that production is not regulated or the regulation is inadequate. Similarly, other federal legislation has the capacity to 'backfill' to address a regulatory deficiency. The Federal Government may pass laws that states must comply with, although in some instances the law permits the states to take more responsibility, such as enacting their own regulations. The United States' regulatory regime has the hallmarks of an incoherent and reactive regime.[263]

18.1 Clean Air Act

The *Clean Air Act 1973* (CAA) gives the US EPA the authority and responsibility to address concerns relating to air quality. The CAA's intention is to safeguard human

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[263] The regulatory activity is subject to the United States Constitution, which determines the extent of the federal and state governments' jurisdiction to regulate shale gas production.

health and the environment from emissions that pollute ambient, or outdoor, air. By way of example, the CAA limits air emissions from engines and gas processing equipment, along with other sources associated with the applicable production. The legislation provides federal standards for mobile sources of air pollution, involving sources of nearly 200 hazardous air pollutants, including a wide-ranging permit system for all major sources of air pollution. The US EPA establishes baseline national standards for air quality, including large or ubiquitous sources of air pollution such as motor vehicles, power plants and other industrial sources. The US EPA accords principal responsibility to the states for ensuring compliance with the standards.[264]

Under the CAA, the US EPA has established National Ambient Air Quality Standards (NAAQS), which are intended to limit the allowable concentrations of six specific 'criteria pollutants'. These are pollutants requiring special measures to limit their presence in the air given they have principal environmental and health effects in the outdoor air. An example is ozone, which is caused in part by the release of nitrogen oxides into the atmosphere. The US EPA designates nonattainment areas[265] when air exceeds the NAAQS for one of the six criteria pollutants. State Implementation Plans (SIPs) set out control strategies to reduce air pollution in the nonattainment areas. The US EPA requires states to adopt such plans for the areas, and from time to time requires the states to evaluate the efficacy of the approaches prescribed in each SIP.[266]

18.1.1 The New Source Review

Major stationary sources of air pollution and certain modifications to those sources are required under the CAA to obtain an air permit before commencing construction.

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[264] Robyn Kenney and Alexander Gastman, 'Clean Air Act, United States' (Online Paper, The Encyclopedia of Earth, 4 July 2012) <http://www.eoearth.org/article/Clean_Air_Act,_United_States>.

[265] Air Quality Division 'FAQ's about Attainment & Nonattainment' (Article, 'Air Waves' Bulletin, Nebraska Department of Environmental Quality, July 2008) <http://www.deq.state.ne.us/AirWaves.nsf/cf7e4bdd49c643bf8625747f005a1515/3b00b887a2bae40b8625748e005ffbf5>.

[266] New York State Department of Environmental Conservation, *State Implementation Plans* <http://www.dec.ny.gov/chemical/8403.html>.

This permitting process is called the New Source Review (NSR), established as a consequence of the 1977 amendments to the CAA. The NSR permits are legal documents that producers must abide by.[267] The NSR program applies to sources in all areas, that is, in attainment areas, nonattainment areas and areas that are unclassifiable with respect to the NAAQS. The program requires that a new or modified source with the potential to release criteria air pollutants in excess of annual thresholds must, among other things, have a permit to construct, comply with stringent emissions limits, install controls, and, depending upon the circumstances, offset the emissions through emission reduction credits.[268]

18.1.2 Application of the Federal Clean Air Act to shale gas production

A number of legally related issues involving the application of the CAA and the Marcellus Shale are playing out. Are shale gas producers open to legal action due to the air emissions resulting from hydraulic fracturing operations? A lawsuit filed by Citizens for Pennsylvania's Future ('PennFuture') in a Pennsylvania Federal Court in July 2011 may help determine the answer to this question.[269] The suit is seeking declaratory and injunctive relief and civil penalties for a gas drilling company's failure to obtain a NSR permit before constructing and operating a network of gas wells, pipelines and compressor stations that are linked to a single hub and operates

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[267] United States Environmental Protection Agency, *New Source Review — Basic Information* (23 July 2011) <http://www.epa.gov/NSR/info.html>.

[268] Deborah E Jennings and Andrew B Schatz, 'Marcellus Shale Drillers Face Potential Liability under Clean Air Act' (Online Publication, DLA Piper, 5 October 2011) <http://www.dlapiper.com/global/publications/Detail.aspx?pub=6304&RSS=true>.

[269] See *Citizens for Pennsylvania's Future v Ultra Resources,* MD Pa, Docket No 4:2011-cv-01360-RDM, quoted in Murray Kamionski, *The Courtroom Problem with Filing a Fracking Claim* (8 August 2012) The Front Page Online <http://www.thefrontpageonline.com/articles1-11409/TheCourtroomProblemwithFilingaFrackingClaim>. For the complaint filed in Court see <http://www.pennfuture.org/UserFiles/File/Legal/Air_JB_UltraComplaint_20110721.pdf>; for corresponding news release see PennFuture, 'PennFuture Files Federal Lawsuit Against Marcellus Shale Driller Ultra Resources, Inc for Violations of Federal and State Air Pollution Laws' (News Release, 21 July 2011) <http://www.pennfuture.org/media_pr_detail.aspx?MediaID=1324&Archive>.

as a single source, with the facilities being located over a 558 square mile area.[270] The basis for the suit is the allegation that the company required a major NSR permit under the CAA and Pennsylvania law, being the law that implemented the CAA, as, although the gas extraction activities are dispersed through a network of infrastructure, the development should be seen as a single source of air emissions for the purposes of the CAA. The activities support one another and are connected by pipeline, and the total nitrogen oxide emissions produced by the gas extraction activities as a single source exceed NSR emissions thresholds.[271]

If the suit is successful it may have significant national implications when a driller's activities are located within ozone NSR nonattainment areas and its nitrogen oxide emissions exceed the applicable threshold.[272] The driller may be liable under the CAA for any failure to get the requisite permits that would place limitations on emissions in association with controls and offsets.[273]

In February 2012 the Clean Air Council petitioned the US EPA to make findings that

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[270] See PennFuture, *Legal Cases/Current Cases — Ultra Resources, Marshlands Play* (21 July 2011) <http://www.pennfuture.org/legal_detail.aspx?Type=C&LegalCaseID=71>; filed complaint <http://www.pennfuture.org/UserFiles/File/Legal/Air_JB_UltraComplaint_20110721.pdf>; Cynthia Stroman, Drew Bell and Stephanie Salek, 'Air and Water Woes in the Marcellus Shale' (Article, Law360, 1 September 2011) <http://www.savecoloradofromfracking.org/harm/Resources/9-11Law360StromanBellSalek.pdf>.

[271] Deborah E Jennings and Andrew B Schatz, above n 268.

[272] PennFuture has been successful procedurally through the court determining that there was no requirement under the CAA to exhaust administrative remedies before bringing the action in federal district court. 'A federal court ruled that an environmental advocacy organization could ignore and bypass state administrative agency environmental permit review procedures and file an action directly in federal court challenging the construction of seven compressor stations that had been permitted and constructed by the defendant.' Saul Ewing LLP, 'Federal District Court Allows an Action to Proceed against a Marcellus Gas Operator Even Though DEP Had Issued Permits and the Facilities had Been Constructed' (Online Article, October 2012) <http://www.saul.com/publications-alerts-945.html>. The proceedings to hear the merits of the case were pending as of 16 August 2013.

[273] Deborah E Jennings and Andrew B Schatz, above n 268.

the Pennsylvania (PA) Department of Environmental Protection (DEP) is failing to implement important requirements of the CAA along with its own state air plan when permitting Marcellus Shale operations.

> When determining whether a source is major or minor and should be permitted as such, PA DEP must aggregate all sources that are under common control, that are part of the same industry and are contiguous or adjacent. Because of the very nature of natural gas operations, which can cover many miles, single source determinations are complex but crucial.[274]

The failure to aggregate these sources means that in some areas the gas industry may locate multiple pollution-emitting facilities within a small area, with each being regulated as a minor source of pollution even though when taken as an aggregate the sources would have a detrimental effect on air quality as defined by the CAA.[275] In June 2013 the Clean Air Council declared its intentions to sue the US EPA for ignoring its petition.[276]

Furthermore, the US EPA is unhappy with the DEP's proposed policy guidelines for regulating air pollutants emitted by Marcellus Shale gas production sites located in close proximity to one another. The US EPA believes the DEP's draft policy[277] differs from the federal law and Pennsylvania's air pollution control plan by imposing new limitations on the aggregation of air emissions from multiple shale gas industry sources.[278] The draft policy uses the physical distance of one-quarter mile as the

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[274] Clean Air Council, 'Clean Air Council Petitions EPA to Find that PA DEP is Failing to Properly Regulate Marcellus Shale Air Pollution' (News Release, 16 February 2012) <http://cleanair.org/program/outdoor_air_pollution/marcellus_shale/clean_air_council_petitions_epa_find_pa_dep_failing_pr>.

[275] Ibid.

[276] Dan Packel, 'Enviros Say [US] EPA Ignoring Pa.'s Lax Emissions Standards' (Online Article, Law360, 3 June 2013) <http://www.law360.com/articles/446505/enviros-say-epa-ignoring-pa-s-lax-emissions-standards>.

[277] The draft policy was implemented on an interim basis on 12 October 2011, with the DEP receiving public comments until 21 November 2011.

[278] John Quigley, 'PA Is Going the Wrong Way on Gas Drilling Regulation' (Online Article, onearth, 7 December 2011) <http://www.onearth.org/blog/pa-is-going-the-wrong-way-on-gas-drilling-regulation>.

'bright line test' between the shale gas facilities as major qualifying criteria for determining whether they should be considered as individual minor sources or a single major source of air pollutants. Industry supports the draft policy on the grounds it promotes certainty and predictability through providing a 'prescriptive definition of proximity',[279] while environmental lobbyists are concerned that multiple sources of pollution could degrade air quality.[280]

In November 2011 the US EPA stated that the CAA required a broader geographic approach to aggregation, which may result in multiple gas development activities being treated as a single major source. Producers will need to meet stricter emissions standards, highlighting an interesting issue of federal/state tension regarding the enforcement of environmental laws. Under the CAA, a policy of 'cooperative federalism' is commonly adopted, essentially leaving it principally to the states to implement measures to fulfil the NAAQS.[281] The DEP has the principal responsibility for implementing the CAA within the State of Pennsylvania, unless the US EPA escalates the issue and challenges the DEP's delegated authority to regulate.[282]

Finally, on 17 April 2012 the US EPA issued amended air regulations that are intended to reduce harmful air pollution (including smog-forming volatile organic compound (VOC) emissions) resulting from the activities of the oil and natural gas industry. The review of air regulations was prompted by litigation initiated by environmental groups in January 2009, which alleged that the US EPA had let pass

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[279] Don Hopey, 'EPA Criticizes State for Shale Air Pollution Rules' (Online Article, post-gazette.com, 6 December 2011) < http://www.post-gazette.com/stories/local/state/epa-criticizes-state-for-shale-air-pollution-rules-222922/> quoting Kathryn Klaber, president of the Marcellus Shale Coalition.

[280] Ibid. For a useful outline of the concerns from environmental groups' perspectives see Clean Air Council, 'New Natural Gas Aggregation Guidance is a Regulation in Disguise and Obstructs the Purpose of the Clean Air Act' (Online Article, 22 November 2011) <http://www.cleanair.org/program/outdoor_air_pollution/marcellus_shale/clean_air_council_pa_dep_new_natural_gas_aggregation_g>. This article relates to the Clean Air Council, jointly with the Columbia Environmental Law Clinic, submitting comments critical of the Pennsylvania Department of Environmental Protection's 12 October 2011 'Guidance for Performing Single Stationary Source Determinations for Oil and Gas Industries'.

[281] Don Hopey, above n 280.

[282] Ibid.

the statutory deadlines for reviewing and updating the National Emission Standards (NES) for New Source Performance Standards (NSPS)[283] and Hazardous Air Pollutants (NESHAP)[284] for the oil and gas sector. In February 2010 the District of Columbia required the EPA to submit a proposed rule by January 2011, with the final rule being submitted by November 2011[285] (although, through agreement, the deadlines were changed during the process):

> The final rules are the result of the review of four air regulations for the oil and natural gas industry required by the Clean Air Act: a new source performance standard for VOCs; a new source performance standard for sulphur dioxide; an air toxics standard for major sources of oil and natural gas production; and an air toxics standard for major sources of natural gas transmission and storage.[286]

The regulations include the first federal air standards for natural gas wells that are subject to hydraulic fracturing. They require new hydraulically fractured wells and wells that are being refractured to control emissions of VOCs released in the course of well completion. Until 1 January 2015 these wells have the option of either combusting these emissions or capturing them through a 'green completion' device[287]

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[283] Under Section 111 of the Clean Air Act the standards are developed and implemented by the US EPA and are delegated to the states. Notwithstanding, the EPA retains authority to implement and enforce the NSPS. The standards regulate specific categories of stationary sources. 'The NSPS apply to new, modified and reconstructed affected facilities in specific source categories such as manufacturers of glass, cement, rubber tires and wool fiberglass. As of 2005, there were approximately 75 NSPS.' United States Environmental Protection Agency, *Compliance Monitoring — New Source Performance Standards and State Implementation Plans* (14 June 2012) <http://www.epa.gov/compliance/monitoring/programs/caa/newsource.html>.

[284] National Emission Standards for Hazardous Air Pollutants (NESHAP) for reciprocating internal combustion engines are intended to reduce emissions of toxic air pollutants, such as formaldehyde (HCHO). DieselNet, *Existing Stationary Engines (NESHAP)* (April 2011) <http://www.dieselnet.com/standards/us/stationary_hap.php>.

[285] Tomás Carbonell, 'EPA Issues Final Emission Standards for Oil and Gas Sector' (Online Article, Van Ness Feldman, 20 April, 2012) <http://www.vnf.com/news-alerts-701.html>.

[286] United States Environment Protection Agency, 'Overview of Final Amendments to Air Regulations for the Oil and Natural Gas Industry' (Fact Sheet, 17 April 2012) 4 <http://www.epa.gov/airquality/oilandgas/pdfs/20120417fs.pdf>.

[287] Green completions are also called reduced emission completions, or RECs.

that separates VOCs and methane from the flow-back fluid. After 1 January 2015 these wells, with specific exceptions, are required to use green completion devices.[288]

The enactment of the CAA has given the US EPA powers to deal with issues relating to air quality. The US EPA has designed initiatives to achieve the purpose of the legislation, some through 'cooperative federalism'. Some of the initiatives have courted controversy, sometimes resulting in litigation. The potential for discord is heightened during change, including the rapidly emerging shale gas industry which is controversial and considered 'game changing', yet is subject to legislation that was enacted while the industry had little or no presence.

18.2 The Clean Water Act

The CWA is an amendment to the federal *Water Pollution Control Act 1972*. The CWA has as its goal the restoration and maintenance of the chemical, physical and biological integrity of the nation's waters.[289] The CWA concentrates on advancing the quality of the country's waters, including the protection of the sources of drinking water. However, the legislation does not regulate drinking water quality directly. The CWA has a number of standards, various tools (regulatory and non-regulatory) and monetary assistance to deal with the causes of pollution and poor water quality. The CWA operates in a number of areas and contexts: municipal and industrial wastewater discharges, polluted runoff from urban and rural regions, and habitat damage. The CWA achieves its overall goal through:[290]

- Requiring municipalities and major industries to meet performance standards to ensure pollution control
- Setting specific water quality criteria that are fit for waters and developing

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[288] Tomás Carbonell, above n 285.

[289] United States Environmental Protection Agency, *The Clean Water Act: Protecting and Restoring our Nation's Waters* (20 September 2012) <http://water.epa.gov/action/cleanwater40/cwa101.cfm>; Sec. 101 (a). Declaration of Goals and Policy, Clean Water Act 33 USC §1251 et seq. (1972) <http://www.epa.gov/agriculture/lcwa.html>.

[290] Civil Enforcement, *Clean Water Act Enforcement* (18 May 2010) United States Environmental Protection Agency <http://www.epa.gov/oecaerth/civil/cwa/index.html>.

pollution control programmes to achieve the criteria

- Providing funds to help establish clean water infrastructure needs, and
- Protecting important wetlands and other aquatic habitats through a permitting process, with the intention that development and other human activities are conducted in a way that respects the natural environment.

The CWA regulates storm water runoff and, for the most part, surface waters, but essentially excludes drinking water quality and groundwater.[291] It also makes it unlawful to discharge a pollutant from a point source into navigable waters unless a permit is obtained.[292] The discharge of water associated with shale gas drilling and production, as well as storm water runoff from production sites, is subject to the jurisdiction of the CWA. By providing the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters, the CWA is the primary legislative source of surface water quality protection in the United States.

18.2.1 National pollutant discharge elimination system process and primacy requirements

The CWA's water quality protection encompasses the regulation of pollutant limits on the discharge of natural gas produced water through the National Pollutant Discharge Elimination System (NPDES) permitting process.[293]

The US EPA sets standards at the federal level. However, states can acquire primacy for the NPDES program by meeting the US EPA's primacy requirements. A primacy requirement is a right that can be granted to states by the Federal Government, permitting the state agencies to execute programmes with federal oversight.

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[291] Betsy Devlin, 'Protecting Drinking Water Quality through the Clean Water Act and the Safe Drinking Water Act' (Paper presented at Fourth International Conference on Environmental Compliance And Enforcement, Chiang Mai, Thailand, 22–26 April 1996) <http://www.inece.org/4thvol2/devlin.pdf>.

[292] United States Environmental Protection Agency, *Summary of the Clean Water Act 33 USC §1251 et seq. (1972)* <http://www2.epa.gov/laws-regulations/summary-clean-water-act>.

[293] Clean Water Act, 33 USC §§ 1251 402 Establishes the National Pollutant Discharge Elimination System ('NPDES') program.

Typically this involves the state implementing its own relevant regulations. Any approach adopted by the states must be at least as protective as the federal standards they substitute. Once these state programmes are approved by the relevant federal agency (such as the US EPA), the state assumes primacy jurisdiction. [294]

The NPDES program controls water pollution through regulating point sources that discharge pollutants into waters. Point sources are, for example, discrete conveyances such as pipes, human-made drainages and ditches. Industrial, municipal and other facilities are required to be permitted if their discharge goes directly into surface waters.[295]

Industrial activities such as shale gas production sites that include the disposal of produced water must obtain permits if the producer is to lawfully discharge directly into surface water.[296] In the event that underground injection is not feasible, the producer may discharge the flow-back to surface waters if the discharge does not violate a stream or lake's water quality standards. Standards established by states under Section 303 of the CWA protect designated beneficial uses of surface waters, such as recreation or public water supply.[297]

States may have different standards under the federal primacy requirements. Differing standards can cause difficulties; for example, industry could be required to manage produced water from a drainage basin located within two or more states differently because the shale play crosses state boundaries. The Marcellus Shale is a case in point.[298] The inconvenience of variable standards may outweigh the

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[294] Ground Water Protection Council and ALL Consulting Modern Shale Gas Development, above n 27, 29 and 82.

[295] United States Environment Protection Agency, *Compliance Monitoring — National Pollutant Discharge Elimination System* (14 June 2012) <http://www.epa.gov/compliance/monitoring/programs/cwa/npdes.html>.

[296] National Energy Technology Laboratory, *Produced Water Management Practices and Applicable Regulations — Federal Regulations: US Environmental Protection Agency* <http://www.netl.doe.gov/technologies/pwmis/regs/federal/epa/index.html>.

[297] Anthony Andrews et al, above n 96, 34.

[298] Ground Water Protection Council and ALL Consulting Modern Shale Gas Development, above n 27, 30.

challenges of having a federal agency imposing the standards. A federal agency would not have the local knowledge or the resources to develop, implement or monitor the standards. Should differing standards pose a challenge, the federal agency may rush to impose a 'one size fits all' solution.

Concern is increasing over the effect the industry is having upon water, although the role the CWA is playing is uncertain. An explanation could be that water is important and tangible, and therefore garners attention readily. Concern over water is conducive to the mobilization of 'grass roots' campaigning, which gains the attention of authorities and industry. Steps are taken to alleviate the community's concerns, reducing the potential for litigation, at least initially.

18.3 Safe Drinking Water Act

The vast majority of public water schemes, and nearly all residents living in rural areas, rely on groundwater as a supply for drinking water. Because of the importance of underground sources, Congress included groundwater protection provisions in the *Safe Drinking Water Act 1974* (SDWA).[299] The SDWA is the main federal law with the purpose of ensuring the quality of the United States' drinking water, both surface and groundwater, through the implementation of a number of programmes: the Public Water Supply Supervision (PWSS) initiative is the primary program for the regulation of public water systems in the vast majority of states. Other programmes are the provision of financial assistance for infrastructure projects and the promotion of the capability of water systems to comply with SDWA regulations.[300] While the US EPA is the federal agency responsible for administering the SDWA, a federal/state structure exists enabling the US EPA to delegate primary enforcement for the drinking water programmes to states.

Through setting standards for drinking water, and overseeing their implementation,

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[299] Mary Tiemann and Adam Vann, 'Hydraulic Fracturing and Safe Drinking Water Act Regulatory Issues' (Report, Congressional Research Service, 10 January 2013) 7 <http://www.fas.org/sgp/crs/misc/R41760.pdf>.

[300] Susan L Sakmar, 'The Global Shale Gas Initiative: Will the United States Be the Role Model for the Development of Shale Gas around the World?' (2011) 33(2) *Houston Journal of International Law* 369, 406–407 <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1927593>.

the US EPA has an important role in achieving the purpose of the SDWA. Consequently, the SDWA is involved in regulating the underground injection of fluids from shale gas activities, such as wastewaters, and therefore has particular relevance for hydraulic fracturing and drilling.[301]

18.3.1 The SDWA and underground injection control

The 1974 SDWA required that the underground injection control (UIC) regulations must not prevent the underground injection of brine from oil and gas production or recovery of oil unless underground sources of drinking water would be affected. Section 1421 of the SDWA directs the US EPA to promulgate regulations for state UIC programmes, and mandates that the US EPA regulations *'contain minimum requirements for programs to prevent underground injection that endangers drinking water sources* (emphasis added).' The SDWA sets standards and requires permits for the underground injection of hazardous substances so that these materials do not endanger underground sources of drinking water. The UIC regulations are recognized as the 'endangerment standard' that acts as a force in the regulation of underground injection under the SDWA in association with the US EPA.

The endangerment standard protecting groundwater, which is used, or may be used, to supply public water systems corresponds to the broad scope of the SDWA. However, it may have limitations. The wording of the endangerment standard (the 'endangerment language') has raised doubts regarding the SDWA's 'reach', prompting uncertainty over the US EPA's jurisdiction.[302]

Through the *Energy Policy Act of 2005*, Congress amended the SDWA to make it explicit that the definition of 'underground injection' excluded the injection of fluids

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[301] United States Environmental Protection Agency, *Safe Drinking Water Act (SDWA)* <http://water.epa.gov/lawsregs/rulesregs/sdwa/>.

[302] Mary Tiemann and Adam Vann, above n 299, 9.

or propping agents (other than diesel fuels)[303] used in hydraulic fracturing operations related to (among other things) oil and gas activities.[304] The provisions that enable the exclusion, Federal Code of Regulations, particularly 40 CFR 144–148, have become known as the 'Halliburton Loophole'. The amendment is generally perceived as providing an exemption at the federal level for gas drilling and extraction activities from the requirements in the UIC program, and the requirements for the prevention of contamination of groundwater under the SDWA.

The exemption was inconsistent with community concern. In 1994 the Legal Environmental Assistance Foundation (LEAF) petitioned the US EPA alleging that hydraulic fracturing had contaminated Alabama residents' drinking water. The petition also alleged that the US EPA had the responsibility to regulate the practice. The LEAF's petition was unsuccessful. In 1997 the LEAF initiated litigation. The Court did not accept the US EPA's argument that the term 'underground injection' applied only to wells whose 'principal function' was the placement of fluids underground.[305] 'The court held that there was no ambiguity in the SDWA's definition of "underground injection" as "the subsurface emplacement of fluids by well injection," noting that the words have a clear meaning and that…'[306]

> The process of hydraulic fracturing obviously falls within this definition [of underground injection], as it involves the subsurface emplacement of fluids by forcing them into cracks in the ground through a well. Nothing in the statutory

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[303] In April 2012 the US EPA released 'draft underground injection control (UIC) program permitting guidance for class II wells that use diesel fuels during hydraulic fracturing activities' (released to notify the public and to receive public comment). The US EPA developed the draft guidance to clarify how companies can comply with a law passed by Congress in 2005, which exempted hydraulic fracturing operations from the requirement to obtain a UIC permit, except in cases where diesel fuel is used as a fracturing fluid. United States Environmental Protection Agency, 'EPA Releases Draft Permitting Guidance for Using Diesel Fuel in Oil and Gas Hydraulic Fracturing/Guidance Will Clarify Means of Compliance with 2005 Amendments to the Safe Drinking Water Act' (News Release, 5 April 2011) <http://yosemite.epa.gov/opa/admpress.nsf/79c090e81f0578738525781f0043619b/1224e5cd2897669f852579f400697788!OpenDocument>.

[304] *Safe Drinking Water Act* 42 USC 42 §§ 300f (1974) Section 322 amended section 1421(d).

[305] Mary Tiemann and Adam Vann, above n 299, 15–16.

[306] Ibid 16.

> definition suggests that [US] EPA has the authority to exclude from the reach of the regulations an activity (ie hydraulic fracturing), which unquestionably falls within the plain meaning of the definition ...[307]

The Court remanded the decision to the US EPA for reconsideration of the LEAF's petition.[308] Yet, in the following decade, upon the recommendation of Vice-President Dick Cheney's Energy Taskforce, the US EPA's power was taken away by the *Energy Policy Act of 2005* (the 'Halliburton loophole'); consequently, the 'oil and gas industry is the only industry in America that is allowed by US EPA to inject known hazardous materials — unchecked — directly into or adjacent to underground drinking water supplies.'[309] The Halliburton Loophole is significant given hydraulic fracturing involves large volumes of water and toxic chemicals.[310]

While the *Energy Policy Act of 2005* exempts hydraulic fracturing from federal regulation under the SDWA, in the absence of federal regulations, specific legislation and regulations promulgated by states are applicable. In addition, gas operations are required to meet the applicable federal environmental regulations that govern resource extraction.[311]

The US EPA has the authority to establish water quality criteria, which place numeric limitations on pollutants. Once developed, the criteria provide recommended

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[307] Ibid 16, quoting Legal Environmental Assistance Foundation, Inc. v. US Environmental Protection Agency, 118F.3d 1474–5 (11th Cir. 1997) ('LEAF I').

[308] Ibid, citing Legal Environmental Assistance Foundation, Inc. v. US Environmental Protection Agency, 118F.3d 1478. (11th Cir. 1997).

[309] Earthworks, *The Halliburton Loophole* <http://www.earthworksaction.org/issues/detail/inadequate_regulation_of_hydraulic_fracturing>.

[310] F William Engdahl, *The Fracked-up USA Shale Gas Bubble* (13 March 2013) Centre for Research on Globalization <http://www.globalresearch.ca/the-fracked-up-usa-shale-gas-bubble/5326504>.

[311] Francis Gradijan, 'State Regulations, Litigation, and Hydraulic Fracturing' (2012) 7(1) *University of Houston Law Center Environmental & Energy Law & Policy Journal* 48, 48–49 <http://www.ourenergypolicy.org/wp-content/uploads/2012/08/02Gradijan.pdf>; *Clean Air Act*, 42 USC §§ 7401, 7411, 7412, 7416 (1972) (being designations and delineations of state authority in the Clean Air Act).

guidance to the local areas:

> Additionally, [US] EPA must approve state water quality standards … [US] EPA has developed criteria for some pollutants of concern in shale gas wastewater, such as chloride, oil and grease, suspended solids, turbidity, and nitrates. However, many other pollutants of concern — like total dissolved solids, bromide, and NORM — lack [US] EPA recommended criteria.[312]

Contributing to a political climate conducive to the enactment of the *Energy Policy Act of 2005* were the findings of an EPA study published in 2004. The study assessed the potential for hydraulic fracturing of coalbed methane (CBM) wells to contaminate underground sources of drinking water. The US EPA's decision to carry out the study was, in part, linked to the implications of the Court's decision (LEAF) as it raised questions regarding whether the SDWA required the US EPA to regulate hydraulic fracturing per se. Although the LEAF decision related only to hydraulic fracturing for CBM production in Alabama, the Court found that hydraulic fracturing 'unquestionably falls within the plain meaning of the definition [of underground injection]'[313] — raising the possibility that the US EPA is required to regulate hydraulic fracturing under the SDWA generally.[314]

The US EPA study published in 2004[315] essentially endorsed the practice of injecting potentially toxic fluids for hydraulic fracturing by concluding that, based on the information collected and reviewed, hydraulic fracturing fluids posed little or no threat to underground sources of drinking water and that no further study of the

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[312] Rebecca Hammer and Jeanne Van Briesen above n 156, 84; see especially 'EPA and the states should develop water quality criteria for all chemicals in shale gas wastewater': at 8

[313] Mary Tiemann and Adam Vann, above n 292, 20, quoting Legal Environmental Assistance Foundation, Inc. v. US Environmental Protection Agency, 118F.3d 1474-75. (11th Cir. 1997).

[314] Before this question was resolved through agency action or litigation, Congress passed an amendment to the SDWA — this being the Energy Policy Act of 2005.

[315] Office of Ground Water and Drinking Water 'Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs (Final)' (Study Report No EPA 816-R-04-003, Office of Water, United States Environmental Protection Agency, June 2004) iii <http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_coalbedmethanestudy.cfm>.

practice was needed at the time of reporting.[316] Industry advocates relied upon the results of the study to justify the amendment to the *Energy Policy Act* of 2005, which exempted hydraulic fracturing from the ambit of the SDWA.[317]

The conclusions of the US EPA were not without controversy, which included the study's methodology, the impartiality of the expert panel that analysed the findings, and the extent to which the findings could be supported. Weston Wilson, a scientist who had been employed by the US EPA for over 30 years, wrote a critical letter to Colorado representatives soon after the release of the report. Wilson alleged that the US EPA's conclusions were unsupportable and, of the panel of seven, five appeared to have a conflict of interest.[318]

Because of the exemption, states are able to regulate hydraulic fracturing as they deem fit. The New York State Department of Environmental Conservation administers the relevant regulations and a permitting program, intended to lessen the possible environmental effects of drilling and the operations of a well.[319] New York State's approach may be contrasted with that of Texas. Rather than adopting a direct approach to the regulation of hydraulic fracturing, Texan authorities use an indirect system, where the regulatory responsibility is spread across a number of agencies, meaning that no one specific authority is responsible for any given activity.[320]

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316 Ibid ES-16–17.

317 Abrahm Lustgarten and Sabrina Shankman, 'Congress Tells EPA to Study Hydraulic Fracturing' (Online Article, ProPublica, 10 November 2009) <http://www.propublica.org/article/congress-tells-epa-to-study-hydraulic-fracturing-hinchey-1110>.

318 Weston Wilson (Letter to Senators Wayne Allard and Ben Nighthorse Campbell, and Representative Diana DeGette, Denver, Colorado, 8 October 2004) <http://latimes.image2.trb.com/lanews/media/acrobat/2004-10/14647025.pdf>.

319 New York State Department of Environmental Conservation, *Oil and Gas — Oil, Gas and Solution Salt Mining in New York State* <http://www.dec.ny.gov/energy/205.html>; New York State Department of Environmental Conservation, *Division of Mineral Resources* <http://www.dec.ny.gov/about/636.html>.

320 Leonie Reins, above n 1, 303–304.

Industry believes the SDWA exemption is needed to avoid imposing a burdensome permitting process that could shut down drilling for natural gas. However, the argument is difficult to sustain. Industry complies with the SDWA when it injects fracturing fluids for disposal, but not when it injects those same fluids for drilling a gas (or oil) well:[321]

> Under the act, the industry has already obtained approval for more than 150,000 injection wells including wells used to inject waste fluids from drilling such as fracturing fluids to ensure that these fluids do not pollute underground sources of drinking water.[322]

18.3.2 The 'FRAC Act' and United States Environmental Protection Agency activity

In 2009 Congress introduced the *Fracturing Responsibility and Awareness of Chemicals Act* (dubbed the '*FRAC Act*'), intended to remove the exemption of hydraulic fracturing from the SDWA by: [323]

- Amending the definition of 'underground injection', where under the UIC program hydraulic fracturing activities would become subject to regulatory measures such as consent, permitting and monitoring
- Requiring the disclosure of chemicals used in the fracturing process, and
- Bringing hydraulic fracturing back under the federal regulatory authority of

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321 Bruce Baizel and Dusty Horwitt, 'Safe Drinking Water Act Should Cover Hydraulic Fracturing — Protect our Drinking Water: Close the Halliburton Loophole in the Safe Drinking Water Act' (Fact Sheet, Oil & Gas Accountability Project, Earthworks and Environmental Working Group, 9 June 2009) <http://www.earthworksaction.org/files/publications/FS_SDWAshouldCoverFracking_lowres.pdf>.

322 Ibid.

323 United States 111th Congress, 'Companion Bills Introduced to Protect Drinking Water from Natural Gas Fracking — American Public Deserves to Know Chemicals Used Near Their Water Sources' (News Release, 9 June 2009) <http://s3.amazonaws.com/propublica/assets/natural_gas/frac_act_press_release_090609.pdf>.

the US EPA.

'Such an alteration would effectively retract the exemption for hydraulic fracturing activities put in effect by the *Energy Policy Act of 2005* and subject drilling companies to stringent federal regulations'. [324]

The '*FRAC Act'* could be the catalyst for industry to take responsibility for managing any harmful consequences of hydraulic fracturing. However, because the '*FRAC Act*' is predominantly focused on drinking water contamination through an amended definition of 'underground injection', there are concerns that it does not go far enough to address potential health hazards and other potential environmental challenges such as water diminution, geological disturbance and greenhouse gas emissions.[325] The *'FRAC Act'* also aims for the energy industry to make public the chemicals mixed with water and sand, but this does not include proprietary mixes, only the chemical constituents used in the fracturing. The industry would be required to post online what the chemicals are, and should a qualified physician believe that the proprietary information is needed due to an emergency requiring management the producer is required to give the information. The trigger is an 'emergency', not public concern, before the proprietary mixture must be disclosed.[326]

While the '*FRAC Act*' had stalled before Congress, on 9 May 2013 it was reintroduced. The 2013 version highlights a possible bipartisan approach to protecting drinking water sources.[327] In the meantime, the regulation of hydraulic fracturing will continue to be the role of the states, and the nature of their regulatory regime will be influenced by a number of factors, including the robustness of the

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[324] JEA Consulting Group, 'Assessing the Federal Regulatory Landscape for Hydraulic Fracturing' (Report, 14 May, 2012) 7 <http://jeaconsulting.com/index.php/download_file/view/92/>.

[325] School of International and Public Affairs, 'The FRAC Act: The Fracturing Responsibility and Awareness of Chemicals Act of 2011' (Paper, Columbia University, 17 August 2011) 5 <http://mpaenvironment.ei.columbia.edu/sitefiles/file/Summer%2011%20reports/The%20FRAC%20Act.pdf>.

[326] JEA Consulting Group, above n 324, 2.

[327] Energy Solutions Forum, 'FRAC Act Reintroduced as Bipartisan Bill' (Online Article, Breaking Energy, 10 May 2013) <http://breakingenergy.com/2013/05/17/frac-act-reintroduced-as-bipartisan-bill/>.

social contract to operate between industry and local communities. In the Marcellus Shale states the level of community concern is such that 'we may see companies voluntarily disclosing more information about fracking fluids as a concession to political realities.'[328]

The US EPA drafted guidelines in 2012 intended to outline how gas-drilling companies can undertake hydraulic fracturing consistent with the 2005 amendments. The guidelines, in part, are a response to the US EPA still having jurisdiction over the use of diesel (regulation by the US EPA of diesel would be discretionary).[329] The proposed guidelines caused industry concern. A broad interpretation of what constitutes diesel may limit drilling, amounting to the implementation of national regulation and the federalization of hydraulic fracturing.[330] While the EPA acknowledges there is some confusion due to the statutory language, the agency does not share industry's concerns: '[US] EPA's goal is to improve compliance with the SDWA requirements and strengthen environmental protections *consistent with existing law*.'[331]

As discussed earlier[332], the US EPA study published in 2004 involved the possibility of underground sources of drinking water being contaminated by the hydraulic fracturing of CBM — the results of which were relied upon to support the exemption of hydraulic fracturing from the SDWA. In 2010 the US EPA announced it was

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[328] David Spence, 'Fracking Regulations: Is Federal Hydraulic Fracturing Regulation around the Corner?' (Energy Management Brief, Energy Management and Innovation Center, McCombs School of Business, University of Texas at Austin, 22 September 2010) 5 <http://www.mccombs.utexas.edu/~/media/Files/MSB/Centers/EMIC/EMIC%20Misc/Fracking-Regulations-Is-Federal-Hydraulic-Fracturing-Regulation-Around-Corner.ashx>.

[329] Mark Drajem and Katarzyna Klimasinska, 'EPA Shrinking 'Halliburton Loophole' Threatens Obama Gas Pledge' (News Story, Bloomberg, 1 February 2012) <http://www.bloomberg.com/news/2012-02-01/epa-shrinking-halliburton-loophole-threatens-obama-gas-pledge.html>.

[330] Ibid.

[331] United States Environmental Protection Agency, *Natural Gas Extraction — Hydraulic Fracturing — Ensuring that Hydraulic Fracturing Using Diesel Fuels Is Properly Permitted* (12 July 2013) <http://www2.epa.gov/hydraulicfracturing> (emphasis added).

[332] Refer to Section 18.3.1, 'The SDWA and underground injection control'.

undertaking a further study focusing upon water-related issues, including the management of produced hydraulic fracturing water. The final report of the study will be published in 2014.[333] There is the possibility that the findings of the 2004 and the 2014 studies are inconsistent. The 2014 study may mean that hydraulic fracturing is no longer exempted from the SDWA.

Should a recommendation of the 2014 study be a need for consistency in hydraulic fracturing and water related issues between states, this will be problematic. The reasons for the variations are attributable to a number of factors, including geology, permitting requirements, and additional site-specific characteristics.[334]

18.4 Resource Conservation and Recovery Act

Under the *Resource Conservation and Recovery Act 1976* (RCRA), the US EPA has the authority to control hazardous waste from creation to disposal through two enforcement processes, tracking and permitting. The US EPA has the jurisdiction to control the generation, transportation, treatment, storage, and disposal of hazardous waste. Waste is considered hazardous if it is ignitable, corrosive, reactive or toxic.[335] Ordinarily the natural gas industry would be subject to the RCRA because:

- Hydraulic fracturing fluid mixtures are likely to contain toxic constituents (albeit as trace elements); some are listed as hazardous wastes under the

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333 [US] EPA's Study of Hydraulic Fracturing and its Potential Impact on Drinking Water Resources, *Questions and Answers about EPA's Hydraulic Fracturing Study* (22 May 2013) United States Environmental Protection Authority <http://www.epa.gov/hfstudy/questions.html#1>.

334 Eric Waeckerlin, *Is [US] EPA Shifting Towards Regulating Fracking Under the Clean Water Act?* (11 March 2011) Fracking Insider <http://www.frackinginsider.com/regulatory/is-epa-shifting-towards-fracking-regulation-under-the-clean-water-act/>.

335 United States Environmental Protection Agency, *Summary of the Resource Conservation and Recovery Act — 42 USC §6901 et seq. (1976)* (16 April 2013) <http://www2.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act>. Amendments to the RCRA in 1986 extended the US EPA’s jurisdiction by allowing the US EPA to attend to environmental problems attributable to underground tanks storing petroleum and other hazardous substances.

RCRA,[336] and

- Of the presence of hydro-frack fluid (sometimes referred to as 'production brine'), some of which returns to the surface and requires appropriate management.[337]

In the 1970's the US EPA was the lead organization for drafting a number of regulatory standards for the governance of hazardous waste management practices. The US EPA's proposal included less onerous standards for certain types of large volume wastes on the grounds they were less toxic than other hazardous wastes that were subject to the RCRA. What resulted was Subtitle C of the RCRA, which provided stringent requirements for the management of hazardous waste, and Subtitle D, which covered 'special wastes' that would be managed through the application of less rigorous requirements.[338]

Due to the US EPA's proposal, Congress exempted exploration and production (E&P) wastes from the RCRA Subtitle C regulations pending a US EPA study and a determination by the US EPA:

> In 1988, [US] EPA issued a regulatory determination stating that control of E&P wastes under RCRA Subtitle C regulations is not warranted. Hence, E&P wastes have remained exempt from Subtitle C regulations [on the grounds that this waste was less toxic and posed less of a risk]. [339]

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[336] David Spence, 'Fracking Regulations: Is Federal Hydraulic Fracturing Regulation around the Corner?' above n 328, 3.

[337] Swarthmore College of Environmental Studies, *Natural Gas Drilling in the Marcellus Shale — Pollution* Swarthmore College <http://www.swarthmore.edu/x29634.xml>.

[338] David L Hippensteel, 'The RCRA Exemption for Oil and Natural Gas Exploration and Production Wastes — What You May Not Know' (1999) 6(2) *Environmental Geosciences* 106, 106–7.

[339] Office of Solid Waste, 'Exemption of Oil and Gas Exploration and Production Wastes from Federal Hazardous Waste Regulations' (Information Booklet No EPA530–K–01-004, United States Environmental Protection Agency, October 2002) 5 <http://www.epa.gov/osw/nonhaz/industrial/special/oil/oil-gas.pdf>. '[T]he exemption does not mean these wastes could not present a hazard to human health and the environment if improperly managed.': at 5.

E&P wastes have remained exempt from Subtitle C regulations. The wastes are classified under Subtitle D, even though the US EPA found up to 70 per cent of the wastes sampled in their 1988 study may potentially show signs of RCRA hazardous waste characteristics.[340]

The US EPA provided a number of reasons in defence of its decision, including that Subtitle C would impose considerable financial cost upon the industry, and that most state regulatory programmes already implemented were satisfactory.[341] More problematic is the full emergence of high volume slick water fracturing techniques, which had not occurred by 1988; therefore the US EPA had not studied the technique at the time it issued its determination, meaning:

> ... the [US] EPA has never directly studied whether the several million gallons of fracture solution injected into a well — some of which flow back up and must be disposed of — have hazardous characteristics and might merit reconsideration of the exemption.[342]

Furthermore, using 1985 data to determine the level of waste the oil and gas industry produced, the US EPA determined what it considered an appropriate regulatory approach, however:

> Considering the exponential growth of the oil and gas industry over the past 20 years, it is time regulators focus on the adequacy of existing regulations to protect human health and the environment from the real and potential dangers of the oil

[340] David L Hippensteel, above n 338, 106–7.

[341] See United States Environmental Protection Agency, 'Regulatory Determination for Oil and Gas and Geothermal Exploration, Development, and Production Wastes' (Notice of Regulatory Determination No 53 FR 25447, 6 July 1988) 26 <http://www.epa.gov/osw/nonhaz/industrial/special/oil/og88wp.pdf>.

[342] Hannah Wiseman, *A Review of Some Oil and Gas Exemptions from Environmental Regulation* (6 May 2011) Environmental Law Prof Blog <http://lawprofessors.typepad.com/environmental_law/2011/05/a-review-of-oil-and-gas-exemptions-from-environmental-regulation.html>.

and gas industry's waste.[343]

The US EPA has recognized that some of the waste might by hazardous, but rather than bringing the wastes under RCRA Subtitle C (with the US EPA also noting that there were 'gaps' in some of the state laws), the US EPA funded external initiatives such as the Interstate Oil and Gas Compact Commission (IOGCC), which was the catalyst for the development of such things as non-binding guidelines for improving state laws. Whether states adopt the guidelines is at their discretion.[344]

While the exemption means produced water, drilling fluids and hydraulic fracturing fluids ('fracking wastes') are unregulated pursuant to the country's primary federal hazardous waste law, the CWA fills some of the regulatory gaps through regulating the disposal of fracking wastes carried by water into streams, lakes and so forth. The *Hazardous Materials Transportation Act 1975* also assists with managing the gaps as it governs the transportation of hazardous chemicals that are added to the fracturing fluids.[345]

18.5 The Comprehensive Environmental Response, Compensation, and Liability Act

The *Comprehensive Environmental Response, Compensation, and Liability Act 1980* (CERCLA) (also known as the 'Superfund') regulates the clean-up of hazardous substance discharges, along with the location of hazardous storage, treatment and disposal sites. A fund, financed through taxes on the petrochemical industry, and fines and penalties imposed by the US EPA, provides the financial resources to

343 Renee Lewis Kosnik, 'The Oil and Gas Industry's Exclusions and Exemptions to Major Environmental Statutes' (Report, Oil & Gas Accountability Project, Earthworks, October 2007) 8 <http://www.earthworksaction.org/files/publications/PetroleumExemptions1c.pdf>.

344 Hannah Wiseman, above n 342.

345 David Spence, 'Fracking Regulations: Is Federal Hydraulic Fracturing Regulation around the Corner?' above n 328, 3; Office of Solid Waste, above n 339, 18. The exemption from Subtitle C does not mean that all wastes from an E&P site are exempt; rather to be 'exempt waste' it must have been 'generated from a material or process uniquely associated with the exploration, development, and production of crude oil and natural gas, though the interpretation and application of this regulatory criteria can be challenging.': at 18.

enable the clean-up, pursuant to the CERCLA, of incidents involving hazard substances. The aim is to hold parties associated with hazardous substances responsible for the cost of any clean-up resulting from an incident involving such substances.[346]

Shale gas production is not subject to CERCLA's requirements:

> Yet [the] CERLCA exempts these substances from liability requirements if they are found ... in natural gas production. Thus, hazardous chemicals that would otherwise be regulated under [the] CERLCA are immune from the statute.
>
> In addition, Superfund allows 'Potentially responsible Parties' to be held liable for clean-up costs for a release or threatened release of a 'hazardous substance.' But [the] CERLCA defines this term to exclude oil and natural gas.[347]

Consequently, those substances ever-present with shale gas are beyond the reach of the legislation, the implications being that industry's potential liability under CERCLA is possibly minimal to non-existent.[348]

It seems the shale gas industry will not be subject to the requirements of the CERCLA, not because of the manner in which the Act is applied, but because of how it is drafted. An unintended consequence of the exemptions (the absence of liability) is that producers may not undertake best practice to prevent incidents, or have the inducement to undertake clean-ups resulting from their activities.[349] Shale gas production is burgeoning, increasing the risk of an incident, yet the CERCLA is unlikely to be available. One salutary lesson from the 2010 Gulf of Mexico oil disaster (BP Deepwater Horizon) is that determining liability for a clean-up is a complex and drawn out affair. The complexity and length of time has implications for the environment, affected communities, government and industry. Is it conscionable to

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[346] JEA Consulting Group, above n 324, 2.

[347] Oil & Gas Accountability Project, 'Loopholes for Polluters — The Oil and Gas Industry's Exemptions to Major Environmental Laws' (Fact Sheet, Earthworks, 1 June 2011) <http://www.shalegas.energy.gov/resources/060211_earthworks_fs_oilgasexemptions.pdf>.

[348] JEA Consulting Group, above n 324, 3.

[349] Oil & Gas Accountability Project, above n 347.

have the natural gas industry exempt from the federal regulatory regime whose purpose is to fund the costs of industrial clean-ups?

18.6 National Environmental Policy Act

Congress enacted the *National Environmental Policy Act 1970* (NEPA) due to concern over the deteriorating human environment and the poor consideration of environmental impacts of large federal projects. The NEPA was the first major environmental law in the United States and is frequently called the 'Magna Carta' of environment laws.[350] The NEPA brought into being the United States' national environmental policies.

For the purposes of the NEPA, the human environment covers the:[351]

- Physical (geology, soils, air, water)
- Biological (plants, animals)
- Social (communities, economics), and
- Cultural (archaeological and historic resources).

The NEPA requires federal agencies to integrate environmental values into their decision-making processes through considering the environmental impacts of their proposals, along with identifying any possible alternative to what is being proposed. The Environmental Impact Assessment process is an important process available to federal agencies as it ensures that the requirements of NEPA are being met through improved decision-making and public participation.[352]

While the NEPA is intended to ensure that the environmental impacts of a proposed

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[350] Council on Environmental Quality, 'A citizen's Guide to the NEPA — Having Your Voice Heard' (Guidebook, Executive Office of the President of the United States, December 2007) 2 <http://ceq.hss.doe.gov/nepa/Citizens_Guide_Dec07.pdf>.

[351] Federal Emergency Management Agency, *National Environmental Policy Act — Description and Intent* (15 June 2012) <http://www.fema.gov/environmental-planning-and-historic-preservation-program/national-environmental-policy-act>.

[352] Council on Environmental Quality, above n 350, 2.

major federal project are appropriately considered, the *Energy Policy Act of 2005* amended the NEPA, including authorizing the BLM to issue permits to drill without site-specific environmental analysis; referred to as 'categorical exclusions', which are established pursuant to section 390 of the *Energy Policy Act of 2005*.[353]

Categorical exclusions are intended to simplify the environmental analysis required when approving projects, including oil and gas activities with the purpose of expediting production. Categorical exclusions are defined as actions that are deemed not to individually or cumulatively have a significant effect on the quality of the human environment. Examples of categorical exclusions include making minor facility renovations such as installing energy efficient lighting and trail maintenance.[354] A further example is 'Drilling an oil and gas well at a location or well pad site at which drilling has occurred previously within five (5) years prior to the date of spudding the well.'[355] Consequently such drilling is not subject to a rigorous environmental assessment or environmental impact statement, which the drilling would have been, but for the amendment.[356]

Categorical exclusions are gaining more attention, not just because the exclusions are seen as pro-industry, but also the Deepwater Horizon disaster in the Gulf of Mexico

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[353] For an explanation of categorical exclusions, see Nancy H Sutley, 'Establishing and Applying Categorical Exclusions Under the National Environmental Policy Act' (Memorandum for Heads of Federal Departments and Agencies, Council on Environmental Quality, Executive Office of the President of the United States, 18 February 2010) <http://ceq.hss.doe.gov/nepa/regs/Categorical_Exclusion_Draft_NEPA_Guidance_FINAL_02182010.pdf>; for an outline of the NEPA process, see Linda Luther, 'The National Environmental Policy Act: Streamlining NEPA' (CRS Report for Congress, Congressional Research Service, 9 January 2007) 5 <http://www.nationalaglawcenter.org/assets/crs/RL33267.pdf>.

[354] Council on Environmental Quality, above n 350, 10. 'Agencies develop a list of [categorical exclusions] specific to their operations when they develop or revise their NEPA implementing procedures in accordance with CEQ's NEPA regulations.': at 10.

[355] Minerals & Geology Management, 'Energy Policy Act of 2005 — Use Of Section 390 — Categorical Exclusions For Oil And Gas Activities' (Instructions, Forest Service, United States Department of Agriculture, 9 June 2010) 1 <http://www.fs.fed.us/geology/June_2010%20guidance%20Sec%20%20390%20CE.pdf>.

[356] Ibid 6.

was approved under an exclusion 'following reviews that concluded a massive oil spill was unlikely'.[357]

Questions regarding the BLM's use of categorical exclusions have been raised, leading to the non-partisan United States Government Accountability Office (GAO) undertaking a study on the subject and subsequently publishing a report in September 2009. The GAO not only found violations of the law but in 85 per cent of the BLM field offices sampled, officials failed to follow guidance correctly, mostly through inadequate justification of why a categorical exclusion was being used.[358] Given GAO's analysis showed that categorical exclusions were used to approve almost 6,900 oil-and-gas-related activities from the fiscal year 2006 through to the fiscal year 2008, with 6,100 of these being used for drilling permits, it is possible that a number of these activities should have been subject to NEPA's requirements as opposed to the 'fast track' process of a categorical exclusion. In response to the GAO's recommendations, the BLM took steps to standardize its decision documentation and generally address the gaps and deficiencies detected by the GAO. However, court proceedings initiated by a pro-industry alliance challenging the BLM's procedures for developing and implementing the recommendations were successful and an injunction was issued. The Court's decision, in effect, prevented the BLM from progressing the recommendations at this time.

Categorical exclusions remain highly contentious. As recently as February 2013 the United States Court of Appeals, Ninth Circuit, heard an appeal on whether BLM's use

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357 Natural Resources Planning and Management, 'Categorical Exclusion under the National Environmental Policy Act (NEPA)' (White Paper, CH2M, June 2011) 1 <http://www.ch2m.com/corporate/services/environmental_management_and_planning/assets/Abstracts/2011/CH2M-HILL-categorical-exclusion.pdf>. For a useful analysis of categorical exclusions and the usefulness of environmental assessments see: Sonja Klopf, Nada Wolff Culver and Pete Morton, 'A Road Map to a Better NEPA: Why Environmental Risk Assessments Should Be Used to Analyze the Environmental Consequences of Complex Federal Actions' (2007) 8(1) *Sustainable Development Law & Policy Journal* <http://digitalcommons.wcl.american.edu/cgi/viewcontent.cgi?article=1155&context=sdlp>.

358 United States Government Accountability Office, 'Energy Policy Act of 2005 — Greater Clarity Needed to Address Concerns with Categorical Exclusions for Oil and Gas Development under Section 390 of the Act' (Report to Congressional Requestors No GAO-09-872, 16 Sep 2009) 1 <http://www.gao.gov/assets/300/295281.pdf>.

of the exclusion to permit a mining company to restart operations, after a 17 year hiatus, under an operations plan BLM approved in 1988, was lawful.[359] The Court held: 'In sum, we conclude that BLM's invocation of the categorical exclusion was not arbitrary and capricious or otherwise not in accordance with law'.[360] The decision demonstrates that the Court adopted an expansive view of what can be excluded, even though the view may be at odds with what was originally contemplated when NEPA was enacted.

19 State regulation of shale gas production — the United States

19.1 An overview of the United States

While the Federal Government exempts hydraulic fracturing activity[361] from the regulatory ambit of the SDWA, the states may regulate the practice as they deem appropriate: 'Despite Congress's power to regulate hydraulic fracturing activities under the Commerce Clause of the US Constitution, regulation of the technology and of the oil and gas industry in general is largely left to the states.'[362]

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[359] Waste Information & Management Services, *Environmental Decisions from US Court of Appeals, all Circuits — Summary — Center for Biological Diversity v. Salazar (DOI/BLM)* (5 February 2013) <http://environmentalappealscourt.blogspot.com.au/2013_02_05_archive.html>.

[360] Ibid.

[361] Renee Lewis Kosnik, above n 343, 9 (except that involving diesel, and whether to regulate diesel is at the US EPA's discretion — see Section 18.3.1, 'The SDWA and underground injection control').

[362] William J Brady, 'Hydraulic Fracturing Regulation in the United States: The Laissez-Faire Approach of the Federal Government and Varying State Regulations' (Paper, Sturm College of Law, University of Denver, 2012) 3 <http://www.law.du.edu/documents/faculty-highlights/Intersol-2012-HydroFracking.pdf>. The industry is exempted from a number of significant federal environmental statutes, such as: the Safe Drinking Water Act; the Resource Conservation and Recovery Act; the Clean Water Act; the Clean Air Act; the Comprehensive Environmental Response, Compensation, and Liability Act; National Environmental Policy Act. Many of the exemptions result from the Energy Policy Act of 2005.

While state and industry regulatory initiatives initially concentrated on managing wells to achieve optimal production and resolving mineral entitlements issues, over the years they have been adapted to reflect environmental concerns; the protection of water resources during hydraulic fracturing is an example.[363]

Producers generally prefer local regulatory oversight, particularly hydraulic fracturing, to federal jurisdiction, because it allows the local regulator to tap into the local expertise of the workforce, acquire a better understanding of the geological character of the state, and share practices and regulatory approaches through the industry coalition named STRONGER.[364]

The degree of involvement of the states in regulating shale gas production reflects the following considerations:[365]

- The states have a comprehensive understanding of the conditions relating to their territory and area such as geology, hydrology, geography and climate

- There is regulatory immediacy, where the close proximity of the regulatory agency permits timely site inspections, the ability to maintain a watch over operations, regulatory enforcement, and the identification of areas for regulatory reform, and

- There are substantial differences in the regulatory requirements between states due to a number of factors, including geology, and proximity to populated areas and water sources, meaning a 'one size fits all' approach

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363 Mary Tiemann and Adam Vann, above n 299, 30.

364 STRONGER (State Review of Oil and Natural Gas Environmental Regulations) is an initiative of the Interstate Oil and Gas Compact Commission (IOGCC). Aaron Mintzes, *Debate over Fracking Regulation Looms Large in the US Senate* (21 October 2011) Earthworks <http://www.earthworksaction.org/earthblog/detail/debate_over_fracking_regulation_looms_large_in_the_us_senate#.UcF9dnWQ994>.

365 ConocoPhillips Natural Gas 'Onshore US Oil and Natural Gas Regulation' (Fact Sheet, December 2012) <http://www.powerincooperation.com/EN/Documents/11-4117%20NatGasFact-Regulations.pdf>.

imposed upon the states would not be appropriate.[366]

The IOGCC supports state regulation on the basis the states are best suited to regulate hydraulic fracturing as each state has the same concern to protect water as the Federal Government but are appropriately situated to take into account the challenges posed by the geological and hydrological structures presented by the state. The state can then implement an appropriate regulatory response.[367] The IOGCC member states have each developed ways to ensure safe operations to protect drinking water sources, and have trained personnel to effectively regulate production. Supplementing the state initiatives, the IOGCC's resolution of January 2009 implored Congress to retain the exemption of hydraulic fracturing from the SDWA.[368] Regulation of gas production, including hydraulic fracturing, has traditionally been the territory of the states, and, in the opinion of the IOGCC, the SDWA was never intended to give to the Federal Government the authority to regulate gas production, like the hydraulic fracturing under the UIC program.[369]

19.2 Texas — a specific overview of a state's regulation

Without federal statutes the regulation of shale gas production is largely left to the states. When they have the responsibility to regulate, the states have taken steps to regulate relevant practices, such as the process for obtaining permits for drilling. These have led to variations between states. There is debate whether the steps are adequate to protect water resources and population health and, if they are not, whether the Federal Government should take over.[370] The debate may (at least

[366] Mark Zoback, Saya Kitasei and Brad Copithorne, above n 101, 13.

[367] Interstate Oil and Gas Compact Commission, *Hydraulic Fracturing — State Regulation* <http://www.iogcc.org/hydraulic-fracturing>.

[368] Interstate Oil and Gas Compact Commission, *2009 Resolutions — Resolution 09.011* <http://www.iogcc.org/2009-resolutions#HF>.

[369] Interstate Oil and Gas Compact Commission, *Hydraulic Fracturing — State Regulation* above n 367.

[370] Robin Kundis Craig, 'Hydraulic Fracturing (Fracking), Federalism, and the Water-Energy Nexus' (2103) 49 *Idaho Law Review* 1, 19–20 <http://www.uidaho.edu/~/media/Files/orgs/Law/law-review/2013-symposium/Fracking-Federalism-and-the-Water-Energy-Nexus.ashx>.

partially) be out of concern that some states, like Texas, consider that their current regulation of conventional gas is largely fit to meet the challenges of shale gas production. Texas' regulator, the Texas Railroad Commission (TRC), believed that nothing else was needed:

> … such as disclosing chemicals used in fracking operations, environmental requirements such as disclosing chemicals used in fracking operations, environmental assessments of proposed frack jobs, or consideration of wild-life-related impacts [the TRC] officials insist that fracking operations are safe, adding the caveat that no documented evidence exists of groundwater contamination …[371]

Texas has had a history of oil and gas production since 1901 and maintained its position as one of the largest producers in the world. The TRC regulates, among other things, the exploration, production, and transportation of natural gas, including shale gas. Its mandate originates from statute, which provides the TRC with the authority to prevent the wastage of Texas' natural resources, protect the correlative rights of different interest owners, prevent pollution, and provide safety in matters such as chemical compounds. The TRC does not have jurisdiction over a number of areas, which are closely linked to the activities of shale gas production, meaning the regulatory regime is not integrated. The TRC, for example, has no jurisdiction over:

- Roads and traffic use; rather jurisdiction belongs to relevant independent authorities which have the authority to issue applicable ordinances. The construction and maintenance of state highways are the responsibility of the Department of Transport, including the issuing of access permits to well sites from a roadway connected to the state highway system

- Noise or nuisance issues, which are administered by local ordinances, and

- Odours and air contaminants. There is a separate agency, called the Texas Commission on Environmental Quality, that has jurisdiction, and, if a well is within city limits, the city has the authority to enact ordinances to address the

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[371] Charles Davis,' The Politics of "Fracking": Regulating Natural Gas Drilling Practices in Colorado and Texas' (Western Political Science Association 2011 Annual Meeting Paper, Department of Political Science, Colorado State University19 April 2011) 6 <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1766675>.

problem.[372]

The TRC's jurisdiction regarding city limits can be contrasted with Colorado, where the Fort Collins City Council voted in February 2013 to give initial approval to an ordinance prohibiting all oil and gas exploration activity in the city, including hydraulic fracturing.[373] Aggrieved parties will not have to rely upon the city authorities or other third parties, as is the case in Texas, to issue an ordinance for the prohibition of specific activity (such as noise pollution).

The TRC has a number of regulatory processes relating to drilling, environmental issues, injection-storage, reporting, and financial assurance.[374] It also has a compliance and enforcement program, which includes inspections, violations, and complaint management. Generic information regarding the results of the program is posted on the TRC's website.[375]

Enforcement seems to be a challenge for the TRC. In November 2011 it was reported that the enforcement data showed that there were 80,000 violations by the oil and gas drillers of which 96 per cent did not lead to enforcement action.[376] Along with other large drilling states, when it came to fines imposed by the TRC 'only a small percentage of violations result in fines, and the fines that are levied often amount to

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[372] Railroad Commission of Texas, *Barnett Shale Information* (22 May 2013) <http://www.rrc.state.tx.us/barnettshale/index.php>.

[373] Kevin Duggan, *Fort Collins Council Backs Ban on Fracking* (19 February 2013) Coloradoan.com <http://www.coloradoan.com/article/20130219/NEWS01/302190039/Fort-Collins-council-backs-ban-fracking?gcheck=1>.

[374] Railroad Commission of Texas, *Surface Waste Management Manual — Application for a Permit to Discharge of Hydrostatic Test Water* <http://www.rrc.state.tx.us/forms/publications/SurfaceWasteManagementManual/hydrostatictestwater1change.php>.

[375] Railroad Commission of Texas, *Compliance & Enforcement* <http://www.rrc.state.tx.us/compliance/index.php>.

[376] Mike Soraghan, 'Oil and Gas: Puny Fines, Scant Enforcement Leave Drilling Violators with Little to Fear' (Online Article, E&E Publishing, 14 November 2011) <http://www.eenews.net/public/Greenwire/2011/11/14/1>.

little more than a rounding error for billion-dollar companies.'[377]

While other states have taken steps to manage the challenges of shale gas production, Texas' efforts have, until recently, been relatively modest, even though it is claimed:

> The Railroad Commission of Texas … has been successfully regulating oil and gas drilling and production operations in the state for over 100 years. These comprehensive laws and regulations provide for safe operations and protect the state's surface and ground water resources.[378]

In November 2011 a review of the TRC led to a number of recommendations to address the problems identified. The recommendations were intended to reposition the organization, enabling it to provide effective oversight of the oil and gas industry, along with providing essential restructuring of the TRC, including its governance arrangements. The report stated that although many different approaches to this end existed, the recommendations were designed to provide the opportunity to address the problems identified that related to governance and organizational structure, so that the TRC could be ready to discharge its duties with vigour.[379]

In December 2011 the TRC adopted the Hydraulic Fracturing Chemical Disclosure Rule,[380] which sets out disclosure requirements for those in the 'production chain' of hydraulic fracturing. However, there is no requirement to disclose trade secret information unless the Attorney General or court thinks otherwise. A trade secret is any 'formula, pattern, device, or compilation of information that is used in a person's

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[377] Ibid.

[378] Groundwork, *Texas State Progress: Shale Gas* Interstate Oil and Gas Compact Commission <http://groundwork.iogcc.org/content/texas-state-progress-shale-gas>.

[379] Sunset Advisory Commission, 'Final Report — Railroad Commission of Texas' (Report, July 2011) 2 <http://www.sunset.state.tx.us/82ndreports/rct/rct_fr.pdf>; see also Sunset Advisory Commission, 'Staff Report — Railroad Commission of Texas' (Report, November 2012) <http://www.sunset.state.tx.us/83rd/RC/RC_SR.pdf>. The Sunset Advisory Commission examined a number of issues and arrived at its findings. One finding was: 'While the Commission has recently adopted penalty guidelines and is field testing changes to its enforcement policies, these changes are too new to evaluate their impact and statutory direction is still needed to ensure these efforts continue in the future': at 31

[380] 16 TEX. ADMIN. CODE § 3.29(b).

business, and that gives the person an opportunity to obtain an advantage over competitors who do not know or use it.'[381]

On 26 March 2013 the TRC issued new rules that are intended to promote the conservation of water used in hydraulic fracturing through eliminating regulatory 'hurdles'. The chairman of the TRC commented: 'By removing regulatory hurdles, these new amendments will help foster the recycling efforts by oil and gas operators who continue to examine ways to reduce freshwater use when hydraulically fracturing well [sic].'[382]

The following quote from a Texas Supreme Court provides an insight to Texas' (and the TRC's) general position to regulating fracturing:

> Though hydraulic fracturing has been commonplace in the oil and gas industry for over sixty years, neither the Legislature nor the Commission has ever seen fit to regulate it, though every other aspect of production has been thoroughly regulated. Into so settled a regime the common law need not thrust itself. Accordingly, we hold that damages for drainage by hydraulic fracturing are precluded by the rule of capture.[383]

While the TRC's attempts to regulate shale gas production may be light handed, anti-federal and imperfect, it implies that federal involvement is not central to a framework.

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[381] Poe Legette et al 'Trade Secrets and the Regulation of Hydraulic Fracturing — Toward a Global Perspective' (Guide, Norton Rose and Fullbright & Jaworski, April 2013) 12 <http://www.nortonrosefulbright.com/files/us/images/publications/20130410TradeSecretsAndTheRegulationOfHydraulicFracturing.pdf>.

[382] Railroad Commission of Texas, 'Railroad Commission Today Adopted New Recycling Rules to Help Enhance Water Conservation by Oil & Gas Operators' (News Release, 26 March 2013) <http://www.rrc.state.tx.us/pressreleases/2013/032613.php>.

[383] In the Supreme Court of Texas, No. 05-0466, *Coastal Oil & Gas Corp. and Coastal Oil & Gas USA, L.P., Petitioners, v. Garza Energy Trust et al.*, Respondents, On Petition for Review from the Court of Appeals for the Thirteenth District of Texas (Argued September 28, 2006) <http://www.supreme.courts.state.tx.us/historical/2008/aug/050466.htm>.

20 Local regulation of shale gas production — United States

While federal and state regulation has a critical role in the regulation of shale gas, additional regulation at local government level may be applied to development, depending upon the location. Development proposed near a city or tribal land is likely to attract permitting and approval conditions that supplement federal and state regulatory requirements, with the purpose of protecting the environment and general wellbeing of affected communities. It is not unusual for local governments to have ordinances that regulate a number of factors, such as the placing of wells in flood zones, setbacks from residential sites, and noise restrictions.[384]

Not all states empower local governments to be involved in the regulation of shale gas production. Local governments may be restricted in their involvement. The State Government of North Carolina prohibits local governments from regulating the key practices of shale gas production (such as horizontal drilling and the injection of wells). Local governments do not possess inherent authority; instead they may only exercise powers delegated to them by the State General Assembly. Consistent with the State of North Carolina's prohibition on regulating key practices, the General Assembly has not explicitly granted regulatory authority to local governments for shale gas production. However, local governments have been granted 'health, safety and welfare' ordinance-making authority.[385]

In the State of Pennsylvania matters have played out a little differently. After having

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384 For example, the following ordinance was established to account for some of these factors: see Fort Worth, Texas Ordinance Number 16986-06-2006 <http://fortworthtexas.gov/uploadedFiles/City_Secretary/City_Council/Official_Documents/2006_Ordinances/16986-06-2006.pdf>; for an explanation of local regulation in the United States (including federal and state law) see J Daniel Arthur, Bruce Langhus, and David Alleman, 'An Overview of Modern Shale Gas Development in the United States', (Paper, ALL Consulting, 2008) 13 <http://www.all-llc.com/publicdownloads/ALLShaleOverviewFINAL.pdf>.

385 Styers, Kemerait & Mitchell, *Legal Updates — State versus Local Regulation of Shale Gas Development* (17 March 2012) <http://www.styerskemerait.com/2012/03/state-versus-local-regulation-of-shale-gas-development/>.

local governments actively drafting ordinances that reflect their local conditions and expectations, state legislation[386] came into force in February 2012 limiting the capacity of local government to regulate oil and gas activity. The legislation also created an impact fee on gas extraction (with some of the proceeds going to the local authorities) from unconventional horizontally drilled or hydraulically fractured wells. Limiting local government was sought by the industry as a concession for accepting the impact fee. The legislation replaces all local regulation of oil and gas, except flood plain management, and bans localities from imposing their own regulations on gas operations that are stricter than those imposed on other industries.[387]

The approaches adopted by North Carolina and Pennsylvania have the potential to add uncertainty to an already complex matter. Can their local governments still be involved in shale gas production and, if they can, to what extent? The uncertainty arises because the local governments still retain some powers, meaning the distinction between the state's powers and that of the local may not be clear in practice. In North Carolina, local governments have powers relating to health, safety and welfare. Which interests should prevail, and to what extent, should there be a threat to health, safety or welfare arising from shale gas production? Can the state regulate on the grounds it relates to shale gas, even though the threat is one that the local governments have the mandate to regulate? Similarly, in Pennsylvania, a production site and a flood plain could coalesce. Could the regulatory demarcation between state government and local governments become problematic, undermining the ability of public officials to manage risks effectively?

21 Regulation of shale gas production — Western Australia

The DMP is Western Australia's lead state government agency for mining, petroleum

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[386] The General Assembly of Pennsylvania House Bill No. 1950, Session of 2011 Report of the Committee of Conference Amending Title 58 (Oil And Gas) of the Pennsylvania Consolidated Statutes
<http://www.legis.state.pa.us/CFDOCS/Legis/PN/Public/btCheck.cfm?txtType=PDF&sessYr=2011&sessInd=0&billBody=H&billTyp=B&billNbr=1950&pn=3048>.

[387] Styers, Kemerait & Mitchell, above n 385.

and geothermal projects. The DMP is responsible for regulating the resources industry in Western Australia:[388] '[the] DMP's role is to ensure the highest levels of safety, health and environmental standards are achieved in accordance with State and Australian Government legislation, regulations and policies.'[389]

The DMP states that research on unconventional gas shows there is about twice as much unconventional gas available onshore in Western Australia than there is conventional gas offshore — meaning Western Australia holds the fifth largest

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[388] Department of Mines and Petroleum, *About DMP* (3 September 2009) Government of Western Australia <http://www.dmp.wa.gov.au/8494.aspx>. The web site states that the responsibilities of the Petroleum Division are to [quoting]:

- Encourage and facilitate responsible exploration, development and production of petroleum resources and other energy sources
- Administer and control petroleum exploration and production in accordance with the various Petroleum Acts and the directions pertaining to those Acts
- Administer and negotiate future act Native Title Act 1993 (Cth) requirements for petroleum title applications under State legislation
- Engage with the petroleum industry on matters pertaining to Aboriginal cultural heritage and Reserve land issues
- Coordinate with State Departments and industry
- Make available areas for exploration and make recommendations on the grant, renewal or cancellation of permits and licences
- Evaluate all technical matters relating to drilling, formation evaluation, reservoir engineering, and production in accordance with good oilfield practice
- Advise on exploration evaluation and assess all permit and work applications.

Department of Mines and Petroleum, *Petroleum Service — Overview* (27 March 2008) Government of Western Australia <http://www.dmp.wa.gov.au/3816.aspx>.

[389] Department of Mines and Petroleum, *Shale and Tight Gas in Western Australia — Legislation* (23 May 2013) Government of Western Australia <http://www.dmp.wa.gov.au/16970.aspx>.

reserves in the world.[390]

The nature of Western Australia's unconventional reserves and the local conditions mean it is likely that production will be less problematic (in the sense of its impact on human activities) for the State to commercialize its gas resources than other areas in Australia. The Western Australian Environmental Protection Authority (WA EPA) believes the situation is very different to that of the eastern states. The latter are predominantly commercializing coal seam gas; in contrast, Western Australia holds reserves of shale (and tight) gas.[391] The WA EPA considers that shale and tight gases are generally 2000 metres or more below the ground surface, this being at least double the distance of coal seam gas: 'The greater depth of gas resources in Western Australia limits the potential for fracking to interfere with water supplies, which are typically drawn above 1000 metres.'[392]

This assertion is based upon three assumptions:

- Should the drilling penetrate an aquifer (for example, at 1000 metres) as the drilling journeys to the shale gas at 2000 metres, there is no contamination possible
- The well is properly sealed, and
- The knowledge of the aquifers is such that all practicable steps can be taken to prevent water contamination.

The likelihood of Western Australia establishing a commercial shale gas industry is

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[390] Fiona Melville, 'Australia Shale Gas Issues Paper' (Paper, K&L GATES LLP, 1 November 2012) <http://www.klgates.com/australia-shale-gas-issues-paper/>. There is some conjecture regarding the estimates, therefore caution is required when reliance is being placed upon them.

[391] Western Australian Environmental Protection Authority, *An Unconventional* Technology Government of Western Australia <http://www.epa.wa.gov.au/AbouttheEPA/EPAnews/Pages/Anunconventionaltechnology.aspx>.

[392] Ibid.

due to a number of factors, including:[393]

- The increased price of conventional gas
- An increased interest in reducing carbon emissions (based upon the assumption that shale gas produces fewer emissions than conventional gases)[394]
- An increasing demand from Asia (with Western Australia already exporting LNG there), and
- The concern that CSG production is occurring on arable land in relatively densely populated regions in the eastern states.

In 2011 a strategic energy paper was published to help inform Western Australia's longer-term approach to energy management. The report noted that unconventional gas could potentially diversify the State's gas supply, with the south west possibly holding enough gas to meet most of the State's needs. However, current industry activity is low, and substantial development of the industry is needed, if there is to be adequate diversification.[395]

22 Federal regulation — Western Australia

Western Australia has very modest Federal (Commonwealth) Government involvement in the regulation of shale gas production. The industry is in its early stages (unlike CSG in the eastern states), so currently there is little need for government involvement. Like other Australian states, Western Australia manages and allocates petroleum resources rights, has the primary responsibility for land

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[393] Fiona Melville, above n 390.

[394] See Chapter 5.4, 'A bridging or permanent role, and greenhouse gases'.

[395] Office of Energy 'Energy 2031 — Strategic Energy Initiative Directions Paper — A Smarter Energy Future for West Australians' (Directions Paper, Government of Western Australia, March 2011) 31 <http://www.parliament.wa.gov.au/publications/tabledpapers.nsf/displaypaper/3813100cb1e5bc616f7914cc48257855000f71a1/$file/3100-15.03.11.pdf>.

administration, and regulates operations, including environmental.[396]These circumstances mean the State Government of Western Australia has the primary role in determining its regulatory regime.

22.1 The Commonwealth Environmental Protection and Biodiversity Conservation Act 1999

Legislation that is likely to interface with the State's regulatory requirements for shale gas production is the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act).

The Australian Federal Government describes the EPBC Act as providing the Australian (Federal) Government a way to link other state governments and territories through the establishment of an overarching national scheme which focuses upon the protection of environmental and heritage interests, including the preservation of biodiversity:

> The EPBC Act focuses Australian Government interests on the protection of matters of national environmental significance,[397] with the states and territories having responsibility for matters of state and local significance.[398]

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[396] Ministerial Council on Mineral and Petroleum Resources, 'Mineral and Petroleum Exploration & Development in Australia — Roles and Responsibilities of Government — Guide For Investors' (Leaflet No 5, Australian Government) <http://www.ret.gov.au/resources/Documents/Minerals%20and%20Petroleum%20Exploration/Guide_for_%20Investors_5Government.pdf>.

[397] The eight matters of national environmental significance to which the EPBC Act applies are: world heritage sites, national heritage places, wetlands of international importance, nationally threatened species and ecological communities, migratory species, Commonwealth marine areas, the Great Barrier Reef Marine Park, and nuclear actions. Department of Sustainability, Environment, Water, Population and Communities, 'EPBC Act — Frequently Asked Questions' (Fact Sheet, Government of Western Australia, November 2010) 1 <http://www.environment.gov.au/epbc/publications/epbc-act-fact-sheet.html>.

[398] Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) *About the EPBC Act* (17 August 2011) Government of Western Australia <http://www.environment.gov.au/epbc/about/index.html>.

Under the EPBC Act it is the proponent who has the responsibility for determining whether its plans require referral to the Commonwealth Department of Sustainability, Environment, Water, Populations and Communities (SEWPAC).

The *Petroleum (Environment) Regulations (2012)* (Western Australia)[399] require that all submissions of an environmental plan (EP)[400] must contain a list of all legal, environmental and other requirements that apply to an activity. An EP includes state and federal legislation that is relevant to the submission.[401]

23 State regulation of shale gas production — Western Australia

> Unconventional petroleum exploration in WA is still in its infancy, but given the prospect of a significant up-tick [sic] in exploration … we expect there will be considerable public interest in (and scrutiny of) the industry. As such, stakeholders should familiarise themselves with the regulatory framework …[402]

The Western Australia Government has recognised that the State's regulatory regime needs to account for unconventional gas production. The Government has implemented a number of activities intended to achieve the necessary regulatory changes. The DMP commissioned an independent review of the current regulatory regime, and this lead to a number of recommendations which the DMP substantially adopted. The review and its outcomes are discussed below. The WA EPA issued a bulletin to convey to the DMP and industry its stance on applicable environmental

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399 Refer to Section 23.3, 'Regulatory review and reform'.

400 See Sub-Chapter 23.4, ' The Environmental Plan'

401 See Stan Bowes et al, 'Guidelines for the Preparation and Submission of an Environment Plan' (Guidelines Document, Department of Mines and Petroleum, Government of Western Australia, 28 August 2012) 28 <http://www.dmp.wa.gov.au/documents/ENV-PEB-177.pdf>. This document lists and provides access to Western Australian legislation that might apply.

402 Hedley Roost, 'The Regulation of Unconventional Petroleum Exploration and Production in Western Australia' (Online Article, Corrs, Chambers, Westgarth Lawyers, 15 May 2013) <http://www.corrs.com.au/publications/corrs-in-brief/the-regulation-of-unconventional-petroleum-exploration-and-production-in-western-australia/#ft12>.

matters.[403] Finally, the DMP has established an interagency working group to promote a coordinated and a thorough approach to onshore regulation.[404]

23.1 Petroleum and Geothermal Energy Act (1967)

The *Petroleum and Geothermal Energy and Resources Act (1967)* (Western Australia)[405] (PGERA) provides the regulatory basis for petroleum exploration and production onshore, and accordingly provides the statutory requirements for the drilling of unconventional gas wells, the granting of production licences, and the registration of titles. The PGERA's role can be described as providing the regulatory framework for all onshore oil and gas exploration and production within Western Australia.[406] Unconventional gas, including shale gas, is therefore regulated under the PGERA.

> All onshore petroleum proposals (proposals) in Western Australia are assessed by the Department of Mines and Petroleum (DMP) under the Petroleum and Geothermal Energy Resources Act 1967. This includes proposals for natural gas from shale and tight rock formations. [407]

The PGERA is complemented by a number of regulations, collectively referred to as the 'Petroleum (Environment) Regulations' and implemented as a result of DMP implementing regulatory reform.[408]

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[403] Western Australia Environmental Protection Authority, 'Hydraulic Fracturing of Gas Reserves' (Environmental Protection Bulletin No 15, Government of Western Australia, September 2011) <http://edit.epa.wa.gov.au/EPADocLib/EPB%2015%20Fracking%20050911.pdf>.

[404] Hedley Roost, above n 402.

[405] For a summary of the full DMP process relating to petroleum and environment regulations, see Department of Mines and Petroleum, 'Petroleum Fact Sheet — Environment Regulations' (Fact Sheet, Government of Western Australia, May 2013) <http://www.dmp.wa.gov.au/documents/Petroleum_environment_regulations(1).pdf>.

[406] Stan Bowes et al, above n 401, 7.

[407] Department of Mines and Petroleum, 'Petroleum Fact Sheet — Environment Regulations' above n 405.

[408] The reform is discussed in Section 23.3, 'Regulatory review and reform'.

23.2 Environmental Protection Act (1986)

Section 38 of the *Environmental Protection Act 1986* (EP Act),[409] provides for a referral process between the DMP and the WA EPA regarding developmental proposals that are likely, if implemented, to have a significant impact on the environment. The EP Act provides that the WA EPA may assess a development proposal to determine whether it should undergo an environmental impact assessment under the EP Act before the proposal can proceed.[410] Assessment reports under section 38 of the EP Act, prepared for the relevant Minister, are published by the Minister within a specified date.[411]

A Memorandum of Understanding (MOU)[412] between the DMP and the WA EPA is in place. It is intended to promote the establishment of efficient and transparent processes for the referral of appropriate proposals to the WA EPA pursuant to the EP Act.[413] The MOU provides guidance for determining whether the DMP is required to refer the proposal.[414] The MOU does not take precedence over the requirements of the EP Act as the WA EPA does not relinquish its powers relating to environmental assessments; meaning the WA EPA is legally entitled to assess any proposal that it

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[409] Being within Part IV of the EP Act (Environmental impact assessment), which deals with referrals by decision-making authorities (DMA).

[410] For an introduction regarding the EP Act, see Environmental Defender's Office of Western Australia (Inc), 'Environmental Impact Assessment in Western Australia' (Fact Sheet No 5, February 2011) <http://www.edowa.org.au/files/factsheets/pdc_eiawa.pdf>.

[411] Section 44 EP Act.

[412] Memorandum of Understanding between the Department of Mines and Petroleum (Richard Sellers, Director General) and the Environmental Protection Authority (Paul Vogel, Chairman) in relation to the referral of Mineral and Petroleum (Onshore and Offshore) and Geothermal Proposals (26 June 2009) <http://edit.epa.wa.gov.au/EPADocLib/EPA-DMP-MOU.pdf>.

[413] Ibid 1.

[414] Ibid 4.

considers is within its jurisdiction.[415]

23.3 Regulatory review and reform

An independent report was commissioned by the DMP into the robustness of the current regulatory framework for unconventional gas. The report made a number of recommendations,[416] including that the DMP:[417]

1. Develop an approach (based on best practice) for the management of produced water from fracturing
2. Develop a strategy that includes a produced water management plan
3. Provide for the transparent disclosure of all chemicals used in the fracking operations
4. Write environmental regulations for onshore petroleum activities (to ensure the enforceability of the environmental management plan), and
5. Write resource regulations for onshore petroleum activities.

In late October 2011 the DMP formally responded to the report.[418] The DMP accepted many of the recommendations, and regulations were implemented. The *Petroleum (Environment) Regulations 2012* (Western Australia) built upon the

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[415] See Schedule 2, Criteria For Referral Of Onshore Petroleum Activities, ibid 8, as an alternative to section 38(5) EP Act as these schedule provide 'prompts' where the DMP is to liaise with the EPA.

[416] Tina Hunter, 'Regulation of Shale, Coal Seam and Tight Gas Activities in Western Australia (Report, Faculty of Law, Hunter University, 2011) <http://www.dmp.wa.gov.au/documents/000041.jason.medd(1).pdf>.

[417] Ibid 3–5.

[418] Department of Mines and Petroleum, 'Department of Mines and Petroleum Response to Report: "Regulation of Shale, Coal Seam and Tight Gas Activities in Western Australia"' (Report, Government of Western Australia, 31 October 2011) <http://www.dmp.wa.gov.au/documents/DMP_Response_to_Report.pdf>.

recommendations of the independent report[419] and complement the PGERA.

The purpose of these regulations is to ensure that: [420]

- Any petroleum or geothermal activity in the State is carried out in a manner consistent with the principles of ecologically sustainable development, and in accordance with an EP that:
    - Demonstrates the environmental impacts and risks of the activity will be reduced to as low as reasonably practicable; and
    - Has appropriate environmental performance objectives and environmental performance standards, and
- There are appropriate criteria for determining whether the objectives and standards have been met.

There are three regulations known as the 'Petroleum (Environment) Regulations', and, of these, the *Petroleum and Geothermal Energy Resources (Environment) Regulations 2012* (Western Australia) are likely to have the most bearing on onshore shale gas production.[421]

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[419] Corrs Chambers Westgarth, Lawyers, *An Emerging New World for the Environmental Regulation of Unconventional Gas Projects in Western Australia* (3 September 2012) <http://www.corrs.com.au/publications/corrs-in-brief/an-emerging-new-world-for-the-environmental-regulation-of-unconventional-gas-projects-in-western-australia/>.

[420] Department of Mines and Petroleum, 'Release of new state Petroleum Environment Regulations and Guidelines' (Notice, Government of Western Australia, 28 August 2012) <http://www.dmp.wa.gov.au/documents/ENV-PEB-179.pdf>.

[421] The regulations being: (1) *Petroleum and Geothermal Energy Resources (Environment) Regulations 2012* (Western Australia); (2) *Petroleum (Submerged Lands) (Environment) Regulations 2012* (Western Australia); and (3) *Petroleum Pipelines (Environment) Regulations 2012* (Western Australia). *Petroleum and Geothermal Energy Resources (Environment) Regulations 2012* (Western Australia) comprises: (a) *Petroleum and Geothermal Energy Resources Act 1967* (PGERA), which establishes the regulatory framework for petroleum exploration and production onshore (including the internal waters of Western Australia*); (b) Petroleum (Submerged Lands) Act 1982* (PSLA), which establishes the regulatory framework relating to the exploration and production of petroleum resources

The DMP views the Petroleum (Environment) Regulations as advancing the regulatory processes for onshore gas projects in the sense that:

> The new regulations ensure petroleum and geothermal operations (including unconventional gas activities) are carried out in accordance with best industry practice, and provide a more robust, enforceable and transparent regulatory framework.[422]

The DMP also reports that, through the EPs, the Petroleum (Environment) Regulations allow for a risk-based approach to be used for regulating the environmental performance of the petroleum industry.[423]

The focus of the Petroleum (Environment) Regulations has a number of objectives, such as ensuring that activities undertaken are done so (where applicable)[424] consistently with the principles of ecologically sustainable development (ESD) and pursuant to an EP, which is required to ensure that environmental impacts and risks arising from the activities are going to be reduced to as low as reasonably practicable (ALARP). 'Practicality' is seen as something that evolves in due course 'as technology, best practice and expertise improve.' [425]

23.4 The Environmental Plan

The EP is seen as a flexible document, reflecting the nature of what is being proposed and thereby avoiding a 'one size fits all' approach. Producers can use the EP to inform themselves with what is required to ensure the activities are consistent with the regulator's expectations.

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located within the Western Australian marine waters (including associated pipelines infrastructure); and (c) *Petroleum Pipelines Act 1969* (PPA), which establishes the regulatory framework for the construction, operation and maintenance of pipelines for the transportation of petroleum in areas that PGERA covers.

[422] Department of Mines and Petroleum, *Shale and Tight Gas in Western Australia — Legislation* above n 389.

[423] Stan Bowes et al, above n 401, 8.

[424] Ibid 7.

[425] Ibid 8.

The EP adopts the ESD principles (1992) of the Council of Australian Governments (COAG). The DMP believes the principles 'encourage[s] continuous improvement in environmental performance and best practice environmental management.'[426] If the EP regime is to be consistent with the COAG's interpretation of the ESD principles, it needs to be consistent with the following: 'Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.'[427]

An EP must undergo a formal assessment and be accepted by the Environment Division of the DMP.[428] The paramount consideration before an EP will be accepted is whether it adequately addresses the risks arising from an activity.[429]

The *Petroleum and Geothermal Energy Resources (Environment) Regulations 2012* (Western Australia) require the Minister to approve an EP if the Minister is reasonably satisfied that the EP meets a number of criteria.[430] Before it can be

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[426] Ibid 8.

[427] Ecologically Sustainable Development Steering Committee, *National Strategy for Ecologically Sustainable Development* (December 1992) Department of Sustainability, Environment, Water, Population and Communities, Australian Government <http://www.environment.gov.au/about/esd/publications/strategy/intro.html#WIESD>.

[428] To manage the DMP's regulatory regime regarding environmental imperatives, the DMP has a dedicated environmental division. Its role is to administer the environmental aspects of Western Australia's relevant Commonwealth mineral and petroleum legislation, undertake environmental assessments, audit and monitoring, apply their enforcement policy, and investigate incidents, liaise with stakeholders and measure the division's performance against customer expectations**.**

[429] Stan Bowes et al, above n 401, 8.

[430] The Petroleum (Environment) Regulations require the submission of an EP which:

- Is appropriate for the nature and scale of the activity, or proposed use
- Demonstrates that the environmental impacts and environmental risks of the activity will continuously be reduced to as low as is reasonably practicable
- Demonstrates that the environmental impacts and environmental risks of the activity will be of an acceptable level
- Provides for appropriate environmental performance objectives, environmental performance standards and measurement criteria

lawfully implemented, the EP must receive approval, upon which it becomes a legally binding agreement.

Performances objectives form the basis of an activity referred to in an EP. There are also performance standards, which, if met, will demonstrate that the objectives are likely to be achieved.[431]

Following the gazettal of the Petroleum (Environment) Regulations in 2012, the DMP is drafting additional regulations, with the intention that these will be available for public comment in mid-2013, with the regulations coming into effect later that year. The regulations will cover 'a range of matters including well operations management plans and drilling, field development plans and resource development and data management for well and survey information.'[432]

23.5 The process for water allocation and water use

When potable water is being sourced, particularly in areas of scarcity, a process for allocating the resource is desirable, especially when hydraulic fracturing, an activity seen by many as requiring large quantities of water, is at issue.[433] Further to water allocation is the issue of water use. Some uses pose a greater risk of harming the environment (including water), for example, hydraulic fracturing; consequently it is desirable for a jurisdiction to have a process for regulating water uses too. Western Australia manages allocation and use through a statutory based mechanism, which primarily involves two state government departments, the Department of Water (the

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- Includes an appropriate implementation strategy and monitoring, recording and reporting arrangements, and
- Complies with applicable laws.

Petroleum and Geothermal Energy Resources (Environment) Regulations 2012 (as at 29 August 2012) Version 00-a0-01 r. 11
<http://www.slp.wa.gov.au/pco/prod/FileStore.nsf/Documents/MRDocument:23969P/$FILE/PetrlmandGeothermalEngyResEnvironmentRegs2012-00-a0-01.pdf?OpenElement>

[431] Stan Bowes et al, above n 401, 7. Note that in many instances the DMP has also provided templates and other documentation in the guidelines to support the operator.

[432] Department of Mines and Petroleum, 'FAQ' above n 50.

[433] See Part III, section 10 for elaboration regarding water related issues.

department) and the DMP (being the lead agency when shale gas production and the associated water requirements are the focus).

The granting or refusal of an application for a licence 'to take certain water' is at the discretion of the department. The discretion is exercised under section 5C of the *Rights in Water and Irrigation Act* 1914 (WA) (*RIWI).* Clause 7(2) of schedule 1 of the RIWI requires the department to consider a number of factors when determining an application under section 5C. In addition to the conditions and restrictions that should be applied to the licence, the department is required to consider all matters the department deems relevant including: the public interest, ecological sustainability, environmentally acceptability and whether the granting of the licence may be prejudicial to current and future needs for water.[434] In exercising its discretion the department may impose terms and conditions it thinks fit, taking into account what it deems relevant and whether the proposed taking and use of water are consistent with those matters expressed in clause 7(2):

> The department will sometimes impose conditions on a section 5C licence that require the licensee to regularly submit groundwater monitoring information on existing operations, to allow the department to assess whether impacts are acceptable, or if changes to groundwater abstraction and/or licence conditions are required.[435]

Alternatively, the department may refuse an application on the basis that the potential use of the water is unacceptable.[436]

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[434] Jolanta Olszewska, *Turning Water into Gold: Water Trading Rights in Western Australia* Find Law Australia <http://www.findlaw.com.au/articles/395/turning-water-into-gold-water-trading-rights-in-we.aspx>. The mechanism works within the concept of allocation planning; to understand what this planning is, see Department of Water, *Managing Water – Allocation Planning* Government of Western Australia <http://www.water.wa.gov.au/Managing+water/Allocation+planning/default.aspx>.

[435] Water Licensing, 'Hydrogeological Reporting Associated with a Groundwater Well Licence (Operational Policy No 5.12, Water Resource Use, Department of Water, Government of Western Australia, November 2009) 5 <http://www.water.wa.gov.au/PublicationStore/first/89953.pdf >.

[436] Ibid 4.

In addition to the department's requirements is the DMP's prerequisite that an applicant submit an EP.[437] In light of the foregoing regarding the EP, it is unsurprising that the applicant (proponent) needs to demonstrate to the satisfaction of the DMP that risks and impacts to the environment (including water resources) of an activity will be reduced continuously to a level that is low as reasonably practicable, and such risks and impacts will be of an acceptable level.[438]

Using the activity of hydraulic fracturing as an example, Western Australia's mechanism for managing water allocation and use requires that a primary focus of the department and DMP is the management of environmental risks and impacts. It is possible that the department may not approve the water sought for a hydraulic fracturing activity, or approval is given subject to conditions. If a licence is granted, the DMP requires active risk management to reasonably reduce the risks and impacts arising from hydraulic fracturing.

23.6 Regulatory objectives

In Western Australia, the *Petroleum and Geothermal Energy Resources (Environment) Regulations 2012* (Western Australia) have a number of legislative objectives, which provide the foundation for the regulation that the DMP administers. The objectives are contained in Regulation 3, which provides:

> The object of these regulations is to ensure that any petroleum activity or geothermal activity carried out in the State is:
>
> (a) Carried out in a manner consistent with the principles of ecologically sustainable development, and
>
> (b) Carried out in accordance with an environment plan that:
>
> (i) Demonstrates that the environmental impacts and environmental risks

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437 The DMP may refer an application to the EPA if the DMP believes that the requirements of the MOU are relevant.

438 Department of Mines and Petroleum, 'Natural Gas from Shale and Tight Rocks Fact Sheet — Water Use and Management' (Fact Sheet. Government of Western Australia) <http://www.dmp.wa.gov.au/documents/Petroleum_Water_Use_and_Management_Fact_Sheet(1).pdf>.

of the activity will be reduced to as low as is reasonably practicable

(ii) Has appropriate environmental performance objectives and environmental performance standards, and

(iii) Has appropriate measurement criteria for determining whether those objectives and standards have been met.[439]

23.7 Regulatory approaches

A proposed regulatory framework for shale gas production requires one or more regulatory approaches to underpin the framework, in the sense that the approach supports the regulatory objectives, and has the capacity to manage the challenges of shale gas production. The DMP believes its regulatory regime encourages operators to use ground-breaking measures that are intended to protect the specific attributes of the environment — resulting in better environmental outcomes. The EP regime in this context may represent a co-regulatory approach 'and encourages ongoing consultation between regulators and operators.'[440] An important feature of co-regulation, however, is that the regulator's involvement may decrease over time. When the regulator believes the producer is operating at an acceptable risk, the regulator may 'pull back'. Should the DMP retreat, co-regulation would reflect more of the features of self-regulation. It is very unlikely that the DMP intends to retreat, given its role and the nature of the industry.

The EP reflects some attributes of co-regulation, through providing guidance and minimum standards to operators; it is then left to the operator to provide the level of detail required to fully inform the DMP of what is being proposed. In addition, the EP is not only a document that the DMP must approve; it also has a practical role: it acts as a management and implementation tool for operators.[441]

The DMP considers the Petroleum (Environment) Regulations as being premised

439 *Petroleum and Geothermal Energy Resources (Environment) Regulation 2012* (Western Australia) reg 3. <http://www.austlii.edu.au/au/legis/wa/consol_reg/pagerr2012676/s3.html>.

440 See Stan Bowes et al, above n 401, 8.

441 Ibid 10.

upon a risk-based approach, to factor in the environment, with the EP playing a pivotal role, given its goal is to lower environmental risks and impacts of petroleum activities:

> … to a level which is 'as low as reasonably practicable' (ALARP). It is important to note that what is considered practical will evolve over time as technology, best practice and expertise improve. Operators should have a mechanism in place to monitor improvements in technology and practices.[442]

A risk-based approach involves a systematic assessment of risks such as an Environmental Risk Assessment (ERA). For the purposes of an EP, the ERA:

1. Involves the assessment of the likelihood and consequence of identified impacts (or potential impacts) occurring. '*The ERA is the core of an EP*',[443] and

2. Evaluates real or potential impacts, with assistance to the operator being provided, which relates to the risk assessment and management component of the EP.

The DMP's reliance upon the risk-based approach provides an important platform for its regulatory regime, complemented by aspects of co-regulation. The way the DMP believes it applies risk-based regulation is consistent with the approach's attributes: a methodology is used to assess risks; there is a matrix for the producer to use (including the risk classification for the different risk sectors), which weights risk levels.[444]

24 Implications

24.1 United States

The proposed regulatory framework requires regulatory objectives, which are inextricably linked to the regulatory approach, providing the raisons d'être for the

[442] Ibid 8.

[443] Ibid 35 (emphasis added).

[444] Stan Bowes et al, above n 401, 17–19

framework. The purpose of this Chapter is to ascertain the extent to which the regulatory regimes of the United States and Western Australia demonstrate an appropriate regard for the objectives and approaches of their respective regimes.

A complex set of federal, state and local laws, intended to manage the challenges that arise from shale gas production, regulate shale gas production in the United States. The complexity has led one commentator to remark:[445]

- The overall state of shale gas regulation is constantly changing
- Regulation for United States shale gas development is complex, diverse, and sometimes conflicting, and
- Delineation of authority between levels of government is often ambiguous and ad hoc.

The consequences can produce a number of problems for regulation:

- Duplication of effort, including policy development
- Industry frustration, as it is operating in a complex regulatory environment
- The adoption by industry of unregulated practices or unsatisfactorily regulated practices
- The undermining of government credibility that also affects the credibility of the regulations. For example, the *Energy Policy Act of 2005*, which introduced a number of exemptions from the SDWA, to the benefit of industry, and
- Increased opportunities for the gaming of the system, particularly by states with a petroleum industry history, because they can draw upon their experience.

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445 Robert Horner and Corrie Clark, 'The Evolving Regulatory Landscape of Shale Gas Development' (Presentation given at Western Energy Policy Research Conference, Boise, Idaho, 30–31 August 2012) 12 <http://epi.boisestate.edu/media/12971/robert%20horner%20the%20evolving%20regulatory%20landscape%20of%20shale%20gas%20development.pdf>.

Due to the interplay between the federal and state governments, the United States' regulatory regime has the attributes of a 'patchwork' of regulation. The Federal Government enacts laws and the states are required to comply. Depending on the law, states can implement the laws through agreements and planning arrangements, which are subsequently endorsed by a federal agency. There are other approaches: 'cooperative federalism,' where federal agencies develop nationwide standards and permitting requirements, and delegate the authority to the states to administer the regulatory programmes; the adoption of primacy requirements, where the states implement their own regulations, subject to federal requirements. Alternatively, other legislation is used to fill the regulatory 'gaps' that occur when legislation is applied by the Federal Government in an unanticipated manner, or where industry is exempt from legislative provisions.

United States regulatory agencies are grappling with the rapid expansion of shale gas production. A variety of regulatory interventions have been developed to meet the challenges.[446] The implications are not insignificant. It is difficult to identify the regulatory objectives, these being values that need to be protected. Being unable to identify the regulatory objectives means it is unclear which regulatory approaches have been used to support the achievement of objectives.

A regulatory framework requires appropriate objectives and suitable regulatory approaches. State regulation provides an opportunity for the states to engage with their local communities to determine their state-specific regulatory objectives, such as identifying what flora and fauna needs protecting, and how best to achieve these objectives. Each state (or locality) will vary in a number of ways, including geology, population density, the characteristics of ground and surface water, and infrastructure. A state-based framework would be responsive to these differences, thereby reducing the potential for a 'patchwork' approach.

[446] Environmental and Regulatory Subgroup of the Operations and Environment Task Group, above n 169, 13.

24.2 Western Australia

The Western Australia regulatory regime[447] is more coherent than that of the United States. The United States has a longer history of oil and gas production, giving the Federal Government more time to involve itself, and more time for industry to lobby.

In Western Australia the Government and regulator can 'wait and see' as the industry is in its early stages (exploration and proof of concept phase), providing the capacity to draw upon the experience of other countries, particularly the United States. Decision-making is largely at the state level, which enhances transparency, as the proximity of the constituency is closer. Close proximity makes it more difficult for special interest groups to have a disproportionate influence upon the nature of the regulation, making it unlikely, for example, that the equivalent to the Halliburton Loophole will occur. The relative lack of complexity gives the opportunity for relatively clear regulatory objectives (as reflected in *the Petroleum and Geothermal Energy Resources (Environment) Regulations* 2012 (Western Australia) and regulatory approaches (co-regulation and risk-based) to be developed.

24.3 An adjusting (modifying) approach

Countries often use existing regulatory regimes for the development of conventional gas to develop their shale gas; an approach that is rejected by the thesis, for the reasons outlined in Part VI.

The regulatory regime of the United States has been adjusted to recognise shale gas production; for example. In March 2013, legislation was introduced to Congress to amend the CAA to account for hydraulic fracturing technology, as the technology was

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[447] See Stan Bowes et al, above n 401, 28; see also Department of Mines and Petroleum, *Shale and Tight Gas in Western Australia* Government of Western Australia <http://www.dmp.wa.gov.au/15136.aspx>; and see Environmental Defender's Office of Western Australia (Inc), *Fact Sheets* <http://www.edowa.org.au/discover/factsheets/>.

unknown at the time the CAA was enacted.[448]

The SDWA is the primary federal law that has the role of maintaining the quality of the United States' drinking water. The SDWA covers underground injection of fluids and therefore is relevant to fracturing. In 2005 the *Energy Policy of Act* amended the SDWA, which removed the SDWA's jurisdiction from fluids and propping agents — creating a partiality towards industry (the Halliburton Loophole). The partiality prompted the drafting of the Fracturing Responsibility and Awareness of Chemicals Act (FRAC Act), a legislative proposal from the United States Congress to define fracking as a federally regulated activity under the SDWA.

Western Australia has also adjusted its regulatory regime, but to a lesser extent and with greater forethought and co-ordination. The PGERA provides the regulatory regime for petroleum exploration and production onshore, under which the DMP assesses a proposal, following a process involving multiple approvals. *The Petroleum (Environment) Regulations* 2012 (Western Australia) were enacted recently, supplementing and modifying the PGERA.[449]

Western Australia needs to be mindful that further amendments to its regulatory regime could undermine its regulatory objectives, making its regulatory approach unsuitable. It is a tempting to be reactive, by hastily legislating to address an issue that has arisen. However, doing so may result in the development of an incoherent regulatory regime.

25 Conclusion

Without the regulatory objectives the proposed regulatory framework does not exist, as they are the basis of the framework. The activities of industry need to be in harmony with the objectives, and industry is required to meet them. In the absence

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[448] Office of Jared Polis (Congressman), 2nd District of Colorado, 'Polis, Cartwright Introduce Legislation to Hold Fracking Industry Accountable — Legislation Would Protect Our Water and Air' (News Release, 14 March 2013) <http://polis.house.gov/news/documentsingle.aspx?DocumentID=323929>.

[449] For a summary of the full DMP, see Department of Mines and Petroleum, 'Petroleum Fact Sheet — Environment Regulations' above n 405.

of objectives it is problematic to determine the appropriate regulatory approach which supports the framework. Western Australia has relatively clear regulatory objectives, due to its recent implementation of regulation, and relies upon two forms of regulatory approaches to assist in meeting the objectives.

The regulation of shale gas in the United States is complex, mainly attributable to two 'active' layers of government, federal and state, where the interrelationship between the two is less than optimal. Both forms of government have struggled to regulate the phenomenal expansion of shale gas production, leading primarily to regulatory intervention that has been reactive rather than proactive. Being proactive involves planning, development and implementation, which takes time — something that a regulator may think it does not have. When an issue needs to be 'fixed', new legislation is drafted or amendments are made, creating a patchwork of regulation. Where there is federation, federal legislation may be enacted to fix the problem. A 'one size fits all' response is possible, given the centralized nature of federal law, which is unlikely to account for state variations.

Western Australia and the United States have adjusted their existing legislation in response to meeting the challenges of shale gas production, although Western Australia to a lesser extent. Adjusting existing regulation is less than optimal, and is rejected by the thesis.

PART VI REGULATORY OPTIONS FOR SHALE GAS PRODUCTION

26 Introduction

If the proposed framework is to reflect best practice, it must manage the spectrum of activities associated with shale gas production. It may be tempting to adopt the approach 'we have always done it this way in the gas industry'. This stance fails to recognize that shale gas production has its own challenges, and if these challenges are disregarded, risks will be created, which would be ironic, given a key purpose of regulation is to mitigate risk. Alternatively, it may be enticing for industry to adjust the regulatory regime for conventional gas in order to accommodate shale gas production. The advantages of this approach include efficiency and being able to rely upon the regulatory experience of conventional gas. This position breaks down, however, as it assumes that the regulation for both forms of natural gas, conventional and unconventional, can be combined without one affecting the other. In particular, the amendments for shale gas may be overshadowed by the regulation for conventional gas. The position also fails to recognize the exogeneity problem, where the regulation intended to manage a problem is endogenous to the regulatory process, raising doubts about the suitability of adjusting regulation to solve problems.

The production of shale gas is not without external costs or negative externalities, costs borne by third parties, particularly local communities. These communities may not be aware that they are indirectly subsidizing the economic cost of shale gas production. The costs are familiar, and relate to water, noise and air pollution. Because third parties incur the costs, as opposed to industry, industry may have difficulty achieving or maintaining a social licence to operate. Unconventional gas production requires a regulatory response that is in itself unconventional, in the sense that it is creative and dispels the 'business as usual' attitude.[450]

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[450] John W Ubinger et al, 'Developing the Marcellus Shale — Environmental Policy and Planning Recommendations for the Development of the Marcellus Shale Play in Pennsylvania' (Report, Pennsylvania Environmental Council, July 2010) 2 <http://www.pecpa.org/sites/pecpa.org/files/downloads/Developing_the_Marcellus_Shale

26.1 The relationship between private costs and negative externalities

To help build the argument that a framework for shale gas production is needed, [451] an understanding of the relationship between private costs and negative externalities is required. [452]

Private costs are borne by the producer. Examples include purchasing capital equipment, and hiring labour and other materials to produce shale gas. They are the 'usual' and tangible costs that are generally seen as the costs of production.

Negative externalities, also known as external costs, on the other hand, are costs that are not reflected in the pricing of production; rather they are borne by a third party. Road congestion and air, noise and water pollution experienced by those living near a shale gas production site are examples of external costs:

> The key point is that even if a firm or individual avoids paying for the external costs arising from their actions, the costs to society as a whole (congestion, pollution, environmental clean-up, visual degradation, wildlife impacts, etc) remain.[453]

26.2 The cost of negative externalities and its effect

Local communities are the main bearer of the cost of negative externalities. They experience a number of 'interferences', including road congestion and road wear and tear, noise, compromised air quality, concern over water pollution, land disturbance, and a lack of information and consultation.

_0.pdf>.

451 R Finkelstein, 'Independent Inquiry into the Media and Media Regulation' (Report, Australian Government, 28 February 2012) 279 <http://www.dbcde.gov.au/__data/assets/pdf_file/0006/146994/Report-of-the-Independent-Inquiry-into-the-Media-and-Media-Regulation-web.pdf>.

452 Federal Reserve Bank of San Francisco, *What is the Difference between Private and Social Costs, and How Do They Relate to Pollution and Production* (November 2002) <http://www.frbsf.org/education/activities/drecon/2002/0211.htm>.

453 Ibid.

Not receiving full and accurate information has the potential to raise a number of issues: the community being complicit (out of ignorance) regarding production, members of the community having concerns that are baseless or even wrong, leading to unnecessary stress and a combative relationships, and producers' incapacity to alter public opinion. The requirement to disclose information aims to correct information asymmetries and promote a social licence to operate.

When there is no social licence, producers can face a number of burdens such as increased financial costs, due to robust community action, labour shortages, and ultimately the closure of operations.[454] A delay in securing and maintaining a social licence can mean that in spite of efforts from government and industry to address the public's concerns it may be impossible to persuade the public that shale gas production is acceptable.

27 Regulation designed for conventional gas is inadequate for shale gas

27.1 Examples of differences between conventional and shale gas production

The production of shale gas is sufficiently different from conventional gas that a distinct regulatory regime is warranted. Many of these differences have already been discussed; in continuing to make a case for a framework, a number of these differences are elaborated.

27.1.1 Hydraulic fracturing fluid and water management

A significant difference between shale gas and conventional gas is shale plays have limited permeability, which reduces the flow of hydrocarbons to the wellbore. Shale gas is effectively trapped within a rock formation rather than by an overlying one. Conventional gas is trapped as gas formations within deposits of porous, sedimentary rock by overlying impermeable layers of rock. Because conventional gas

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[454] MiningFacts.org *What is the Social Licence to Operate (SLO)?* <http://www.miningfacts.org/Communities/What-is-the-social-licence-to-operate/>.

is found in more permeable and porous rock formations, it is easier and more cost-effective to extract.

Vertical drilling is the principal technique used in the commercial extraction of conventional gas,[455] and regulation for natural gas production has been designed in response to this extraction method. In recent decades, horizontal drilling, particularly when combined with hydraulic fracturing, has become an important procedure allowing for the commercial production of unconventional gas, including shale gas.[456]

Apart from the different technology used for extraction, other differences between conventional and shale gas production, include:[457]

- In shale gas production, there are large volumes of flow-back water during the initial stages that need to be managed from the start of the production, and
- Produced water from shale gas usually contains high TDS levels, which limits the type of water reuse in subsequent operations and the ability to process the waste water into fresh.

Given hydraulic fracturing's heavy reliance upon water, there is a need to appropriately source the water, reduce the quantity of water used, and treat and recycle the fracturing fluids appropriately.[458]

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455 NaturalGas.org, *Directional and Horizontal Drilling* <http://www.naturalgas.org/naturalgas/extraction_directional.asp>.

456 Halliburton, above n 38, 1.

457 Melissa Stark et al, 'Water and Shale Gas Development — Leveraging the US Experience in New Shale Developments' (Paper, Accenture, 10 December 2012) 30 <http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Water-And-Shale-Gas-Development.pdf>.

458 Commonwealth Scientific and Industrial Research Organisation, 'Developing the Shale Gas Potential' (Fact Sheet) 1 <http://www.csiro.au/~/Media/CSIROau/Divisions/CSIRO%20Earth%20Science%20and%20Resource%20Engineering/PDFs/Developing%20the%20shale%20gas%20potential.pdf>.

27.1.2 Air quality

There are a number of risks to air quality arising from shale gas production. These risks are:[459]

- Dust and engine exhaust from increased traffic activity, particularly trucks
- Emissions from generators fuelled by diesel. Diesel emissions from generators compromise air quality due to the release of mono-nitrogen oxides (nitric oxide and nitrogen dioxide), carbon monoxide, hydrocarbons, and particulate matter at levels shown by a United States study to be at levels that contribute significantly to poor air quality[460]
- Deliberate flaring or venting of gas, and
- Unintentional discharge of pollutants from faulty equipment or through poor design.

27.1.3 Seismic activity

Shale gas production penetrates the earth's surface to send fluids under pressure upwards of two thousand metres underground, which risks inducing seismic activity (called anthropogenic seismicity). The seismic activity is considered to be environmental pollution originating in human activity. The re-injection of wastewater for disposal, being a wastewater management option, has been linked to seismic activity, although these seismic events are unlikely to be detectable without appropriate equipment. The potential for seismic activity does raise a number of important questions. Does such activity undermine the ability to establish a social licence, and is there a role for the precautionary principle? How does industry prove that the seismic activity is not attributable to its actions or, if it is, that it poses no

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459 Office of Fossil Energy, 'Shale Gas Development Challenges — A Closer Look' (Fact Sheet, US Department of Energy, 2013) <http://energy.gov/sites/prod/files/2013/04/f0/shale_gas_challenges_air.pdf>.

460 Diesel Service & Supply, *Diesel Generator Engine Emissions Explained* <http://www.dieselserviceandsupply.com/Generator_Engine_Emissions_Explained.aspx>. In 1994 a plan was developed by the US EPA, along with interested parties, to reduce emissions over specified time periods; and to assist states to comply with the CAA.

(substantive) risk? From a policy perspective, the risk of seismic events will require a way of deciding the distance hydraulic fracturing operations should be from built up regions, culturally sensitive sites and environmentally significant areas. [461]

27.2 The relationship to risk

The framework needs to account for the activities applied by industry, the nature and intensity of the industrial activity, and whether the proposed regulatory interventions will mitigate the risks arising from the activity.

The following table[462] highlights some of the issues a framework for shale gas production would need to consider.

Table 1: Issues a Framework Needs to Account for (State and Federal)[463]

Land position	Issues
Above ground	
Ground Ownership	Rights of First Nation peoples
	Planning
	Environmental and conservation
	Considerations unique to the development (micro-climate)
Underground level	
Resources (Public or private ownership)	Issues relating to resources (oil and gas resource/ environmental)
	Considerations unique to the development (geology)

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[461] Tim Boersma and Corey Johnson, 'Risks and Potentials of the Shale Gas Revolution — Consequences for Markets and the Environment' (Comments, Stiftung Wissenschaft und Politik, German Institute for International and Security Affairs and American Institute for Contemporary German Studies, Johns Hopkins University, 2012) 4 <http://www.swp-berlin.org/fileadmin/contents/products/comments/2012C39_boersma_johnson.pdf>.

[462] Adopted and modified from Cécile Musialski, 'The Legal and Regulatory Framework for Shale Gas Exploration and Exploitation Activities in the EU' (Presentation delivered for Philippe Partners, Berlin, 25 October 2011) 12–13 <http://frackingfreeireland.org/wp-content/uploads/2011/08/shale_gas_regulatory_framework_c_musialski.pdf>.

[463] The table is for illustrative purposes and is not an exhaustive list of the issues the framework would need to account for.

Underground and surface level	
Activities arising from production	Water management (lifecycle) (contamination)
	Chemical management (including fracturing fluids (composition))
	Social licence generally
	Cumulative impacts
	Air and noise pollution
	Construction (and in some instances, maintenance) of roads, well pads, ponds, and buildings
	Legacy

Regulations for conventional gas cannot satisfactorily consider every activity arising from the production of shale gas. Compared to conventional gas, the impacts of shale gas production mean there are a variety of environmental risks. 'Consequently, a reduced risk compared to conventional oil and gas operations, including the risk of large-scale accidental pollutions such as the recent catastrophe in the Gulf of Mexico, cannot be claimed.'[464]

A number of organizations and jurisdictions recognize this:

1. The International Energy Agency (IEA) in its special report 'Are we Entering a Golden Age of Gas?' observed that the rapid expansion of hydraulic fracturing in unconventional gas development (including shale gas) has resulted in the pre-existing regulatory frameworks being tested and serious environmental concerns being identified, despite hydraulic fracturing having been practised for well over half a century,[465] and

2. As discussed earlier, the ERCB implemented an organization-wide initiative called the 'Unconventional Gas Regulatory Framework Project' (the project). The project had a number of goals, including assessing the regulatory risk of unconventional gas development with a broader aim of developing and

[464] Stefan Lechtenböhmer et al, above n 85, 35.

[465] Robert Priddle (ed), 'Are We Entering a Golden Age of Gas?' (Special Report for World Energy Outlook 2011, International Energy Agency, 6 June 2011) 45 <http://www.iea.org/weo/docs/weo2011/WEO2011_GoldenAgeofGasReport.pdf>.

implementing a new regulatory framework for Alberta, Canada.[466]

27.3 Regulation in the United Kingdom

In the United Kingdom opinion on whether the regulation of shale gas production can be left to that country's conventional gas regulation appears divided. The United Kingdom Parliament, through the House of Commons Energy and Climate Change Committee (ECCC), examined shale gas resources in the United Kingdom and the implications arising from exploration and production of the resource. In May 2011 the ECCC issued its report.[467] The report highlighted that the United Kingdom Government witnesses before the ECCC believed their regulation was 'well-designed with clear lines of responsibility among several different bodies' and that the United Kingdom had a 'robust regime, which is fit for purpose' [468]

A witness to the ECCC was the Department of Environment and Climate Change (DECC), which, along with other government agencies, makes up the regulatory regime for natural gas production in the United Kingdom. The DECC stated that it did not think there was a need for the United Kingdom legislation to specifically refer to unconventional gas because the technologies used were nothing new. Other witnesses had a contrary view on the grounds that the techniques used for shale gas are so different from conventional gas that they are not even part of current European regulations: 'I think just relying on existing legislative framework for a new process is not sufficient.'[469] While there were conflicting views, the ECCC recommended that the United Kingdom's regulation should consider the challenges unique to shale gas. Specifically, the challenges were hydraulic fracturing and

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[466] Energy Resources Conservation Board, 'Unconventional Gas Regulatory Framework — Jurisdictional Review' above n 93, 1.

[467] House of Commons, *Energy and Climate Change Committee — Fifth Report — Shale Gas* (23 May 2011) United Kingdom Parliament <http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenergy/795/79502.htm>.

[468] Energy And Climate Change Committee, 'Shale Gas — Fifth Report of Session 2010–12 (Volume I)' (Report, House of Commons, United Kingdom Parliament, 10 May 2011) 16, 68 <http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenergy/795/795.pdf>.

[469] Ibid 34.

horizontal drilling at multiple wells, which use chemicals and produces large volumes of wastewater.[470]

The Tyndall Centre for Climate Change Research (TCCCR) of the University of Manchester conducted a study into the emerging shale gas industry in the United Kingdom and issued its report in November 2011. After reviewing key regulatory mechanisms, the TCCCR's findings questioned the government witnesses' views.[471] The TCCCR found, among other things, that under the current regulatory regime:[472]

1. A shale gas operator would not be routinely required to obtain an environmental permit on the basis that shale gas development did not amount to groundwater activity.

2. No environmental impact assessments of existing well pads were required because the local planning authority considered that the projects fell outside the area-based (size only) criterion of the United Kingdom's implementing legislation.

3. While there is regulatory power to ensure any chemical is registered for a given use, complemented by safety assessments, at least one chemical had been used in hydraulic fracturing in the United Kingdom that had not been registered for this purpose, giving pause to question the effectiveness of the compliance and enforcement regime.

In 2011 the United Kingdom Government imposed a temporary moratorium on hydraulic fracturing, which was lifted on 13 December 2012, only eight days after the government issued its Gas and Generation Strategy paper,[473] the timing indicating

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470 Ibid [93].

471 John Broderick et al, 'Shale Gas: An Updated Assessment of Environmental and Climate Change Impacts' (Research Report, Tyndall Centre for Climate Change Research, University of Manchester, November 2011) 115 <http://www.co-operative.coop/Corporate/Fracking/Shale%20gas%20update%20-%20exec%20summary%20and%20conclusions.pdf>.

472 Ibid 116–117.

473 Department of Energy & Climate Change, above n 82.

that there is a strong connection between the two.[474] It appears the United Kingdom will rely mainly upon conventional gas regulation, supplemented by a number of regulatory checks and balances, involving a variety of government regulatory agencies, some of which have an environmental focus:[475]

> [T]he industry has a good record, and … there are already in place robust regulatory controls on all oil and gas activities … the existing regulatory framework already provides the means to ensure that the industry does apply good practice … *But we are taking further steps to reinforce the regime*.[476]

Steps taken by the DECC to reinforce the regulatory regime include the establishment of a senior strategy group specifically involved in shale, having representation from relevant departments. The Office of Unconventional Gas, being part of the DECC, was established to assist with shale related activities and to act as 'a single point of contact for investors and ensur[e] a streamlined regulatory process.'[477] The United Kingdom Government's lifting of the moratorium was accompanied by certain expectations of the oil and gas industry. The Government has requested industry provide input on shale gas, including regulations that are relevant to an expanding shale gas industry.

The intense focus on shale gas production, especially relating to regulation and the need to gain public confidence (a social licence to operate), prompted the United Kingdom's Onshore Operators Group (UKOOG) to publish guidelines relating the exploration and appraisal phase.[478] The subsequent phases will be published in the

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474 Reed Smith, 'UK Shale Gas: Regulatory Update' (Online Article, Commodities Now, 19 March 2013) <http://www.commodities-now.com/reports/power-and-energy/14134-uk-shale-gas-regulatory-update.html>.

475 Department of Energy & Climate Change, above n 82, 56 [5.18].

476 Edward Davey, 'Exploration for Shale Gas' (Written Ministerial Statement to Parliament, Department of Energy & Climate Change, United Kingdom Government, 13 December 2012) <https://www.gov.uk/government/speeches/written-ministerial-statement-by-edward-davey-exploration-for-shale-gas> (emphasis added).

477 Ibid.

478 United Kingdom Onshore Operators Group, 'UK Onshore Shale Gas Well Guidelines — Exploration and Appraisal Phase' (Guidelines, Issue 1, February 2013) <http://www.ukoog.org.uk/elements/pdfs/ShaleGasWellGuidelines.pdf>.

future: 'The UKOOG guidelines are intended to supplement the existing framework and apply to the unique aspects of shale gas wells and high-volume fracturing operations.'[479]

27.4 Rapid changes in the United States

The risk of unsuitable regulation for shale gas production and conventional gas regulation is more apparent in the United States. In contrast to other countries, shale gas production has advanced rapidly there.

The pace of shale gas production means the regulators have had to play catch-up in an attempt to meet the substantial demands that have resulted. Verrastro and Conor describe this situation:

> In the past few years, as the scale of unconventional gas development has literally [sic] exploded — including in geographic areas unfamiliar with large-scale energy development activity — public concern over shale gas exploration, safety and contamination issues associated with the fracking process and frack chemicals, and concerns over water quality and resources has increased.[480]

28 Adjusting regulation for conventional gas production as an approach to regulating shale gas production

A common approach in responding to the challenges posed by shale gas production has been to adjust existing regulatory requirements for conventional gas.[481] The approach is aptly described as: 'Others have opened their shale gas formations (called "shale plays" in the industry vernacular) to development under existing State

[479] Reed Smith, above n 474.

[480] Frank Verrastro and Conor Branch, above n 45, 13.

[481] Terence H Thorn, 'Environmental Issues Surrounding Shale Gas Production — The US Experience — A Primer' (Paper, International Gas Union, April 2012) 19-20 <http://newgas.org.ua/sites/default/files/analytics/2012-Apr_IGU%20Environmental%20Issues%20and%20Shale%20Gas.pdf>.

regulatory regimes, adjusting those regimes to address new or newly recognized risks.'[482] Adjusting regulation for conventional gas production has been used in the United States and Canada.

A United States' study undertaken in 2012 confirmed that the principal responsibility for regulating shale gas is at the state level, with many *federal* requirements being delegated to the individual states. However, the majority of the regulatory instruments available to states had been drafted before shale gas production had become prominent, prompting some states to alter their regulations. These alterations covered, amongst other things, disclosure regimes of hydraulic fracturing chemicals, suitable casing of wells to prevent aquifer contamination, and management of wastewater from flow-back and produced water.[483] Even though adjustments had been made, the 2012 study also showed that the regulatory regimes were not comprehensive when it came to activities such as water management (water withdrawal, usage, and waste storage and disposal).

28.1 Examples of the adjusting-the-regulatory-regime approach

28.1.1 Disclosure rules

In February 2012 Texas' state regulator (Texas Railroad Commission) implemented what it considered to be one of the United States' most comprehensive chemical disclosure rules for hydraulic fracturing. The *Hydraulic Fracturing Chemical Disclosure Rule* requires operators intending to undertake hydraulic fracturing to disclose on a national website[484] the chemical make-up and water volumes for all

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482 David Spence, 'Is It Time for Federal Regulation of Shale Gas Production?' (Energy Management Brief, Energy Management and Innovation Center, McCombs School of Business, University of Texas at Austin, 19 April 2012) 3 [1] <http://www.mccombs.utexas.edu/centers/~/media/d4dbd2d555f740d8ae6b510d35c8d6b1.ashx>.

483 Charles Groat, 'Separating Fact from Fiction in Shale Gas Development' (Report (Overview), Energy Institute, University of Texas at Austin, February 2012) 5 <http://energy.utexas.edu/images/ei_shale_gas_reg_booklet1202.pdf>.

484 FracFocus, <www.FracFocus.org>.

wells issued with an initial drilling permit on or after 1 February 2012.[485]

The intention of the rule is ostensibly to strike a balance between protecting legitimate business information and the public's right to be informed:[486]

> By enacting House Bill 3328, the Texas Legislature *added a new Subchapter S* to Chapter 91 of the Texas Natural Resources Code. The new law directed the Texas Railroad Commission … to promulgate new rules requiring the disclosure of the composition of the hydraulic fracturing fluids …[487]

Texas' approach permits production of its shale gas resources under its current regulatory regime, making adjustments to address new or emerging risks. The 'process of state regulatory adjustment continues, but it has not quieted opponents of shale gas production.'[488]

Similarly, the State of Colorado's Oil and Gas Conservation Commission (OGCC) has amended its rules principally in response to increasing concerns over not knowing the characteristics of the chemicals contained in hydraulic fracturing fluids, which applied to hydraulic fracturing undertaken on or after 1 April 2012. The amendments require specific information relating to hydraulic fracturing to be publicly

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[485] Leslie Savage, 'New 16 Tex. Admin. Code §3.29, relating to Hydraulic Fracturing Chemical Disclosure Requirements' (Memorandum, Oil and Gas Division, Railroad Commission of Texas, 22 August 2011) <http://www.rrc.state.tx.us/rules/prop-new-3-29-frac-disclosure-Aug29.PDF>.

[486] Railroad Commission of Texas, 'Railroad Commissioners Adopt One of Nation's Most ComprehensiveHydraulic Fracturing Chemical Disclosure Requirements' (News Release, 13 December 2011) <http://www.rrc.state.tx.us/pressreleases/2011/121311.php>.

[487] Anthony B Cavender, 'Texas Law Requires Disclosure of Hydraulic Fracturing Chemicals as of February 1, 2012' (Client Alert, Pillsbury Winthrop Shaw Pittman LLP, 21 December 2011) <http://www.pillsburylaw.com/publications/texas-law-requires-disclosure-of-hydraulic-fracturing-chemicals-as-of-february-1-2012> (emphasis added).

[488] David Spence, 'Is It Time for Federal Regulation of Shale Gas Production?' above n 482, 1.

disclosed,[489] however, exceptions to the obligation to publicly disclose include chemicals not intentionally added to the hydraulic fracturing fluid or information that is entitled to protection as a trade secret.[490]

The OGCC believes the changes should increase transparency of hydraulic operations, including increasing the OGCC's capacity to oversee hydraulic fracturing, while providing suitable protections for trade secrets.[491] Colorado's response has been described as being consistent with a state experiencing a spectacular rise in shale gas industrial activities, involving prompt and deliberate steps to adjust its regulation, commensurate with the challenges posed by shale gas development.[492]

28.1.2 Environmental impact statements

Since December 2010 the State of New York has had a moratorium in place on the issuing of new permits for 'high volume' hydraulic fracturing. The Department of Environmental Conservation (DEC) is required by the State Governor to undertake a review of the possible environmental effects of high-volume hydraulic fracturing and horizontal drilling, which complements the moratorium. Through examining high-volume hydraulic fracturing operations and reviewing the possible environmental impacts that might arise from such operations, the DEC is developing a revised draft Supplemental Generic Environmental Impact Statement (SGEIS).[493]

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489 Before the Oil and Gas Conservation Commission of the State of Colorado in the Matter of Changes to the Rules of Practice and Procedure of the Oil and Gas Conservation Commission of The State Of Colorado, Cause No 1R and Order No. 1R–114, Rule 205A subparts a and b <http://cogcc.state.co.us/RR_HF2011/Order1R-114FinalFracingDisclosureRule.pdf>.

490 Ibid, Rule 205A, Subparts (5) c and d.

491 Ibid, conclusion on page 14.

492 Terence H Thorn, above n 481, 20.

493 Also referred to as a 'draft SGEIS', 'dSGEIS', or 'draft Supplement'. For full details, including related details see New York State Department of Environmental Conservation, *Revised Draft SGEIS on the Oil, Gas and Solution Mining Regulatory Program (September 2011) — Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing in the Marcellus Shale and Other Low-Permeability Gas Reservoirs* <http://www.dec.ny.gov/energy/75370.html>.

The DEC previously evaluated the environmental impacts of natural gas drilling through a Generic Environmental Impact Statement (GEIS) (on the Oil, Gas and Solution Mining Regulatory Program), which regulates the permitting of oil and gas development. The draft GEIS was finalized in 1992; however, new technologies had been developed since, necessitating a supplement to the GEIS.[494]

The issues of particular concern were: [495]

- Water related:
    - The use of large quantities of water and additives (including chemical additives that might be hazardous in high concentrations)
    - The additional water usage affecting adversely upon water supplies, and
    - The need for substantial wastewater treatment and disposal.
- Increased volumes of drilling waste (cuttings) arising from horizontal drilling
- Bigger well pads where intense industrial activity occurs, and
- Quality of life for local communities being undermined.

When the draft SGEIS (the supplement) is finalized the DEC will process permit applications by applying the requirements contained within any regulation(s) that have been revised or added to the current regulatory requirements applicable to high-volume hydraulic fracturing, along with the draft SGEIS, in conjunction with

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494 New York City Environmental Protection, About *the DEC Supplemental Generic Environmental Impact Statement (SGEIS)* <http://www.nyc.gov/html/dep/html/news/natural_gas_drilling_sgeis.shtml>.

495 New York State Department of Environmental Conservation, 'Revised Draft — Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program — Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs' (Statement, New York State Government, 7 September 2011) 1–2 <http://www.dec.ny.gov/docs/materials_minerals_pdf/rdsgeisexecsum0911.pdf>.

the 1992 GEIS.[496]

28.1.3 Moving towards a new regulatory regime

Alberta's Energy Resources Conservation Board (ERCB) has stated that the 'development of extensive unconventional gas plays, sometimes described as manufacturing, lends itself to new regulatory approaches especially related to assessment and approval of a development or scheme.'[497]

ERCB has undertaken a review of its regulatory response to shale gas (and other types of unconventional gas), to ensure it is appropriate. 'The Energy Resources Conservation Board is continually working to improve its regulations and processes to ensure Alberta's energy resources are developed in a manner that is responsible, safe, and efficient.'[498]

In late 2012 a discussion paper was released by ERCB for feedback.[499] In the discussion paper the ERCB remarked that while the current regulation does provide a good foundation for regulating unconventional resources, the current regulation could be built upon to account for unique characteristics, risks and challenges which arise from unconventional production.[500]

There are two principles to the new framework that build upon the current

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[496] Ibid 2.

[497] Energy Resources Conservation Board, 'Unconventional Gas Regulatory Framework — Jurisdictional Review' above n 93, 16.

[498] Energy Resources Conservation Board, 'Regulatory Document Review' (Bulletin No 2013–07, Alberta Energy Regulator, 13 February 2013) 1 <http://www.aer.ca/documents/bulletins/Bulletin-2013-07.pdf>.

[499] Energy Resources Conservation Board, 'Regulating Unconventional Oil & Gas in Alberta' (Discussion Paper, Alberta Energy Regulator, 17 December 2012) <http://www.aer.ca/documents/projects/URF/URF_DiscussionPaper_20121217.pdf>. The discussion paper is an important means of seeking external feedback. The ERCB reports that it will consider the feedback, as it progresses its new regulation, and once the approach is finalized, it will be trialed (with expert monitoring) before it is used elsewhere in Alberta: at 5.

[500] Ibid 2.

regulatory regime:[501]

- Risk-based regulatory responses that are proportionate to the level of risk posed by a development, and

- Play-focused regulation, being solutions that are tailored to an entire 'play' to meet environmental, economic, and social outcomes. The intention is the regulatory response will be based upon the characteristics of the resource play.[502]

In addition, performance-based regulation is relied upon:

> The ERCB intends to apply performance-based regulation to unconventional resource development and establish regulatory outcomes where appropriate. Industry will be expected to meet or exceed these expectations through collaboration with other operators in the play and with the communities affected by development.[503]

The ERCB's initiative is a bold and innovative step to implement a regulatory regime. However, while it appears that the initiative is de novo, it is not. The existing regulatory regime will act as a base, providing a 'solid foundation' upon which it can be built[504] to reflect the challenges of unconventional gas:

> Once a play is declared, the ERCB will identify expected outcomes, *modifications to existing ERCB requirements*, and new requirements and/or regulatory processes for that play in a Board Order. As a baseline, operators within a play must follow all current regulatory requirements except where modified or superseded by play-

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[501] Ibid.

[502] Nigel Bankes, 'A New Approach to Regulating Unconventional Resource Plays in Alberta: The ERCB Takes a Bold Step Forward' (Online Article, Faculty of Law, University of Calgary, 10 January 2013) <http://ablawg.ca/2013/01/10/a-new-approach-to-regulating-unconventional-resource-plays-in-alberta-the-ercb-takes-a-bold-step-forward/>.

[503] Energy Resources Conservation Board, 'Regulating Unconventional Oil & Gas in Alberta' above n 499, 13.

[504] Energy Resources Conservation Board, 'Regulating Unconventional Oil & Gas in Alberta' above n 499, 2.

focused requirements in the Board Order.[505]

28.1.4 Assessment and Prohibition

On 31 August 2010 Quebec's Minister of Sustainable Development, Environment and Parks directed the Bureau d'audiences publiques sur l'environnement to establish a commission of inquiry to investigate and hold public hearings on the sustainable development of Quebec's shale gas industry, and provide a report.[506]

In March 2011 the Minister released the commission's report. The commission made 43 findings and 101 recommendations. Significantly the commission found and recommended:

> In the case of some fundamental issues, however, the answers are partial or even non-existent. Accordingly, to meet the need for more scientific knowledge and in the absence of proven facts that can be used to identify the potential risks associated with shale gas exploration and extraction, the inquiry commission has proposed a strategic environmental assessment.[507]

The commission stated that while the strategic environmental assessment was in progress, hydraulic fracturing would not occur, except if the fracturing was directly

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[505] Energy Resources Conservation Board, 'Regulating Unconventional Oil & Gas in Alberta' above n 499, 12 (emphasis added).

[506] The Bureau d'audiences publiques sur l'environnement (BAPE) is an independent agency that reports to the Minister. Its mission is to enlighten government decision-making based upon a sustainable development perspective. 'The Bureau d'audiences publiques sur l'environnement (BAPE) is an agency dedicated to public information and consultation on projects likely to have a major impact on the environment or any other question related to the quality of the environment. The BAPE is the gateway for citizens to get involved in the project authorization process. It visits the community concerned by the project to facilitate the participation of citizens. They can obtain information from, and express their concerns to, a neutral agency and through a transparent process.' Bureau d'audiences publiques sur l'environnement, *Frequently Asked Questions* Government of Québec <http://www.bape.gouv.qc.ca/sections/faq/eng_faq_ind.htm#qcq>.

[507] Bureau d'audiences publiques sur l'environnement, 'Sustainable Development of the Shale Gas Industry in Québec' (Report No 273 (Excerpts), Government of Québec, February 2011) 245. <http://www.bape.gouv.qc.ca/sections/rapports/publications/bape273_excerpts.pdf>.

related to the assessment.[508]

A further recommendation was that the strategic environmental assessments include an assessment of the applicability of implementing scientific observatories, to acquire knowledge on an ongoing basis '*and ensure that regulations are updated to reflect new developments*.'[509]

28.1.5 Complementary

In September 2011 the Canadian Association of Petroleum Producers (CAPP) released its guiding principles for hydraulic fracturing. These principles placed importance upon safeguarding water resources through sound practices, water efficiency, disclosure, and promoting technological advances to reduce the potential risk to the environment.[510]

The CAPP has developed hydraulic fracturing operating practices intended to improve water management.[511] The practices apply to CAPP members who are exploring for and producing natural gas. However, given the CAPP has no enforcement powers, there is no guarantee that its members will comply with the practices. The CAPP submits that the practices were developed to inform and complement regulations, and are not a substitute for regulatory oversight, where

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[508] Ibid.

[509] Ibid 225 (emphasis added).

[510] Canadian Association of Petroleum Producers, 'Guiding Principles for Hydraulic Fracturing' (Guiding Principles, December 2012) <http://www.capp.ca/getdoc.aspx?DocId=218125&DT=NTV>.

[511] Canadian Association of Petroleum Producers, 'Industry Establishes Canada-wide Operating Practices for Shale, Tight Natural Gas Hydraulic Fracturing' (News Release, 30 January 2012) CAPP Hydraulic Fracturing Operating Practices (2012) <http://www.capp.ca/aboutUs/mediaCentre/NewsReleases/Pages/operating-practices-for-hydraulic-fracturing.aspx>.

regulation is largely performed by the applicable jurisdictions.[512]

28.2 The advantages of the adjusting-the-regulatory-regime approach

Jurisdictions adjusting their regulations do so for a number of reasons, including:

- Experience — it provides the opportunity to draw upon the techniques used in the conventional gas industry, including any lessons learnt
- Efficiency — industry and the regulator have fewer regulatory variations to follow, promoting expeditious development and implementation
- Perception — industry is likely to view the regulatory changes as less burdensome, which may enhance its willingness to comply
- Cost-effectiveness — it is likely to be less expensive than starting afresh
- Proportionality — less open to the accusation that the response is excessive, and
- Convergence — it recognizes that some of the activities for the production of conventional and shale gas are not dissimilar.

28.3 The disadvantages of the adjusting-the-regulatory-regime approach

Adjusting a regulatory regime for conventional gas to accommodate the activities of shale gas has its advantages; however, it also has its challenges. The quality of the proposed regulation may be affected as it is part of a wider regulatory regime that includes conventional gas. Therefore the proposal could be developed through the lens of the conventional gas experience, running the risk that the regulatory measures for shale gas may not be implemented fully. Instead, the measures are

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[512] Canadian Association of Petroleum Producers, 'Governments Regulate Shale Gas, Industry Promotes Operating Practices' (News Release, 11 June 2012) <http://www.capp.ca/aboutUs/mediaCentre/NewsReleases/Pages/operating-practices-for-hydraulic-fracturing.aspx>.

marginalized or interpreted (deliberately or not) by the more established ‘tried and true’ measures for conventional gas production.

There could be regulatory requirements that are irrelevant to the regulation of conventional gas but are pertinent to shale gas production and require a distinct regulatory response. It would be challenging to implement these distinct requirements ‘in the shadow’ of regulation intended for conventional gas. The reverse may also be true, where changes made to regulate conventional gas for the purposes of regulating shale gas could be detrimental to the regulation of conventional gas.

Finally, it is commonly thought that specific problems that any regulatory regime is intended to deal with (for example, water management) are exogenous to the regulatory process. A problem is identified and a regulatory response is developed to manage it. However, this thinking may be flawed: ‘Exogeneity is a bold assumption because problems may be at least partly endogenous to regulation, *ie caused by the very regulation* designed to reduce the probability of problems emerging.’[513] Ayadi, referring to the regulation of the financial industry, believes the ‘endogeneity problem’ raises serious doubts over the appropriateness of the ‘traditional incremental [adjusting] approach’. Often those being regulated try to circumvent regulation or at least minimize its impact, and consequently the regulator responds with additional regulatory adjustments, where each successive adjustment causes the cost of regulation to rise.[514]

Ayadi’s argument is applicable to the shale gas industry as the problem of endogeneity pertains to the very regulation designed to achieve a specific outcome (it is the regulation not the industry that raises the prospect of the ‘endogeneity problem’). If Ayadi is correct, a regulatory regime specifically designed for shale gas would be superior to adjusting the regulation for conventional gas as the latter requires more changes to regulate production. A dedicated regime is more likely to account for shale gas production from the outset, lessening the need for adjustments,

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513 Rym Ayadi, Emrah Arbak and Willem Pieter de Groen, ‘Regulation of European Banks and Business Models: Towards a New Paradigm?’ (Report, Centre for European Policy Studies, Brussels, 26 June 2012) 75 <http://bankingsins.eu/pdf/Bank_Regulation_in_the_EU.pdf> (emphasis added).

514 Ibid.

reducing the susceptibility to the endogeneity problem. For example, regulation developed reactively minimizes the opportunity to promulgate appropriate regulation. Regulatory adjustment may resolve the immediate challenge; for instance, the unauthorized discharge of untreated produced water prompts the regulator to act by amending the regulations so they [the regulations] are more onerous. Relying upon Ayadi's reasoning, the implementation of stricter regulations could necessitate further adjustments, posing more problems than what the initial intervention was intended to address.

29 Conclusion

A common response to the regulation of shale gas production is regulating in the same way as conventional gas. There is no perceived need for a regulatory response that specifically accounts for the activities of shale gas production. Conventional and unconventional gases are both natural gases; the suggestion is that shale gas can be regulated in an equivalent way. Other jurisdictions have responded by adjusting their current regulatory regime for conventional gas. Adjustments presume that regulation for conventional gas is largely adequate, however, recognizing that the regulation needs to be modified to accommodate shale gas production.

As its focal point is on conventional gas, the first response is incapable of meeting the challenges unique to shale gas production, such as the increased use of horizontal drilling combined with hydraulic fracturing. The response is therefore rejected. The second response may appear practicable and commonsensical, with a number of perceived advantages. Nevertheless, it has weaknesses, meaning there are concerns over its capability to address the critical aspects of shale gas production. The response is rejected; rather, a proposed regulatory framework is presented in the next part, Part VII.

PART VII THE PROPOSED BEST PRACTICE REGULATORY FRAMEWORK

30 Introduction

This Part presents the proposed best-practice regulatory framework for shale gas production. The purpose of the framework is to enable shale gas production to occur consistent with a set of regulatory objectives. These objectives focus for the most part on protecting the environment and are the key feature of the framework. There are other features, including factors, traits and regulatory approaches.

Management-based regulation is the principal regulatory approach underpinning the framework. Management-based regulation requires a management plan, which must show how the producer proposes to manage the activities of shale gas production effectively, so the potential risks to the objectives are minimized to an acceptable level. Disclosure rules ('information regulation') in the shape of elementary forms of management-based regulation complement the management-based approach.

The regulator undertakes an assessment of a proposed management plan. The purpose of the assessment is to determine the extent to which the objectives will be protected and what additional management intervention(s), if any, is required before the draft plan is approved.

The assessment involves the application of precautionary risk regulation and threat ranking regulatory methods. As a 'back-up', performance-based regulation is available to the regulatory agency, if the regulator considers it necessary. The back-up acts as an assurance that the draft management plan is appropriate.

The proposed framework has a number of features; the diagram below illustrates the main arrangements, and is followed by an explanation.

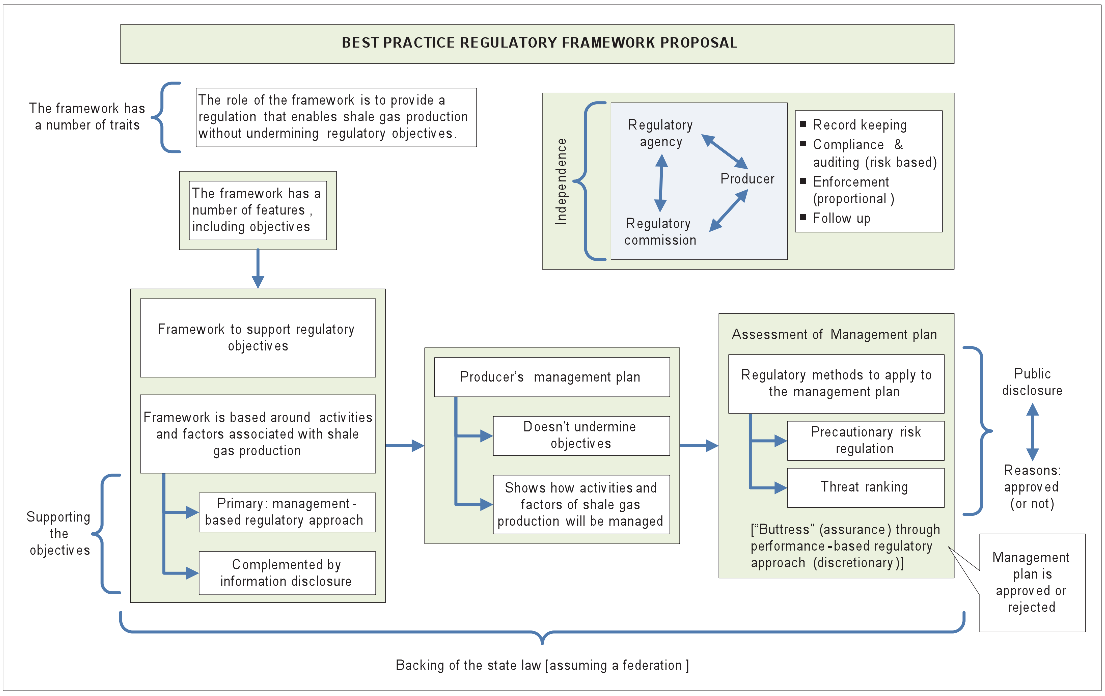

Figure 1 Best Practice Regulatory Framework Proposal[515]

31 Objectives, activities, factors and traits

31.1 Regulatory objectives

Collectively the objectives of the proposed regulatory framework provide the raisons d'être for the framework. The objectives must:[516]

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515 For a full page rendition of the diagram refer to Appendix A.

516 These objectives (some modified) are sourced from: South East Australia Gas Pty Ltd, 'Statement of Environmental Objectives' (Statement, 14 December 2009) 6–7 <http://www.misa.net.au/__data/assets/pdf_file/0017/123560/OHSE-MAN-001-Statement_of_Environmental_Objectives__SEO__Rev.4.pdf>. The statement has a number of environmental objectives for the development phases: construction, operation, and decommissioning (some of the objectives are applicable to more than one development phase); and from New South Wales Environment Protection Authority, *Waste and Resource Recovery — Appendix A: Facility Planning* (13 June 2013)

- Protect natural water resources, ground and surface (including drinking water)
- Protect flora and fauna considered to be in need of active protection
- Protect heritage and culturally sensitive sites, and areas considered to be of high environmental value
- Manage, to a level that is as low as is reasonably practicable (LARP), the risk of noise, atmospheric emissions, seismic activity, disturbance to third party interests, and the risk to health and safety of persons (irrespective of whether they are involved in the shale gas production)
- Take all reasonable steps that are foreseeable for the prevention of harm to the environment generally, and
- Take all reasonable steps to secure and maintain a social licence to operate.[517]

Where ambiguity exists in the interpretation and/or application of the regulatory objectives, the regulatory agency will make a determination, but only after consulting the producer and any third party the regulatory agency considers appropriate.

31.2 Activities of shale gas production

The primary activities of shale gas production must be managed appropriately for the regulatory objectives to be met. The producer is required to address the activities in its draft management plan for the regulatory agency's consideration. The activities are shown in the table below.[518]

<http://www.epa.nsw.gov.au/waste/envguidlns/compostinga.htm>.

[517] A social licence is required, as without it, third party 'activism' could undermine the regulatory objectives.

[518] The table is for illustrative purposes only; for example, activities such as the management of noise and air quality are not included.

Table 2: Activities critical to achieving objectives of the regulatory framework[519]

Activity	Environmental loading source as a result of the activity
Development of site and drill preparation	▪ Site traffic ▪ Construction of roads, well pads, pipelines, ponds and buildings
Vertical drilling	▪ Drilling equipment at surface ▪ Drilling underground ▪ Casing ▪ On-road and off-road vehicle activity ▪ Use of recycled drilling fluids ▪ Use of surface water and groundwater ▪ Venting and flaring methane ▪ Storage and subsequent disposal of drilling fluids ▪ Accidental releases from well (eg blowouts) ▪ Disposal of drill solids and cuttings
Horizontal drilling	▪ Drilling equipment at surface ▪ Drilling underground ▪ Cementing and casing ▪ On-road and off-road vehicle activity ▪ Use of surface water and groundwater ▪ Venting and flaring methane ▪ Storage and subsequent disposal of drilling fluids ▪ Use of recycled drilling fluids ▪ Disposal of drilling fluids ▪ Accidental releases from well (eg blowouts) ▪ Disposal of drill solids and cuttings
Hydraulic fracturing and completion	▪ Use of surface water and groundwater ▪ Well casing and cementing ▪ Hydraulic fracture propagation ▪ Introduction of proppant ▪ Flushing of wellbore ▪ Flow back of reservoir fluids ▪ Venting and flaring methane

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[519] The loadings are not unique to a particular activity. For example, the use of surface and groundwater is a loading for vertical drilling, horizontal drilling, and hydraulic fracturing and completion.

The table is sourced (and moderately modified) from Sheila M Olmstead, 'Managing the Risks of Shale Gas: Identifying a Pathway toward Responsible Development' (Presentation, Center for Energy Economics and Policy, Resources for the Future, 14 November 2011) <http://www.rff.org/Documents/Events/Seminars/111114_Managing_the_Risks_of_Shale_Gas/Olmstead%20Nov%2014%20FINAL.pdf>.

	▪ Storage of fracturing fluids at drill site ▪ Use of recycled fracturing fluids ▪ On-road and off-road vehicle activity ▪ Fracturing equipment operation ▪ Accidental releases from well (eg blowouts) ▪ Seismic activity
Well production and operation[520]	▪ Well production and operation ▪ Well production ▪ Compressor operation ▪ Condensate tank, dehydration unit operation ▪ Venting of methane ▪ Flaring of methane ▪ Escape of (fugitive) methane ▪ Accidental releases from wellbore (eg blowouts)
Water (flow-back, produced water storage and disposal, surface and ground, aquifer)	▪ On-site pit or pond storage ▪ On-site tank storage ▪ Transport off-site ▪ On-site treatment and re-use ▪ Treatment, release by industrial wastewater treatment plants ▪ Treatment, release by municipal wastewater ▪ Removal of sludge and other solids to landfills ▪ Deep underground injection ▪ Application of wastewater for road de-icing, dust suppression ▪ Spraying of produced water on forested land ▪ Tilling of produced water
Shutting-in, plugging and abandonment (legacy)	▪ Surface and groundwater contaminated through fluid migration ▪ Disposal methods generally and their effectiveness
Work-overs	▪ Well casing permits flow back ▪ Seepage from well ▪ Gas migration ▪ Blowouts

31.3 Factors to consider

While the producer and regulatory agency must focus upon the activities, the following factors must also be considered, and any implications for the regulatory

[520] While water-related issues are referred to in separate parts of the table, a water management plan is required that addresses all foreseeable issues in an integrated way.

objectives addressed. There may be some overlap with the activities.[521] Any overlap is to be reconciled in a manner that is most likely to achieve the regulatory objectives.

The factors are:

- Cultural values
- Geological profile
- Identification and profile of ground and surface water
- Environmental track record of the producer
- How a social licence will be achieved and maintained
- The footprint of the proposed production, including the number of multiple wells to be drilled from a common pad (and the number of common pads). This factor also requires consideration of the total number of wells and well pads, and the estimated contiguous surface area disturbance
- Locality of the proposed production in relation to specific human activity (for example, schools, urban development)
- Proposed technology
- Cumulative impacts
- Contingency planning, and
- Legacy management

[521] There, however, may be factors whose characteristics are unique to (in its broadest sense) the production site. These need to be addressed in a manner that is directed to meeting the regulatory objects.

31.4 Traits

Underpinning the proposed regulatory framework are specific traits. For instance, if the framework failed to be flexible and durable, regulatory amendments would be needed as the framework lacked the capacity to meet the demands of a changing industry, and that of a specific production site. Amendments would be burdensome, risking the emergence of patchwork regulation and a failure to appreciate the endogeneity problem. The traits are:[522]

- **De novo**: the framework avoids the assumption that the regulation for conventional gas has the capacity to effectively regulate shale gas production, or that the regulation can be adjusted or modified to account for shale gas
- **Object focused**: there are a number of objectives, all of which have been identified as important and particularly vulnerable to the activities of shale gas production. The objectives are why the framework exists. If one or more of the objectives are not met, and this is attributable to shale gas production, the framework has failed and best practice has not been achieved
- **Regulatory approaches and regulatory methods**: the approaches provide a mechanism to support the achievement of the objectives, and the methods provide the regulator with the assurance it needs
- **Flexible and durable ('future proofed')**: the producer and the regulatory agency need to manage, on a regular basis, the activities of shale gas production and any emerging issues
- **Independent**: The funding mechanisms for the regulatory agency and regulatory commission must be structured so that budgets cannot be used to undermine or coerce the decision-making of the regulatory agency or commission

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[522] Environment Protection Authority Victoria 'Compliance and Enforcement Policy' (Publication No 1388, State Government of Victoria, Australia, June, 2011) 5, 12 <http://www.epa.vic.gov.au/~/media/Publications/1388.pdf> (modified). The characteristics have been adapted from Peter Mumford, 'Best Practice Regulation — Setting Targets and Detecting Vulnerabilities' (2011) 7(3) *Policy Quarterly* 36, 37 <http://ips.ac.nz/publications/files/f34b30a11f9.pdf>; and R Finkelstein above n 451. Some of the characteristics have been developed by the author.

- **Integrated**: when regulation is undertaken in a piece-by-piece reactive manner, it is likely to result in a 'collection' of incoherent regulation'. The objectives are the focal point of the framework; the regulatory intervention will be integrated and planned, reducing the risk of the 'endogeneity problem'

- **Transparent and accountable**: for the framework to have credibility, third parties, including the public, will have access to relevant information and the ability to have input before a decision is finalized

- **Compliance (audits and enforcement)**: Third party audits (scheduled, unscheduled, and spot) will be undertaken to assess the level of compliance with the management plan. A risk-based model to auditing is recommended as it allocates resources to areas most needed to protect the objectives. A risk-based approach requires targeting, where past history of compliance, including the number and type of incidences, determine the extent to which a producer is targeted. It is the responsibility of the auditor, relying upon their expertise and the auditing results, to determine the level of risk posed. The regulatory agency can then determine a proportionate response. If an audit shows that a producer poses a serious risk, such as failure (or likelihood of failure) to comply with all or part of their management plan, the regulatory agency has available a range of enforcement mechanisms.[523] The aim is to target enforcement resources to areas

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[523] 'Enforcement tools range from those at the light end of the spectrum (written warnings or instructions), to the middle (enforceable undertakings) and finally to the heavy end (civil penalties and criminal prosecution). The method(s) of enforcement used depend on a variety of circumstances, such as: the range of tools available to a particular regulator (as the enforcement; powers of regulators differ); the seriousness of the breach of regulation; whether it is necessary to immediately stop the contravention; whether this is the first breach by the regulated entity; whether the offending entity is likely to comply voluntarily; the enforcement strategy that will be the most efficient and cost-effective in the circumstances'. Victorian Competition and Efficiency Commission, 'Victoria's Regulatory Management System — Research Supporting the VCEC Inquiry into Victoria's Regulatory Framework' (Research Paper, Government of Victoria, Australia) 13–14 <http://www.vcec.vic.gov.au/CA256EAF001C7B21/WebObj/Victoriasregulatorymanagementsystem16February/$File/Victoria%20s%20regulatory%20management%20system%2016%20February.pdf>; OECD (2010), *Better Regulation in Europe: United Kingdom* (OECD Publishing, 2010) 125.

posing the most risk to the objectives.[524] One approach to compliance and enforcement is to:

> Speak softly and carry a big stick, [which] is an appropriate aphorism for today's environmental regulator, but to be effective there must be certainty that the big stick can and will be used and the how, why and where of its use. It is the anticipation of enforcement action that confers the ability to deter.[525]

- **Systematic and assessment**: A systematic approach is used to reduce subjectivity in decision-making by the regulatory agency. The robustness of the proposed management plan needs to be assessed for its capacity to meet the regulatory objectives. The precautionary risk regulation and the threat ranking methods provide a systematic means of determining vigour and subjectivity, and
- **Proximity**: the proposed framework is state-based (assuming a federal system) or otherwise unitary-based, which enhances immediacy between the regulatory agency, the producer and the public. Immediacy promotes the achievement of a social licence, and ensures that the benefits and burdens of the regulation are

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524 For instance, the failure to manage generator noise within an acceptable level will attract less regulatory 'attention' (enforcement) than would the failure to implement an effective wastewater management system.

525 Rob White and Diane Heckenberg, 'Legislation, Regulatory Models and Approaches to Compliance and Enforcement' (Briefing Paper No 6, School of Sociology and Social Work, University of Tasmania, July 2012) 19 <http://www.utas.edu.au/__data/assets/pdf_file/0006/278007/Briefing_Paper_6_-_Laws_Regulation_Enforcement.pdf> quoting B Robinson, 'Review of the Enforcement and Prosecution Guidelines of the Department of Environmental Protection of Western Australia' (Perth: Communication Edge, 2003). The approach is appropriate as it recognizes that for a regulatory agency to be effective it must build a rapport, without which the agency loses the capacity to influence — a 'soft' approach is conducive to achieving this. However, the approach is sufficiently broad to give respective agencies the ability to calibrate, so when implemented, it reflects the nature of the environment, the communities, and industry.

close to the relevant parties (regulator, producer and immediate communities).[526]

32 The regulatory approach for the proposed framework

The framework has a number of features, including a combination of regulatory approaches: management-based regulation, which is used to source the information from the producer; information disclosure, being an elementary form of management-based regulation; and performance-based regulation — to provide greater accountability if there is a particular issue regarding a producer, such as a history of poor compliance or there are doubts remaining regarding the robustness of the management plan.

The approaches help to achieve the following:

> Societies form regulations through an ongoing negotiating process that seeks to reconcile the often-conflicting objectives of governments and stakeholders (such as companies, consumers, unions, and environmental organizations), many of which have considerable influence. Successfully navigating this process can allow companies not only to manage regulatory risk but also to shape their industries and to create potential opportunities for themselves.[527]

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[526] The approach to proximity is reflected in other ways within the petroleum industry. For example, the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) (Australia) has a national as opposed to a state-by-state approach to offshore environmental activities. This may be attributable to the petroleum being offshore, and the authority resulting from a commission of inquiry into a blowout on a wellhead platform leading to a very significant oil and gas leak occurring on a drilling platform in August 2009. However, it is arguable that having a regulator 'closer' to production in this instance also has merit given there is already geographical distance between the regulator and the regulated. For further information see NOPSEMA's website: http://www.nopsema.gov.au/

[527] Scott C Beardsley, Denis Bugrov and Luis Enriquez, 'The Role of Regulation in Strategy — Companies Have Everything to Gain From Linking Them' [2005] (4) *The McKinsey Quarterly* 1, 1 <http://www.executivesondemand.net/managementsourcing/images/stories/artigos_pdf/estrategia/The_role_of_regulation_in_strategy.pdf>.

32.1 Management-based regulation

There are a number of forms of management-based regulation. Management-based regulation might be relatively unsophisticated; as simple as requiring those being regulated to submit an unequivocal statement on what has been planned to meet the regulatory objectives. A more onerous management-based regulation is likely to involve the regulated to evaluate its processes, think laterally to identify techniques or provide strategies intended to meet those objectives requiring further attention, including assessing the practicality of what is being proposed. When the process is completed the results (being the draft management plan) are submitted to the regulatory agency for appraisal and approval.[528] It is the more onerous management-based approach that is used for the framework.

The management plan provides 'measures for evaluating and refining the firm's management with respect to the stated social [regulatory] objective[s]. These plans sometimes are made subject to approval or ratification by government regulators ...'[529]

The emphasis of management-based regulation is on reviewing and planning processes, and establishing a set of internal initiatives intended to meet the regulatory objectives.[530] By way of example:

- Using management-based regulation in the shale gas industry will require the regulatory agency to determine the criteria for planning, as well as the general parameters for a process (regulatory objects are protected from the activities of shale gas production, which is demonstrated in the management plan), and

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528 Lori D Snyder, 'Are Management-Based Regulations Effective?: Evidence from State Pollution Prevention Programs' (Regulatory Policy Program Working Paper No RPP–2003–21, Center for Business and Government, John F Kennedy School of Government, Harvard University, 2003) 4 <http://www.hks.harvard.edu/m-rcbg/research/rpp/RPP-2003-21.pdf>.

529 Cary Coglianese and David Lazer, above n 230, 694.

530 Neil Gunningham and Darren Sinclair, 'On the Limits of Management Based Regulation' (Working Paper No 69, Australian National University, July 2009) 4 <http://regnet.anu.edu.au/sites/default/files/WorkingPaper_69.pdf>.

- The regulatory agency certifies (and enforces) that private [producer's] behaviour is consistent with the regulatory agency's requirements.

The regulation recognizes that producers are more likely to have a better understanding than the regulator of its practices, the risks arising, and how risks could be mitigated.[531] Management-based regulation requires the producer to review its production practices and establish a set of goals and procedures that will reduce the specified harm at issue (for instance, water contamination) and, in doing so, meet the objective(s). The regulatory approach is a rejection of prescription as it is inflexible and unresponsive, and therefore is incapable of managing variation, which is characteristic of shale gas production.[532]

The regulatory approach is most likely to succeed in situations where there is a degree of heterogeneity among an industry's regulated entities. The greater the heterogeneity amongst the group of regulated entities, the more appropriate it is to have greater non-uniformity in the regulation, which is a quality of the regulation:

> Management-based regulations will also yield non-uniform changes in environmental performance, since each plant develops its own pollution prevention plan and voluntarily decides whether to undertake activities that follow from that plan.[533]

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[531] Cary Coglianese and Jennifer Nash 'Leveraging the Private Sector: Management-Based Strategies for Improving Environmental Performance' (Regulatory Policy Program Report No RPP-06-2004, Center for Business and Government, John F. Kennedy School of Government, Harvard University, 2004) 3 <http://www.hks.harvard.edu/var/ezp_site/storage/fckeditor/file/pdfs/centers-programs/centers/mrcbg/programs/rpp/reports/RPPREPORT6.pdf>.

[532] Peter J May, 'Performance-Based Regulation' (Jerusalem Papers in Regulation and Governance Working Paper No.10, Center for American Politics and Public Policy, Department of Political Science, University of Washington, Seattle, April 2010) 9 <http://regulation.huji.ac.il/papers/jp2.pdf>.

[533] Lori Snyder Bennear, 'Evaluating Management-Based Regulation: A Valuable Tool in the Regulatory Tool Box?' in Cary Coglianese and Jennifer Nash (eds) 'Leveraging the Private Sector: Management-Based Strategies for Improving Environmental Performance' (forthcoming 2005) —, 34 <http://people.duke.edu/~lds5/Papers/Bennear_RFF_Chapter.pdf>.

What is heterogeneity? Heterogeneity recognizes that things do not remain static. Rather, production sites use various technologies that change over time, the number of wells and pads of a production site alter as production progresses, and each site requires a different water management plan, which will be updated to reflect changing circumstances. Heterogeneity is a concept to be viewed over time, such as the evolution of technology. Rapid change should signal to the regulatory agency that it would be inappropriate to impose regulations that are too rigid, making them superfluous in a short period of time.[534]

Examples of heterogeneity of shale gas production include:[535]

- Communities altering their wastewater treatment requirements, along with the level of regulatory oversight, to keep abreast of expanding drilling operations. Pennsylvania, for example, has new requirements that ban produced waters from being discharged into state waters unless the water is appropriately treated.

- Increased air emissions associated with increased shale gas activities. In the Dallas–Fort Worth, Texas area, the rapid growth in shale gas wells has resulted in a significant increase in the total volatile organic compound (VOC) emissions: 'Presently, it is debatable whether oil and gas production is well suited to conventional emissions inventory approaches now employed by [US] EPA and many states.'[536]

- The Appalachia, Northern Louisiana, British Columbia, and Texas basins each having unique exploration requirements and operational challenges. 'No two shales are alike. Shales vary … even along a well bore … There are no

[534] Ibid 35.

[535] Environmental and Regulatory Subgroup of the Operations and Environment Task Group, above n 169, 7, 10.

[536] Ibid.

optimum, one-size-fits-all ... designs for shale wells.'[537]

- The hydrogeology of Arkansas's Fayetteville Shale basin is very different from Pennsylvania's Marcellus Shale. The Arkansas study suggests that variations in local and regional geology play major roles in determining the possible risk of groundwater impacts from shale gas development. As such, they must be taken into consideration before drilling begins.[538]

32.1.1 Why adopt management-based regulation?

Why is management-based regulation suitable as the primary regulatory approach of the proposed regulatory framework? As management-based regulation requires the producer to engage in management practices that are designed to achieve the objectives, it is a regulatory approach that can inform the regulatory agency of the producer's potential risk profile and capabilities. The approach gives the producer the flexibility to manage risks in its own ways, drawing upon its better understanding of its operations. The producer may promote improved solutions that are a more affordable way to address regulatory problems:

> The underlying reasoning is that the flexibility afforded to business is expected to align the firm's commercial goals with the intended social objectives and as a result induce compliance beyond what would be possible under traditional forms of regulation.[539]

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537 George E King, 'Thirty Years of Gas Shale Fracturing: What Have We Learned?' (Online preview of paper presented at SPE (Society of Petroleum Engineers) Annual Technical Conference and Exhibition, Florence, Italy, 19–22 September 2010) <http://www.onepetro.org/mslib/app/Preview.do?paperNumber=SPE-133456-MS&societyCode=SPE>.

538 Tim Lucas, 'Study Finds No Evidence of Water Contamination from Shale Gas Drilling in Arkansas' (Online Article, Nicholas School of the Environment, Duke University, Durham, North Carolina, 15 May 2013) <http://www.nicholas.duke.edu/news/study-finds-no-evidence-of-water-contamination-from-shale-gas-drilling-in-arkansas>.

539 Mohamud Hussein, Marian Garcia Martinez and Andrew Fearne, 'On The Efficiency of Management-Based Regulation: A Case Study of the UK Poultry Inspection' (Contributed Paper prepared for presentation at the 87th Annual Conference of the Agricultural Economics Society, University of Warwick, 8–10 April 2013) 2

32.2 The management plan

The purpose of the management plan is to demonstrate:

1. How the regulatory objectives will not be compromised by the production, principally through addressing all the activities of shale gas production and the regulatory factors, and

2. Why the draft management plan should be acceptable to the regulator.

As the producer is required to address every activity and factor of shale gas production, a methodical approach is advisable. The table below provides an example, by focusing upon horizontal drilling.

Table 3: An example of a management plan

Management Plan	
Component	**Description**
Specific activity and factors	Activity: *Horizontal drilling* (including the environmental loads associated with horizontal drilling, such as: the use of surface and groundwater) Factors: locality, cultural values, geology, footprint, contingency planning, proposed technology, social licence, environmental track record, contingency planning, proposed technology. (It is likely that the 'factors' will be the same for each activity).
Interaction	Groundwater

<http://www.aes.ac.uk/cms/upload_area/member_documents/Mohamud_Hussein_On%20The%20Efficiency%20of%20Management%20Based%20Regulation.pdf>; see also Cary Coglianese, 'Management-based Regulation: Implications for Public Policy' above n 228, 169–170. In summary, the regulation is appropriate when a governing body is faced with difficult-to-determine risks produced by varied organizations. The approach draws upon the superior knowledge held by the producer, as opposed to that held by the regulatory agency.

Risk to objective(s)	Water contamination (Objective: natural water resources)
Mitigation measures	Preserve water quality with multiple layers of cemented steel casings[540]
Explain how this will safeguard the objective	Consistent with an industry best practice (The producer is required to show how the best practice will be applied and evidence (if any) of its application elsewhere.)

32.3 Information disclosure (elementary forms of management-based regulation)

Regulators operate in a context where they have a concentration of power, are often appointed and not elected, and are at arm's length from government, with indirect accountability.[541] The context is the quid pro quo of independent decision-making.

A balance needs to be struck between maintaining the regulatory agency's independence, and the community having confidence that the agency's decisions are lawful. The balance will be achieved by the regulatory agency making the draft management plans available to the public for comment. When the management plan is finalized, the regulator will publish its reasoning why the plan has been approved (or not, as the case may be). Third parties will have an opportunity to review the (scheduled) updates provided by the producer to the regulator concerning how the producer is complying with the requirements of the management plan.

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540 Andrea Aguilera-Moreno, 'Conference Note: Horizontal Drilling and Completion Fall Symposium' (Online Article, University of Denver Water Law Review at the Sturm College of Law, 28 November 2012) summarizing John Jaffee, 'Niobrara Water Use and Reuse' (Presentation at Horizontal Drilling and Completion Fall Symposium, Denver, Colorado, 23 October 2012) <http://duwaterlawreview.com/conference-note-horizontal-drilling-and-completion-fall-symposium/>.

541 Georgina Lawrence, 'Who Regulates the Regulators?' (Occasional Paper No 16, Centre for The Study of Regulated Industries, School of Management, University of Bath, July 2002) 20 <http://www.bath.ac.uk/management/cri/pubpdf/Occasional_Papers/16_Lawrence.pdf>, quoting D Souter, 'A Stakeholder Approach to Regulation, British Utility Regulation: Principles, Experience and Reform' Dieter Helm (ed), Oxera, Oxford, 108.

If the purpose of the information disclosure is to change behaviour, so that a producer is willing to take responsibility for its operations and the effect the operations have externally, 'then we would consider information disclosure rules to be elementary forms of management-based regulation. The gathering of information is, after all, a necessary step in any management or planning process.'[542]

33 Regulatory method — assessing the proposed management plan

An important feature of the framework is the regulatory method, which is used by the regulatory agency to assess the rigor of the draft management plan and to minimize subjective decision-making. Two methods are primarily used: precautionary risk regulation and threat ranking.

33.1 The precautionary risk regulatory method

A modified version of *A General Model of Precautionary Risk Regulation*[543] is adopted as a regulatory method to assess the nature of the risks and threats to the objectives arising from shale gas activities. The precautionary principle plays both the 'justification' role, where the principle is used to support the case that the nature of shale gas production requires applicable regulatory intervention, and the embedded role where the principle itself is part of the proposed framework.

A characteristic of precautionary risk regulation is that it analyses threats and risks. It does so through the following phases:

- Screening

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[542] Cary Coglianese and David Lazer, above n 230, 695; Cary Coglianese, 'Management-based Regulation: Implications for Public Policy' above n 228, 166.

[543] Ortwin Renn and Andrew Stirling, 'The Precautionary Principle: A New Paradigm for Risk Management and Participation' (Paper presented at Environmental Economics and Sustainable Development Seminar, Paris, 27 January 2004) <http://www.iddri.org/Publications/Collections/Idees-pour-le-debat/id_0403_renn&stirling.pdf>.

- Appraisal, and
- Management: where management instruments are selected for inclusion in the draft management plan, to reflect the outcome of applying precautionary risk regulation (modified).

The precautionary risk regulation is illustrated in the following diagram and explained below.

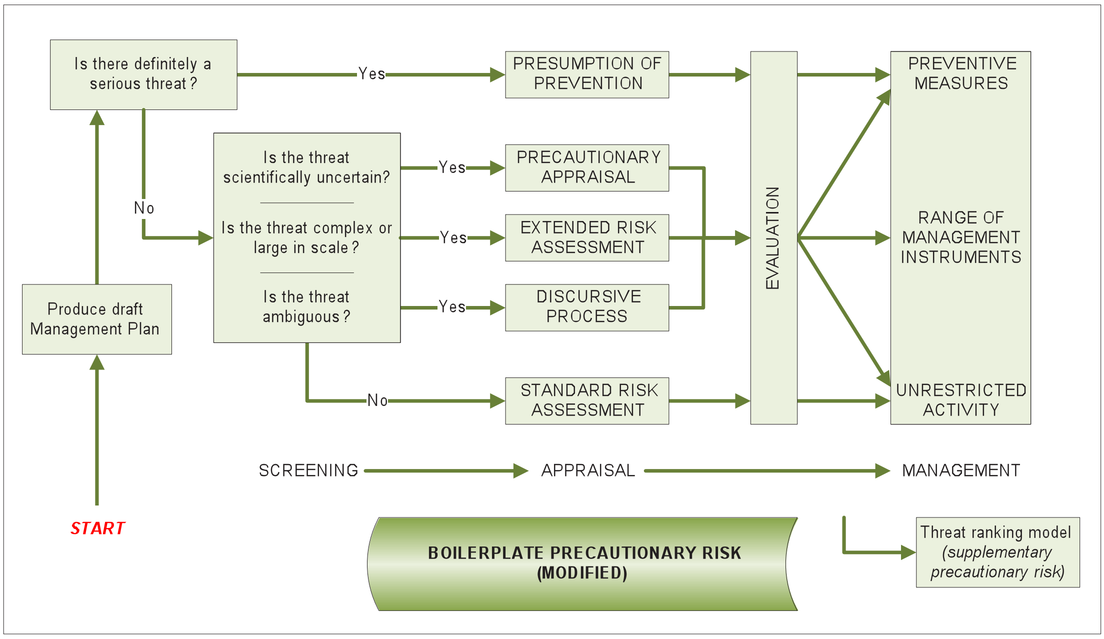

Figure 2 Precautionary Risk Regulation[544]

33.1.1 Stage one: Screening[545]

The screening stage is intended to identify the key features of the threat. The features are relied upon to select the appropriate approach in the appraisal stage.

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544 Adapted from Ortwin Renn et al, *Precautionary Risk Appraisal and Management — An Orientation for Meeting the Precautionary Principle in the European Union* (Europäischer Hochschulverlag GmbH & Co. KG, 1st ed, 2009) 28. For a full page rendition of the diagram refer to Appendix B.

545 For illustrative purposes the activities of shale gas production are referred to/applied, the factors are not.

1. Does the activity definitely pose a serious threat?

The first step in the screening stage is to determine whether the activity definitely poses a serious threat to the objectives. The determination is important because if the activity is so serious, then a very cautious regulatory response from the regulatory agency is likely to lead to a very cautious response by the regulatory agency in order to protect the objectives.

Renn and others describe 'seriousness' as the inherent potential of a risk agent to produce damage to the environment or human wellbeing. Examples are exposure-based hazard criteria such as persistency (the continuance of an effect after its cause is removed), bio-accumulation (the build-up of substances such as pesticides in a life form), or cause-effect related criteria such as carcinogenicity and mutagenicity. Fracturing fluids might be deemed serious. 'Alternatively, in areas where robust applicable data exists, seriousness may refer to risk-based thresholds, such as mortality rates from rail accidents or injury rates in the construction sector.'[546]

There are three other types of threats that need to be identified, these being whether the risk is:

- Scientifically uncertain
- Complex or large in scale, or
- Ambiguous.

2. Is the threat scientifically uncertain?

A threat is likely to be scientifically uncertain where there is a reduction in the level of confidence in the calculated cause and effect ('trail of dominoes'). A reduction in confidence could be due to inconsistency in responses to the same stimuli, the inability to measure with precision, or a lack of understanding and general ignorance.[547] For example, the failure of a well casing could be such a threat.

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546 Ortwin Renn and Andrew Stirling, above n 543, at 4.

547 Ibid 7.

The means of screening a risk for its degree of scientific uncertainty is the examination of the applicability of probabilistic risk assessment techniques in any given case. Risk is determined by two factors: how often a particular hazard might arise and how much harm is likely to result.[548] Determining whether probabilistic risk assessment is applicable involves asking questions about the standing of theoretical frameworks, the presence of substantive innovation or unprecedented characteristics in the processes adopted, and the sufficiency and applicability of the relevant models and data sources. Where any of these criteria are activated, a precautionary appraisal is undertaken.[549]

3. Is the threat complex or large in scale?

A threat may be of such scale or complexity that it warrants regulatory intervention even though it is not serious or scientifically uncertain. The potential sources of the threat are activities that are cumulative or involve populations being exposed to potential harm, or where there is the potential for damage that exceeds important thresholds. For example, noise levels and air quality could pose such a threat: 'Where any one of these filters is activated, then the threat in question is assigned to "extended risk assessment" in [a] subsequent regulatory appraisal.'[550]

4. Is the threat ambiguous?

A threat may seem benign because it is not serious, scientifically uncertain or off-scale, but could nevertheless be perceived as having socio-political implications thereby creating ambiguity. Whether the threat is ambiguous may be determined by assessing whether it is linked to institutional conflict, political mobilization, or perceptions of disastrous harm or strong media interest. Should such circumstances exist then a discursive process, such as legal deliberations and innovative participatory approaches, is applicable as part of determining an appropriate

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[548] 'Probabilistic risk assessment (PRA) systematically looks at how the pieces of a complex system work together to ensure safety. PRA allows analysts to quantify risk and identify what could have the most impact on safety.' Office of Public Affairs, 'Probabilistic Risk Assessment' (Fact Sheet, United States Nuclear Regulatory Commission, October 2007) 1 <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/probabilistic-risk-asses.pdf>.

[549] Ortwin Renn and Andrew Stirling, above n 543, 7.

[550] Ortwin Renn and Andrew Stirling, above n 543, 8.

regulatory response. Issues associated with a social licence to operate could be such a threat. All remaining threats can then be treated in a standard way through risk assessment processes applied to most threats.[551]

33.1.2 Stage two: Appraisal

The appraisal stage is intended to gather sufficient information (type, scope and quality) to make an informed regulatory decision. Much of the information relied upon is sourced from the screening stage as the screening indicates the characteristics of the threat.

1. Presumption of prevention

The appraisal of threats assessed as serious is likely to be relatively straightforward as the model deems that these threats are so serious they need to be subject to preventive measures. Nevertheless, the model provides that an appraisal can still take place in order to determine whether there are mitigating factors that warrant 'conditional relaxation' of regulatory restrictions. For instance, there may be countervailing risks, over-riding benefits or unavoidable constraints on control that justify fewer regulatory controls.[552]

2. Precautionary appraisal

Where the threat is screened as being scientifically uncertain, the activity is subject to a precautionary appraisal — but without the implication that preventive measures apply, although regulatory intervention is likely to be needed to meet the objectives. The principle being that in the face of doubt or lack of knowledge one can 'justify a more thorough and comprehensive approach to regulatory appraisal before reaching a verdict on the appropriate management measures.'[553]

3. Extended risk assessment

A threat that has been screened as a large-scale or complex risk is subsequently

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551 Ibid 7.

552 Ortwin Renn et al, above n 544, 37–38.

553 Ibid 39.

appraised using an extended risk assessment. This form of assessment is considered appropriate given there is no scientific uncertainty at issue and therefore can be depicted by probabilistic techniques.

But what would an 'extended' risk assessment require?

> In such cases, regulatory appraisal uses conventional methods (including systematic modelling and safety margins) applied in a transparent and accountable fashion by interdisciplinary groups of external independent specialists.[554]

Moreover, a thorough analysis of all facets of the threat is involved, undertaken by interdisciplinary groups comprising independent experts.[555]

4. Discursive process

Where a threat is ambiguous (particularly relating to socio-political issues), it is appraised using a discursive process. If the threat is *not* considered ambiguous, then a 'standard' risk assessment is applied.

Like an extended risk assessment (and a standard risk assessment), there is no authoritative meaning of what a discursive process might entail. Nevertheless, there seems to be some agreement that the process includes:[556]

- Accessibility (in the sense that all affected and interested parties have full access to the procedure)
- Flexibility in scope (nothing is ruled out) and how participants can express their views
- Reflection (all angles that bear down on the threat are considered), and
- Transparency (a process of documentation so that parties can understand how the various aspects relate to each other).

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[554] Ortwin Renn and Andrew Stirling, above n 543, 8.

[555] Ortwin Renn et al, above n 544, 41.

[556] Ortwin Renn et al, above n 544, 42–3.

5. Standard risk assessment

Where the threat is not serious, scientifically uncertain, complex or large in scale, or ambiguous, a 'standard' risk assessment is applied. Characteristics of such an assessment are likely to include a straightforward appraisal using probabilities and magnitudes, performed in-house and, where it is assumed that regulatory approval will be given, subject to management input.[557]

33.1.3 Stage three: Management stage

The result of the appraisal stage and the ensuing evaluation determines which management instruments are deemed appropriate. When the draft management plan is applied to the precautionary risk regulation and the result is different to that proposed in the plan, appropriate management instruments will be applied so that plan is consistent with the outcomes of applying the precautionary risk regulation. These instruments range from 'preventive' measures, such as prohibitions or phasing-out activities, to 'permissive' activities — those that are regulatory unrestricted, or something 'in between'. However, 'there is no implication that any one will necessarily lead to any one form of management measure.'[558]

It is practical to assume that all mechanisms ordinarily associated with regulation are considered management instruments that can be adopted to support the objectives. Instruments are designed to manage the outcome of applying the modified precautionary risk regulatory method. For example, the proposed activity of 'site and drill preparation' outlined in a producer's management plan may be considered an 'ambiguous threat' requiring the threat to be subject to a 'discursive process', and making it very probable that management intervention would be needed. The intervention is likely to be in the form of 'mid-range instruments' in terms of their level of restriction to safeguard the objectives. While these instruments are frequently considered non-regulatory (such as the industry's best practice on water

[557] Ortwin Renn and Andrew Stirling, above n 543, 8.

[558] Ibid 9.

management), when used in the approved plan they have the force of regulation.[559]

A further example of a management instrument is Tasmania's Environmental Protection Notice (EPN), which is used as a regulatory tool. The EPN has two roles: to ensure industry compliance with standards and to act as a proactive tool, compelling compliance to reduce the risk of an environmental detriment.[560] A form of EPN could be used as a management instrument to meet the objectives.

Finally, the Australian Petroleum Production and Exploration Association Ltd has a code of practice for hydraulic fracturing.[561] If the regulatory agency considered it important to manage the risks of fracturing, and the producer had not included the code in their draft management plan, the regulatory agency could require the producer to include the code as a management instrument.

33.1.4 The objectives and precaution

The objectives recognize the risks posed by shale gas production remain uncertain and potentially broad (for example, the potential risks to aquifers). The uncertainty makes it problematic to determine an appropriate policy response. The objectives are precautionary in the sense that they are intended to provide a means to aid the protection of certain values until there is a better understanding of what the risks of shale gas production are. When this is achieved, as part of the policy response, the objectives may be reviewed, with the presumption that if an objective is amended, it will provide the same level of protection. Part of the precautionary risk model recognizes the potential for threats that are scientifically uncertain, thereby requiring a precautionary appraisal. However, what the model does not explicitly require is

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559 Jackie Robinson and Sean Ryan, 'A Review of Economic Instruments for Environmental Management in Queensland — CRC for Coastal Zone, Estuary and Waterway Management' (Paper, School of Economics and School of Law, University of Queensland, June, 2002) iii <http://www.ozcoasts.org.au/pdf/CRC/economic_instruments.pdf>.

560 Tasmania Environment Protection Authority, *Regulatory Tools* <http://epa.tas.gov.au/regulation/regulatory-tools>.

561 Australian Petroleum Production & Exploration Association, 'Western Australia Onshore Gas — Code of Practice for Hydraulic Fracturing' (Code of Practice, Western Australia Onshore Gas) <http://wa-onshoregas.info/sites/wa-onshoregas.info/files/APPEA_Code_of_Practice.pdf>.

that the burden of overcoming the threat potential shifts (solely) to the producer, which is at least one way the precautionary principle can be applied.[562]

The precautionary principle has been seen as vague and incapable of providing solutions. There is potential that any action based upon ‘precaution’ could unjustifiably prevent or delay an industrial process as its indistinct characteristics and inability to provide answers give it scope to be relied upon in this way.[563] However, given the principle is embedded in the precautionary risk regulatory method, as opposed to it being the sole means for determining possible detriment, there is less chance that the precautionary principle will become a delaying tactic.

33.2 The threat ranking model

In addition to the precautionary risk regulatory method, threat ranking is used as another form of regulatory assessment method. Threat ranking provides quantified information to the regulatory agency. Threat ranking is a practice that introduces a systematic process using criteria to determine the degree to which a regulatory objective is threatened. ‘In essence, the formula states that risk (the possibility that “bad things might happen”) [*eg groundwater contamination*] is a function of a threat (a source of harm or attack) [*eg drilling and reservoir fluids*] acting on a

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[562] See Noah M Sachs, ‘Rescuing the Strong Precautionary Principle from its Critics’ [2011] (August) *University Of Illinois Law Review* 1285, 1295 <http://illinoislawreview.org/wp-content/ilr-content/articles/2011/4/Sachs.pdf>. ‘... strong Precautionary Principle suggests that some precautionary regulation should be a *default response* (emphasis in original) to serious risks under conditions of scientific uncertainty. Such regulation could range from a blanket prohibition on a proposed technology or a dangerous activity to less aggressive defaults, such as use restrictions or warning requirements. Furthermore, whereas weak versions are primarily concerned with the timing of *governmental* (emphasis in original) decision making, *the Strong Precautionary Principle explicitly places the burden on the private proponent of the risk-creating activity to overcome the default by proving that risks are acceptable or reasonable* (emphasis added).’: at 129. There are number of definitions of the Precautionary Principle: see, eg, Annette Weier and Paul Loke, above n 249, 5.

[563] Stephen M Gardiner, ‘A Core Precautionary Principle’ (2006) 14(1) *The Journal of Political Philosophy* 33, 33 <http://www.public.iastate.edu/~jwcwolf/Papers/Gardiner%20on%20Precautionary%20Principle.pdf>.

vulnerability (a weakness or deficiency in controls) [*eg substandard well casing*].'[564]

Once the precautionary risk regulation method has been applied to the management plan, including deciding upon the appropriate management instruments, threat ranking is used. Threat ranking determines whether the outcome of applying the precautionary risk regulation method to the management plan is defensible (justifiable), including the management instruments proposed, and if it is not defensible, the regulatory agency would review the proposed management instruments.

33.2.1 Criteria for Threat Ranking [565]

Scope — the *proportion* to which the objective(s) will be expected to be detrimentally affected given the continuation of current circumstances and trends. The proportion (scope) of the objective(s) affected by the threat is reflected numerically (see below). For example, if a threat is likely to have a widespread detrimental effect on one or more of the objective(s), then this threat is deemed 'high', which is numerically[566] reflected as a '3' and indicates 31–70% of the objectives are likely to be affected.

4 = Very High: The threat is likely to be pervasive in its scope (71–100%).

3 = High: The threat is likely to be widespread in its scope (31–70%).

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564 Cynthia A Bonnette, 'Assessing Threats to Information Security in Financial Institutions' (GSEC Certification Assignment Paper, Information Security Reading Room, SANS Institute 9 July 2003) 1 <http://www.sans.org/reading_room/whitepapers/threats/assessing-threats-information-security-financial-institutions_1143>.

565 Sourced and modified from World Wildlife Fund (WWF) Programme Standards, 'Resources for Implementing the WWF Project & Programme Standards — Step 1.4 Define: Threat Ranking' (Standards, WWF Global, July 2007) 3 <www.panda.org/standards/1_4_threats_ranking/>.

566 The numbers assigned from 1–4 and the corresponding percentage range are illustrative only, so that the method can be demonstrated. Like the precautionary risk regulation, the threat ranking approach will require qualified and experienced individuals to formulate and apply the method.

2 = Medium: The threat is likely to be restricted in its scope (11–30%).

1 = Low: The threat is likely to be very narrow in its scope (1–10%).

Severity — within the scope, severity is the *level of damage* to the objective(s) from the threat that can reasonably be expected given the continuation of current circumstances and trends. In the same way that the scope is measured numerically, so is the potential severity of the threat.

4 = Very High: Within the scope, the threat is likely to destroy or eliminate the objective(s), and the level of destruction or elimination can be quantified as between 71–100% within ten years.

3 = High: Within the scope, the threat is likely to seriously degrade or reduce the objective(s) by 31–70% within ten years.

2 = Medium: Within the scope, the threat is likely to moderately degrade or reduce the objective(s) by 11–30% within ten years.

1 = Low: Within the scope, the threat is likely to only slightly degrade or reduce the objective by 1–10% within ten years.

Irreversibility (*permanence and impact*) — the degree to which the effects of a threat can be reversed and the objective(s) (or part thereof) be restored.

4 = Very High: The effects of the threat cannot be reversed; it is very unlikely the objective(s) can be restored and/or it would take more than 100 years to achieve.

3 = High: The effects of the threat can technically be reversed and the objective(s) restored, but it is not practically affordable and/or it would take 21–100 years to achieve this.

2 = Medium: The effects of the threat can be reversed and the target restored with a realistic commitment of resources and/or within 6–20 years.

1 = Low: The effects of the threat are easily reversible and the target can be easily restored at a relatively low cost and/or within 0–5 years.

A range will need to be developed as a tolerance scale for the regulatory agency. For example, a scale of one–ten could be used where, for instance, a range of 'nine–ten' would be a definitely serious threat; 'seven–eight', a scientifically uncertain threat; 'five–six', a complex or large scale threat; 'three–four', an ambiguous threat; and 'one–two', all other threats.

Example: threat classification — what a *definitely serious threat* might be

If the sum of the assigned numbers (threshold) for *scope* and *severity* reach or surpass what is considered to be a *definitely serious threat* for one of the activities in the draft management plan, but when the same activity was applied to the precautionary risk regulatory model it had not been assessed as such a significant threat, but something 'less', then the management instruments would be reappraised as they are deficient to meet the objectives.[567]

33.3 Performance-based regulation

In one sense management-based regulation has similar qualities to performance-based regulation because the required planning and management practices for each are intended to achieve a specific type of outcome, such as reducing the risk of water contamination from industrial activity. Like performance-based regulation, management-based regulation gives flexibility and discretion to producers to manage risk: 'Management-based regulation directs regulated organizations to engage in a planning process that aims toward the achievement of public goals, offering firms flexibility in how they achieve public goals.'[568]

But unlike performance-based regulation, which imposes an obligation to attain a specified outcome, management-based regulation requires the regulated entity to take part in certain management practices that are intended to achieve the

567 Alternatively, what could be considered a *definitely serious threat* could be met by adding the numeric value for *irreversibility* (for the activity being assessed) to the sum of *scope* and *severity*.

568 Cary Coglianese and David Lazer, above n 230, 691.

outcome.[569]

In the thesis, performance-based regulation does not assist with the development of the management plan; rather it is adopted by the regulator to assess the robustness of the plan and provide an assurance that the draft plan is consistent with the objectives. In this sense, performance-based regulation is performing the role of a regulatory method, not a regulatory approach.[570] The regulation acts as a 'buttress' to the regulatory methods of the precautionary risk regulation and threat ranking[571] by imposing applicable outcomes on the producer, in association with the draft management plan, once the other two regulatory methods have been applied. The regulation can be used by applying quantifiable requirements to monitor performance or by developing criteria for assessing performance.[572] The application of performance-based regulation would be discretionary, applied when a producer has a poor history of compliance or the robustness of a draft plan is questionable.

34 Other considerations of the proposed framework

34.1 Backing of the law

The draft management plan, when approved by the regulatory agency, will become a regulation. The regulations will be promulgated under the enabling legislation, which establishes the overall regulatory arrangements.

Where the regulatory agency and producer cannot reach agreement over the draft management plan or any other matter under the enabling legislation, either party may seek a determination from the regulatory commission.

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569 Cary Coglianese, 'Management-based Regulation: Implications for Public Policy' above n 228, 166.

570 Ibid.

571 Ibid 176.

572 Adapted from United States Nuclear Regulatory Commission, *Background and Staff Guidance* (3 January 2013) <http://www.nrc.gov/about-nrc/regulatory/risk-informed/concept/performance.html#process>.

34.2 Funding source

A contentious and challenging issue is how to fund the regulatory agency and commission. The regime should not be subject to the whims of third parties, including politicians. Such behaviour can compromise the regulatory agency and regulatory commission's capacity to carry out their responsibilities independently[573] 'and [the funding regime] can limit their ability to obtain expert legal or technical advice, or to thoroughly investigate a controversial statement or stance by a regulated service provider'[574] and:

> The source of a regulatory authority's funds and the process by which these funds become part of the authority's actual budget can directly impact the degree of a regulator's autonomy and competence when carrying out its responsibilities.[575]

The regulatory agency will have the statutory authority to collect revenue from producers. There will be a number of fee types, including payments by producers for annual licences. The licence will be a flat price, with additional 'loadings' depending upon the size of the operation and the assessed risk to one or more of the regulatory objectives. Penalties for the lack of compliance and the cost of enforcement will be struck at the time of the incidence. Appropriations from the treasury (tax funding) will complement revenue from the fees. The funding through taxation is intended to supplement any funding shortfall as revenue obtained from fees will fluctuate in any given year. The regulatory agency will lodge a budget-funding bid to the treasury for assessment. The bid will ultimately be approved (or otherwise) by the legislature, not

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573 The attributes of independence will be: a clear legal mandate; capacity to make decisions within the agency's legal mandate without fear or favour; protection from arbitrary removal of office; staggered terms that do not coincide with the election cycle; ability to hire staff at above public service salaries (if required); and ring-fenced and secure funding. Ashley C Brown, 'The Funding of Independent Regulatory Agencies — A Special Report to the Public Utilities Commission of Anguilla' (Report, Harvard Electricity Policy Group, John F Kennedy School of Government, Harvard University) Appendix G *xix* <http://www.hks.harvard.edu/hepg/Papers/AnguillaPUC.pdf>.

574 Georgina Lawrence, above n 541, 27.

575 International Telecommunications Union, *ICT Regulation Toolkit — Financial Independence regulation toolkit (5.1.2)* <http://www.ictregulationtoolkit.org/en/Section.2114.html>.

the government.

The regulatory commission will receive a percentage of the revenue the regulator receives from annual licences, as opposed to other types of fees, which are more likely to create a conflict of interest. The percentage will be specified in statute and an independent auditor will verify that the level of funding is appropriate. To deal with fluctuations in revenue, the regulatory commission will have the statutory power to bid for additional funding from the legislature, through the treasury.

Establishment funding to support the regulatory agency and the regulatory commission in the early years will be required; funding that will be specified in the enabling legislation, to maintain independence. Funding through taxation is likely to be the source. A sunset clause will be used as an incentive to achieve self-funding.

The overall funding approach is intended to promote independence, where decision-making is free from inappropriate influence and the cost of regulation is borne, where practicable, by those using the framework.[576]

34.3 Federal government

The framework does not include a role for the federal government. State-based regulation means the regulator is close to the activity the regulation is intended to manage and 'subsumes all or most of the costs and benefits of the activity to be

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[576] Ashley C Brown, above n 573, 4 <http://www.hks.harvard.edu/hepg/Papers/AnguillaPUC.pdf>; the points have been paraphrased. There are a number of different commentaries regarding the different funding models. The following extract may assist as a generally summary: 'There are two primary vehicles used by countries to fund a regulator's budget. One source of funding is a formal allocation from the government's budget. This approach, however, may permit a greater role of the elected government in directing regulation as well as establishing policies to support the overall economic goals of a country. A second approach is to allow the regulator to collect monies from the industry through fees and contributions. Regulators may receive payments from operators … licensing fees, penalties resulting from enforcement, or charges associated with administrative tasks such as providing numbering resources. Some countries assess special taxes on telecommunication operator revenues (in addition to income taxes imposed by the treasury), of which a portion is often earmarked for universal service purposes.': at Ibid.

regulated.'[577]

Regulatory agencies that function at the state level are more likely to have good knowledge of local conditions and community expectations,[578] which means they have the potential to develop relevant policies and be efficient at discharging their responsibilities:

> In addition, federal regulation may not always be the most effective way of assuring the desired level of environmental protection. Therefore, most of these federal laws have provisions for granting primacy to the States, which have usually developed their own sets of regulations.[579]

When there is both federal and state involvement, there is the potential for confusion. An example is the regulations for High-Volume Hydraulic Fracturing (HVHF) being proposed by the DEC (the New York State regulator). The regulator had to determine whether the Federal Government had promulgated laws for HVHF. The State concluded that there was no federal regulatory program covering HVHF.[580] Furthermore:

> There is no federal regulatory framework over HVHF, although in April 2012, [US] EPA finalized air emission standards ... There are no applicable Federal standards for groundwater protection. Thus, the proposed revised rules exceed minimum federal government standards.[581]

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577 David Spence, 'Is It Time for Federal Regulation of Shale Gas Production?' above n 482, 1–2.

578 Alan J Krupnick and Nathan Richardson, 'Shale Gas, Federalism, and First Principles' (Online Article, Common Resources, 23 July 2012) <http://common-resources.org/2012/shale-gas-federalism-and-first-principles/>.

579 J Daniel Arthur, Bruce Langhus, and David Alleman, above n 384, 11.

580 New York State Department of Environmental Conservation, 'Revised Regulatory Impact Statement Summary — High-Volume Hydraulic Fracturing — 6 NYCRR Parts 52, 190, 550-556, 560, and 750' (Statement Summary) <http://www.dec.ny.gov/docs/administration_pdf/summaryrevisedris.pdf>.

581 Ibid.

Those in favour of a role for federal regulation refer to a number of issues:[582]

1. The inability of states to adequately address risks that are not contained within a respective state, such as air and water pollution (often referred to as 'spillovers'). Spillovers can be addressed by the state legislature, through a law which places a presumption of liability upon the state where the spillover originated. The law allows the affected state to take remedial action, and is subsequently reimbursed for all actual and reasonable costs.

2. The risk of the 'race to the bottom' exists, where states try to outbid each other by reducing regulatory compliance to attract industry and investment. Because shale gas is not a scarce commodity in the shale states, the plentiful supply reduces the incentive to compete. If there is a 'race to the bottom', federal intervention, through passing more stringent regulation, may prompt states to compensate by lowering standards in other areas of their economy to attract industry:

> Proponents of federal environmental standards argue that the competition for industrial development creates a 'race to the bottom' in which states relax their own environmental standards to avoid losing business to states with more 'business-friendly' regulations.[583]

Graham argues that the race to the bottom concept is overly simplistic in contemporary society:[584]

- Business rarely decides where to locate based on the nature of a state's environmental requirements

- Politics are such that it is more likely that environmental issues will get a fair

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[582] David Spence, 'Is It Time for Federal Regulation of Shale Gas Production?' above n 482, 1–2.

[583] Matthew Potoski, 'Clean Air Federalism: Do States Race to the Bottom?' (2001) 61(3) *Iowa State University Public Administration Review* 335, 335 <http://www.cherrycreekschools.org/Schools/CherryCreek/Departments/Social%20Studies/Documents/Clean%20Air%20and%20Federalism.pdf>.

[584] Mary Graham, 'Environmental Protection & the States: "Race to the Bottom" or "Race to the Bottom Line"?' (Online Article, Brookings Institution, Winter 1998) <http://www.brookings.edu/research/articles/1998/12/winter-environment-graham>.

hearing, independent of federal action, and

- In a dynamic economy, there is increasing awareness that environmental measures can aid economic prosperity.

3. There are other possible benefits of federal involvement:[585]

- The potential for regulatory capture is minimized
- Economies of scale are taken advantage of
- Well-qualified people are attracted and retained, and
- An opportunity to formulate better policy responses is provided.

Regulatory capture is nebulous concept. In the political spectrum, some see regulation as a tool used to favour private interests and not the wider public, not seeing it possible 'that a regulator might seek "not to maximize his [sic] own utility, but to find the 'public interest' or 'common good'."'[586] Regulation has been captured, but not in the interests of the public. Alternatively, there are libertarians who consider the regulatory state as something to be limited, in so doing, curtailing regulatory capture.[587] If regulatory capture is not nebulous, its effects can be mitigated through practical measures: no one person is permitted to make important decisions, such as the approval of a management plan, without the scrutiny of a peer; peer review will be complemented by staff rotation, so that no one employee becomes 'entrenched' in their role, which could affect their ability to make independent decisions; and undertaking random reviews of files.

The concept of economy of scale is challenging to demonstrate and measure. Nevertheless, any additional costs of having state-based agencies would be outweighed by the benefits of agencies being closer to those using and those affected by the framework; these arrangements are likely to be more efficient. Having well-qualified people can be achieved through providing personal and professional

[585] Alan J Krupnick and Nathan Richardson, above n 578.

[586] Jodi Short, 'The Paranoid Style in Regulatory Reform' above n 211, 27 quoting James M Buchanan and Gordon Tullock, 'The Calculus of Consent: Logical Foundations of Constitutional Democracy' (1962) 20.

[587] Ibid.

development, and competitive salaries, supplemented by internships with other regulatory agencies.

35 Conclusion

> *A ride on the road to serfdom entails recognition that… '[t]he capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectively rational behavior in the real world.*[588]

The rapid expansion of shale gas production offers drawbacks and benefits at the same time, meaning the expansion is a mixed blessing. Shale gas production has many (and in some instances arguable) qualities: the capacity to provide a country with energy security, the potential to act as a source for a bridging fuel until a 'greener' global energy resource is developed, and a catalyst for significant job growth.

Production that is unsatisfactorily managed will lead to problems. Threats to water quality, air and noise pollution, potential seismic activity, and pressure upon infrastructure are some of the drawbacks. Individually they have the potential to cause harm, and cumulatively their effects could be considerable. Poor management will increase the community's cost of subsidizing shale gas production, eventually leading to the withdrawal of the social licence to operate. Effectively, shale gas production would be contributing to its own demise.

The primary purpose of regulation is to alter behaviour in a predetermined way. Rather than viewing regulation pejoratively, the thesis considers it helpful, whilst acknowledging that regulation is not without its imperfections, including unintended

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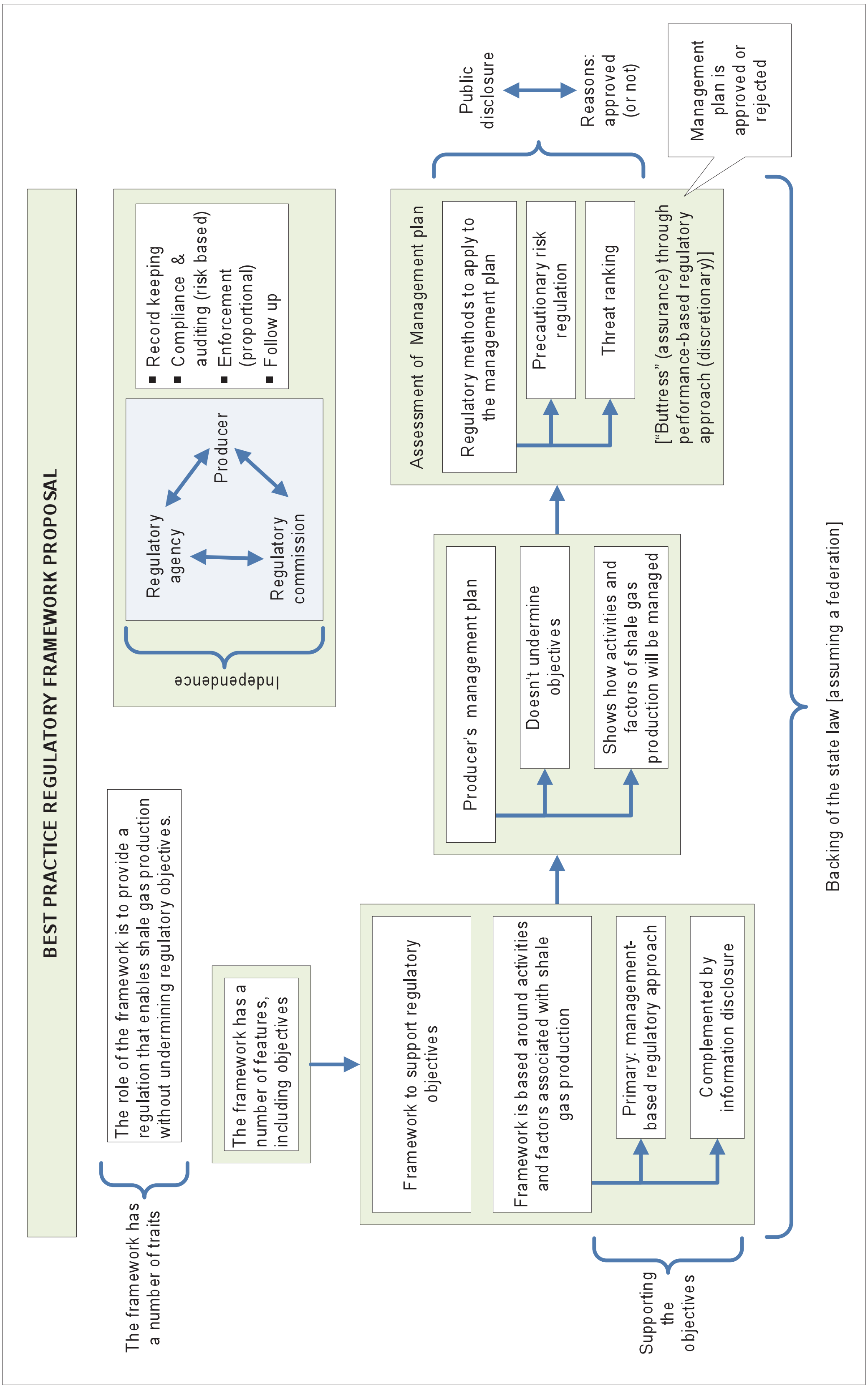
[588] Barak Orbach, above n 260, quoting Herbert Simon, Models of Men 198 (1957) (defining bounded rationality). In 'The Road to Serfdom', Friedrich Hayek acknowledged that the 'adequate organization of certain institutions like money, markets, and channels of information … can never be adequately provided by the private enterprise — but it depends, above all, on the existence of an appropriate legal system.' He nevertheless argued that '[i]t is by no means sufficient that the law should recognize the principle of private property and freedom of contract.' Friedrich A Hayek, 'The Road to Serfdom' (Bruce Caldwell ed., 2007) 87.

consequences and unreasonable regulatory burden.

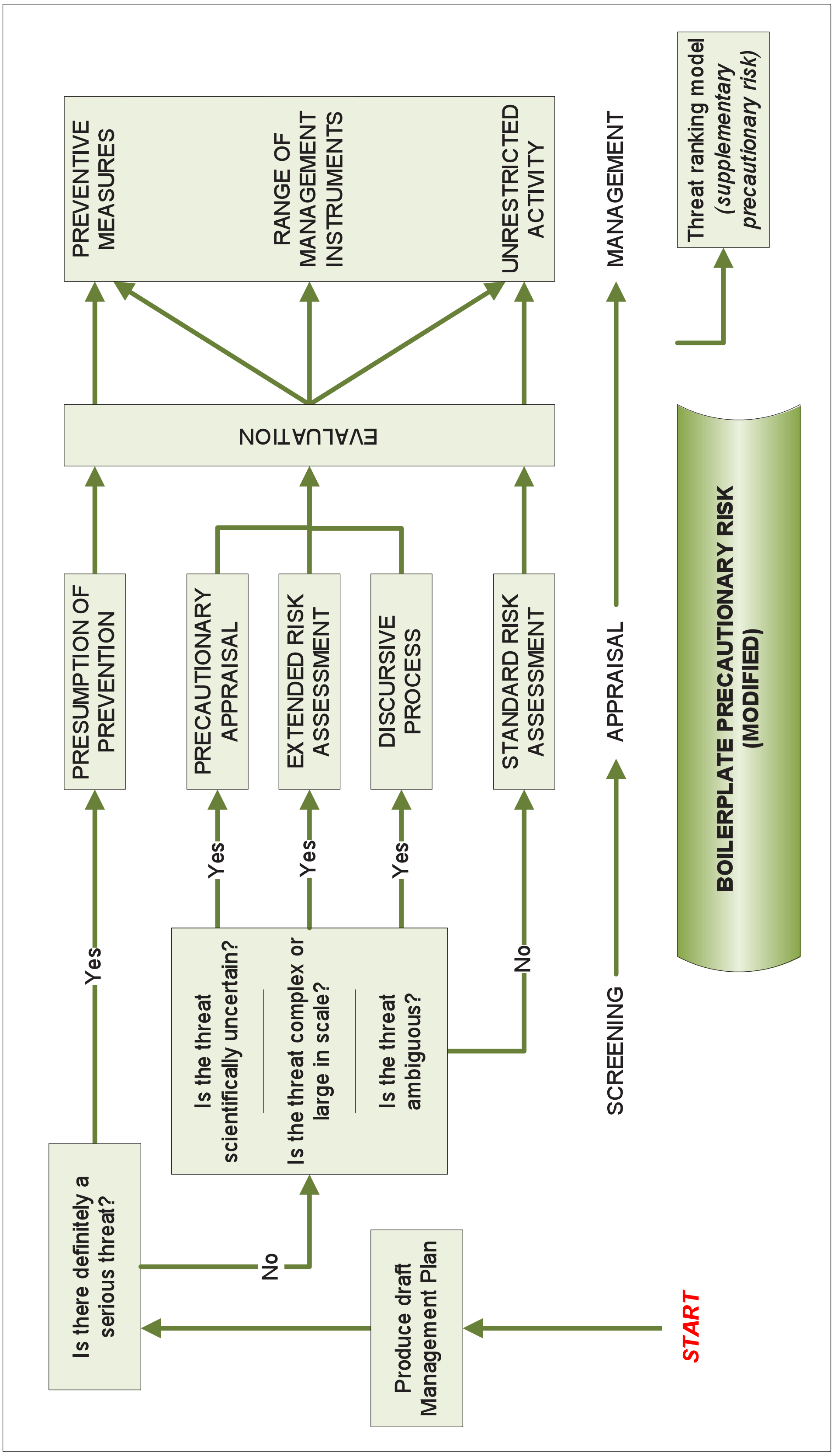
The premise of the thesis is if regulatory best practice is to be achieved, a framework is needed. The framework requires a new beginning, as it is unsatisfactory to rely upon conventional gas regulation, or upon adjusting that regulation, to regulate shale gas production. The framework is proposed in the thesis.

The proposed framework has numerous features. There are regulatory objectives, which are matters of special significance and are particularly vulnerable to shale gas production. The purpose of the framework is to ensure that the activities of shale gas production are undertaken consistent with the objectives. When the remaining regulatory features are combined in a deliberate way, the framework is complete. The litmus test of the framework is: when shale gas production occurs, will production be consistent with the regulatory goal of meeting the objectives? Failing the test means the framework does not embody best practice.

Appendix A: Best Practice Regulatory Framework Proposal



Appendix B: Boilerplate Precautionary Risk (Modified)



Bibliography

A. Articles/Books/Reports

Aguilera-Moreno, Andrea 'Conference Note: Horizontal Drilling and Completion Fall Symposium' (Online Article, University of Denver Water Law Review at the Sturm College of Law, 28 November 2012) <http://duwaterlawreview.com/conference-note-horizontal-drilling-and-completion-fall-symposium/>

Air Quality Division 'FAQ's about Attainment & Nonattainment' (Article, 'Air Waves' Bulletin, Nebraska Department of Environmental Quality, July 2008) <http://www.deq.state.ne.us/AirWaves.nsf/cf7e4bdd49c643bf8625747f005a1515/3b00b887a2bae40b8625748e005ffbf5>

American Petroleum Institute, 'Water Management Associated with Hydraulic Fracturing' (Guidance Document No HF2, June 2010) <http://www.shalegas.energy.gov/resources/HF2_e1.pdf>

Analysis & Projections, 'Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States' (Report, United States Energy Information Administration, United States Department of Energy, 13 June 2013) <http://www.eia.gov/analysis/studies/worldshalegas/>

Andrews, Anthony et al 'Unconventional Gas Shales: Development, Technology, and Policy Issues' (Report, Congressional Research Service, 30 October 2009) <http://www.fas.org/sgp/crs/misc/R40894.pdf>

Arthur, J Daniel, Bruce Langhus, and David Alleman, 'An Overview of Modern Shale Gas Development in the United States', (Paper, ALL Consulting, 2008) <http://www.all-llc.com/publicdownloads/ALLShaleOverviewFINAL.pdf>

Arthur, J Daniel, Brian Bohm and Mark Layne, 'Hydraulic Fracturing Considerations for Natural Gas Wells of the Marcellus Shale' (Paper presented at the Ground Water Protection Council Annual Forum, Cincinnati, Ohio, 21–24 September 2008) <http://www.dec.ny.gov/docs/materials_minerals_pdf/GWPCMarcellus.pdf>

Arthur, J Daniel and Bobbi Jo Coughlin, ‘Hydraulic Fracturing Considerations for Natural Gas Wells of the Fayetteville Shale’ (Paper, ALL Consulting, 2008) <http://all-llc.com/publicdownloads/ALLFayettevilleFracFINAL.pdf>

Arthur, J Daniel et al, ‘Evaluating the Environmental Implications of Hydraulic Fracturing in Shale Gas Reservoirs’ (Paper, ALL Consulting, 2008) <http://www.all-llc.com/publicdownloads/ArthurHydrFracPaperFINAL.pdf>

Australian Petroleum Production & Exploration Association, ‘Western Australia Onshore Gas — Code of Practice for Hydraulic Fracturing’ (Code of Practice, Western Australia Onshore Gas) <http://wa-onshoregas.info/sites/wa-onshoregas.info/files/APPEA_Code_of_Practice.pdf>

Ayadi, Rym, Emrah Arbak and Willem Pieter de Groen, ‘Regulation of European Banks and Business Models: Towards a New Paradigm?’ (Report, Centre for European Policy Studies, Brussels, 26 June 2012) <http://bankingsins.eu/pdf/Bank_Regulation_in_the_EU.pdf>

Backes, Chris W and Jonathan M Verschuuren, ‘The Precautionary Principle in International, European and Dutch Wildlife Law’ (1998) 9(1) Colorado Journal of International Environmental Law and Policy 43 <http://arno.uvt.nl/show.cgi?fid=4977>

Baizel, Bruce and Dusty Horwitt, ‘Safe Drinking Water Act Should Cover Hydraulic Fracturing — Protect our Drinking Water: Close the Halliburton Loophole in the Safe Drinking Water Act’ (Fact Sheet, Oil & Gas Accountability Project, Earthworks and Environmental Working Group, 9 June 2009) <http://www.earthworksaction.org/files/publications/FS_SDWAshouldCoverFracking_lowres.pdf>

Baldwin, Robert and Martin Cave, *Understanding Regulation — Theory, Strategy, and Practice* (Oxford University Press, 1999)

Bankes, Nigel, ‘A New Approach to Regulating Unconventional Resource Plays in Alberta: The ERCB Takes a Bold Step Forward’ (Online Article, Faculty of Law, University of Calgary, 10 January 2013) <http://ablawg.ca/2013/01/10/a-new-approach-to-regulating-unconventional-resource-plays-in-alberta-the-ercb-takes-a-bold-step-forward/>

Barker, George, ‘A Framework for Regulatory Decision-Making under Uncertainty’ (Working Paper No 2, Centre for Law & Economics, Australian National University, 2008)
<http://150.203.86.5/cle/Papers/Regulation_and_Uncertainty_Conference%20.pdf
>

Baroness Deech of Cumnor, ‘Regulating the Regulators’ (Speech delivered at Gresham College, City of London, 23 May 2012)
<http://www.gresham.ac.uk/lectures-and-events/regulating-the-regulators>

Bartle, Ian and Peter Vass, ‘Self-Regulation and the Regulatory State — A Survey of Policy and Practice’ (Research Report No 17, Centre for the study of Regulated Industries, School of Management, University of Bath October 2005)
<http://www.bath.ac.uk/management/cri/pubpdf/Research_Reports/17_Bartle_Vass.pdf>

Beardsley, Scott C, Denis Bugrov and Luis Enriquez, ‘The Role of Regulation in Strategy — Companies Have Everything to Gain from Linking Them’ [2005] (4) *The McKinsey Quarterly*
<http://www.executivesondemand.net/managementsourcing/images/stories/artigos_pdf/estrategia/The_role_of_regulation_in_strategy.pdf>

Behr, Peter, ‘Safety of Shale Gas Wells up to States — And the “Cement Job”’ (Online Article, Midwest Energy News, 2 October 2012)
<http://www.midwestenergynews.com/2012/10/02/safety-of-shale-gas-wells-up-to-states-and-the-cement-job/>

Berkowitz, Michael ‘Toxic Chemicals on Tap — How Natural Gas Drilling Threatens Drinking Water’ (Report, Environment America Research and Policy Center, November
2009) <http://www.eenews.net/public/25/13089/features/documents/2009/11/04/document_gw_02.pdf>

Better Regulation Executive, ‘Reducing Regulation Made Simple — Less Regulation, Better Regulation and Regulation as a Last Resort’ (Publication, United Kingdom Government, December 2010).
<https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/31626/10-1155-reducing-regulation-made-simple.pdf>

Better Regulation Office, ‘Guide to Better Regulation’ (Guide, NSW Department of Premier and Cabinet, NSW Government, November 2009) <http://www.dpc.nsw.gov.au/__data/assets/pdf_file/0009/16848/01_Better_Regulation_eGuide_October_2009.pdf>

Boersma, Tim and Corey Johnson, ‘Risks and Potentials of the Shale Gas Revolution — Consequences for Markets and the Environment’ (Comments, Stiftung Wissenschaft und Politik, German Institute for International and Security Affairs and American Institute for Contemporary German Studies, Johns Hopkins University, 2012) <http://www.swp-berlin.org/fileadmin/contents/products/comments/2012C39_boersma_johnson.pdf>

Bonnette, Cynthia A, ‘Assessing Threats to Information Security in Financial Institutions’ (GSEC Certification Assignment Paper, Information Security Reading Room, SANS Institute 9 July 2003) <http://www.sans.org/reading_room/whitepapers/threats/assessing-threats-information-security-financial-institutions_1143>

Bounds, Gregory, ‘Challenges to Designing Regulatory’, Chapter 1 of ‘Regulatory Policy — Improving the Governance of Risk’ (OECD Publication, Organisation for Economic Co-Operation and Development (OECD), 2010) <http://www.planejamento.gov.br/secretarias/upload/Arquivos/seges/arquivos/OCDE2011/OECD_Risk.pdf>

Bowes, Stan et al, ‘Guidelines for the Preparation and Submission of an Environment Plan’ (Guidelines Document, Department of Mines and Petroleum, Government of Western Australia, 28 August 2012) <http://www.dmp.wa.gov.au/documents/ENV-PEB-177.pdf>

Brady, William J, ‘Hydraulic Fracturing Regulation in the United States: The Laissez-Faire Approach of the Federal Government and Varying State Regulations’ (Paper, Sturm College of Law, University of Denver, 2012) <http://www.law.du.edu/documents/faculty-highlights/Intersol-2012-HydroFracking.pdf>

Bramley, Matthew, 'Is Natural Gas a Climate Change Solution for Canada?' (Report, David Suzuki Foundation and the Pembina Institute, 2011) <http://www.davidsuzuki.org/publications/downloads/2011/DSF-Pembina-NatGas-web.pdf>

Broderick, John et al, 'Shale Gas: An Updated Assessment of Environmental and Climate Change Impacts' (Research Report, Tyndall Centre for Climate Change Research, University of Manchester, November 2011) <http://www.co-operative.coop/Corporate/Fracking/Shale%20gas%20update%20-%20exec%20summary%20and%20conclusions.pdf>

Brown, Ashley C, 'The Funding of Independent Regulatory Agencies — A Special Report to the Public Utilities Commission of Anguilla' (Report, Harvard Electricity Policy Group, John F Kennedy School of Government, Harvard University) <http://www.hks.harvard.edu/hepg/Papers/AnguillaPUC.pdf>

Bureau d'audiences publiques sur l'environnement, 'Sustainable Development of the Shale Gas Industry in Québec' (Report No 273 (Excerpts), Government of Québec, February 2011) <http://www.bape.gouv.qc.ca/sections/rapports/publications/bape273_excerpts.pdf>

Cameron, Linda, 'Environmental Risk Management in New Zealand — Is there Scope to Apply a More Generic Framework?' (Policy Perspectives Paper 06/06, New Zealand Treasury, July 2006) <http://www.treasury.govt.nz/publications/research-policy/ppp/2006/06-06/05.htm>

Campbell, Curtis, 'Shale Gas Issues Yield to Adroit Community Relations Efforts' (2011) 238(1) *Pipeline & Gas Journal* <http://pipelineandgasjournal.com/shale-gas-issues-yield-adroit-community-relations-efforts>

Campbell, Jon, 'Hydrofracking: Most NY treatment plants not equipped to handle wastewater' (Online Article, pressconnects.com, 15 March 2011) <http://www.pressconnects.com/article/20110315/NEWS01/103150384/Hydrofracking-Most-N-Y-treatment-plants-not-equipped-handle-wastewater?nclick_check=1>

Canadian Association of Petroleum Producers, 'The Facts on Natural Gas' (e-Newsletter 'Upstream Dialogue', 2011) <http://www.capp.ca/getdoc.aspx?DocId=217568&DT=NTV>

Canadian Association of Petroleum Producers, 'Industry Establishes Canada-wide Operating Practices for Shale, Tight Natural Gas Hydraulic Fracturing' (News Release, 30 January 2012) CAPP Hydraulic Fracturing Operating Practices (2012) <http://www.capp.ca/aboutUs/mediaCentre/NewsReleases/Pages/operating-practices-for-hydraulic-fracturing.aspx>

Canadian Association of Petroleum Producers, 'Governments Regulate Shale Gas, Industry Promotes Operating Practices' (News Release, 11 June 2012) <http://www.capp.ca/aboutUs/mediaCentre/NewsReleases/Pages/operating-practices-for-hydraulic-fracturing.aspx>

Canadian Association of Petroleum Producers, 'Guiding Principles for Hydraulic Fracturing' (Guiding Principles, December 2012) <http://www.capp.ca/getdoc.aspx?DocId=218125&DT=NTV>

Canadian Society of Unconventional Resources, 'Understanding Water and Unconventional Resources' (Information Booklet) <http://www.csur.com/sites/default/files/Understanding_Water_final.pdf>

Carbonell, Tomás, 'EPA Issues Final Emission Standards for Oil and Gas Sector' (Online Article, Van Ness Feldman, 20 April, 2012) <http://www.vnf.com/news-alerts-701.html>

Carvajal, Ana and Jennifer Elliott, 'Strengths and Weaknesses in Securities Market Regulation: A Global Analysis' (Working Paper No WP/07/259, International Monetary Fund, November 2007) <http://www.imf.org/external/pubs/ft/wp/2007/wp07259.pdf>

Cavender, Anthony B, 'Texas Law Requires Disclosure of Hydraulic Fracturing Chemicals as of February 1, 2012' (Client Alert, Pillsbury Winthrop Shaw Pittman LLP, 21 December 2011) <http://www.pillsburylaw.com/publications/texas-law-requires-disclosure-of-hydraulic-fracturing-chemicals-as-of-february-1-2012>

Christopherson, Susan and Ned Rightor, 'How Should We Think about the Economic Consequences of Shale Gas Drilling?' (Working Paper, Cornell University, May 2011) <http://www.greenchoices.cornell.edu/downloads/development/marcellus/Marcellus_SC_NR.pdf>

Clean Air Council, 'New Natural Gas Aggregation Guidance is a Regulation in Disguise and Obstructs the Purpose of the Clean Air Act' (Online Article, 22 November 2011) <http://www.cleanair.org/program/outdoor_air_pollution/marcellus_shale/clean_air_council_pa_dep_new_natural_gas_aggregation_g>

Clean Air Council, 'Clean Air Council Petitions EPA to Find that PA DEP is Failing to Properly Regulate Marcellus Shale Air Pollution' (News Release, 16 February 2012) <http://cleanair.org/program/outdoor_air_pollution/marcellus_shale/clean_air_council_petitions_epa_find_pa_dep_failing_pr>

Coglianese, Cary, 'Reducing Risk with Management-Based Regulation', (Participant Notes presented at Columbia-Wharton/Penn Roundtable on 'Risk Management Strategies in an Uncertain World', IBM Palisades Executive Conference Center, Palisades, New York, 12–13 April 2002) <http://www.ldeo.columbia.edu/chrr/documents/meetings/roundtable/pdf/notes/coglianese_cary_note.pdf>

Coglianese, Cary, 'Management-based Regulation: Implications for Public Policy' in Gregory Bounds and Nikolai Malyshev (eds), 'Risk and Regulatory Policy — Improving the Governance of Risk' (OECD Publication, Organisation for Economic Co-Operation and Development (OECD), 2010) <http://www.planejamento.gov.br/secretarias/upload/Arquivos/seges/arquivos/OCDE2011/OECD_Risk.pdf>

Coglianese, Cary and David Lazer, 'Management-Based Regulation: Prescribing Private Management to Achieve Public Goals' (2003) 37(4) *Law & Society Review* 691–730 <http://iris.lib.neu.edu/cgi/viewcontent.cgi?article=1000&context=comp_info_sci_fac_pubs>

Coglianese, Cary and Jennifer Nash ‘Leveraging the Private Sector: Management-Based Strategies for Improving Environmental Performance’ (Regulatory Policy Program Report No RPP-06-2004, Center for Business and Government, John F. Kennedy School of Government, Harvard University, 2004) <http://www.hks.harvard.edu/var/ezp_site/storage/fckeditor/file/pdfs/centers-programs/centers/mrcbg/programs/rpp/reports/RPPREPORT6.pdf>

Collins, Emily A, ‘New Withdrawals, New Impairments as Pennsylvania Develops the Marcellus Shale’ (Working Paper No 2010-34, University of Pittsburgh, October 2010) <http://ssrn.com/abstract=1699731>

Commission of the European Communities, ‘Communication from the Commission on the Precautionary Principle Brussels (Communications No COM(2000) 1, Brussels, 2 February, 2000) <http://ec.europa.eu/dgs/health_consumer/library/pub/pub07_en.pdf>

Commonwealth Scientific and Industrial Research Organisation, ‘Developing the Shale Gas Potential’ (Fact Sheet) <http://www.csiro.au/~/Media/CSIROau/Divisions/CSIRO%20Earth%20Science%20and%20Resource%20Engineering/PDFs/Developing%20the%20shale%20gas%20potential.pdf>

ConocoPhillips Natural Gas ‘Onshore US Oil and Natural Gas Regulation’ (Fact Sheet, December 2012) <http://www.powerincooperation.com/EN/Documents/11-4117%20NatGasFact-Regulations.pdf>

Considine, Timothy J, Robert Watson and Seth Blumsack, ‘The Economic Impacts of the Pennsylvania Marcellus Shale Natural Gas Play: An Update’ (Report, Department of Energy and Mineral Engineering, College of Earth and Mineral Sciences, Pennsylvania State University (24 May 2010) <http://marcelluscoalition.org/wp-content/uploads/2010/05/PA-Marcellus-Updated-Economic-Impacts-5.24.10.3.pdf>

Cooper, Roger, ‘Natural Gas Reconsidered’ (Policy Memo, Progressive Policy Institute, July 2011) <http://progressivefix.com/wp-content/uploads/2011/07/07.2011_Cooper_Natural-Gas-Reconsidered-1.pdf>

Costello, Ken, ‘Hydraulic Fracturing: Placing What We Know Today in Perspective’ (Paper, National Regulatory Research Institute, October 2011) <http://www.nrri.org/pubs/gas/NRRI_Hydraulic_Fracturing_Oct11-16.pdf>

Council on Environmental Quality, ‘A citizen’s Guide to the NEPA — Having Your Voice Heard’ (Guidebook, Executive Office of the President of the United States, December 2007) <http://ceq.hss.doe.gov/nepa/Citizens_Guide_Dec07.pdf>

Coyne, Christopher J ‘Unintended Consequences — How Regulation Changes Behaviour’ [2009] July–August *Fraser Forum* 16–17 <http://www.ccoyne.com/Unintended_Consequences_-_Fraiser.pdf>

Craig, Robin Kundis, ‘Hydraulic Fracturing (Fracking), Federalism, and the Water-Energy Nexus’ (2103) 49 *Idaho Law Review* 1–21 <http://www.uidaho.edu/~/media/Files/orgs/Law/law-review/2013-symposium/Fracking-Federalism-and-the-Water-Energy-Nexus.ashx>

Cull, Alex et al, ‘Australia: Unconventional Series — The Shale Gas Revolution Comes to Australia’ (Online Article, Norton Rose Fulbright, 19 August 2011) <http://www.mondaq.com/australia/x/143146/Renewables/Unconventional+series+The+shale+gas+revolution+comes+to+Australia>

Davey, Edward, ‘Exploration for Shale Gas’ (Written Ministerial Statement to Parliament, Department of Energy & Climate Change, United Kingdom Government, 13 December 2012) <https://www.gov.uk/government/speeches/written-ministerial-statement-by-edward-davey-exploration-for-shale-gas>

Davis, Charles, ‘The Politics of “Fracking”: Regulating Natural Gas Drilling Practices in Colorado and Texas’ (Western Political Science Association 2011 Annual Meeting Paper, Department of Political Science, Colorado State University19 April 2011) <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1766675>

Davis Vaughan, Ann and David Pursell, ‘Frac Attack: Risks, Hype, and Financial Reality of Hydraulic Fracturing in the Shale Plays’ (Report, Reservoir Research Partners and Tudor Pickering Holt & Co, 8 July 2010) <http://tudor.na.bdvision.ipreo.com/NSightWeb_v2.00/Handlers/Document.ashx?i=2ac12b4d442943a090b8b0a8c8d24114>

Department of Energy & Climate Change, 'Gas Generation Strategy' (Strategy Paper, Department of Energy & Climate Change, United Kingdom Government, December 2012) <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65654/7165-gas-generation-strategy.pdf>

Department of Mines and Petroleum 'Department of Mines and Petroleum Response to Report: "Regulation of Shale, Coal Seam and Tight Gas Activities in Western Australia"' (Report, Government of Western Australia, 31 October 2011) <http://www.dmp.wa.gov.au/documents/DMP_Response_to_Report.pdf>

Department of Mines and Petroleum, 'FAQ' (Frequently Asked Questions, Government of Western Australia, April 2012) <http://www.dmp.wa.gov.au/documents/Unconventional_Gas_in_WA_FAQ.pdf>

Department of Mines and Petroleum, 'Release of new state Petroleum Environment Regulations and Guidelines' (Notice, Government of Western Australia, 28 August 2012) <http://www.dmp.wa.gov.au/documents/ENV-PEB-179.pdf>

Department of Mines and Petroleum, 'Petroleum Fact Sheet — Environment Regulations' (Fact Sheet, Government of Western Australia, May 2013) <http://www.dmp.wa.gov.au/documents/Petroleum_environment_regulations(1).pdf>

Department of Mines and Petroleum, 'DMP sets record straight for shale and tight gas' (Online Article, Government of Western Australia, 29 May, 2013) <http://www.dmp.wa.gov.au/7105_17715.aspx>

Department of Mines and Petroleum, 'Natural Gas from Shale and Tight Rocks Fact Sheet — Water Use and Management' (Fact Sheet. Government of Western Australia) <http://www.dmp.wa.gov.au/documents/Petroleum_Water_Use_and_Management_Fact_Sheet(1).pdf>

Department of Petroleum Engineering, 'Shale Gas Consortium' (Notice, Curtin University) <https://petroleum.curtin.edu.au/local/docs/ugrg/Shale.pdf>

Department of Sustainability, Environment, Water, Population and Communities, ‘EPBC Act — Frequently Asked Questions’ (Fact Sheet, Government of Western Australia, November 2010) <http://www.environment.gov.au/epbc/publications/epbc-act-fact-sheet.html>

Department of Treasury and Finance, ‘Victorian Guide to Regulation (Guide, Government of Victoria, Australia, August 2011) <http://www.dtf.vic.gov.au/CA25713E0002EF43/WebObj/VictorianGuidetoRegulationJuly2011/$File/VictorianGuidetoRegulationJuly2011.pdf>

Devlin, Betsy, ‘Protecting Drinking Water Quality through the Clean Water Act and the Safe Drinking Water Act’ (Paper presented at Fourth International Conference on Environmental Compliance And Enforcement, Chiang Mai, Thailand, 22–26 April 1996) <http://www.inece.org/4thvol2/devlin.pdf>

Drajem, Mark and Katarzyna Klimasinska, ‘EPA Shrinking ‘Halliburton Loophole’ Threatens Obama Gas Pledge’ (News Story, Bloomberg, 1 February 2012) <http://www.bloomberg.com/news/2012-02-01/epa-shrinking-halliburton-loophole-threatens-obama-gas-pledge.html>

Dutzik, Tony, Elizabeth Ridlington and John Rumpler, ‘The Cost of Fracking — The Price Tag of Dirty Drilling’s Environmental Damage’ (Report, Environment America Research & Policy Center Fall, 2012) <http://www.environmentamerica.org/sites/environment/files/reports/The%20Costs%20of%20Fracking%20vUS.pdf>

Earthworks, ‘Frack Fluids: Injected and Left Behind’ (Fact Sheet) <http://www.earthworksaction.org/files/publications/FS_LeftBehind_lowres.pdf>

Elizabeth Nielsen, ‘Regulation, Co-regulation, or Self Regulation — What Is the Best Approach?’ (Presentation to Copolco Workshop, Prague, Czech Republic, 17 May 2004) <http://www.google.com.au/url?sa=t&rct=j&q=coregulation&source=web&cd=4&sqi=2&ved=0CDgQFjAD&url=http%3A%2F%2Fwww.iso.org%2Fiso%2Flivelinkgetfile%3FllNodeId%3D21969%26llVolId%3D-2000&ei=yOKEUP61FsiRiQeg20CgCw&usg=AFQjCNGepRpb6PlWphmpN_r-CzHz8VRLEQ&sig2=9iGdC4E_5-T6WGN_dcTMNQ&cad=rjt>

Energy And Climate Change Committee, ‘Shale Gas — Fifth Report of Session 2010–12 (Volume I)’ (Report, House of Commons, United Kingdom Parliament, 10 May 2011) <http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenergy/795/795.pdf>

Energy Project, ‘Shale Gas: New Opportunities, New Challenges’ (White Paper, Bipartisan Policy Center, January 2012) <http://www.bipartisanpolicy.org/sites/default/files/BPC%20Shale%20Gas%20Paper.pdf>

Energy Resources Conservation Board, ‘Unconventional Gas Regulatory Framework — Jurisdictional Review’ (Report No 2011–A, 28 January 2011) <http://www.ernstversusencana.ca/wp-content/uploads/2012/12/2011-03-02-ERCB-unconventional-gas-report-2011-A.pdf>

Energy Resources Conservation Board, ‘Regulating Unconventional Oil & Gas in Alberta’ (Discussion Paper, Alberta Energy Regulator, 17 December 2012) <http://www.aer.ca/documents/projects/URF/URF_DiscussionPaper_20121217.pdf>

Energy Resources Conservation Board, ‘Regulatory Document Review’ (Bulletin No 2013–07, Alberta Energy Regulator, 13 February 2013) <http://www.aer.ca/documents/bulletins/Bulletin-2013-07.pdf>

Energy Solutions Forum, ‘FRAC Act Reintroduced as Bipartisan Bill’ (Online Article, Breaking Energy, 10 May 2013) <http://breakingenergy.com/2013/05/17/frac-act-reintroduced-as-bipartisan-bill/>

Environment Protection Authority Victoria ‘Compliance and Enforcement Policy’ (Publication No 1388, State Government of Victoria, Australia, June, 2011) <http://www.epa.vic.gov.au/~/media/Publications/1388.pdf>

Environmental and Regulatory Subgroup of the Operations and Environment Task Group, ‘Evolving Regulatory Framework’ (Paper No 2-6, National Petroleum Council North American Resource Development Study, 15 September 2011) <http://www.npc.org/Prudent_Development-Topic_Papers/2-6_Evolving_Regulatory_Framework_Paper.pdf>

Environmental Defender’s Office of Western Australia (Inc) ‘Environmental Impact Assessment in Western Australia’ (Fact Sheet No 5, February 2011) <http://www.edowa.org.au/files/factsheets/pdc_eiawa.pdf>

Finkelstein, R, Independent Inquiry into the Media and Media Regulation’ (Report, Australian Government, 28 February 2012) <http://www.dbcde.gov.au/__data/assets/pdf_file/0006/146994/Report-of-the-Independent-Inquiry-into-the-Media-and-Media-Regulation-web.pdf>

Flüeler, Thomas and Hansjörg Seiler, ‘Risk-Based Regulation of Technical Risks: Lessons Learnt from Case Studies in Switzerland’ (2003) 6 (3) *Journal of Risk Research* 213–231 <https://www1.ethz.ch/uns/people/associated/thomasfl/publ/Risk_Based_Regulations.pdf>

Franks, Daniel et al, ‘Cumulative Impacts — A Good Practice Guide for the Australian Coal Mining Industry’ (Guide, Centre for Social Responsibility in Mining and Centre for Water in the Minerals Industry, Sustainable Minerals Institute, University of Queensland,
2010) <http://commdev.org/files/2648_file_CSRM_20SMI_20Good_20Practice_20Guide_20document_20LR.PDF>

Freeland, Nathaniel, ‘The Strategic Importance of Shale Gas’ (Issue Paper, Center for Strategic Leadership, US Army War College, August 2011) <http://www.csl.army.mil/usacsl/publications/IP16_11.pdf>

Gardiner, Stephen M, ‘A Core Precautionary Principle’ (2006) 14(1) *The Journal of Political Philosophy* 33–60 <http://www.public.iastate.edu/~jwcwolf/Papers/Gardiner%20on%20Precautionary%20Principle.pdf>

Gény, Florence, ‘Can Unconventional Gas Be a Game Changer in European Gas Markets?’ (Report, Oxford Institute for Energy Studies, December 2010) <http://www.oxfordenergy.org/wpcms/wp-content/uploads/2011/01/NG46-CanUnconventionalGasbeaGameChangerinEuropeanGasMarkets-FlorenceGeny-2010.pdf>

George E King, ‘Thirty Years of Gas Shale Fracturing: What Have We Learned?’ (Online preview of paper presented at SPE (Society of Petroleum Engineers) Annual Technical Conference and Exhibition, Florence, Italy, 19–22 September 2010) <http://www.onepetro.org/mslib/app/Preview.do?paperNumber=SPE-133456-MS&societyCode=SPE>

Geoscience Australia and Australian Bureau of Agricultural and Resource Economics, ‘Australian Energy Resource Assessment (Chapter 4)’ (Report No 70142, Geoscience Australia, 1 March 2010) 87 <http://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=70142> and <https://www.ga.gov.au/image_cache/GA17052.pdf>

Global Insight, ‘Measuring the Economic and Energy Impacts of Proposals to Regulate Hydraulic Fracturing’ (Report No 1, Prepared for American Petroleum Institute, 2009) <http://s3.amazonaws.com/propublica/assets/natural_gas/ihs_gi_hydraulic_fracturing_task1.pdf>

Goldman, Jennifer and Lisa Sumi, ‘How Fracturing Works’ (Fact Sheet, Earthworks, 2 February 2009) <http://www.earthworksaction.org/files/publications/Fracking_Facts.pdf>

Gradijan, Francis, ‘State Regulations, Litigation, and Hydraulic Fracturing’ (2012) 7(1) *University of Houston Law Center Environmental & Energy Law & Policy Journal* 47–85 <http://www.ourenergypolicy.org/wp-content/uploads/2012/08/02Gradijan.pdf>

Graham, Mary, ‘Environmental Protection & the States: “Race to the Bottom” or “Race to the Bottom Line”?’ (Online Article, Brookings Institution, Winter 1998) <http://www.brookings.edu/research/articles/1998/12/winter-environment-graham>

Griffiths, Mary, ‘Protecting Water, Producing Gas — Minimizing the Impact of Coalbed Methane and Other Natural Gas Production on Alberta’s Groundwater’ (Report, Pembina Institute, April 2007) <www.pembina.org/pub/1434>

Groat, Charles, ‘Separating Fact from Fiction in Shale Gas Development’ (Report (Overview), Energy Institute, University of Texas at Austin, February 2012) <http://energy.utexas.edu/images/ei_shale_gas_reg_booklet1202.pdf>

Groat, Charles G et al, ‘Fact-Based Regulation for Environmental Protection in Shale Gas Resource Development’ (Report, Institute of Energy, University of Texas at Austin, February 2012) <http://cewc.colostate.edu/2012/02/fact-based-regulation-for-environmental-protection-in-shale-gas-development/>

Ground Water Protection Council and ALL Consulting, ‘Modern Shale Gas Development in the United States: A Primer’ (Report, US Department of Energy, Office of Fossil Energy and National Energy Technology Laboratory, April 2009) <http://www.netl.doe.gov/technologies/oil-gas/publications/EPreports/Shale_Gas_Primer_2009.pdf>

Gunningham, Neil and Darren Sinclair, ‘On the Limits of Management Based Regulation’ (Working Paper No 69, Australian National University, July 2009) <http://regnet.anu.edu.au/sites/default/files/WorkingPaper_69.pdf>

Haines, Fiona ‘Regulatory Failures and Regulatory Solutions: A Characteristic Analysis of Meta-regulation’ (Conference Paper presented at Proceedings, Annual Meeting, Law and Society Association, Baltimore, Maryland, 2006) <http://dtl.unimelb.edu.au/R/U6V8IAH6NHKNDN8T1PA8UR3JVUVEKDY6K8PCRPEQF7PIVQMFPX-01506?func=dbin-jump-full&object_id=67730&local_base=GEN01&pds_handle=GUEST>

Haines, Leslie (ed), ‘Tight Gas’ (Supplementary Report, Oil and Investor, March 2006) <http://www.oilandgasinvestor.com/pdf/TightGas.pdf>

Hall, Christopher et al, ‘Developing the Marcellus Shale: Environmental Policy and Planning Recommendations for the Development of the Marcellus Shale Play in Pennsylvania’ (Report, Pennsylvania Environmental Council, July 2010) <http://www.pecpa.org/sites/pecpa.org/files/downloads/Developing_the_Marcellus_Shale_0.pdf>

Halliburton, ‘US Shale Gas: An Unconventional Resource. Unconventional Challenges’ (White Paper, July 2008) <http://www.halliburton.com/public/solutions/contents/shale/related_docs/H063771.pdf>

Hammer, Rebecca and Jeanne Van Briesen, ‘In Fracking’s Wake: New Rules Are Needed to Protect Our Health and Environment from Contaminated Wastewater’ (Report No D:12-05 A, Natural Resources Defense Council, May 2012) <http://www.nrdc.org/energy/files/Fracking-Wastewater-FullReport.pdf>

Hannah Jacobs Wiseman and Francis Gradijan, ‘Regulation of Shale Gas Development, Including Hydraulic Fracturing’ (Research Paper No. 2011-11, University of Tulsa Legal Studies, 31 October 2011) <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1953547>

Hardacre, Alan, ‘Better Regulation — What is at Stake?’ (Training Paper, European Institute of Public Administration, 2008) <http://www.eipa.eu/files/repository/eipascope/20080905132115_SCOPE2008-2_1_AlanHardacre.pdf>

Hayes, Tom, ‘Shale Gas Water Management Consortiums: Marcellus and Barnett Regions’ (Paper presented at GWPC Water/Energy Symposium, Pittsburgh, PA, 27 September 2010) <http://www.gwpc.org/sites/default/files/event-sessions/3Hayes_Tom.pdf>

Hedley Roost, ‘The Regulation of Unconventional Petroleum Exploration and Production in Western Australia’ (Online Article, Corrs, Chambers, Westgarth Lawyers, 15 May 2013) <http://www.corrs.com.au/publications/corrs-in-brief/the-regulation-of-unconventional-petroleum-exploration-and-production-in-western-australia/#ft12>

Helms, Lynn, ‘Horizontal Drilling’ 35(1) *DMR Newsletter* 1–3 <https://www.dmr.nd.gov/ndgs/newsletter/NL0308/pdfs/Horizontal.pdf>

Hippensteel, David L, ‘The RCRA Exemption for Oil and Natural Gas Exploration and Production Wastes — What You May Not Know’ (1999) 6(2) *Environmental Geosciences* 106–109

Hopey, Don, ‘EPA Criticizes State for Shale Air Pollution Rules’ (Online Article, post-gazette.com, 6 December 2011) <http://www.post-gazette.com/stories/local/state/epa-criticizes-state-for-shale-air-pollution-rules-222922/>

Horner, Robert and Corrie Clark, ‘The Evolving Regulatory Landscape of Shale Gas Development’ (Presentation given at Western Energy Policy Research Conference, Boise, Idaho, 30–31 August 2012) <http://epi.boisestate.edu/media/12971/robert%20horner%20the%20evolving%20regulatory%20landscape%20of%20shale%20gas%20development.pdf>

Horwitt, Dusty, ‘Drilling around the Law’ (Report, Environmental Working Group, 20 January 2010) <http://static.ewg.org/files/EWG-2009drillingaroundthelaw.pdf>

Howarth, Robert W, Renee Santoro and Anthony Ingraffea, ‘Methane and the Greenhouse-Gas Footprint of Natural Gas from Shale Formations — A Letter’ (2011) 16(4) *Climatic Change Journal* 679–690 <http://www.springerlink.com/content/e384226wr4160653/fulltext.pdf?MUD=MP>

Hoxtell, Wade, Michael LaBelle and Cillian O’Donaghue, ‘Dialogue Shale Gas: A Game Changer for European Energy Security?’ (Conference Report of 9th Transatlantic Energy Governance Dialogue, Central European University, Budapest, 12–13 May 2011, Central European University (CEU), The Global Public Policy Institute and The Brookings Institution, 2011) <http://www.globalenergygovernance.net/fileadmin/media/events/2011/event_2011_TEGD-9-conference-report.pdf>

Hunter, Tina, ‘Regulation of Shale, Coal Seam and Tight Gas Activities in Western Australia (Report, Faculty of Law, Bond University, July 2011) <http://www.dmp.wa.gov.au/documents/000041.jason.medd(1).pdf>

Husain, Taha Murtuza et al, ‘Economic Comparison of Multi-Lateral Drilling over Horizontal Drilling for Marcellus Shale Field Development’ (Final Project Report, Penn State University, 5 January 2011) <http://www.ems.psu.edu/~elsworth/courses/egee580/2011/Final%20Reports/fishbone_report.pdf>

Hussein, Mohamud, Marian Garcia Martinez and Andrew Fearne, 'On The Efficiency of Management-Based Regulation: A Case Study of the UK Poultry Inspection' (Contributed Paper prepared for presentation at the 87th Annual Conference of the Agricultural Economics Society, University of Warwick, 8–10 April 2013) <http://www.aes.ac.uk/cms/upload_area/member_documents/Mohamud_Hussein_On%20The%20Efficiency%20of%20Management%20Based%20Regulation.pdf>

Hutter, Bridget M, 'The Attractions of Risk-Based Regulation Accounting for the Emergence of Risk Ideas in Regulation' (Discussion Paper No 33, London School of Economics and Political Science. Discussion, May 2005) <http://webfirstlive.lse.ac.uk/researchAndExpertise/units/CARR/pdf/DPs/Disspaper33.pdf>

IHS Cambridge Energy Research Associates, 'Fueling North America's Energy Future: The Unconventional Natural Gas Revolution and the Carbon Agenda' (Special Report, IHS Cambridge Energy Resources Associations, 2010) <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43227/1296-ihs-cera-special-report.pd>

JEA Consulting Group, 'Assessing the Federal Regulatory Landscape for Hydraulic Fracturing' (Report, 14 May, 2012) <http://jeaconsulting.com/index.php/download_file/view/92/>

Jennings, Deborah E and Andrew B Schatz, 'Marcellus Shale Drillers Face Potential Liability under Clean Air Act' (Online Publication, DLA Piper, 5 October 2011) <http://www.dlapiper.com/global/publications/Detail.aspx?pub=6304&RSS=true>

Johnson, Mike, Jim Davidson and Paul Mortensen, 'A Perspective on Canadian Shale' (Report, World Energy Council, 2009) <http://www.worldenergy.org/documents/congresspapers/248.pdf>

Jones, Judith S, 'Regulatory Design for Scientific Uncertainty: Acknowledging the Diversity of Approaches in Environmental Regulation and Public Administration' (2007) 19(3) *Journal of Environmental Law* 347–365

Kennett, Steven A and Michael M Wenig, 'Alberta's Oil and Gas Boom Fuels Land-Use Conflicts — But Should the EUB Be Taking the Heat?' (*Resources* Newsletter Article No 91, Canadian Institute of Resource Law, 2005) <http://dspace.ucalgary.ca/bitstream/1880/47049/1/Resources91.pdf>

Kenney, Robyn and Alexander Gastman, 'Clean Air Act, United States' (Online Paper, The Encyclopedia of Earth, 4 July 2012) <http://www.eoearth.org/article/Clean_Air_Act,_United_States>

Khemani, R S and D M Shapiro, 'Glossary of Industrial Organisation Economics and Competition Law' (Glossary, Organisation for Economic Co-Operation and Development, 1993) <http://www.oecd.org/dataoecd/8/61/2376087.pdf>

Kiernan, Peter, 'The Shale Gas Phenomenon: Altering the Western Discourse on Energy Geopolitics' (2010) 3(2) *Analytical Journal* 35–41 <http://www.analyticalmk.com/files/04-2010/journal_06.pdf>

Klopf, Sonja, Nada Wolff Culver and Pete Morton, 'A Road Map to a Better NEPA: Why Environmental Risk Assessments Should Be Used to Analyze the Environmental Consequences of Complex Federal Actions' (2007) 8(1) *Sustainable Development Law & Policy Journal* 38–43, 84–85 <http://digitalcommons.wcl.american.edu/cgi/viewcontent.cgi?article=1155&context=sdlp>

Kosnik, Renee Lewis, 'The Oil and Gas Industry's Exclusions and Exemptions to Major Environmental Statutes' (Report, Oil & Gas Accountability Project, Earthworks, October 2007) <http://www.earthworksaction.org/files/publications/PetroleumExemptions1c.pdf>

KPMG Global Energy Institute, 'Shale Gas — A Global Perspective' (Report, KPMG International, December 2011) <http://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Documents/shale-gas-global-perspective.pdf>

Krawiec, Kimberly D, 'Cosmetic Compliance and the Failure of Negotiated Governance' (2003) 81 *Washington University Law Quarterly* 487–544 <http://scholarship.law.duke.edu/cgi/viewcontent.cgi?article=2674&context=faculty_scholarship>

Krupnick, Alan J and Nathan Richardson, ‘Shale Gas, Federalism, and First Principles’ (Online Article, Common Resources, 23 July 2012) <http://common-resources.org/2012/shale-gas-federalism-and-first-principles/>

Kuhn, Maximilian and Frank Umbach, ‘Strategic Perspectives of Unconventional Gas: A Game Changer with Implications for EU's Energy Security’ (Strategy Paper, Vol 01 No 1, European Centre for Energy and Resource Security (EUCERS), Department of War Studies, King‘s College London, 1 May 2011) <http://www.kcl.ac.uk/sspp/departments/warstudies/research/groups/eucers/strategy-paper-1.pdf>

Kusnetz, Nicholas, EPA Plans to Issue Rules Covering Fracking Wastewater (Online Article, ProPublica, 20 October 2011) <http://www.propublica.org/article/epa-plans-to-issue-rules-covering-fracking-wastewater>

Lawrence, Georgina, ‘Who Regulates the Regulators?’ (Occasional Paper No 16, Centre for the Study of Regulated Industries, School of Management, University of Bath, July 2002) <http://www.bath.ac.uk/management/cri/pubpdf/Occasional_Papers/16_Lawrence.pdf>

Lechtenböhmer, Stefan et al, ‘Impacts of Shale Gas and Shale Oil Extraction on the Environment and on Human Health’ (Study, Directorate General for Internal Policies, Policy Department A: Economic And Scientific Policy, European Parliament 2011) <http://europeecologie.eu/IMG/pdf/shale-gas-pe-464-425-final.pdf>

Legette, Poe et al ‘Trade Secrets and the Regulation of Hydraulic Fracturing — Toward a Global Perspective’ (Guide, Norton Rose and Fullbright & Jaworski, April 2013) <http://www.nortonrosefulbright.com/files/us/images/publications/20130410TradeSecretsAndTheRegulationOfHydraulicFracturing.pdf>

Lucas, Tim, ‘Study Finds No Evidence of Water Contamination from Shale Gas Drilling in Arkansas‘ (Online Article, Nicholas School of the Environment, Duke University, Durham, North Carolina, 15 May 2013) <http://www.nicholas.duke.edu/news/study-finds-no-evidence-of-water-contamination-from-shale-gas-drilling-in-arkansas>

Lustgarten, Abrahm and Sabrina Shankman, ‘Congress Tells EPA to Study Hydraulic Fracturing’ (Online Article, ProPublica, 10 November 2009) <http://www.propublica.org/article/congress-tells-epa-to-study-hydraulic-fracturing-hinchey-1110>

Luther, Linda, ‘The National Environmental Policy Act: Streamlining NEPA’ (CRS Report for Congress, Congressional Research Service, 9 January 2007) <http://www.nationalaglawcenter.org/assets/crs/RL33267.pdf>

March, Bruce, ‘Taking Steps to Responsibly Develop Canada’s Oil and Gas’ [Winter 2011] *Imperial Oil — The Review* 4–5 <http://www.imperialoil.ca/Canada-English/Files/imperial_review2011_chairman.pdf>

May, Peter J, ‘Performance-Based Regulation’ (Jerusalem Papers in Regulation and Governance Working Paper No.10, Center for American Politics and Public Policy, Department of Political Science, University of Washington, Seattle, April 2010) <http://regulation.huji.ac.il/papers/jp2.pdf>

McClure, Susan, ‘Marcellus Shale Natural Gas: From the Ground to the Customer’ (Study Guide No 1 from ‘Marcellus Shale Natural Gas Extraction Study’, The League of Women Voters of Pennsylvania, 2009–2010) <http://www.bfenvironmental.com/pdfs/Marcellus_Shale_Study_Guide_Parts_1-5.pdf>

McKay, Lynn Kerr, Ralph H Johnson, and Laurie Alberts Salita, ‘Science and the Reasonable Development of Marcellus Shale Natural Gas Resources in Pennsylvania and New York’ (2011) 32(125) *Energy Law Journal* 125–143

Mead, Jerry V et al, ‘The Marcellus Shale Play — Impacts to Stream Ecosystems and Potential Regulation of Intensity of Mining’ (Presentation, Patrick Center for Environmental Research, Academy of Natural Sciences, Drexel University) <http://www.pinchot.org/uploads/download?fileId=955>

Medlock III, Kenneth B, Amy Myers Jaffe and Peter R Hartley, ‘Shale Gas and US National Security’, (Policy Paper, James A Baker III Institute for Public Policy, Rice University, July 2011) <http://www.bakerinstitute.org/publications/EF-pub-DOEShaleGas-07192011.pdf>

Melville, Fiona, 'Australia Shale Gas Issues Paper' (Paper, K&L GATES LLP, 1 November 2012) <http://www.klgates.com/australia-shale-gas-issues-paper/>

Memorandum of Understanding between the Department of Mines and Petroleum (Richard Sellers, Director General) and the Environmental Protection Authority (Paul Vogel, Chairman) in relation to the referral of Mineral and Petroleum (Onshore and Offshore) and Geothermal Proposals (26 June 2009) <http://edit.epa.wa.gov.au/EPADocLib/EPA-DMP-MOU.pdf>

Michler, Andrew, *Updated Cornell Study Shows Fracking Causes More Global Warming than Coal* (17 April 2012) <http://inhabitat.com/updated-cornell-study-shows-fracking-causes-more-global-warming-than-coal/>

Minerals & Geology Management, 'Energy Policy Act Of 2005 — Use Of Section 390 — Categorical Exclusions For Oil And Gas Activities' (Instructions, Forest Service, United States Department of Agriculture, 9 June 2010) <http://www.fs.fed.us/geology/June_2010%20guidance%20Sec%20%20390%20CE.pdf>

Ministerial Council on Mineral and Petroleum Resources, 'Mineral and Petroleum Exploration & Development in Australia — Roles and Responsibilities of Government — Guide for Investors' (Leaflet No 5, Australian Government) <http://www.ret.gov.au/resources/Documents/Minerals%20and%20Petroleum%20Exploration/Guide_for_%20Investors_5Government.pdf>

Moniz, Ernest J et al, 'The Future of Natural Gas' (Interdisciplinary MIT Study No 4, Massachusetts Institute of Technology (MIT), 6 June 2011) <http://mitei.mit.edu/system/files/NaturalGas_Report.pdf>

Mumford, Peter, 'Best Practice Regulation — Setting Targets and Detecting Vulnerabilities' (2011) 7(3) *Policy Quarterly* 36–42 <http://ips.ac.nz/publications/files/f34b30a11f9.pdf>

Musialski, Cécile, 'The legal & regulatory framework for shale gas exploration and exploitation activities in the EU' (Presentation delivered for Philippe Partners, Berlin, 25 October 2011) <http://frackingfreeireland.org/wp-content/uploads/2011/08/shale_gas_regulatory_framework_c_musialski.pdf>

National Energy Board/Office national de l'energie (Canada), 'A Primer for Understanding Canadian Shale Gas' (Energy Briefing Note, November 2009) http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/ntrlgs/prmrndrstndngshlgs2009/prmrndrstndngshlgs2009-eng.pdf>

National Energy Board/Office national de l'energie (Canada), 'Understanding Canadian Shale Gas' (Energy Brief, November 2009) <http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/ntrlgs/prmrndrstndngshlgs2009/prmrndrstndngshlgs2009nrgbrf-eng.pdf>

National Park Service, 'Potential Development of the Natural Gas Resources in the Marcellus Shale — New York, Pennsylvania, West Virginia, and Ohio' (Report, US Department of the Interior, December 2008) <http://www.nps.gov/frhi/parkmgmt/upload/GRD-M-Shale_12-11-2008_high_res.pdf>

Natural Resources Planning and Management, 'Categorical Exclusion under the National Environmental Policy Act (NEPA)' (White Paper, CH2M, June 2011) <http://www.ch2m.com/corporate/services/environmental_management_and_planning/assets/Abstracts/2011/CH2M-HILL-categorical-exclusion.pdf>

New York State Department of Environmental Conservation, 'Revised Draft — Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program — Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs' (Statement, New York State Government, 7 September 2011) <http://www.dec.ny.gov/docs/materials_minerals_pdf/rdsgeisexecsum0911.pdf>

New York State Department of Environmental Conservation, 'Revised Regulatory Impact Statement Summary — High-Volume Hydraulic Fracturing — 6 NYCRR Parts 52, 190, 550-556, 560, and 750' (Statement Summary) <http://www.dec.ny.gov/docs/administration_pdf/summaryrevisedris.pdf>

New, James and Marco Matteini (eds), ‘Introduction to Energy Regulation’ (Training Package, United Nations Industrial Development Organization and the Renewable Energy and Energy Efficiency Partnership) Module 3 of ‘Training Manual on Sustainable Energy Regulation and Policymaking for Africa’ s 7.1, 3.16 <http://www.unido.org/fileadmin/media/documents/pdf/training_manual_on_sustainable_energy_regulation_and_policymaking_for_Africa.pdf>

Nielsen, Elizabeth, ‘Regulation, Co-regulation, or Self Regulation — What is the Best Approach?’ (Presentation to Copolco Workshop, Prague, Czech Republic, 17 May 2004) <http://www.google.com.au/url?sa=t&rct=j&q=coregulation&source=web&cd=4&sqi=2&ved=0CDgQFjAD&url=http%3A%2F%2Fwww.iso.org%2Fiso%2Flivelinkgetfile%3FllNodeId%3D21969%26llVolId%3D-2000&ei=yOKEUP61FsiRiQeg20CgCw&usg=AFQjCNGepRpb6PlWphmpN_r-CzHz8VRLEQ&sig2=9iGdC4E_5-T6WGN_dcTMNQ&cad=rjt>

Niemi, Ernie and Paul Thoma, ‘Potential Economic Impacts of Regulations to Rein-In the External Costs of the American Oil and Natural Gas Production Industry — A Critique of Recent Reports.’ (Report prepared for the Natural Resources Defense Council, ECONorthwest, 2009) <http://docs.nrdc.org/energy/files/ene_09091001b.pdf>

The Obama Administration, ‘Blueprint for a Secure Energy Future’ (Strategic Document, The White House, Washington, 30 March 2011) <http://www.whitehouse.gov/sites/default/files/blueprint_secure_energy_future.pdf>

OECD (2010), *Better Regulation in Europe: United Kingdom* (OECD Publishing, 2010)

Ofcom (Office of Communications) ‘Identifying Appropriate Regulatory Solutions: Principles for Analysing Self- and Co-Regulation’ (Statement, 10 December 2008) <http://stakeholders.ofcom.org.uk/binaries/consultations/coregulation/statement/statement.pdf>

Office of Energy ‘Energy 2031 — Strategic Energy Initiative Directions Paper — A Smarter Energy Future for West Australians’ (Directions Paper, Government of Western Australia, March 2011) <http://www.parliament.wa.gov.au/publications/tabledpapers.nsf/displaypaper/3813100cb1e5bc616f7914cc48257855000f71a1/$file/3100-15.03.11.pdf>

Office of Federal Activities, ‘Consideration of Cumulative Impacts in EPA Review of NEPA Documents’, (Guidance, Environmental Protection Agency, May 1999) <http://www.epa.gov/compliance/resources/policies/nepa/cumulative.pdf>

Office of Fossil Energy, ‘Shale Gas Development Challenges — A closer Look’ (Fact Sheet, US Department of Energy, 2013) <http://energy.gov/sites/prod/files/2013/04/f0/shale_gas_challenges_air.pdf>

Office of Ground Water and Drinking Water ‘Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs (Final)’ (Study Report No EPA 816-R-04-003, Office of Water, United States Environmental Protection Agency, June 2004) <http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_coalbedmethanestudy.cfm>

Office of Jared Polis (Congressman), 2nd District of Colorado, ‘Polis, Cartwright Introduce Legislation to Hold Fracking Industry Accountable — Legislation Would Protect Our Water and Air’ (News Release, 14 March 2013) <http://polis.house.gov/news/documentsingle.aspx?DocumentID=323929>

Office of Public Affairs, ‘Probabilistic Risk Assessment’ (Fact Sheet, United States Nuclear Regulatory Commission, October 2007) <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/probabilistic-risk-asses.pdf>

Office of Research and Development, ‘Hydraulic Fracturing Research Study’ (Fact Sheet, United States Environmental Protection Agency, June 2010) <http://www.epa.gov/safewater/uic/pdfs/hfresearchstudyfs.pdf>

Office of Research and Development, ‘Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources: Progress Report’ (Report, Environmental Protection Agency, December 2012) <http://www2.epa.gov/hfstudy/study-potential-impacts-hydraulic-fracturing-drinking-water-resources-progress-report-0>

Office of Solid Waste, ‘Exemption of Oil and Gas Exploration and Production Wastes from Federal Hazardous Waste Regulations’ (Information Booklet No EPA530–K–01-004, United States Environmental Protection Agency, October 2002) <http://www.epa.gov/osw/nonhaz/industrial/special/oil/oil-gas.pdf>

Office of Water and Hazardous Materials, ‘The Integrity of Water’ (Proceedings of a Symposium, United States Environmental Protection Agency, Washington DC, 10–12 March 1975) <http://nepis.epa.gov/Adobe/PDF/P1004625.PDF>

Oil & Gas Accountability Project, ‘Loopholes for Polluters — The Oil and Gas Industry’s Exemptions to Major Environmental Laws’ (Fact Sheet, Earthworks, 1 June 2011) <http://www.shalegas.energy.gov/resources/060211_earthworks_fs_oilgasexemptions.pdf>

Ojo, Marianne, ‘Responsive Regulation: Achieving the Right Balance between Persuasion and Penalisation’ (Paper, Centre for European Law and Politics, University of Bremen, 19 March 2009) <http://mpra.ub.uni-muenchen.de/14170/1/MPRA_paper_14170.pdf>

Olmstead, Sheila M, ‘Managing the Risks of Shale Gas: Identifying a Pathway toward Responsible Development’ (Presentation, Center for Energy Economics and Policy, Resources for the Future, 14 November 2011) <http://www.rff.org/Documents/Events/Seminars/111114_Managing_the_Risks_of_Shale_Gas/Olmstead%20Nov%2014%20FINAL.pdf>

Orbach, Barak, ‘What is Regulation?’ (Online Article, Yale Journal on Regulation Online, 11 March 2013) <http://jreg.commons.yale.edu/what-is-regulation/#note-133-48>

Organisation for Economic Co-operation and Development, ‘The OECD Report on Regulatory Reform: Synthesis’ (Report, 1997) <http://www.oecd.org/dataoecd/17/25/2391768.pdf>

Packel, Dan, ‘Enviros Say [US] EPA Ignoring PA.'s Lax Emissions Standards’ (Online Article, Law360, 3 June 2013) <http://www.law360.com/articles/446505/enviros-say-epa-ignoring-pa-s-lax-emissions-standards>

Parker, Christine, ‘Meta-Regulation: Legal Accountability for Corporate Social Responsibility?’ (Legal Studies Research Paper No. 191, Faculty of Law, Monash University, 3 November 2006) <http://ssrn.com/abstract=942157>

Paul Kralovic, ‘North American Natural Gas Market Dynamics: Shale Gas Plays in North America — A Review’ (Study No 123, Canadian Energy Research Institute, February 2011) <http://www.ceri.ca/images/stories/Shale%20Gas%20Plays.pdf>

Penn State Extension, ‘Latest Update on Shale Oil and Gas Assessments Worldwide’ (Online Article, College of Agriculture Sciences, Penn State, 17 June 2013) <http://extension.psu.edu/natural-resources/natural-gas/news/2013/06/latest-update-on-shale-oil-and-gas-assessments-worldwide>

Penn State Extension, ‘Marcellus Shale Wastewater Issues in Pennsylvania — Current and Emerging Treatment and Disposal Technologies’ (Fact Sheet, College of Agricultural Sciences, Pennsylvania State University, April 2011) <http://extension.psu.edu/water/marcellus-shale/waste-water/current-and-emerging-treatment-and-disposal-technologies-1/marcellus-shale-wastwater-issues-in-pennsylvania-current-and-emerging-treatment-and-disposal-technologies/view>

PennFuture, ‘PennFuture Files Federal Lawsuit Against Marcellus Shale Driller Ultra Resources, Inc for Violations of Federal and State Air Pollution Laws’ (News Release, 21 July 2011) <http://www.pennfuture.org/media_pr_detail.aspx?MediaID=1324&Archive>

Perry, Kent and John Lee, ‘Unconventional Gas Reservoirs — Tight Gas, Coal Seams, and Shales’ (Working Document No 29, National Petroleum Council, 21 February, 2007) <http://www.npc.org/study_topic_papers/29-ttg-unconventional-gas.pdf>

Peterson, Deborah and Sally Fensling, ‘Risk-Based Regulation: Good Practice and Lessons for the Victorian Context’ (Paper presented at the Victorian Competition and Efficiency Commission Regulatory Conference, Melbourne, 1 April 2011) <http://www.vcec.vic.gov.au/CA256EAF001C7B21/WebObj/20110328-Risk-basedregulation-DPIpaperforVCECconference/$File/20110328%20-%20Risk-based%20regulation%20-%20DPI%20paper%20for%20VCEC%20conference.PDF>

Potoski, Matthew, ‘Clean Air Federalism: Do States Race to the Bottom?’ (2001) 61(3) *Iowa State University Public Administration Review* 335–342 <http://www.cherrycreekschools.org/Schools/CherryCreek/Departments/Social%20Studies/Documents/Clean%20Air%20and%20Federalism.pdf>

Priddle, Robert (ed), ‘World Energy Outlook [Part C — Prospects for Natural Gas]’ (Study, International Energy Agency, 2009) <http://www.worldenergyoutlook.org/media/weowebsite/2009/WEO2009.pdf>

Priddle, Robert (ed), ‘Are We Entering a Golden Age of Gas?’ (Special Report for World Energy Outlook 2011, International Energy Agency, 6 June 2011) <http://www.iea.org/weo/docs/weo2011/WEO2011_GoldenAgeofGasReport.pdf>

Quigley, John, ‘PA Is Going the Wrong Way on Gas Drilling Regulation’ (Online Article, onearth, 7 December 2011) <http://www.onearth.org/blog/pa-is-going-the-wrong-way-on-gas-drilling-regulation>

Rahm, Dianne, ‘Regulating Hydraulic Fracturing in Shale Gas Plays: The Case of Texas’ (2011) 39(5) *Energy Policy Journal* 2974–2981

Railroad Commission of Texas, ‘Railroad Commission Today Adopted New Recycling Rules to Help Enhance Water Conservation by Oil & Gas Operators’ (News Release, 26 March 2013) <http://www.rrc.state.tx.us/pressreleases/2013/032613.php>

Railroad Commission of Texas, ‘Railroad Commissioners Adopt One of Nation's Most Comprehensive Hydraulic Fracturing Chemical Disclosure Requirements’ (News Release, 13 December 2011) <http://www.rrc.state.tx.us/pressreleases/2011/121311.php>

Reeves, Scott ‘Unconventional Gas Resources to Reserves — A Predictive Approach’ (Paper presented at Rocky Mountain Geology & Energy Resources Conference, Denver, Colorado, 9–11 July 2008) <http://www.adv-res.com/pdf/Rocky%20Mountain%20G%20&%20E%20Resources%20Conference.pdf>

Regulation Taskforce, ‘Rethinking Regulation — Report of the Taskforce on Reducing Regulatory Burdens on Business’ (Report, Australian Government, January 2006) <http://www.regulationtaskforce.gov.au/__data/assets/pdf_file/0007/69721/regulation-taskforce.pdf>

Reins, Leonie, ‘The Shale Gas Extraction Process and Its Impacts on Water Resources’, (2011) 20(3) Review of European Community & International Environmental Law

Renn, Ortwin and Andrew Stirling, ‘The Precautionary Principle: A New Paradigm for Risk Management and Participation’ (Paper presented at Environmental Economics and Sustainable Development Seminar, Paris, 27 January 2004) <http://www.iddri.org/Publications/Collections/Idees-pour-le-debat/id_0403_renn&stirling.pdf>

Renn, Ortwin et al, *Precautionary Risk Appraisal and Management — An Orientation for Meeting the Precautionary Principle in the European Union* (Europäischer Hochschulverlag GmbH & Co. KG, 1st ed, 2009)

Revesz Richard L, ‘Rehabilitating Interstate Competition: Rethinking the "Race-to-the-Bottom" Rationale for. Federal Environmental Regulation’ (1992) 67(1210) *New York University Law Review* 1210–1254

Ridley, Matt, ‘The Shale Gas Shock’ (GWPF Report No 2, The Global Warming Policy Foundation, April 2011) <http://www.marcellus.psu.edu/resources/PDFs/shalegas_GWPF.pdf>

Rimington, John, Jim McQuaid and Vladimir Trbojevic, ‘Application of Risk Based Strategies to Workers Health and Safety Protection — UK Experience’ (Report, Ministry of Social Affairs and Employment, 15 May 2003) <http://www.risk-support.co.uk/SZW-published_report.pdf>

Robinson, Jackie and Sean Ryan, 'A Review of Economic Instruments for Environmental Management in Queensland — CRC for Coastal Zone, Estuary and Waterway Management' (Paper, School of Economics and School of Law, University of Queensland, June, 2002) <http://www.ozcoasts.org.au/pdf/CRC/economic_instruments.pdf>

Rowley, Peter, 'Meeting the challenge of unconventional gas' (Article, ERM Foundation, 30 April 2010) <http://www.erm.com/Analysis-and-Insight/Articles/Meeting-the-challenge-of-unconventional-gas/>

Sachs, Noah M, 'Rescuing the Strong Precautionary Principle from its Critics' [2011] (August) *University Of Illinois Law Review* 1285 <http://illinoislawreview.org/wp-content/ilr-content/articles/2011/4/Sachs.pdf>

Sakmar, Susan L, 'The Future of Unconventional Gas: Legal, Policy and Environmental Challenges to the Development of North American Shale Gas' (Paper presented at 29th USAEE/IAEE North American Conference, Calgary, Canada, 14–16 October 2010) <http://www.usaee.org/usaee2010/submissions/OnlineProceedings/Sakmar_Paper_Shale%20Gas.pdf>

Sakmar, Susan L, 'The Global Shale Gas Initiative: Will the United States Be the Role Model for the Development of Shale Gas around the World?' (2011) 33(2) *Houston Journal of International Law* 369–416 <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1927593>

Sakmar, Susan L, 'Shale Gas Development in North America: An Overview of the Regulatory and Environmental Challenges Facing the Industry', (Paper presented at 2011 Society of Petroleum Engineers North American Unconventional Gas Conference and Exhibition, The Woodlands, Texas 14–16 June 2011)

Sample, V Alaric and Will Price, 'Assessing the Environmental Effects of Marcellus Shale Gas Development: The State of Science' (Workshop Summary, Academy of Natural Sciences and Pinchot Institute for Conservation, 1 April 2011), found at <http://www.pinchot.org/gp/EffectsofMarcellusShale>

Savage, Leslie, 'New 16 Tex. Admin. Code §3.29, relating to Hydraulic Fracturing Chemical Disclosure Requirements' (Memorandum, Oil and Gas Division, Railroad Commission of Texas, 22 August 2011) <http://www.rrc.state.tx.us/rules/prop-new-3-29-frac-disclosure-Aug29.PDF>

School of International and Public Affairs, 'The FRAC Act: The Fracturing Responsibility and Awareness of Chemicals Act of 2011' (Paper, Columbia University, 17 August 2011) <http://mpaenvironment.ei.columbia.edu/sitefiles/file/Summer%2011%20reports/The%20FRAC%20Act.pdf>

School of Public Policy, 'Marcellus Shale Gas Development: Reconciling Shale Gas Development with Environmental Protection, Landowner Rights, and Local Community Needs' (Report, University of Maryland, July 2010) <http://www.ela-iet.com/EMD/MARCELLUS_SHALE_GAS_DEVELOPMENT.pdf>

Schrag, Daniel P, 'Is Shale Gas Good for Climate Change?' (2012) 141(2) *Dædalus, Journal of the American Academy of Arts and Sciences* 72–80 <http://schraglab.unix.fas.harvard.edu/publications/128_Schrag.pdf>

Segal, Jillian, 'Institutional Self-Regulation: What Should Be the Role of the Regulator?' (Speech delivered at the National Institute for Governance Twilight Seminar, Canberra, 8 November 2001) <http://www.asic.gov.au/asic/pdflib.nsf/LookupByFileName/NIGConf_081101.pdf/$file/NIGConf_081101.pdf>

Shale Gas Subcommittee, 'Ninety-Day Report' (Report, Secretary of Energy Advisory Board, 11 August 2011) <http://www.shalegas.energy.gov/resources/081111_90_day_report.pdf>

Sharif, Ali, 'Tight Gas Resources in Western Australia' (Article, Petroleum in Western Australia Magazine, September 2007) <http://www.dmp.wa.gov.au/documents/Tight-gas__Resources_in_Western_Australia.pdf>

Short, Jodi, 'Governing without Commands or Controls: The Emergence of Self-Regulation as Reform and Justification' (Paper presented at the annual meeting of the American Sociological Association, New York, New York, 11 Aug 11 2007) <http://www.irle.berkeley.edu/culture/papers/short07.pdf>

Short, Jodi, 'The Paranoid Style in Regulatory Reform' (Georgetown Public Law Research Paper No. 11-10, Georgetown University Law Center, 12 January 2011) <http://ssrn.com/abstract=1739015>

Shramko, Andrea et al, Analytical Characterization of Flowback Waters in the Field' (Paper presented at 16th Annual Petroleum & Biofuels Environmental Conference (IPEC), Houston, Texas, 3–5 November 2009) <http://ipec.utulsa.edu/Conf2009/Papers%20received/Shramko_106.pdf>

Smith, Reed, 'UK Shale Gas: Regulatory Update' (Online Article, Commodities Now, 19 March 2013) <http://www.commodities-now.com/reports/power-and-energy/14134-uk-shale-gas-regulatory-update.html>

Snyder, Lori D, 'Are Management-Based Regulations Effective?: Evidence from State Pollution Prevention Programs' (Regulatory Policy Program Working Paper No RPP–2003–21, Center for Business and Government, John F Kennedy School of Government, Harvard University, 2003) <http://www.hks.harvard.edu/m-rcbg/research/rpp/RPP-2003-21.pdf>

Snyder Bennear, Lori, 'Evaluating Management-Based Regulation: A Valuable Tool in the Regulatory Tool Box?' in Cary Coglianese and Jennifer Nash (eds) 'Leveraging the Private Sector: Management-Based Strategies for Improving Environmental Performance' (forthcoming 2005) <http://people.duke.edu/~lds5/Papers/Bennear_RFF_Chapter.pdf>

Soeder, Daniel J and William M Kappel, 'Water Resources and Natural Gas Production from the Marcellus Shale' (Fact Sheet No 2009-3032, US Geological Survey, May 2009) <http://pubs.usgs.gov/fs/2009/3032/pdf/FS2009-3032.pdf>

Soraghan, Mike, 'Oil and Gas: Puny Fines, Scant Enforcement Leave Drilling Violators with Little to Fear' (Online Article, E&E Publishing, 14 November 2011) <http://www.eenews.net/public/Greenwire/2011/11/14/1>

South East Australia Gas Pty Ltd, ‘Statement of Environmental Objectives’ (Statement, 14 December 2009) <http://www.misa.net.au/__data/assets/pdf_file/0017/123560/OHSE-MAN-001-Statement_of_Environmental_Objectives__SEO__Rev.4.pdf>

Spence, David, ‘Fracking Regulations: Is Federal Hydraulic Fracturing Regulation around the Corner?’ (Energy Management Brief, Energy Management and Innovation Center, McCombs School of Business, University of Texas at Austin, 22 September 2010) <http://www.mccombs.utexas.edu/~/media/Files/MSB/Centers/EMIC/EMIC%20Misc/Fracking-Regulations-Is-Federal-Hydraulic-Fracturing-Regulation-Around-Corner.ashx>

Spence, David, ‘Is It Time for Federal Regulation of Shale Gas Production?’ (Energy Management Brief, Energy Management and Innovation Center, McCombs School of Business, University of Texas at Austin, 19 April 2012) <http://www.mccombs.utexas.edu/centers/~/media/d4dbd2d555f740d8ae6b510d35c8d6b1.ashx>

Spence, David B, ‘Federalism, Regulatory Lags, and the Political Economy of Energy Production’ (2013) 161 *University of Pennsylvania Law Review* 431–508 <http://www.pennumbra.com/issues/pdfs/161-2/Spence-161-U-Pa-L-Rev-431.pdf>

Stark, Melissa et al, ‘Water and Shale Gas Development — Leveraging the US Experience in New Shale Developments’ (Paper, Accenture, 10 December 2012) <http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Water-And-Shale-Gas-Development.pdf>

Stevens, Paul, ‘The “Shale Gas Revolution”: Hype and Reality’ (Report, Chatham House, September 2010) <http://www.chathamhouse.org/sites/default/files/public/Research/Energy,%20Environment%20and%20Development/r_0910stevens.pdf>

Stevens, Paul, ‘The “Shale Gas Revolution”: Developments and Changes’ (Briefing Paper, Chatham House, August 2012) <http://www.chathamhouse.org/sites/default/files/public/Research/Energy,%20Environment%20and%20Development/bp0812_stevens.pdf>

Stroman, Cynthia, Drew Bell and Stephanie Salek, ‘Air and Water Woes in the Marcellus Shale’ (Article, Law360, 1 September 2011) <http://www.savecoloradofromfracking.org/harm/Resources/9-11Law360StromanBellSalek.pdf>

Sugerman, Stephen D, ‘Let’s Try Performance-Based Regulation to Attack our Smoking and Obesity Problems’ (Transcript Magazine Article, School of Law, University of California, Berkeley, Summer 2005) <http://www.law.berkeley.edu/faculty/sugarmans/Lets%20try%20Performance%20Based%20Regulation.pd>

Sumi, Lisa, ‘Shale Gas: Focus on the Marcellus Shale’ (Report, Oil & Gas Accountability Project/Earthworks, May 2008) <http://www.marcellus.psu.edu/resources/PDFs/Focusonthemarcellus.pdf>

Sumi, Lisa, ‘Environmental Concerns and Regulatory Initiatives Related to Hydraulic Fracturing in Shale Gas Formations: Potential Implications for North American Gas Supply’ (Report prepared for the Council of Canadians, Earthworks, 21 September 2010) <http://canadians.org/sites/default/files/L-Sumi-Report.pdf>

Sunset Advisory Commission, ‘Final Report — Railroad Commission of Texas’ (Report, July 2011) <http://www.sunset.state.tx.us/82ndreports/rct/rct_fr.pdf>

Sunset Advisory Commission, ‘Staff Report — Railroad Commission of Texas’ (Report, November 2012) <http://www.sunset.state.tx.us/83rd/RC/RC_SR.pdf>

Sutley, Nancy H, ‘Establishing and Applying Categorical Exclusions Under the National Environmental Policy Act’ (Memorandum for Heads of Federal Departments and Agencies, Council on Environmental Quality, Executive Office of the President of the United States, 18 February 2010) <http://ceq.hss.doe.gov/nepa/regs/Categorical_Exclusion_Draft_NEPA_Guidance_FINAL_02182010.pdf>

Taskforce on Reducing the Regulatory Burden on Business, ‘Regulation Taskforce Issues Paper (Attachment B)’ (Issues Paper, Australian Government, 25 October 2005) <http://www.regulationtaskforce.gov.au/__data/assets/pdf_file/0004/69727/issuespaper.pdf>

Thorn, Terence H, 'Environmental Issues Surrounding Shale Gas Production — The US Experience — A Primer' (Paper, International Gas Union, April 2012) <http://newgas.org.ua/sites/default/files/analytics/2012-Apr_IGU%20Environmental%20Issues%20and%20Shale%20Gas.pdf>

3Legs Resources, 'An introduction to shale gas' (Report, June 2011) <http://www.3legsresources.com/media/A%20guide%20to%20shale%20gas.pdf>

Tickner, Joel, Carolyn Raffensperger and Nancy Myers Tickner, 'The Precautionary Principle in Action' (Handbook, Science and Environmental Health Network) <http://www.mindfully.org/Precaution/Precaution-In-Action-Handbook.htm#ii>

Tiemann, Mary and Adam Vann, 'Hydraulic Fracturing and Safe Drinking Water Act Regulatory Issues' (Report, Congressional Research Service, 10 January 2013) (April 15, 2011) <http://www.fas.org/sgp/crs/misc/R41760.pdf>

Ubinger, John W et al, 'Developing the Marcellus Shale — Environmental Policy and Planning Recommendations for the Development of the Marcellus Shale Play in Pennsylvania' (Report, Pennsylvania Environmental Council, July 2010) <http://www.pecpa.org/sites/pecpa.org/files/downloads/Developing_the_Marcellus_Shale_0.pdf>

United Kingdom Onshore Operators Group, 'UK Onshore Shale Gas Well Guidelines — Exploration and Appraisal Phase' (Guidelines, Issue 1, February 2013) <http://www.ukoog.org.uk/elements/pdfs/ShaleGasWellGuidelines.pdf>

United States 111th Congress, 'Companion Bills Introduced to Protect Drinking Water from Natural Gas Fracking — American Public Deserves to Know Chemicals Used near Their Water Sources' (News Release, 9 June 2009) <http://s3.amazonaws.com/propublica/assets/natural_gas/frac_act_press_release_090609.pdf>

United States Environmental Protection Agency, 'Regulatory Determination for Oil and Gas and Geothermal Exploration, Development, and Production Wastes' (Notice of Regulatory Determination No 53 FR 25447, 6 July 1988) <http://www.epa.gov/osw/nonhaz/industrial/special/oil/og88wp.pdf>

United States Environmental Protection Agency, 'New Source Review Workshop Manual — Prevention of Significant Deterioration and Nonattainment Area Permitting' (Manual, October 1990) <http://www.epa.gov/nsr/>

United States Energy Information Administration, 'World Shale Gas Resources: An Initial Assessment of 14 Regions outside the United States' (Report, US Department of Energy, 5 April, 2011) <http://www.eia.gov/analysis/studies/worldshalegas/>

United States Energy Information Administration, 'Review of Emerging Resources: US Shale Gas and Shale Oil Plays' (Report, US Department of Energy, July 2011) <http://www.eia.gov/analysis/studies/usshalegas/pdf/usshaleplays.pdf>

United States Environmental Protection Agency, 'EPA Releases Draft Permitting Guidance for Using Diesel Fuel in Oil and Gas Hydraulic Fracturing/Guidance Will Clarify Means of Compliance with 2005 Amendments to the Safe Drinking Water Act' (News Release, 5 April 2011) <http://yosemite.epa.gov/opa/admpress.nsf/79c090e81f0578738525781f0043619b/1224e5cd2897669f852579f400697788!OpenDocument>

United States Environmental Protection Agency, 'EPA Initiates Rulemaking to Set Discharge Standards for Wastewater from Shale Gas Extraction' (Fact Sheet, October 2011) <http://water.epa.gov/scitech/wastetech/guide/upload/shalereporterfactsheet.pdf>

United States Energy Information Administration 'AEO2012 [Annual Energy Outlook] Early Release Overview' (Report, United States Energy Department) <http://www.eia.gov/forecasts/aeo/er/pdf/0383er(2012).pdf>

United States Environment Protection Agency, 'EPA's Air Rules for the Oil & Natural Gas Industry — Summary of Key Changes to the New Source Performance Standards' (Fact Sheet, 17 April 2012) <http://www.epa.gov/airquality/oilandgas/pdfs/20120417changes.pdf>

United States Environment Protection Agency, 'Overview of Final Amendments to Air Regulations for the Oil and Natural Gas Industry' (Fact Sheet, 17 April 2012) <http://www.epa.gov/airquality/oilandgas/pdfs/20120417fs.pdf>

United States Environmental Protection Agency, ‘EPA Releases Update on Ongoing Hydraulic Fracturing Study’ (News Release, 21 December 2012) <http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/4af0024955d936ef85257adb0058aa29%21OpenDocument>

United States Environmental Protection Agency, ‘Getting up to Speed: Ground Water Contamination’ (Guide) <http://www.epa.gov/region1/students/pdfs/gwc1.pdf>

United States Government Accountability Office, ‘Energy Policy Act of 2005 — Greater Clarity Needed to Address Concerns with Categorical Exclusions for Oil and Gas Development under Section 390 of the Act’ (Report to Congressional Requestors No GAO-09-872, 16 Sep 2009) <http://www.gao.gov/assets/300/295281.pdf>

US Energy Information Administration, ‘World Shale Gas Resources: An Initial Assessment of 14 Regions outside the United States’ (Report, US Department of Energy, 5 April, 2011) <http://www.eia.gov/analysis/studies/worldshalegas/>

Veil, John A et al, ‘A White Paper Describing Produced Water from Production of Crude Oil, Natural Gas and Coal Bed Methane’ (White Paper, National Energy Technology Laboratory, US Department of Energy, January 2004) <http://www.circleofblue.org/waternews/wp-content/uploads/2010/08/prodwaterpaper1.pdf>

Verrastro, Frank A et al ‘The Geopolitics of Energy — Emerging Trends, Changing Landscapes, Uncertain Times’ (Report, CSIS Energy and National Security Program, October 2010) <http://csis.org/files/publication/101026_Verrastro_Geopolitics_web.pdf>

Verrastro, Frank and Conor Branch, ‘Developing America’s Unconventional Gas Resources — Benefits and Challenges’ (A Report of the CSIS Energy & National Security Program, Center for Strategic and International Studies, December 2010) <http://csis.org/files/publication/101209_Verrastro_UncontentionalGas_Web.pdf>

Victorian Competition and Efficiency Commission, 'Victoria's Regulatory Management System — Research Supporting the VCEC Inquiry into Victoria's Regulatory Framework' (Research Paper, Government of Victoria, Australia) <http://www.vcec.vic.gov.au/CA256EAF001C7B21/WebObj/Victoriasregulatorymanagementsystem16February/$File/Victoria%20s%20regulatory%20management%20system%2016%20February.pdf>

Weier, Annette and Paul Loke, 'Precaution and the Precautionary Principle: Two Australian Case Studies' (Staff Working Paper, Productivity Commission, Australian Government, September 2007) <http://www.pc.gov.au/__data/assets/pdf_file/0005/67271/precautionaryprinciple.pdf>

Welborn, David M, 'Conjoint Federalism and Environmental Regulation in the United States' (1988) 18(1) *Publius: The Journal of Federalism* 27–43

Western Australia Environmental Protection Authority, 'Hydraulic Fracturing of Gas Reserves' (Environmental Protection Bulletin No 15, Government of Western Australia, September 2011) <http://edit.epa.wa.gov.au/EPADocLib/EPB%2015%20Fracking%20050911.pdf>

White, Rob and Diane Heckenberg, 'Legislation, Regulatory Models and Approaches to Compliance and Enforcement' (Briefing Paper No 6, School of Sociology and Social Work, University of Tasmania, July 2012) <http://www.utas.edu.au/__data/assets/pdf_file/0006/278007/Briefing_Paper_6_-_Laws_Regulation_Enforcement.pdf>

Wilson, Weston (Letter to Senators Wayne Allard and Ben Nighthorse Campbell, and Representative Diana DeGette, Denver, Colorado, 8 October 2004) <http://latimes.image2.trb.com/lanews/media/acrobat/2004-10/14647025.pdf>

Wiseman, Hannah, 'Untested Waters: The Rise of Hydraulic Fracturing in Oil and Gas Production and the Need to Revisit Regulation' (2009) 20 *Fordham Environmental Law Review* 115–169 <http://ssrn.com/abstract=1595092>

Wiseman, Hannah, ‘Regulatory Adaptation in Fractured Appalachia’ (Research Paper No. 08-10, The Centre for Global Energy, International Arbitration, and Environmental Law, The University of Texas School of Law, 1 November 2010) <http://eidmarcellus.org/wp-content/uploads/2011/08/SSRN-id159495212.pdf>

Wood, Ruth et al, ‘Shale Gas: A Provisional Assessment of Climate Change and Environmental Impacts’ (Research Report, The Tyndall Centre, University of Manchester January 2011) <http://www.tyndall.ac.uk/sites/default/files/tyndall-coop_shale_gas_report_final.pdf>

World Commission on the Ethics of Scientific Knowledge and Technology, ‘The Precautionary Principle’ (Report, United Nations Educational, Scientific and Cultural Organization (UNESCO), 2005) <http://unesdoc.unesco.org/images/0013/001395/139578e.pdf>

World Wildlife Fund (WWF) Programme Standards, ‘Resources for Implementing the WWF Project & Programme Standards — Step 1.4 Define: Threat Ranking’ (Standards, WWF Global, July 2007) <www.panda.org/standards/1_4_threats_ranking/>

Zoback, Mark, Saya Kitasei and Brad Copithorne, ‘Addressing the Environmental Risks from Shale Gas Development’ (Briefing Paper No 1, Worldwatch Institute, July 2010) <http://www.worldwatch.org/system/files/BP1.pdf>

B. Websites

Advanced Resources International, *Unconventional Gas* <http://www.adv-res.com/unconventional-gas-nonconventional-resources.asp>

American Society of Civil Engineers, *Policy Statement 539 — Hydraulic Fracturing* (20 July 2012) <http://www.asce.org/Public-Policies-and-Priorities/Public-Policy-Statements/Policy-Statement-539---Hydraulic-Fracturing/>

Bureau d’audiences publiques sur l’environnement, *Frequently Asked Questions* Government of Québec <http://www.bape.gouv.qc.ca/sections/faq/eng_faq_ind.htm#qcq>

Campbell, Cheryl, *Natural Gas: Bridging the Gap between Fossil Fuels and Renewable Energy* College of Engineering and Applied Science, University of Colorado <http://www.colorado.edu/engineering/profile/natural-gas-bridging-gap-between-fossil-fuels-and-renewable-energy>

Canadian Association of Petroleum Producers, *Natural Gas: Conventional & Unconventional* <http://www.capp.ca/CANADAINDUSTRY/NATURALGAS/CONVENTIONAL-UNCONVENTIONAL/Pages/default.aspx>

Centre for Global Energy Studies, *What is unconventional gas?* (21 Jul 2010) <http://www.cges.co.uk/news/624-what-is-unconventional-gas>

Civil Enforcement, *Clean Water Act Enforcement* (18 May 2010 United States Environmental Protection Agency <http://www.epa.gov/oecaerth/civil/cwa/index.html>

Commonwealth Scientific and Industrial Research Organisation, *Australia's Shale Gas Potential* (31 August 2012) http://www.csiro.au/Outcomes/Energy/Energy-from-oil-and-gas/Shale-gas-potential.aspx>

Corrs Chambers Westgarth, Lawyers, *An Emerging New World for the Environmental Regulation of Unconventional Gas Projects in Western Australia* (3 September 2012) <http://www.corrs.com.au/publications/corrs-in-brief/an-emerging-new-world-for-the-environmental-regulation-of-unconventional-gas-projects-in-western-australia/>

Cumulative Impacts Project, *About the Cumulative Impacts Project* <http://www.cumulativeimpacts.org/about.html>

Department for Business Innovation & Skills, *Co-regulation*, The United Kingdom Government <http://webarchive.nationalarchives.gov.uk/+/http://www.dius.gov.uk/policies/bre/better-regulation-framework/alternatives-to-regulation/choose-the-alternative/co-regulation>

Department of Environment and Resource Management, *About Coal Seam Gas* (1 April 2013) Queensland Government <http://www.ehp.qld.gov.au/management/coal-seam-gas/index.html>

Department of Mines and Energy, *What is the Difference between Conventional and Unconventional Gas?* (3 September 2012) Northern Territory Government <http://www.nt.gov.au/d/Minerals_Energy/index.cfm?header=What%20is%20the%20difference%20between%20Conventional%20and%20Unconventional%20Gas?>

Department of Mines and Petroleum, *Petroleum Service — Overview* (27 March 2008) Government of Western Australia <http://www.dmp.wa.gov.au/3816.aspx>

Department of Mines and Petroleum, *About DMP* (3 September 2009) Government of Western Australia <http://www.dmp.wa.gov.au/8494.aspx>

Department of Mines and Petroleum, *Natural Gas from Shale and Tight Rocks — Legislation* (23 May 2013) Government of Western Australia <http://www.dmp.wa.gov.au/16970.aspx>

Department of Mines and Petroleum, *Shale and Tight Gas in Western Australia — Legislation* (23 May 2013) Government of Western Australia <http://www.dmp.wa.gov.au/16970.aspx>

Department of Mines and Petroleum, *Shale and Tight Gas in Western Australia* Government of Western Australia <http://www.dmp.wa.gov.au/15136.aspx>

Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) *About the EPBC Act* (17 August 2011) Government of Western Australia <http://www.environment.gov.au/epbc/about/index.html>

Department of Water, *Managing Water – Allocation Planning* Government of Western Australia <http://www.water.wa.gov.au/Managing+water/Allocation+planning/default.aspx>

DieselNet, *Existing Stationary Engines (NESHAP)* (April 2011) <http://www.dieselnet.com/standards/us/stationary_hap.php>

Diesel Service & Supply, *Diesel Generator Engine Emissions Explained* <http://www.dieselserviceandsupply.com/Generator_Engine_Emissions_Explained.aspx>

Drajem, Mark, *Cornell Researcher Rebuts Colleagues on Fracking Leaks* Bloomberg Businessweek (10 July 2012) <http://www.businessweek.com/news/2012-07-10/cornell-researcher-rebuts-colleagues-on-fracking-leaks>

Duggan, Kevin, *Fort Collins Council Backs Ban on Fracking* (19 February 2013) Coloradoan.com <http://www.coloradoan.com/article/20130219/NEWS01/302190039/Fort-Collins-council-backs-ban-fracking?gcheck=1>

Earthworks, *The Halliburton Loophole* <http://www.earthworksaction.org/issues/detail/inadequate_regulation_of_hydraulic_fracturing>

Earthworks, *Hydraulic Fracturing 101* <http://www.earthworksaction.org/issues/detail/hydraulic_fracturing_101>

Ecologically Sustainable Development Steering Committee, *National Strategy for Ecologically Sustainable Development* (December 1992) Department of Sustainability, Environment, Water, Population and Communities, Australian Government <http://www.environment.gov.au/about/esd/publications/strategy/intro.html#WIESD>

Engdahl, F William, *The Fracked-up USA Shale Gas Bubble* (13 March 2013) Centre for Research on Globalization <http://www.globalresearch.ca/the-fracked-up-usa-shale-gas-bubble/5326504>

Environment, Technology & Regulatory Affairs Division, *Precautionary Principle* United States Chamber of Commerce <http://www.uschamber.com/issues/regulatory/precautionary-principle>

Environmental Defender's Office of Western Australia (Inc), *Fact Sheets* <http://www.edowa.org.au/discover/factsheets/>

[US] EPA's Study of Hydraulic Fracturing and its Potential Impact on Drinking Water Resources, *Questions and Answers about EPA's Hydraulic Fracturing Study* (22 May 2013) United States Environmental Protection Authority <http://www.epa.gov/hfstudy/questions.html#1>

EuropeUnconventionalGas.org, *Unconventional Gas in the United States* <http://www.europeunconventionalgas.org/home/unconventional-gas/unconventional-gas-in-the-united-states>

Experimental Economics Center, Andrew Young Center at Georgia State University, *Benefits and Drawbacks of Command-and-Control EconPort* <http://www.econport.org/content/handbook/Environmental/pollution-control-revised/Traditional-Pollution-Techniques/Traditional-methods-sub-page.html>

Federal Emergency Management Agency, *National Environmental Policy Act — Description and Intent* (15 June 2012) <http://www.fema.gov/environmental-planning-and-historic-preservation-program/national-environmental-policy-act>

Federal Reserve Bank of San Francisco, *What is the Difference between Private and Social Costs, and How Do They Relate to Pollution and Production* (November 2002) <http://www.frbsf.org/education/activities/drecon/2002/0211.htm>

FracFocus, <www.FracFocus.org>

FracFocus *Hydraulic fracturing: A Historic Perspective* <http://fracfocus.org/hydraulic-fracturing-how-it-works/history-hydraulic-fracturing>

FracFocus, *Hydraulic Fracturing: The Process* <http://fracfocus.org/hydraulic-fracturing-how-it-works/hydraulic-fracturing-process>

geology.com, *Shale* <http://geology.com/rocks/shale.shtm>

Geoscience Australia, *Unconventional Petroleum Resources* (31 May 2012) <http://www.ga.gov.au/energy/petroleum-resources/unconventional-resources.html>

Groundwork, *Texas State Progress: Shale Gas* Interstate Oil and Gas Compact Commission <http://groundwork.iogcc.org/content/texas-state-progress-shale-gas>

House of Commons, *Energy and Climate Change Committee — Fifth Report — Shale Gas* (23 May 2011) United Kingdom Parliament <http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenergy/795/79502.htm>

International Telecommunications Union, *ICT Regulation Toolkit — Financial Independence regulation toolkit (5.1.2)* <http://www.ictregulationtoolkit.org/en/Section.2114.html>

Interstate Oil and Gas Compact Commission, *2009 Resolutions — Resolution 09.011* <http://www.iogcc.org/2009-resolutions#HF>

Interstate Oil and Gas Compact Commission, *Hydraulic Fracturing — State Regulation* <http://www.iogcc.org/hydraulic-fracturing>

Kamionski, Murray, *The Courtroom Problem with Filing a Fracking Claim* (8 August 2012) The Front Page Online <http://www.thefrontpageonline.com/articles1-11409/TheCourtroomProblemwithFilingaFrackingClaim>

Laffin, Michael and Katie Jamieson, *ERCB Alters Alberta Well Spacing Framework* (25 November 2011) Blakes <http://www.blakes.com/English/Resources/Bulletins/Pages/Details.aspx?BulletinID=1418>

MiningFacts.org, *What is the Social Licence to Operate (SLO)?* <http://www.miningfacts.org/Communities/What-is-the-social-licence-to-operate/>

Mintzes, Aaron, *Debate over Fracking Regulation Looms Large in the US Senate* (21 October 21 2011) Earthworks <http://www.earthworksaction.org/earthblog/detail/debate_over_fracking_regulation_looms_large_in_the_us_senate#.UcF9dnWQ994>

National Energy Technology Laboratory, *Introduction to Produced Water* <http://www.netl.doe.gov/technologies/pwmis/intropw/index.html>

National Energy Technology Laboratory, *Produced Water Management Practices and Applicable Regulations — Federal Regulations: US Environmental Protection Agency* <http://www.netl.doe.gov/technologies/pwmis/regs/federal/epa/index.html>

NaturalGas.org, *Directional and Horizontal Drilling* <http://www.naturalgas.org/naturalgas/extraction_directional.asp>

NaturalGas.org, *Onshore Drilling* <http://www.naturalgas.org/naturalgas/extraction_onshore.asp>

NaturalGas.org, *Overview of Natural Gas: Background*, <http://www.naturalgas.org/overview/background.asp>

Nevill, Jon, *The Precautionary Principle* (2004) Only One Planet <http://www.onlyoneplanet.com/Precautionary_principle.htm>

New South Wales Environment Protection Authority, *Waste and Resource Recovery — Appendix A: Facility Planning* (13 June 2013) <http://www.epa.nsw.gov.au/waste/envguidlns/compostinga.htm>

New York State Department of Environmental Conservation, *Revised Draft SGEIS on the Oil, Gas and Solution Mining Regulatory Program (September 2011) — Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing in the Marcellus Shale and Other Low-Permeability Gas Reservoirs* <http://www.dec.ny.gov/energy/75370.html>

New York City Environmental Protection, About *the DEC Supplemental Generic Environmental Impact Statement (SGEIS)* <http://www.nyc.gov/html/dep/html/news/natural_gas_drilling_sgeis.shtml>

New York State Department of Environmental Conservation*, Division of Mineral Resources* <http://www.dec.ny.gov/about/636.html>

New York State Department of Environmental Conservation, *Marcellus Shale* <http://www.dec.ny.gov/energy/46288.html>

New York State Department of Environmental Conservation, *Oil and Gas — Oil, Gas and Solution Salt Mining in New York State* <http://www.dec.ny.gov/energy/205.html>

New York State Department of Environmental Conservation, *State Implementation Plans* <http://www.dec.ny.gov/chemical/8403.html>

Olszewska, Jolanta, *Turning Water into Gold: Water Trading Rights in Western Australia* Finding Law Australia <http://www.findlaw.com.au/articles/395/turning-water-into-gold-water-trading-rights-in-we.aspx>

ParisTechReview, *Unconventional Gas: A Reasoned View from France* (28 June 2011) Natural Gas Europe <http://www.naturalgaseurope.com/reasoned-view-france>

PennFuture, *Legal Cases/Current Cases — Ultra Resources, Marshlands Play* (21 July 2011) <http://www.pennfuture.org/legal_detail.aspx?Type=C&LegalCaseID=71>

Pinchot Institute for Conservation, *Assessing the Environmental Effects of Marcellus Shale Gas Development: The State of Science* <http://www.pinchot.org/gp/EffectsofMarcellusShale>

Proactive Investors Australia, *New Standard Energy Joined by PetroChina in WA Shale Gas Ventur*e (21 February 2013) <http://www.proactiveinvestors.com.au/companies/news/39851/new-standard-energy-joined-by-petrochina-in-wa-shale-gas-venture-39851.html>

ProPublica, *What is Hydraulic Fracturing?* <http://www.propublica.org/special/hydraulic-fracturing-national>

Railroad Commission of Texas, *Barnett Shale Information* (22 May 2013) <http://www.rrc.state.tx.us/barnettshale/index.php>

Railroad Commission of Texas, *Surface Waste Management Manual — Application for a Permit to Discharge of Hydrostatic Test Water* <http://www.rrc.state.tx.us/forms/publications/SurfaceWasteManagementManual/hydrostatictestwater1change.php>

Railroad Commission of Texas, *Compliance & Enforcement* <http://www.rrc.state.tx.us/compliance/index.php>

Regulatory Reform Committee, *Themes and Trends in Regulatory Reform — The Implications of the Financial Crisis for Regulation* (21 July 2009) United Kingdom Parliament <http://www.publications.parliament.uk/pa/cm200809/cmselect/cmdereg/329/32906.htm>

Schramm, Erich, *What Is Flowback, and How Does it Differ from Produced* Water*?* (24 March 2011) Energy and Environmental Research of Northeastern Pennsylvania Clearinghouse <http://energy.wilkes.edu/pages/205.asp>

Science & Environmental Health Network, *Precautionary Principle — Frequently Asked Questions* <http://www.sehn.org/ppfaqs.html>

ShaleGasInfo.eu, *Issues and Policy* <http://www.shalegasinfo.eu/index.php/en/info/issues-a-policy.html>

SociaLicense.com, *The Social License to Operate* <http://socialicense.com/index.html>

Styers, Kemerait & Mitchell, *Legal Updates — State versus Local Regulation of Shale Gas Development* (17 March 2012) <http://www.styerskemerait.com/2012/03/state-versus-local-regulation-of-shale-gas-development/>

Swarthmore College of Environmental Studies, *Natural Gas Drilling in the Marcellus Shale — Pollution* Swarthmore College <http://www.swarthmore.edu/x29634.xml>

Today in Energy, *Shale Oil and Shale Gas Resources Are Globally Abundant* (14 June 2013) United States Energy Information Administration <http://www.eia.gov/todayinenergy/detail.cfm?id=11611>

United Nations Environment Programme, *Rio Declaration on Environment and Development* <http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=78&ArticleID=1163>

United States Environmental Protection Agency, *New Source Review — Basic Information* (23 July 2011) <http://www.epa.gov/NSR/info.html>

United States Environmental Protection Agency, *Hydraulic Fracturing Background Information* (Wednesday, 9 May 2012) <http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydrowhat.cfm>

United States Environment Protection Agency, *Compliance Monitoring — National Pollutant Discharge Elimination System* (14 June 2012) <http://www.epa.gov/compliance/monitoring/programs/cwa/npdes.html>

United States Environmental Protection Agency, *Compliance Monitoring — New Source Performance Standards and State Implementation Plans* (14 June 2012) <http://www.epa.gov/compliance/monitoring/programs/caa/newsource.html>

United States Environmental Protection Agency, *The Clean Water Act: Protecting and Restoring our Nation's Waters* (20 September 2012) <http://water.epa.gov/action/cleanwater40/cwa101.cfm>

United States Environmental Protection Agency, *Summary of the Resource Conservation and Recovery Act — 42 USC §6901 et seq. (1976)* (16 April 2013) <http://www2.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act>

United States Environmental Protection Agency, *Natural Gas Extraction — Hydraulic Fracturing — Ensuring that Hydraulic Fracturing Using Diesel Fuels Is Properly Permitted* (12 July 2013) <http://www2.epa.gov/hydraulicfracturing>

United States Environmental Protection Agency, *Safe Drinking Water Act (SDWA)* <http://water.epa.gov/lawsregs/rulesregs/sdwa/>

United States Environmental Protection Agency, *Summary of the Clean Water Act 33 USC §1251 et seq. (1972)* <http://www2.epa.gov/laws-regulations/summary-clean-water-act>

United States Nuclear Regulatory Commission, *Background and Staff Guidance* (3 January 2013) <http://www.nrc.gov/about-nrc/regulatory/risk-informed/concept/performance.html#process>

un-naturalgas.org, *How about horizontal drilling?* <http://www.un-naturalgas.org/hydraulic_fracturing_a-z.htm#horizontal%20drilling>

Veolia Water Solutions & Technologies, *Shale Gas Water Treatment Strategies* Veolia Water <http://www.vwsoilandgas.com/medias/articles/shalegaswatertreatmentstategies.htm>

WA Onshore Gas, *Securing economic growth* <http://waonshoregas.info/securing_economic_growth>

Waeckerlin, Eric, *Is EPA Shifting Towards Regulating Fracking Under the Clean Water Act?* (11 March 2011) Fracking Insider <http://www.frackinginsider.com/regulatory/is-epa-shifting-towards-fracking-regulation-under-the-clean-water-act/>

Waste Information & Management Services, *Environmental Decisions from US Court of Appeals, all Circuits — Summary — Center for Biological Diversity v. Salazar (DOI/BLM)* (5 February 2013) <http://environmentalappealscourt.blogspot.com.au/2013_02_05_archive.html>

West Virginia Surface Owners' Rights Organization, *Why Multiple Horizontal Wells from Centralized Well Pads Should Be Used for the Marcellus Shale* (August 27 2012) <http://www.wvsoro.org/resources/marcellus/horiz_drilling.html>

Western Australian Environmental Protection Authority, *An Unconventional* Technology Government of Western Australia <http://www.epa.wa.gov.au/AbouttheEPA/EPAnews/Pages/Anunconventionaltechnology.aspx>

Wiseman, Hannah, *A Review of Some Oil and Gas Exemptions from Environmental Regulation* (6 May 2011) Environmental Law Prof Blog <http://lawprofessors.typepad.com/environmental_law/2011/05/a-review-of-oil-and-gas-exemptions-from-environmental-regulation.html>

World Coal Association, *Total World Electricity Generation by Fuel (2009) [Source: IEA 2010]* <http://www.worldcoal.org/coal/uses-of-coal/coal-electricity>

C. Legislation

Notice of Final Rulemaking, Environmental Quality Board, Department of Environmental Protection *25 Pa. Code, Chapter 78* Oil and Gas Well Cementing and Casing (29 September 2010) <http://www.pabulletin.com/secure/data/vol41/41-6/239.html>

16 TEX. ADMIN. CODE § 3.29(b)

1R–114, Rule 205A subparts a and b <http://cogcc.state.co.us/RR_HF2011/Order1R-114FinalFracingDisclosureRule.pdf>

Clean Water Act, 33 USC §§ 1251 402

Fort Worth, Texas Ordinance Number 16986-06-2006 <http://fortworthtexas.gov/uploadedFiles/City_Secretary/City_Council/Official_Documents/2006_Ordinances/16986-06-2006.pdf>

In the Supreme Court of Texas, No. 05-0466, *Coastal Oil & Gas Corp and Coastal Oil & Gas USA, LP, Petitioners, v Garza Energy Trust et al*, Respondents, On Petition for Review from the Court of Appeals for the Thirteenth District of Texas, (Argued September 28, 2006) <http://www.supreme.courts.state.tx.us/historical/2008/aug/050466.htm>

Safe Drinking Water Act 42 USC 42 §§ 300f (1974) Section 322 amended section 1421(d)

Section 44 EP Act

The General Assembly of Pennsylvania House Bill No. 1950, Session of 2011 Report of the Committee of Conference Amending Title 58 (Oil And Gas) of the Pennsylvania Consolidated Statutes <http://www.legis.state.pa.us/CFDOCS/Legis/PN/Public/btCheck.cfm?txtType=PDF&sessYr=2011&sessInd=0&billBody=H&billTyp=B&billNbr=1950&pn=3048>

Petroleum and Geothermal Energy Resources (Environment) Regulation 2012 (WA) reg 3. <http://www.austlii.edu.au/au/legis/wa/consol_reg/pagerr2012676/s3.html>

Petroleum and Geothermal Energy Resources (Environment) Regulations 2012 (as at 29 August 2012) Version 00-a0-01 r. 11 <http://www.slp.wa.gov.au/pco/prod/FileStore.nsf/Documents/MRDocument:23969P/$FILE/PetrlmandGeothermalEngyResEnvironmentRegs2012-00-a0-01.pdf?OpenElement>

Sec. 101 (a). Declaration of Goals and Policy, Clean Water Act 33 USC §1251 et seq. (1972) <http://www.epa.gov/agriculture/lcwa.html>