

2015

DISCLOSING THE FACTS:

TRANSPARENCY AND RISK IN HYDRAULIC FRACTURING



A COLLABORATIVE PROJECT OF:



AS YOU SOW[®]



BOSTON COMMON
ASSET MANAGEMENT



Investor Environmental
Health Network
HEALTHY PEOPLE...HEALTHY BUSINESS

AUTHORS

Richard Liroff, Investor Environmental Health Network
Danielle Fugere, As You Sow
Steven Heim, Boston Common Asset Management, LLC

COLLABORATING ORGANIZATIONS

AS YOU SOW promotes environmental and social corporate responsibility through shareholder advocacy, coalition building, and innovative legal strategies. Its efforts create large-scale systemic change by establishing sustainable and equitable corporate practices.

BOSTON COMMON ASSET MANAGEMENT, LLC is a sustainable investment firm dedicated to generating competitive financial returns and meaningful improvements in corporate performance on environmental, social, and governance (ESG) issues. We are long-term investors. We believe that markets typically misvalue the timing and magnitude of risks and opportunities presented by ESG factors. Therefore, our investment strategy is to build and grow diversified portfolios using the high-quality but undervalued sustainable stocks that our integrated investment research identifies. As part of this, we look to add value through targeted company and industry engagement efforts.

THE INVESTOR ENVIRONMENTAL HEALTH NETWORK (IEHN) is a collaborative partnership of investment managers and advisors concerned about the impact of corporate practices on environmental health.

ACKNOWLEDGEMENTS

This report was made possible by the generous support of the (in alphabetical order): Firedoll Foundation, Nathan Cummings Foundation, Park Foundation, The Roddenberry Foundation, Tides Foundation, and the V. Kann Rasmussen Foundation. Additional support was provided by the Arkay Foundation, Arntz Family Foundation, Campbell Foundation, Libra Foundation, and New Belgium Foundation.

This report has benefited from the suggestions of outside reviewers. They include (in alphabetical order by last name with affiliations for identification purposes only): Scott Anderson (Environmental Defense Fund), Jim Bolander (Southwestern Energy), Jonas Kron (Trillium Asset Management), Karina Litwack, Amy Mall (Natural Resources Defense Council), Granville Martin (JPMorgan Chase), Nora Nash (Sisters of St. Francis of Philadelphia), Samantha Rubright (FracTracker Alliance), Nichole Saunders (Environmental Defense Fund), Lucas Schoeppner (Sustainalytics), Ken Scott (Walden Asset Management), Donna Vorhees (Health Effects Institute), Heidi Welsh (Sustainable Investments Institute), and Aaron Ziulkowski (Walden Asset Management). Thanks also to the additional professionals from industry and other sectors who provided reviews. Any errors or omissions are solely the responsibility of the authors.

Special thanks to David Shugar, Yun Liang, Sasan Saadat, Katie Levitt, and Amelia Timbers for their research support.

We would also like to thank Sanford Lewis (IEHN counsel) for legal review, Leah Turino (Boston Common Asset Management) for copy-editing, and Andrew Montes and Kristin Costa for other support.

DISCLAIMER

The information in this report has been prepared from sources and data the authors believe to be reliable, but we assume no liability for and make no guarantee as to its adequacy, accuracy, timeliness, or completeness. Boston Common Asset Management, LLC may have invested in and may in the future invest in some of the companies mentioned in this report. The information in this report is not designed to be investment advice regarding any security, company, or industry and should not be relied upon to make investment decisions. We cannot and do not comment on the suitability or profitability of any particular investment. All investments involve risk, including the risk of losing principal. No information herein is intended as an offer or solicitation of an offer to sell or buy, or as a sponsorship of any company, security, or fund. Opinions expressed and facts stated herein are subject to change without notice.

TABLE OF CONTENTS

- EXECUTIVE SUMMARY4
- INTRODUCTION.....10
- SCORECARD11
- COMPANY PERFORMANCE ON RISK MANAGEMENT
DISCLOSURE INDICATORS12
 - Toxic Chemicals12
 - Water and Waste Management15
 - Air Emissions27
 - Community Impacts.....32
 - Management and Accountability.....37
- CONCLUSION41
- APPENDIX A: SCORECARD QUESTIONS.....42
- APPENDIX B: METHODOLOGY.....44

EXECUTIVE SUMMARY

Disclosing the Facts 2015 is the fourth in a series of investor reports intended to promote improved operating practices among oil and gas companies engaged in horizontal drilling and hydraulic fracturing. Hydraulic fracturing operations often use toxic chemicals and high volumes of water, release significant levels of greenhouse gases and other pollutants, and have the potential to adversely impact local communities when not properly managed. These issues translate into financial risks to companies and shareholders in the form of fines, regulations, or threats to companies' social license to operate.

Following the maxim of "what gets measured, gets managed", this report encourages oil and gas companies to increase disclosure about their use of current best practices to minimize the environmental risks and community impacts of their "fracking" activities. Disclosure of best management practices and associated key performance indicators is the primary means by which investors gauge how companies are managing the business risks associated with their environmental and community impacts. Disclosure helps both investors and other stakeholders determine whether companies have the systems in place to minimize the community and environmental risks of their operations.

This 2015 scorecard benchmarks the public disclosures of 30 companies on 39 key performance indicators. It distinguishes companies disclosing more about practices and impacts from those disclosing less. The scorecard assesses five areas of environmental, social, and governance metrics emphasizing, on a play-by-play basis, quantitative disclosures for: (1) Toxic chemicals; (2) Water and waste management; (3) Air emissions; (4) Community impacts; and (5) Management accountability.¹ It relies solely on publicly available information companies provide on their websites or in corporate financial statements or other reports linked from their websites.

This year, the report card has been compiled amidst a dramatic contraction of well drilling and completion activities and enormous financial write-offs. In this operating environment, companies might be tempted to slow disclosure efforts and perhaps even cut corners on best practices. However, this year's scorecard results show that corporate disclosure efforts have increased among a core group of industry disclosure leaders and even some companies that have been disclosure laggards. Companies continue to pursue operating innovations that not only save money but also yield environmental benefits. These include, for example, substituting pipelines for trucks to move water and waste water, enhancing leak detection and repair efforts, and using less, but safer and more cost-effective chemicals.

Yet, while progress has been made, much more remains to be done. For instance, the industry as a whole must improve its localized disclosures since companies' social license to operate is often determined by local concerns and perceptions of corporate responsiveness. Local impacts can include land and water use, air and water pollution, and nuisances such as noise, light pollution, traffic, and road damage. Progress must also continue on issues such as reducing chemical toxicity, setting goals for reducing methane and other air emissions, and identifying local community concerns and company responses.

KEY FINDINGS

1. **BHP Billiton stands out as the disclosure leader.** BHP Billiton scored 32 out of a possible 39 points. BHP Billiton's disclosure scores follow a trajectory that investors hope a growing number of companies will emulate. The company ranked near the bottom of the industry in disclosure in the 2013 edition of *Disclosing the Facts*, raced to the top in 2014, and further outdistanced even other improving companies in 2015. Through its score, the company demonstrates that it has been putting systems in place to track data and increase disclosures. Its swift ascent from the bottom of the 2013 scorecard confirms investors' view that at least some of the companies that are disclosure laggards may in fact have good policies, practices, and data systems in place,

1. Play-by-play disclosure refers to a company reporting the distinct operational practices and impacts that are occurring at each play in which a company is operating, as distinct from reporting at an aggregate level such as company- or country-wide. 'Play-by-play' is a short-hand way of referring to appropriate localized reporting since impacts and social license controversies are most important at the local level.

but are not revealing them. BHP Billiton's website features a case study of its fracturing operations, written to the *Disclosing the Facts* scorecard outline and addressing investor concerns in a concise, readily accessible manner.

- Hess, Apache, Noble Energy, and CONSOL Energy comprise a core of disclosure leadership companies outpacing the rest of the industry, with Southwestern Energy, Anadarko Petroleum, QEP Resources, and EQT slightly behind.** Hess, Apache, and Noble built on their leadership positions from 2014, disclosing information for about half of the scorecard indicators. CONSOL nearly quadrupled its 2014 score, largely by securing third-party certification for compliance with the best practice standards of the Center for Sustainable Shale Development (CSSD). Many of its standards match scorecard practices. Southwestern Energy, following in BHP Billiton's path, moved from near the bottom of the scorecard to join the leadership group. The company accomplished this leap by incorporating the scorecard in the development of its inaugural corporate sustainability report. By nearly doubling its score in 2015, Anadarko narrowed its gap with the leaders. QEP Resources, like Southwestern Energy, significantly improved its score, moving up from near the bottom of the industry in 2014. EQT's score dropped slightly from 2014 but the company remains ahead of most of the industry.
- Most of the industry—70 percent of the companies assessed—continue to leave investors substantially in the dark about their policies, practices, and impacts, especially on a quantitative play-by-play basis.** These companies disclose from zero to 28% on the scorecard indicators. Some companies that scaled back on reporting, or failed to update their disclosures, lost points. Some companies have good quantitative disclosures for individual shale plays, or informative narrative disclosures across their entire operations, but fail to provide sufficient, quantitative, play-by-play disclosure for each of their major plays. Carrizo Oil & Gas, Continental Resources, and Whiting Petroleum are the lowest scorers, with Carrizo earning zero points.
- Broad policies, not play-by-play quantitative performance metrics, remain the most commonly reported indicators.** The scorecard includes a mix of quantitative indicators and non-quantitative best practice indicators. Since the initial scorecard in 2013, scores have increased by five or more points on about 40% of the original indicators, primarily the non-quantitative ones. The five most widely reported indicators include: substituting pipelines for trucks to transport water for fracturing (23 companies); declaring a practice to use non-potable water instead of fresh water for fracturing whenever feasible (19 companies); avoiding use of diesel fuel in hydraulic fracturing fluids (16 companies); relying on independent third-party databases to screen potential contractors (16 companies); and linking compensation of senior management to health, safety, and environment metrics (15 companies). The three most significant scoring changes on indicators between 2014 and 2015 were for: play-by-play reporting of the types of water sources used for fracturing activities (from 1 to 6 companies); percentages of wastewater reused for fracturing (from 2 to 7); and addressing naturally occurring radioactive materials (NORMs) (from 6 to 12).

CONCLUSIONS

The rising scores of leadership companies, a trend that began with the second edition of *Disclosing the Facts* in 2014, show that, at least for a segment of the oil and gas industry, the scorecard is having its desired effect of triggering a “race to the top” in improved disclosure.

As the scoring leader, BHP Billiton has demonstrated that companies can tell their story concisely and in a fashion readily accessible to investors and other stakeholders. Such information is critical to investors who seek clear data on which to base investment decisions, especially in an industry that is facing tremendous challenges, including the most basic challenge of retaining a social license to operate. Through this scorecard, investors seek to encourage the entire industry to implement current best management practices, to report on those practices, and to provide quantitative indicators of success in reducing impacts.

While significant improvement in reporting has been seen in a handful of companies, 70 percent of the companies assessed still score below 28 percent on scorecard indicators. Companies continue to miss opportunities to address issues of public concern that feature prominently in media reports and activist advocacy critical of the industry. These issues include, for example, use of diesel fuel in fracturing fluids, radioactive waste, and induced seismicity (earthquakes). Diesel fuel does not appear to be widely used in fracturing fluids, yet many companies are silent on whether they have a policy to avoid it. Naturally occurring radioactive material waste has surfaced as an issue, especially in Pennsylvania and North Dakota, but few companies discuss straightforward procedures for reducing radioactivity risks. Additionally, while companies increasingly acknowledge induced seismicity as a risk, they often fail to discuss the specific steps they are taking to manage the hazard.

The failure of the majority of the largest oil and gas companies to either adopt current best management practices or to report on their adoption is a continuing challenge requiring ongoing engagement by investors.

RECOMMENDATIONS

Companies should report data associated with their operational impacts using quantitative metrics, on a play-by-play basis, in order for investors to be able to rigorously assess company practices. In particular:

1. Companies should disclose their leak detection and repair programs for methane emissions, providing information on program scope (percentage of facilities/assets covered), technologies deployed, frequency of inspection, and results.
2. Companies should develop systems to track community concerns and corporate responses and provide such information to senior management, corporate boards of directors, investors, and other stakeholders.
3. Companies not using diesel or BTEX chemicals in their fracturing fluids should disclose this, and companies not relying on their own toxicity scoring systems should draw on those of their principal chemical suppliers to report progress in reducing toxicity of fracturing fluids.

SCORECARD

(Out Of 39 Possible Points*)

COMPANY

2015 SCORE 2014 SCORE

COMPANY	2015 SCORE	2014 SCORE
BHP Billiton, Ltd. (BHP)	32	18
Hess Corp. (HES)	21	17
Apache Corp. (APA)	20	13
CONSOL Energy, Inc. (CNX)	19	5
Noble Energy, Inc. (NBL)	19	13
Southwestern Energy Co. (SWN)	16	2
Anadarko Petroleum Corp. (APC)	15	8
QEP Resources, Inc. (QEP)	15	1
EQT Corp. (EQT)	14	16
ConocoPhillips Corp. (COP)	11	5
Range Resources Corp. (RRC)	11	9
Royal Dutch Shell plc (RDS)	11	9
Occidental Petroleum Corp. (OXY)	10	7
Penn Virginia Corp. (PVA)	10	9
BP plc (BP)	8	6
Cabot Oil & Gas Corp. (COG)	8	8
Encana Corp. (ECA)	8	15
EOG Resources, Inc. (EOG)	8	9
Devon Energy Corp. (DVN)	7	5
Exco Resources, Inc. (XCO)	7	7
Newfield Exploration Co. (NFX)	6	4
Chesapeake Energy Corp. (CHK)	4	7
Chevron Corp. (CVX)	4	6
Exxon Mobil Corp. (XOM)	4	5
Pioneer Natural Resources** (PXD)	3	–
Ultra Petroleum Corp. (UPL)	3	9
WPX Energy, Inc. (WPX)	3	3
Continental Resources, Inc. (CLR)	2	0
Whiting Petroleum Corp. (WLL)	2	3
Carrizo Oil & Gas, Inc. (CRZO)	0	0

* 2014 had a total of 35 possible points.

** For the 2015 scorecard, Pioneer Natural Resources was substituted for Talisman Energy, Inc., which was acquired by Repsol, S.A.

4. Naturally occurring radioactive material waste has been a high-profile issue, especially in Pennsylvania and North Dakota. Companies operating in those states in particular should disclose what steps, if any, they take to measure, track, and assure appropriate disposal of contaminated materials.
5. Seismicity has been a high-profile issue in Oklahoma, Texas, Arkansas, and Ohio. Companies operating in those states in particular should disclose what steps they take, consistent with and beyond applicable state regulations, to reduce the risk of inducing seismic events, including implementing precautionary practices for their own drilling, completion, and disposal operations and assuring sound practices by their waste disposal contractors.
6. Companies should employ a wide range of tools for avoiding groundwater contamination, including assessing and monitoring adjacent wells, identifying existing faults and fractures, and testing ground water before and after drilling to further reduce the potential for contamination and to detect and remedy any contamination that does occur.

In addition to enhancing their reporting,

7. Companies should link executive compensation to corporate performance on health, safety, and environmental indicators, and should incorporate metrics beyond the injury and spill data which are most commonly relied on in such linked compensation systems. Additional metrics might include, for example, measures to reduce companies' environmental impact, such as implementation of leak detection and repair programs and progress towards greenhouse gas reduction goals.
8. Government agencies and the oil and gas industry should work together to develop more systematic research and data on the human health effects (including worker health) of hydraulic fracturing operations. This might follow the model of the U.S. government and the automobile industry agreeing on creation of the Health Effects Institute to produce credible, broadly accepted research on the health effects of air pollution.

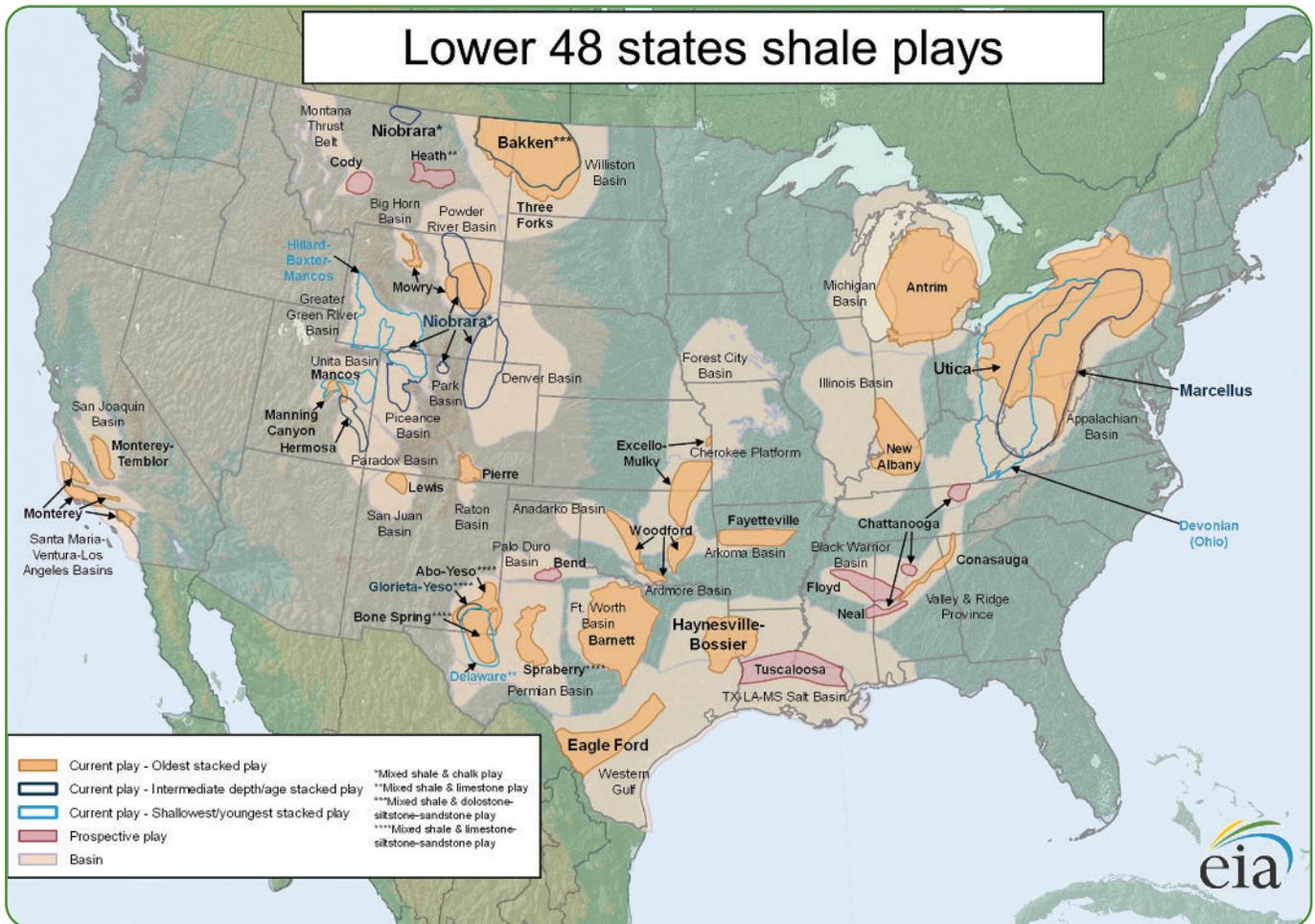


IMAGE: U.S. Energy Information Administration

Source: U.S. Energy Information Administration based on data from various published studies.
 Updated: April 13, 2015

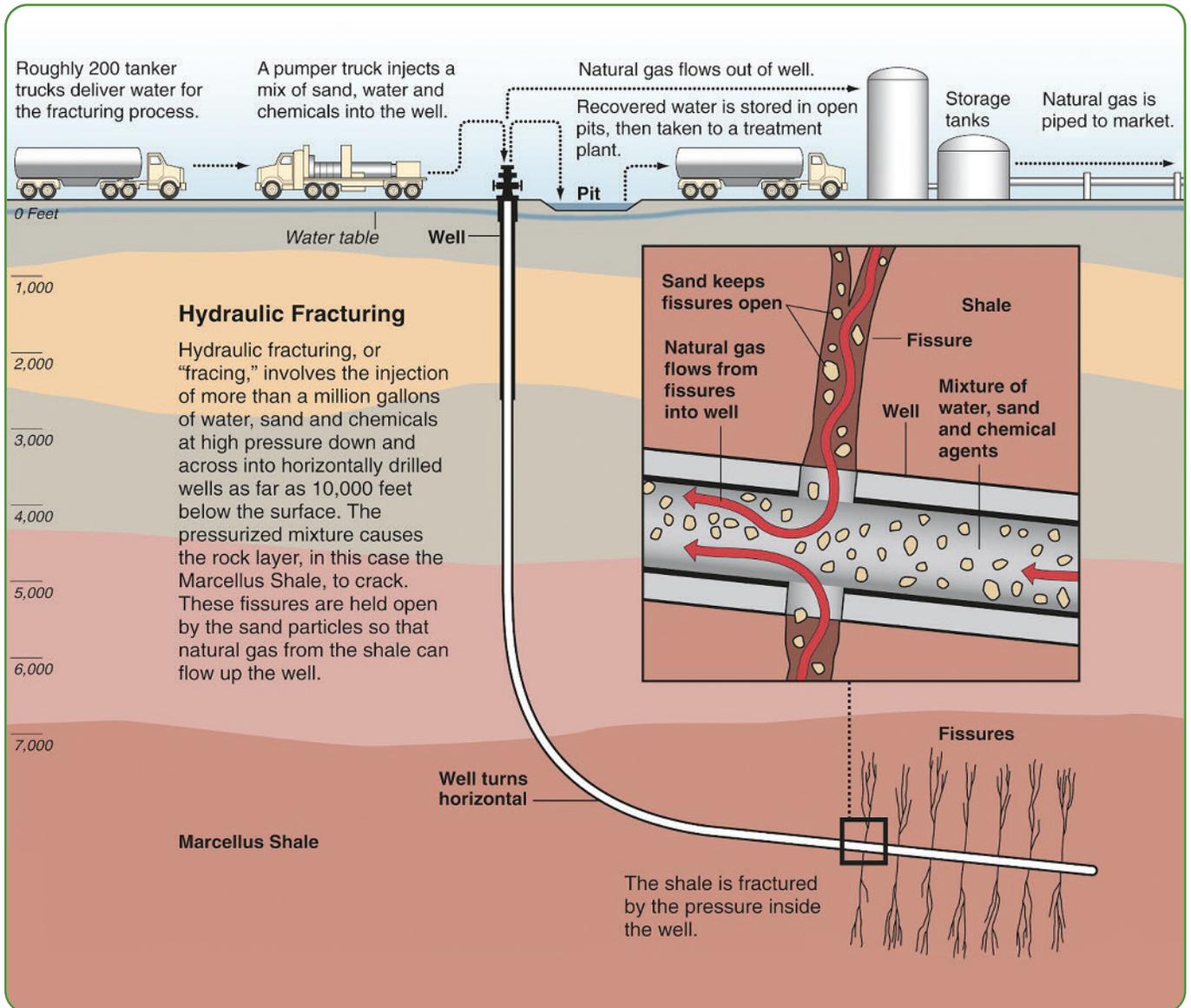


IMAGE: Al Granberg / Propublica.org

INTRODUCTION

Since 2009, coalitions of investors, including public pension funds, faith-based, socially responsible, and other institutional investors, have been pressing companies—through dialogues and shareholder proposals—to be more transparent about how they manage and mitigate the environmental risks and community impacts inherent in hydraulic fracturing operations. Investors require rigorous, relevant information to make informed investment decisions; hence, this report emphasizes quantitative reporting. Quantitative data also provides assurance to investors that companies have appropriate oversight and accountability practices in place to track—and therefore be able to mitigate—impacts of their operations. Companies implementing best practices in operations and providing transparent information about these efforts will reduce regulatory and reputational risks, enhance the likelihood of securing and maintaining their social license to operate, and reduce liabilities associated with poor performance, spills, contamination, and lawsuits.

Disclosing the Facts 2015 is the fourth in a series of disclosure guidelines and scorecards intended to encourage oil and gas companies engaged in horizontal drilling and hydraulic fracturing to adopt current best practices in risk management and provide quantitative reporting on operational metrics, including specific practices and improvements. These reports serve to inform shareowners and oil and gas production companies about effective risk management practices, implementation of those best practices, and industry-level performance against key risk management indicators. These reports also facilitate shareowner engagements with companies by clearly establishing investor expectations and providing a framework for investors and companies to work together to better meet these expectations.

The scorecards' foundation, *Extracting the Facts: An Investor Guide to Disclosing Risks from Hydraulic Fracturing Operations*, offers best practice recommendations to oil and gas companies for reporting and reducing risks and impacts from natural gas operations.² Investors in North America, Europe, and Australia managing more than \$1.3 trillion in assets have supported the report, which was published in 2011. It offers a framework for assessing core management goals, current best practices, and key performance indicators for reporting progress.

Building on *Extracting the Facts*, the initial scorecard, *Disclosing the Facts: Transparency and Risk in Hydraulic Fracturing Operations* (“DTF 2013”), benchmarked 24 oil and gas companies on their disclosures against 32 performance indicators across five areas of environmental, social, and governance metrics: (1) Toxic chemicals; (2) Water management: sourcing, well integrity, waste management, and water quality monitoring; (3) Air emissions; (4) Community impacts; and (5) Management and accountability.³ The scorecard focused on the need for quantitative disclosures and region-specific reporting where relevant, with the goal of increasing company and investor attention to localized risk. Local risks are important not only for their significance to local stakeholders but also because they provide insight for investors into how well company systems for managing risks and impacts are functioning in practice. DTF 2013 revealed an industry-wide failure to provide investors and the public with the information necessary to evaluate whether companies are effectively managing the risks and impacts associated with their hydraulic fracturing operations.

-
2. See Investor Environmental Health Network and Interfaith Center on Corporate Responsibility, *Extracting the Facts: An Investor Guide to Disclosing Risks from Hydraulic Fracturing Operations* (2011), <http://www.iehn.org/documents/frackguidance.pdf>. An eighteen-month investor dialogue with oil and gas companies, convened by Boston Common Asset Management and Apache Corporation and supported by members of the Interfaith Center on Corporate Responsibility and Ceres, provided a venue for extended conversations concerning risks, management practices, and disclosures associated with hydraulic fracturing operations and a forum for industry experts to review draft practices and indicators. The dialogue became the foundation for *Extracting the Facts*, which identifies 12 core management goals, best management practices, and key performance indicators on which investors require disclosure to adequately assess risk management practices. *Extracting the Facts* was intended to promote a “race to the top”, encouraging companies to be more transparent and strive for and report on best practices. It urges companies to implement best management practices or to explain why such practices cannot be carried out. Furthermore, it emphasizes the importance of going beyond compliance with existing regulations since the current regulatory framework, particularly at the state level, varies in stringency and, as evident from local bans and moratoria, may not be trusted by local communities.
 3. As You Sow, Boston Common Asset Management, Green Century Capital Management, The Investor Environmental Health Network, *Disclosing the Facts: Transparency and Risk in Hydraulic Fracturing Operations*, 2013, available at http://disclosingthefacts.org/report/DisclosingTheFacts_2013.pdf.

Disclosing the Facts 2014 (“DTF 2014”) updated *DTF 2013*.⁴ It assessed 30 companies on 35 indicators in the five issue areas. In addition to evaluating how well these oil and gas companies disclosed best management practices and impacts across their operations, the report highlighted emerging trends that directly impact companies engaged in hydraulic fracturing and evaluated how well oil and gas companies are addressing these growing concerns. Developments addressed by the 2014 report included: regulators’ tightening controls on air emissions, especially fugitive emissions (i.e., methane leaks); high profile contamination incidents and accidents continuing to undercut industry safety claims and bolster local concerns; growing evidence of links between deep well injection of fluid wastes and nearby seismic events, with accompanying tightening of state regulations; elevated attention to the quantity of water used for hydraulic fracturing and water quality risk persisting in many regions; confirmed or strengthened local government regulatory authority regarding hydraulic fracturing operations in certain states; and litigant success in court cases that may foreshadow increased litigation risks for companies.

Overall, these scorecards have concluded that the oil and gas industry as a whole is failing to meaningfully address on-going public concerns reflected in continuous media attention, an increased number of studies into health and pollution impacts, continued calls for bans and moratoria, and uneven but improving state regulations. Companies have begun responding to these growing concerns by providing some voluntary disclosures. However, the lack of quantitative reporting makes it challenging for investors and other key stakeholders to objectively evaluate operational risks and the integrity and robustness of corporate risk management systems. With consideration to the proverb “what gets measured, gets managed”, investors and other key stakeholders are concerned with this lack of accountability and will continue to press for more transparent and rigorous reporting from companies engaged in hydraulic fracturing.

SCORECARD

OVERVIEW

Disclosure is critical as it is the primary vehicle by which investors gain insight into the extent to which companies are adopting current best management practices and reducing key risks. Risk management policies are most meaningful to investors when companies disclose data demonstrating their policies’ effectiveness. Some companies may, in fact, be implementing current best practices on a broad scale but, absent disclosure, investors are left in the dark about the effectiveness of their systems and relations they have built with local stakeholders.

DTF 2015 scores 30 oil and gas companies⁵ on their performance on 39 disclosure indicators⁶ derived from *Extracting the Facts*. Each company is scored based solely on documents and information available on, or linked from, its public website. The indicators include practices found in cutting-edge regulations recently adopted or proposed in various jurisdictions and are grouped into the five aforementioned areas of risk management.

DTF 2015 places special emphasis on the quantitative reporting of activities and impacts on a play-by-play⁷ basis due to the local consequences of hydraulic fracturing operations. While we recognize that companies must have

4. As You Sow, Boston Common Asset Management, Green Century Capital Management, The Investor Environmental Health Network, *Disclosing the Facts 2014: Transparency and Risk in Hydraulic Fracturing*, 2014, available at www.disclosingthefacts.org/2014/DisclosingTheFacts_2014.pdf.

5. *DTF 2015* reports on 29 of the 30 companies evaluated in *DTF 2014*; Talisman Energy was dropped from coverage because Repsol has acquired the company. In *DTF 2015*, Pioneer Natural Resources replaces Talisman. As described more fully in Appendix B-Methodology, we began in 2013 with the 24 largest gas producers in the U.S. and Canada and in 2014 added six companies to include the three largest publicly owned producers in each of the major plays at the time. There have since been major changes in shale play activity by various companies.

6. See Appendix A for more detail on the indicators used.

7. The U.S. Geological Survey defines a play as a “set of known or postulated oil and/or gas accumulations sharing similar geologic, geographic, and temporal properties”. See p. GL-6, <http://certmapper.cr.usgs.gov/data/PubArchives/WEcont/chaps/GL.pdf>. Examples include the Barnett, Marcellus, and Fayetteville Shales and the Bakken Formation. Many plays extend across state or provincial boundaries.

company-wide policies and risk management practices in place to guide operations across all plays, play-by-play reporting is critical as it enables investors to gain confidence that companies are accountable for how they manage risks that manifest on a local level, including water quantity and quality, air quality, waste management, and community impacts such as increased traffic, noise, and strain on infrastructure. The scorecard's focus on play-by-play reporting also reflects the regional and local variations among plays, as well as the reality of diverse regulatory systems where onshore oil and gas exploration and production in the U.S. is largely state—as opposed to federally—regulated.

While seeking to maintain consistency across scorecards, *DTF 2015* expands the number of questions, from 35 in *DTF 2014* to 39 in *DTF 2015*. The four additional questions address well siting, seismicity, and greenhouse gas emission reduction goals.⁸

DTF 2015, for the sake of brevity offers much less detailed information and documentation about the five areas of risk management than was provided in earlier versions of the scorecard; however, we provide numerous cross-references to where such details can be found in prior reports. Since *DTF 2015* only provides examples of exemplary corporate disclosures that have surfaced since publication of *DTF 2014*, readers should consult *DTF 2014* and *DTF 2013* for prior noteworthy practices.

COMPANY PERFORMANCE ON RISK MANAGEMENT DISCLOSURE INDICATORS

The following sections describe why the five areas of risk management concern investors, detail company scores, and provide examples of notable practices and disclosures. The five score charts list those companies that scored at least one point in a risk section. Companies not listed in a chart scored no points in that section.

1. TOXIC CHEMICALS

Issue and Questions

The toxic chemicals used in hydraulic fracturing operations have generated significant public concern and become a flashpoint for public controversy. These chemicals, if released into the environment, can have a range of harmful impacts based on their toxicity, mobility, solubility, volatility, and persistence.^{9,10} Companies reducing the toxicity of



IMAGE: Robert M. Donnan

Chemical totes

8. Appendix A lists the complete set of questions for *DTF 2015*.

9. The California Council on Science and Technology, in a report requested by California's state legislature, recommended, "the use of chemicals with unknown environmental profiles should be disallowed. The overall number of different chemicals should be reduced, and the use of more hazardous chemicals and chemicals with poor environmental profiles should be reduced, avoided, or disallowed". The council further suggested that operators should apply green chemistry principles (e.g., reducing innate chemical hazard) in formulating hydraulic fracturing fluids. See p. 36, California Council on Science and Technology, *An independent scientific assessment of well stimulation in California—summary report—an examination of hydraulic fracturing and acid stimulations in the oil and gas industry*, 2015, <https://ccst.us/publications/2015/2015SB4summary.pdf>.

10. In its 2015 draft report on hazards to drinking water from hydraulic fracturing operations, the U.S. Environmental Protection Agency similarly noted sizeable gaps in knowledge about the potential human health impacts posed by chemicals used in hydraulic fracturing. See p. ES-12, U.S. Environmental Protection Agency, *Assessment of the potential impacts of hydraulic fracturing for oil and gas on drinking water resources, executive summary*, 2015, http://www2.epa.gov/sites/production/files/2015-06/documents/hf_es_erd_jun2015.pdf.

TOXICS COMPANY	Quantitative Reporting Toxicity Reduction	No Diesel Fuel in Fracturing Fluids	No BTEX in Fracturing Fluids	Website Disclaimer CBI Exclusion	TOTAL
Apache	✓	✓	✓	✓	4
BHP Billiton	✓	✓	✓	✓	4
QEP	✓	✓	✓	✓	4
Cabot		✓	✓	✓	3
Hess		✓	✓	✓	3
Anadarko		✓		✓	2
EQT	✓	✓			2
Noble Energy		✓		✓	2
Occidental Petroleum		✓	✓		2
Range Resources		✓	✓		2
Shell		✓		✓	2
Southwestern Energy		✓	✓		2
BP				✓	1
Chesapeake	✓				1
CONSOL		✓			1
Continental Resources				✓	1
Encana		✓			1
ExxonMobil		✓			1
Newfield Resources		✓			1

Companies that did not receive points for any indicator in this category are not included in this chart. They are Carrizo, Chevron, ConocoPhillips, Devon, EOG, Exco Resources, Penn Virginia, Pioneer, Ultra Petroleum, Whiting Oil & Gas, and WPX.

their chemicals or eliminating them entirely mitigate associated environmental and social risks. Companies that disclose their chemical use publicly can enhance credibility if they are clear about when those disclosures are limited by trade secret constraints. In the past, trade secret disclosure limitations have been a significant critique of the FracFocus database.

The scorecard asks whether a company provides quantitative reporting on its progress in reducing the toxicity of hydraulic fracturing additives, has a practice to not use diesel or BTEX in its fracturing fluids, and clearly states on its website that FracFocus reports may not include chemicals protected by claims of confidential business information (CBI).¹¹

Scores

Measuring elimination of harmful chemicals. Many oil and gas companies communicate their intention to use “environmentally friendly” fluids, but few provide specifics that would allow investors or other stakeholders to evaluate the effectiveness of these initiatives. Five companies—Apache, BHP Billiton, Chesapeake, EQT, and QEP—quantitatively report toxicity reductions; these company disclosures vary in their detail.

11. As noted in *DTF 2013*, p. 12: “Two chemical categories of particular concern (among many others, including endocrine disruptors and bio-accumulative chemicals) are diesel fuels and BTEX (benzene, toluene, ethylbenzene, and xylenes). Diesel fuel contains chemicals of concern including BTEX, which is a family of ‘poster child’ toxic chemicals associated with leukemia, neurological damage, and other health effects”. For further background, see *DTF 2014*, p. 10 and p. 24. New North Carolina regulations governing hydraulic fracturing outlaw the use of diesel fuel in fracturing fluids. See North Carolina General Statutes, Subchapter V. Oil and Gas Conservation. Article 27, §113-391(a)(5)(g), http://www.ncga.state.nc.us/EnactedLegislation/Statutes/PDF/ByArticle/Chapter_113/Article_27.pdf. FracFocus (www.fracfocus.org) is the principal vehicle by which companies report chemical use on a well-by-well basis. For additional discussion about the evolution and limitations of FracFocus, see *DTF 2014*, p. 13 and *DTF 2013*, note 10.

Eliminating diesel and BTEX chemicals. Sixteen companies report eliminating diesel from their fracturing fluids.¹² Eight companies report eliminating the suite of benzene, toluene, ethylbenzene, and xylene (BTEX) chemicals. Since diesel use has been reported only several hundred times in a FracFocus database that now holds chemical records for about 100,000 wells, it is likely that most companies now use diesel rarely if they use it at all.

Disclosure of toxic chemicals and CBI. Corporate disclosure of the chemicals used for hydraulic fracturing has increased exponentially, from virtually no disclosure in 2010 to disclosure of most of the chemicals used in the approximately 100,000 wells completed since 2011. However, companies sometimes do not disclose all the chemicals used because of their chemical suppliers' confidential business information (CBI)¹³ or trade secrecy claims in sales contracts. To protect their credibility, when companies discuss chemical disclosure on their websites, they should acknowledge when disclosure is limited by CBI claims. Currently ten companies provide such acknowledgement. CBI claims are likely to be less of an issue in the future, as FracFocus is implementing a new reporting format that reduces the need for reporting companies to claim confidentiality or trade secrecy.¹⁴



IMAGE: Bill Hughes/FracTracker Alliance & OVEC

Truck hauling chemicals, West Virginia

Notable Practices

- *Apache* began reporting progress towards its goal of using chemicals from the U.S. Environmental Protection Agency's Safer Choices Program (formerly the "Design for the Environment" program), which identifies products that are safer for the environment.¹⁵ *Apache* has established a clear risk reduction program, with stated goals, including to reduce overall chemical volume, reduce use of BTEX chemicals, and favor chemical components that pose less risk of bioaccumulation and are more biodegradable. *Apache* states that it has achieved a 30 to 40 percent chemical volume reduction to date.¹⁶

12. Diesel use is subject to regulation by the U.S. Environmental Protection Agency, so companies have an incentive to avoid it. As noted in *DTF 2014*, an independent analysis of FracFocus data in 2014 showed that diesel had only been used in several hundred of the thousands of wells reported. See *DTF 2014*, p. 11 and footnote 8.

13. "Confidential Business Information" as used in this report denotes trade secret and all other claims of business confidentiality related to chemical disclosure.

14. In February 2015, FracFocus's joint venture partners, the Groundwater Protection Council and the Interstate Oil and Gas Compact Commission, announced plans for wide-ranging improvements to FracFocus. In addition to a format change that should help reduce confidential business information claims, FracFocus is putting in place new systems to reduce data errors and increase the ability of the public to search the data. See <http://fracfocus.org/major-improvements-fracfocus-announced>.

15. See *DTF 2013*, note 19.

16. http://www.apachecorp.com/Sustainability/Environment/Chemicals/Greener_chemicals/index.aspx.

- *CONSOL Energy* has joined the ranks of companies employing chemical hazard rating systems for managing and reducing the toxicity of fracturing chemicals. CONSOL reports that if a chemical exceeds a calculated hazard ranking, it can only be used if approved by CONSOL's Senior Vice President of Environmental Strategy and Regulatory Affairs.¹⁷
- *BHP Billiton* ranks the toxicity of the chemicals it uses and works with its service providers to reduce its use of hazardous chemicals. BHP reports that 81% of the chemicals it uses satisfy its most demanding toxicity reduction criteria which exclude endocrine disruptors, known or suspected carcinogens, mutagens, reproductive toxicants, or federally listed "priority pollutants" or Safe Drinking Water Act contaminants. Another 11% satisfy all criteria except for suspected carcinogenicity, mutagenicity, or reproductive toxicity. The remaining 8% of their chemicals are used only when necessary. The company also reports that its service contractor in the Haynesville Shale has eliminated use of the three most hazardous categories of chemicals ranked according to the contractor's hazard ranking scheme.¹⁸
- *Southwestern Energy* launched its Right Products program in 2013 to lower risks from fracturing fluids. Because some of its chemical suppliers consider some of their chemical formulas proprietary and so will not release the identity of their specific components, Southwestern uses a neutral, third-party toxicologist to conduct its hazard assessments. The toxicologist provides to Southwestern the product's final score (based on Southwestern's hazard assessment scoring tool). By the end of 2014, the company had evaluated more than 90% of its chemicals, enabling it to identify and use safer substitutes where necessary to reduce toxicity.¹⁹
- *Noble Energy* has developed a risk screening process for its chemicals, drawing on both U.S. Environmental Protection Agency and European Union processes, but it has not yet reported results.²⁰

Progress and Prospects

Apache, BHP Billiton, and QEP Resources are the only companies to earn credit on all four toxics indicators. Overall, disclosures have changed little since 2014, although the number of company toxicity tracking systems under development suggests that quantitative reporting of toxicity reductions may increase in the future. The increase in such systems testifies to the impact of investor disclosure requests on corporate action. Those companies that have not yet developed their own toxicity tracking systems might consider relying on the toxicity rating and tracking systems developed by their service contractors.

2. WATER AND WASTE MANAGEMENT

Issue

Due to the high volume of water and toxic chemicals used during hydraulic fracturing, risks related to water quality are a significant concern for companies, their investors, and the public. Hydraulic fracturing of horizontally drilled wells typically requires millions of gallons of water per well, which can be an issue in water-stressed areas.

17. See CONSOL 2014 Corporate Responsibility Report, p. 26, <http://www.consolenergy.com/media/28541/2014-consol-energy-corporate-responsibility-report.pdf>. The requirement to obtain upper management approval disincentivizes use of the most hazardous chemicals. Consumer goods company S.C. Johnson & Son, Inc. pioneered this approval system when it introduced its Greenlist chemical management system nearly 15 years ago. See Richard Liroff, "5 Ways to Clean up Fracking's Chemical Act", <http://www.greenbiz.com/blog/2012/09/21/5-ways-clean-frackings-chemical-act>.

18. "Responsibly managing hydraulic fracturing", p. 1, http://www.bhpbilliton.com/~media/bhp/documents/society/reports/2015/150922_society_environment_responsiblymanaginghydraulicfracturing.pdf?la=en.

19. See Southwestern Energy Corporate Responsibility Report 2014-15, p. 23, https://www.swn.com/responsibility/Documents/SWN_CR_Report_2014-15_MR_FINAL.PDF. The third-party evaluation process is similar to one employed by Walmart, which has developed one of the leading retail programs for reducing its chemical footprint. Its suppliers provide data to a third-party analyst. Since Walmart produces private-label products, its suppliers are understandably reluctant to share their information directly with the company.

20. Noble Energy 2014 Corporate Sustainability Report, p. 15, http://sr.nobleenergyinc.com/wp-content/uploads/2015/08/NobleEnergy_2014_SR.pdf.

Well drilling and fracturing present potential for chemicals used in fracturing fluid or methane and other naturally-occurring pollutants to migrate into ground water. One pathway is through wellbore leaks that allow pollutants, including methane from non-targeted methane-bearing formations, to travel along the outside of the well casing into ground water. A second pathway can be created by contaminants moving, via newly created fractures in the production zone, through intersecting neighboring wells, abandoned wells, or existing natural or man-made fractures.²¹

After the fracturing process is completed, some of the water containing intentionally added chemicals and chemicals present in the formation being fractured returns to the surface and must be stored, treated, reused, and/or disposed of safely. One of the highest risk pathways for water contamination of surface and ground waters is through surface spills and leaks of this return water. Finally, some deep wells drilled for the purpose of disposing liquid wastes from producing wells have been associated with increased seismicity risks.

Management of water risks at each stage of drilling and completion must be a core priority for companies. In evaluating corporate disclosures on water management practices, play-by-play reporting is critical because water concerns are primarily local in nature. Accountability at this level serves as an important indicator to investors of a company's ability to effectively manage local operating challenges. In some cases, water risk can vary even within plays, where the plays are several hundred square miles across and cut across diverse hydrological systems. In other cases, plays are stacked on top of one another, so it may be most appropriate to aggregate reporting for such plays. While localized reporting is critical to understanding water risk, selection of the most appropriate reporting units remains an evolving challenge.

Questions

Due to the large number of indicators in this section, questions regarding water and waste management, scores, and notable practices are presented in subsections below.²² *DTF 2015* adds two additional indicators beyond those used in *DTF 2014*. One pertains to pre-drilling company assessment of existing nearby wells. The second indicator relates to assessment of seismicity risks.

21. For a detailed review of the literature on contamination risks from drilling and fracturing, see *DTF 2014*, note 24. In 2015, additional risk reviews were published, including a long-awaited review from the U.S. Environmental Protection Agency. The EPA's draft report noted that there are above- and below-ground mechanisms by which hydraulic fracturing activities have the potential to impact drinking water resources and identified specific instances of impacts on drinking water resources, including contamination of drinking water wells, but concluded that it did not find evidence of widespread, systemic impacts on drinking water resources in the U.S. from hydraulic fracturing. The EPA noted, however, that this finding may be due to a rarity of effects on drinking water resources or a result of other limiting factors including insufficient pre- and post-fracturing data on the quality of drinking water resources; the paucity of long-term systematic studies; the presence of other sources of contamination precluding a definitive link between hydraulic fracturing activities and an impact; and the inaccessibility of some information on hydraulic fracturing activities and potential impacts. See p. ES-6, U.S. Environmental Protection Agency, *Assessment of the potential impacts of hydraulic fracturing for oil and gas on drinking water resources, executive summary*, 2015, http://www2.epa.gov/sites/production/files/2015-06/documents/hf_es_erd_jun2015.pdf. The EPA's external scientific advisors for the report expressed concern about the EPA's conclusion of absence of evidence of widespread, systemic impacts, suggesting that the conclusion be reworded, for example, to acknowledge the severity of the local impacts that have occurred. See "EPA finding of no 'widespread, systemic' problems under fire", *EENews*, 2015, <http://www.eenews.net/stories/1060027402>. In addition to the U.S. EPA study, the Susquehanna River Basin Commission released the third report in a series of water monitoring studies for the Marcellus Shale that showed good water quality at most monitoring stations for 58 watersheds and no significant changes in water quality. See SRBC Press Release, "SRBC releases report for its remote water quality monitoring network", 2015, <http://www.srbcc.net/newsroom/NewsRelease.aspx?NewsReleaseID=144>. In January 2015, academic researchers published a study of wastewater discharges from both conventional and shale oil and gas operations in Pennsylvania and West Virginia that found "high levels of two potentially hazardous contaminants, ammonium and iodide". Ammonium levels more than 50 times higher than the EPA water quality threshold for protecting freshwater organisms were detected in the effluents collected at wastewater discharge sites. See "New Contaminants Found in Oil and Gas Wastewater", 2015, <https://nicholas.duke.edu/news/new-contaminants-found-oil-and-gas-wastewater>.

22. Many of the well integrity, water, waste, and seismicity practices discussed in this section are increasingly being addressed in state regulations governing hydraulic fracturing operations. For example, California's new regulations (SB 4—Well Stimulation Treatment Regulations) call for identification of nearby offset wells (Sec. 1784(a)(2)) and nearby faults (Sec. 1784(a)(3)); running a cement evaluation log (Sec. 1784.2); seismicity monitoring (Sec. 1785.1); storage of waste fluids in containers instead of pits (Sec. 1786(a)(4)); and identification of water sources for fracturing fluids (Sec. 1788(a)(12). See <ftp://ftp.consrv.ca.gov/pub/oil/laws/Final%20Text%20of%20SB%204%20WST%20Regulations.pdf>.

WATER AND WASTE ISSUES

COMPANY	Reports Cement Evaluation Practices	Assesses Offset Wells	Avoids Inducing Seismic Activity	Pre-drill H ₂ O monitor	Post-drill H ₂ O monitor	Flowback water reuse %	Total water use	Water source types	Non-potable water policy	Water intensity	Closed tank water store	Closed loop drilling residuals	NORMs disclosure	TOTAL
BHP Billiton	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	12
Hess	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	11
Apache	✓	✓			✓	✓	✓	✓	✓	✓			✓	8
CONSOL		✓		✓	✓	✓		✓		✓	✓	✓	✓	8
Noble Energy	✓	✓		✓			✓	✓	✓	✓		✓	✓	8
Penn Virginia	✓	✓		✓	✓			✓		✓	✓	✓	✓	8
Anadarko	✓						✓	✓				✓	✓	5
EQT				✓	✓	✓						✓	✓	5
Occidental Petroleum	✓				✓	✓	✓	✓						5
Range Resources				✓				✓		✓	✓	✓	✓	5
Southwestern Energy			✓			✓		✓			✓	✓	✓	5
EOG	✓			✓				✓					✓	4
QEP	✓	✓						✓					✓	4
ConocoPhillips	✓	✓						✓						3
Exco Resources	✓							✓		✓				3
Shell				✓	✓			✓						3
BP			✓	✓										2
Devon								✓					✓	2
Encana			✓					✓						2
WPX	✓			✓										2
Cabot	✓													1
Chesapeake								✓						1
Newfield Resources				✓				✓						1
Pioneer								✓						1
Ultra Petroleum													✓	1

Companies that did not receive points for any indicator in this category are not included in this chart. They are Carrizo, Chevron, Continental Resources, ExxonMobil, and Whiting Oil & Gas.

^ Question requests disclosure by play.

CEMENT INTEGRITY: Proper construction of wells—an essential element of well integrity—is widely viewed by experts as a key factor in reducing risks to ground water from hydraulic fracturing operations. The methods for constructing wells and monitoring integrity have been improving continually.²³ States have been tightening regulations

23. The published literature contains diverse estimates of the frequency of problems with well construction. Wells are constructed with multiple pipe and cement barriers, so even if one barrier fails, the well may not pose a risk to the environment. However, poor cementing jobs in regions where methane exists close to the surface may allow methane to move upward through the outermost portion of the well bore into drinking water aquifers or may allow it to escape to the atmosphere. It is generally believed that risks increase as wells age and that even when constructed properly, earlier generations of wells are riskier than newer wells due to the continual improvement of cementing practices over time. See sources cited in *DTF 2014*, note 25, and *DTF 2013*, notes 24 and 28. Although practices are improving, well construction issues can still occur. In August 2015, Pennsylvania’s Department of Environmental Protection announced a fine of nearly \$200,000 against Chesapeake Energy for a May 2012 incident affecting both private water wells and surface water caused by casing issues in one of Chesapeake’s wells. The incident was initially reported by the company. The Department also announced a fine of nearly \$100,000 levied against Exxon Mobil’s XTO unit, for a May 2011 incident affecting both private water wells and surface water caused by casing and cementing issues at two of the company’s wells. This action was triggered by a citizen complaint. See “DEP reaches penalty agreements with three natural gas exploration companies in the Northern Tier”, DEP Press Release, 2015, <http://www.ahs.dep.pa.gov/NewsRoomPublic/SearchResults.aspx?id=20820&typeid=1>.

governing well integrity as experience with horizontal drilling and hydraulic fracturing has grown since the early 2000s; however, regulations still vary in their stringency.²⁴

The scorecard focuses in particular on whether companies disclose cement evaluation practices that can provide an extra level of assurance about the integrity of their cement.²⁵

Scores: Thirteen companies reference the use of cement evaluation practices.

Notable Practice

- *ConocoPhillips'* "Wells Excellence Cementing Manual" provides minimum global requirements for all of its operated wells, drawing on industry best practices and following American Petroleum Institute cement testing methods. It enumerates several of its approaches, noting that it uses American Petroleum Institute cement blends proven to deliver long-term cement integrity. It also uses cement bond logs, ultrasonic cement evaluation tools, or wireline temperature surveys to verify proper cement placement when required.²⁶

RISKS FROM NEARBY WELLS AND EXISTING FAULTS AND FRACTURES: The scorecard asks if companies disclose the steps they take to identify and avoid the risk that hydraulic fracturing fluids, water, gas, and other pollutants could intersect nearby wells and existing faults and fractures from past drilling, allowing fracturing fluids, water, and other pollutants to move out through them in what is colloquially known as "frac hits".²⁷

Frac hits have been a special concern in the Province of Alberta, Canada, where 21 such incidents were reported between 2010 and 2012, some leading to spills and others leading to nearby well damage.²⁸ Alberta regulators, while noting that such incidents are "very rare" among the more than 5,000 multi-stage fracturing operations in recent years, nevertheless issued a directive to companies to do appropriate planning and modeling (including assessing the risks that new fractures might impact nearby wellbores, both active and abandoned), and to notify and work with

24. For example, a review of regulations in 27 states by the multi-state Groundwater Protection Council found that all states require cementing outer surface casing from top to bottom, but other provisions for well integrity vary substantially among the states. See Groundwater Protection Council, "State oil & gas regulations designed to protect water resources", 2014, Appendix 3, pp. 71-74, <http://www.gwpc.org/sites/default/files/Oil%20and%20Gas%20Regulation%20Report%20Hyperlinked%20Version%20Final-rfs.pdf>.

25. A survey of state regulations by the Groundwater Protection Council indicates that regulators in 12 states may require cement evaluation logs to be conducted under specific conditions. See Groundwater Protection Council, "State oil & gas regulations designed to protect water resources", 2014, p. 72, <http://www.gwpc.org/sites/default/files/Oil%20and%20Gas%20Regulation%20Report%20Hyperlinked%20Version%20Final-rfs.pdf>. Texas' regulations require cement bond logs for the production casing of minimum separation wells—wells where the formation being fractured is less than 1,000 feet vertically from usable water. See 16 TAC Sec. 3.13(a)(7)(D)(iv) and 16 TAC Sec. 3.13(a)(2)(L), [http://texreg.sos.state.tx.us/public/readtac\\$ext.TacPage?sl=T&app=9&p_dir=F&p_rloc=162156&p_tloc=14633&p_ploc=1&pg=2&p_tac=8&ti=16&pt=1&ch=3&rl=13#](http://texreg.sos.state.tx.us/public/readtac$ext.TacPage?sl=T&app=9&p_dir=F&p_rloc=162156&p_tloc=14633&p_ploc=1&pg=2&p_tac=8&ti=16&pt=1&ch=3&rl=13#) and <http://www.rrc.state.tx.us/oil-gas/compliance-enforcement/rule-13-geologic-formation-info/summary-of-amendments-to-swr-13/>. Cement bond logs can be imprecise and require exercise of considerable interpretive judgment. See George King, "Basic cement isolation evaluation", 2014, http://www.shale-gas-information-platform.org/fileadmin/ship/dokumente/expert_articles/Water_protection/Basic_Cement_Isolation_Evaluation_18_November_2014.pdf. The American Petroleum Institute has published standards and guidelines for well construction that identify multiple steps for promoting well integrity, including sound cementing practices. See, for example, "Hydraulic Fracturing Operations—Well Construction and Integrity Guidelines", API Guidance Document HF1, First Edition, 2009, <http://www.shalegas.energy.gov/resources/HF1.pdf>. Updated versions were published in 2015. See <http://www.api.org/Oil-and-Natural-Gas-Overview/Exploration-and-Production/Hydraulic-Fracturing/ANSI-API-Bulletin-100-1-Well-Integrity-and-Fracture-Containment> and <http://www.api.org/Oil-and-Natural-Gas-Overview/Exploration-and-Production/Hydraulic-Fracturing/ANSI-API-Bulletin-100-2-Managing-Environmental-Aspects>.

26. <http://www.conocophillips.com/sustainable-development/common-questions/can-hydraulic-fracturing-be-done-responsibly/Pages/default.aspx>.

27. In August 2015, Pennsylvania's Department of Environmental Protection announced a fine of over \$85,000 levied against Royal Dutch Shell's SWEPI LP unit for a 2012 incident affecting both private water wells and surface water "caused by communication between an old abandoned gas well and one or more of SWEPI's gas wells on its Cochran, Guindon, and/or Yaggie well pads". The incident was initially reported by the company. See "DEP reaches penalty agreements with three natural gas exploration companies in the northern tier", DEP Press Release, 2015. <http://www.ahs.dep.pa.gov/NewsRoomPublic/SearchResults.aspx?id=20820&typeid=1>.

28. "As 'frac hits' grew in Alberta, regulators stepped in", *EnergyWire*, 2014, <http://www.eenews.net/stories/1059992459>.

nearby well licensees, so as to minimize risks from such events.²⁹ A consortium of Canadian companies also developed a best-practice guidance for reducing these risks.³⁰ In the U.S., state regulations addressing existing wells are uneven.³¹ Model drilling regulations developed by Southwestern Energy and the Environmental Defense Fund call for states to establish databases of existing and abandoned wells and for drilling permit applicants to identify them during the permit process.³²

Scores: Eight companies discuss their review of risks from offset wells.

Notable Practices

- *BHP Billiton* reviews its own wells and those of other operators to identify significant hazards. It reviews the results with its drilling service company, isolates nearby wells if they have the potential to interfere, and works to ensure that its new fractures do not intersect existing wells.³³
- *Chevron* reports that, before drilling in the Appalachian basin, it assesses subsurface geology within a minimum radius of 1,000 feet. The company identifies and mitigates risks associated with groundwater aquifers, faults and geological pathways, historical wells in the area, active and inactive coal mining areas, and shallow gas reservoirs.³⁴

MINIMIZING RISK OF INDUCED SEISMICITY: Public and regulatory concern has grown in recent years about seismic events (i.e., earthquakes) induced by activities related to hydraulic fracturing. For example, the state of Oklahoma reports that it experienced 109 magnitude 3.0+ earthquakes in 2013 and 585 in 2014. The current average rate of earthquakes in Oklahoma is approximately 600 times historical averages. The seismic events appear related primarily to the operation of deep injection wells for disposing of fracturing waste water,³⁵ although “only a

29. See Alberta Energy Resources Conservation Board, “Bulletin 2012-02, January 23, 2012 Hydraulic Fracturing: Interwellbore Communication between Energy Wells”, <https://www.aer.ca/documents/bulletins/Bulletin-2012-02.pdf>. The bulletin has since been incorporated into a broader directive on fracturing, “Bulletin 2013-19 May 21, 2013 Directive 083: Hydraulic Fracturing – Subsurface Integrity”, <http://www.aer.ca/documents/bulletins/Bulletin-2013-19.pdf>.

30. Enform, “DACC IRP Volume #24 - Fracture Stimulation (Draft), May 25, 2015”, <http://www.enform.ca/resources/detail/29/dacc-irp-volume-24-fracture-stimulation>.

31. For example, Alaska regulations on hydraulic fracturing operations, effective in 2015, require companies to identify and report on the condition of nearby wells and to identify faults that could compromise efforts to prevent contamination. See 20 AAC 25.283(a)(10) and (11), <https://aws.state.ak.us/OnlinePublicNotices/Notices/Attachment.aspx?id=97850>.

32. Environmental Defense Fund, “Model Regulatory Framework for Hydraulically Fractured Hydrocarbon Production Wells (2014)”, Sections 2.2 and 2.5, https://www.edf.org/sites/default/files/content/Model_Regulatory_Framework_For_Hydraulically_Fractured_Hydrocarbon_Production_Wells_2014.pdf.

33. “Responsibly managing hydraulic fracturing”, p. 2, http://www.bhpbilliton.com/~media/bhp/documents/society/reports/2015/150922_society_environment_responsiblymanaginghydraulicfracturing.pdf?la=en.

34. “Chevron in Appalachia: Managing Performance, Measuring Results”, 2015, p. 6, <http://www.chevron.com/Documents/Pdf/cvx-ambu-report.pdf>.

35. “In a few cases, however, hydraulic fracturing has led directly to earthquakes larger than magnitude 2.0, including at sites in Oklahoma, Ohio, England, and Canada. See Congressional Research Service (CRS), “Human-Induced earthquakes from deep-well injection: a brief overview”, 2014, p. 1, <https://www.fas.org/sgp/crs/misc/R43836.pdf>.

small fraction of the more than 30,000 U.S. wastewater disposal wells appears to be associated with damaging earthquakes”.³⁶

Regulators in several states have turned their attention to the increasing incidence and magnitude of earthquakes.³⁷ In Ohio, Arkansas, Colorado, Ohio, and Texas, regulators have tightened requirements relating to permitting and operation of disposal wells and drilling of new oil and gas wells.³⁸ Though most disposal wells are operated independently of the oil and gas production companies relying on them, in Arkansas, BHP Billiton settled litigation claiming earthquake-related damage from its deep well disposal operations and Chesapeake Energy closed a disposal well in response to regulatory concern.³⁹ In August 2015, Oklahoma regulators sent letters to operators of 23 injection wells northeast of Oklahoma City instructing them to cut by 38% the amount of waste water they pump underground.⁴⁰ In Oklahoma, the state Supreme Court decided unanimously, in a June 2015 opinion, that homeowners who have sustained injuries or property damage from earthquakes allegedly caused by oil and gas operations can sue for damages in state trial courts rather than have their claims adjudicated by state oil and gas regulators.⁴¹

The scorecard asks if companies disclose the steps they take to identify and avoid inducing seismic activity of a magnitude posing a risk to property and human health.

Scores: Three companies discuss their specific approaches to addressing seismicity risk. Other companies, if they discuss seismicity, merely note that scientific research is highlighting risks from deep well injection and regulators are working to manage these risks, but are silent about their own precautionary actions.

36. See www.earthquakes.ok.gov. The recent earthquake swarm does not seem to be due to typical, random changes in the rate of seismicity, according to the U.S. Geological Survey. Also see Congressional Research Service Report, p. 1, <https://www.fas.org/sgp/crs/misc/R43836.pdf>. CRS reviews data on earthquakes associated with disposal wells in Texas, Arkansas, New Mexico/Colorado, Ohio, and Oklahoma. CRS also reviews data on earthquakes associated with fracturing in Canada, England, Oklahoma, and Ohio. CRS concludes that the potential for damaging earthquakes by fracturing itself “appears to be much smaller” than the risks from deep well injection. In September 2015, a working group of state regulators and technical experts, convened under the auspices of the Interstate Oil and Gas Compact Commission and Ground Water Protection Council, published a detailed primer that identifies the range of approaches states have used to manage and mitigate seismicity risks, discusses scientific methods for evaluating causes, and identifies faults of concern. See Ground Water Protection Council and Interstate Oil and Gas Compact Commission, “Potential injection-induced seismicity associated with oil & gas development: A primer on technical and regulatory considerations informing risk management and mitigation”, 2015, available at http://media.wix.com/ugd/d3e01e_7a12408392f240c89943d3f500039004.pdf. The report (pp. 10-11) provides a useful overview of the sizes of earthquakes and their associated effects. It states that it is “commonly accepted” that structural damage to modern buildings happens at larger than magnitude 5.0 earthquakes, though poorly constructed buildings can incur damage at lower magnitudes. In the U.S., structural damage has been documented in at least three cases of potentially induced earthquakes, of magnitudes 5.7 (Oklahoma), 5.3 (Colorado) and 4.8 (Texas). Because induced seismic events generally are smaller than magnitude 5.0, with short durations, the primary concern is ground shaking. Lower magnitude earthquakes, even if they do not cause property damage, can result in human anxiety if felt at the surface. For additional sources, see *DTF 2014*, note 39.

37. See Congressional Research Service Report, p. 1, <https://www.fas.org/sgp/crs/misc/R43836.pdf>. According to the CRS, 20 earthquakes of magnitudes 4.0 to 4.8 have struck central Oklahoma since 2009, with the largest earthquake in state history—magnitude 5.6—occurring in 2011.

38. *Ibid.*, pp. 17-20.

39. “BHP Billiton settles with homeowners over ‘fracking damage’”, *The Telegraph*, 2013, <http://www.telegraph.co.uk/finance/newsbysector/energy/10272592/BHP-Billiton-settles-with-homeowners-over-fracking-damage.html> and “Waste wells to be closed in Arkansas”, *New York Times*, 2011, http://www.nytimes.com/2011/03/05/us/05fracking.html?_r=0.

40. See Oklahoma Corporation Commission, “Media advisory—oil and gas disposal well volume reduction plan”, 2015, <http://www.occeweb.com/News/08-03-15VOLUME%20ADVISORY%20RELEASE.pdf> and “Oklahoma acts to limit earthquake risk at oil and gas wells”, *New York Times*, 2015, <http://www.nytimes.com/2015/08/05/us/oklahoma-acts-to-limit-earthquake-risk-at-oil-and-gas-wells.html>. A Stanford University study of quakes in one section of Oklahoma concluded that the injection of waste water from oil and gas operations was the triggering mechanism for the quakes. The waste water in this study came primarily from conventional oil extraction techniques, not from fracturing operations. See “Oklahoma earthquakes linked to oil and gas wastewater disposal wells, say Stanford researchers”, *Stanford Report*, 2015, <http://news.stanford.edu/news/2015/june/okla-quake-drilling-061815.html>. A broader University of Colorado/U.S. Geological Survey study of thousands of wells concluded that the likelihood of earthquakes was related to how much and how fast waste water was pumped. See Associated Press story, “Study: Mega injections of wastewater triggers more quakes”, <http://www.aol.com/article/2015/06/18/study-mega-injections-of-wastewater-triggers-more-quakes/21198176/>.

41. “Energy’s new legal threat: earthquake suits”, *Wall Street Journal*, 2015, <http://www.wsj.com/articles/frackings-new-legal-threat-earthquake-suits-1427736148> and “Oklahoma court rules homeowners can sue oil companies over quakes”, *New York Times*, 2015, http://www.nytimes.com/2015/07/01/us/oklahoma-court-rules-homeowners-can-sue-oil-companies-over-quakes.html?_r=0.

Notable Practice

- *Southwestern Energy* has developed protocols for determining where induced seismicity might be possible, studying background seismicity, geological formations, and faulting.⁴² Southwestern also notes that because of its increased recycling of water in Arkansas, it was able to reduce its use of deep well injection of wastes from 5 wells to 1 well.⁴³

PRE- AND POST-DRILLING WATER QUALITY MONITORING: The scorecard asks if companies report their pre- and post-drill monitoring practices on a play-by-play basis.

Pre-drill testing is useful for providing a baseline of water quality data against which claims of water contamination can be measured. Post-drill monitoring is important for continued evaluation of water quality to ensure timely action should any problem arise.⁴⁴

Scores: On a play-by-play basis, 12 companies surveyed report that they conduct some type of pre-drilling monitoring in all plays, while only six report that they conduct post-drill monitoring in all plays. If other companies discuss their monitoring, they often discuss it only in very general terms or not for all their plays.

Notable Practices

- *Noble Energy* reports conducting pre-drilling water quality monitoring in its two major plays—the Denver-Julesburg (DJ) Basin in Colorado and the Marcellus Shale in Pennsylvania and West Virginia. For prospective activity in Nevada, the company has conducted a baseline water quality study and committed to ongoing monitoring of water quality.⁴⁵ In Colorado, the company is a founding member of Colorado Water Watch, a groundwater monitoring study in Weld County (DJ Basin). Real-time water quality data are posted on-line.⁴⁶
- *WPX Energy* details its play-by-play water monitoring practices in its 10-K. These monitoring disclosures are part of a broader discussion of hydraulic fracturing water quality and well integrity risks that typically are not included by companies in their 10-Ks.⁴⁷
- *Chevron* reports that in 2014 it completed 285 water sampling tests in its Appalachian Region, which includes Pennsylvania.⁴⁸ It tests four times: before drilling, after drilling, after the last well on the pad is hydraulically fractured, and one year after production begins. Through 2014, the samples showed that the water sources tested near the company's wells had not changed significantly after it began operations.

42. Southwestern Energy Corporate Responsibility Report, 2014-15, p. 45, https://www.swn.com/responsibility/Documents/SWN_CR_Report_2014-15_MR_FINAL.PDF.

43. *Ibid.*, p. 25.

44. For more detailed information, see *DTF 2014*, pp. 16-17. As noted in *FracFocus*, the American Petroleum Institute's hydraulic fracturing guidelines recommend baseline testing of private water wells before fracturing operations begin. See <http://fracfocus.org/groundwater-protection/groundwater-quality-testing>. North Carolina's 2015 regulations governing fracturing operations call for pre- and post-drilling monitoring. See 15A NCAC §05H.1803, <http://ncrules.state.nc.us/ncac/title%2015a%20-%20environmental%20quality/chapter%2005%20-%20mining%20-%20mineral%20resources/subchapter%20h/15a%20ncac%2005h%20.1803.pdf>.

45. Noble Energy 2013 Sustainability Report, p. 17, <http://sr.nobleenergyinc.com/wp-content/uploads/2015/08/Noble-2013-Sustainability-Report1.pdf>.

46. *Ibid.*, p. 26, <http://sr.nobleenergyinc.com/wp-content/uploads/2015/08/Noble-2013-Sustainability-Report1.pdf>. Real-time data are available at <http://waterwatch.colostate.edu/Home/Sensors>.

47. WPX Energy 2014 10-K, p. 21, <http://d1lge852tjqow.cloudfront.net/CIK-0001518832/25599b57-fa32-4ea6-ae83-0469799a5bcc.pdf>.

48. "Chevron in Appalachia: Managing Performance, Measuring Results", p. 7, <http://www.chevron.com/Documents/Pdf/cvx-ambu-report.pdf>. Pennsylvania encourages companies to test water before they drill to establish baseline water quality conditions. Companies are presumed liable if water wells are found to be contaminated after drilling has started. The state does not require post-drilling monitoring.

- *EOG Resources* reports that it has implemented a pre-drilling baseline water sampling program in all of its U.S. divisions. In addition, it conducts post-drilling testing based on state regulations and on a case-by-case basis as it deems operationally appropriate.⁴⁹

WATER USE AND RECYCLING: Around the globe, fresh water is a scarce and threatened resource in many locations and companies across economic sectors are assessing their water risk and water footprint. Oil and gas companies can reduce their water footprint and water risk by increasing their recycling of waste water and using other non-potable water sources.⁵⁰ Further, they can gain competitive advantage by reducing the intensity of their water use; while doing so, though, they must responsibly manage risks associated with recycling.⁵¹

The scorecard asks whether companies disclose the percentage of flowback⁵² waste water managed and reused, the aggregate quantity of water used, the sources of water used in operations (e.g., ground and surface water), and the intensity of water use (i.e., the amount of water used to produce a unit of energy). The scorecard also asks whether companies have a policy to use non-potable water whenever technically possible.

Scores

For each shale play:

- Six companies disclose the aggregate quantity of water used for hydraulic fracturing.
- Six companies report the types of water used.
- Seven companies report the percentage of flowback water managed and reused.
- Four companies report the intensity of their water use.

In addition, nineteen companies report having a policy to use non-potable water sources where feasible.

49. http://www.eogresources.com/responsibility/water_management.html.

50. The U.S. Geological Survey reports that water use for fracturing individual wells can vary dramatically both among and within shale plays. The national average in 2014 was 4 million gallons per oil well and 5.1 million gallons per gas well. See USGS Press Release, "Water used for hydraulic fracturing varies widely across United States", 2015, <http://www.usgs.gov/newsroom/article.asp?ID=4262#.VcJ2QvVhHx>. See also Gallegos, T. J., B. A. Varela, S. S. Haines, and M. A. Engle, 2015, Hydraulic fracturing water use variability in the United States and potential environmental implications, *Water Resour. Res.*, 51, pp. 5839-5845, <http://onlinelibrary.wiley.com/doi/10.1002/2015WR017278/full>.

51. Water recycling risks include increased handling of flowback and produced waste water, potentially increasing risks from spills and leaks. Recycling also increases the amount of concentrated residual wastes requiring management and disposal. See Dan Mueller, "Recycling wastewater from oil and gas wells poses challenges", EDF Energy Exchange Blog, 2015, <http://blogs.edf.org/energyexchange/2015/11/11/recycling-wastewater-from-oil-and-gas-wells-poses-challenges-2/>. Additionally, use of highly saline fracturing waste water as brine on roads is an area of public concern. See <http://www.newsweek.com/oil-and-gas-wastewater-used-de-ice-roads-new-york-and-pennsylvania-little-310684>. An interagency agreement in West Virginia has set limits on salt brine water from gas wells used for road salting. See <http://www.dep.wv.gov/WWE/Documents/WVDOHVVDEP%20Salt%20Brine%20Agreement.pdf>. In 2015, the U.S. Environmental Protection Agency proposed a ban on disposal of fracturing waste water at municipal sewage treatment plants. Such disposal is not presently occurring, but the EPA rule would prohibit such use in the future. See "EPA to block drillers from sending wastewater to municipal treatment plants", *Fuelfix*, 2015, <http://fuelfix.com/blog/2015/07/22/epa-to-block-drillers-from-sending-wastewater-to-municipal-treatment-plants/#2572101=0>. New Mexico issued regulations in early 2015 to encourage reuse of produced water for fracturing operations. See "New rule clears way for NM oil producers to reuse water", *Albuquerque Journal*, 2015, <http://www.abqjournal.com/557662/biz/biz-most-recent/new-rule-clears-way-for-nm-oil-producers-to-reuse-water.html>.

52. Flowback water is the water that flows back to the surface immediately after a well is fractured and includes both injected materials, including chemicals used in frac fluids, and water already present in the formation. See http://www.afdc.energy.gov/uploads/publication/anl_hydraulic_fracturing.pdf, pp. vii-viii. Another form of waste water, produced water, refers to the water in the formation that subsequently flows back in smaller quantities over the life of the well. This water has high levels of total dissolved solids and leaches out minerals from the shale including barium, calcium, iron, and magnesium. It also contains dissolved hydrocarbons such as methane, ethane, and propane along with naturally occurring radioactive materials (NORMs) such as radium isotopes. See <http://energy.wilkes.edu/pages/205.asp> and http://www.afdc.energy.gov/uploads/publication/anl_hydraulic_fracturing.pdf, pp. vii-viii. Plays vary in the proportions of injected fluids that return to the surface and the chemical characteristics of formation waters. See *DTF 2014*, notes 40 and 41.

Notable Practices

- *Devon Energy* has been reusing so much of its waste water in the Wolfcamp Shale of West Texas that its effort “has virtually eliminated our need for disposal wells in the play”. The water reuse has allowed the company to conserve more than 4.5 million barrels of fresh water from mid-2013 through the end of 2014.⁵³
- *Noble Energy* is one of several companies reporting play-by-play water use, recycling, and sourcing from non-potable water sources. It is doing so not only for its two major shale operations, the DJ Basin in Colorado and the Marcellus Shale in Pennsylvania and West Virginia, but also for its nascent operations in Nevada.⁵⁴
- *Southwestern Energy* created its ECH2O (Energy Conserving Water) Program to support its commitment that “for each gallon of fresh water we use in our operations, we will replenish or offset an equivalent amount through conservation and innovation”.⁵⁵ Southwestern reports that in 2014 it recycled 99% of flowback and produced water from the Fayetteville and Marcellus Shales. Recycled water accounted for 40% of the total water sourced for fracturing, up from 28% in 2013.⁵⁶ Company-wide, freshwater withdrawals decreased 15% between 2012 and 2014. In general, Southwestern designs its water systems to collect rainwater runoff, minimize use of water from public sources, and reduce water-hauling trucks on the road.⁵⁷
- *Pioneer Natural Resources* created a separate company, Pioneer Water Management LLC, in 2014 whose main objective is to reduce the volume of fresh water used in drilling and completions by exploring alternate, cost-effective water sourcing options. The company is also focused “on mitigating the disposal of produced water through water recycling efforts, reducing water acquisition and transportation costs, and minimizing water trucking on public roadways”.⁵⁸ In 2014, the newly created company entered an agreement with the City of Odessa, Texas and initiated negotiations with the City of Midland, Texas to purchase effluent water from the cities for use in operations.⁵⁹
- *CONSOL Energy* created CNX Water Assets LLC as a vehicle to develop water-related services, evaluate emerging treatment technologies, champion the reuse of treated mine water, and pursue a strategic approach to water asset management.⁶⁰ CONSOL also reports that it has established sharing agreements with industrial consumers, which serve to reduce the surface footprint of water infrastructure and the need for trucking water.⁶¹

SURFACE WATER PROTECTION AND TREATMENT AND DISPOSAL OF WASTE WATER: Water contamination can result from the chemicals used in drilling the well and those used in fracturing fluids plus naturally occurring contaminants in waters that are brought back to the surface. Open surface pits for storing waste materials have been identified as a relatively high water contamination risk as well as an air quality concern.⁶² Above-ground

53. Devon 2015 Corporate Responsibility Report, p. 35, <http://www.devonenergy.com/documents/Social-Responsibility/2015-CSR-Report.pdf>.

54. Noble Energy 2014 Sustainability Report, p. 7, http://sr.nobleenergyinc.com/wp-content/uploads/2015/08/NobleEnergy_2014_SR.pdf.

55. <http://www.swn.com/responsibility/pages/water.aspx>.

56. Southwestern Corporate Responsibility Report 2014-15, p. 24, https://www.swn.com/responsibility/Documents/SWN_CR_Report_2014-15_MR_FINAL.PDF.

57. http://www.swn.com/responsibility/documents/water_fact_sheet.pdf.

58. <http://www.pxd.com/operations/water-management>.

59. <http://www.pxd.com/operations/water-management/operations>.

60. CNX Water Assets LLC was created in 2012.

61. CONSOL 2014 Corporate Responsibility Report, p. 30, <http://www.consolenergy.com/media/28541/2014-consol-energy-corporate-responsibility-report.pdf>.

62. “Small study may have big answers on health risks of fracking’s open waste ponds”, InsideClimate News, 2014, <http://insideclimatenews.org/news/20141010/small-study-may-have-big-answers-health-risks-frackings-open-waste-ponds>.

storage tanks equipped with vapor controls, while not entirely risk-free, can lower various risks compared to surface pits.⁶³

The scorecard asks whether companies report, on a play-by-play basis, their practices for storing waste water and whether they similarly report on the use of closed loop systems⁶⁴ for their drilling wastes.⁶⁵

Scores

- Six companies disclose their policies for each play to store flowback water in closed tanks.
- Nine companies disclose their policies to use closed loop systems for managing drilling residuals for each play.



IMAGE: Robert M. Donnan

Bednarski waste water impoundment, Pennsylvania

Notable Practice

- *Chevron* implemented pitless operations in the Appalachian Region, using closed loop drilling for the wells it drilled in 2014. The company also completed in 2015 its phase-out of 48 lined brine storage pits, a process begun in 2013.⁶⁶

IDENTIFYING AND MANAGING NORMS: Waste containing naturally occurring radioactive materials (“NORMs”) has drawn considerable attention in the Marcellus Shale region and in North Dakota, raising community concern about company management and disposal practices.⁶⁷

The scorecard asks whether companies report practices for identifying and managing hazards associated with NORMs.

Scores

Twelve companies address, in some form, their practices for identifying and managing hazards from NORMs.

63. For an assessment of risks from pits and tanks, based on 14 years of data from New Mexico, see Resources for the Future, “Pits versus tanks: comparing storage methods for fluids used in fracking”, *Resources* 189, 2015, http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-Resources-189_Infographic.pdf. The RFF study found that spills from pits occurred twice as often as spills from tanks, while also losing over ten times as much fluid. In 2015, the Groundwater Protection Council published a non-quantitative comparison of risk factors from pits and tanks, not including air pollution. See Groundwater Protection Council, “State oil & gas regulations designed to protect water resources”, 2014, Appendix 15, pp. 106-109, <http://www.gwpc.org/sites/default/files/Oil%20and%20Gas%20Regulation%20Report%20Hyperlinked%20Version%20Final-rfs.pdf>.

64. In a closed loop system, open reserve pits for capturing drilling muds are replaced by a series of storage tanks. Solids and liquids are separated, minimizing the amount of drilling waste muds and cuttings that require disposal and maximizing the amount of drilling fluid recycled and reused in the drilling process. See https://www.earthworksaction.org/issues/detail/alternatives_to_pits#CLOSEDLOOP.

65. In August 2015, a coalition of environmental and community organizations concerned about disposal of both drilling wastes and waste water notified the U.S. Environmental Protection Agency of their intention to sue the agency for failure to update federal regulations governing management of oil and gas wastes. Seismic events from underground injection and contamination from spreading of waste water onto roads and fields were among the risks cited by the filers. See “Groups file notice of intent to sue EPA over dangerous drilling and fracking waste”, 2015, <http://environmentalintegrity.org/archives/7421>. For the text of the filing, see <http://environmentalintegrity.org/wp-content/uploads/2015-08-26-OG-Wastes-RCRA-Notice-Letter-FINAL.pdf>.

66. “Chevron in Appalachia: Managing Performance, Measuring Results”, p. 13, <http://www.chevron.com/Documents/Pdf/cvx-ambu-report.pdf>.

Notable Practice

- *Southwestern Energy* reports that its NORM management program specifies procedures for detecting, managing, and disposing of NORM-affected materials, and all remediating or decommissioning of detected NORM waste is done by a specially licensed third party. The company states that it did not generate any NORM waste in 2014⁶⁸

Progress and Prospects

Increased sourcing of water from deep, non-potable aquifers, municipal sewage treatment plant effluent, and even acid mine drainage has reduced demand for fresh water. Development of a new generation of fracturing chemicals that can work cost-effectively with non-potable water has accompanied this increased sourcing of non-potable water. In tandem with this technological innovation, companies have been scaling up waste treatment operations and increasing collaboration with other companies on waste treatment.

Increasing on-site wastewater recycling has lowered demand for fresh water withdrawals while reducing air emissions, road damage, and community disruption from trucks, particularly when recycling is done on multi-well pads. Induced seismicity from deep wastewater injection wells has increased dramatically in recent years; wastewater recycling has the salutary effect of lowering the need for such wells.

Companies' disclosures on their websites attest to the increasing uptake of cost-effective innovations to decrease use of fresh water and to handle waste more effectively. Such disclosures provide investors with insight into the quality of corporate management, particularly regarding the extent to which companies have developed data on, and planning processes enabling adoption of, improved measures. While certain companies have improved corporate disclosures, the industry as a whole has a long way to go to present a complete picture of the effectiveness of management practices to decrease water and waste impacts. Currently, a significant portion of the industry is leaving investors substantially in the dark.

Well integrity remains a core issue. There have been a sufficient number of documented incidents of water contamination to merit investor concern about well integrity. Companies must assure investors and other stakeholders that they have adopted current best practices for well integrity and, more importantly, that those practices have been effectively implemented. Well integrity not only involves the sound construction of production wells but also must take into account nearby wells in fracturing operations and the siting and operation of disposal wells to minimize induced seismicity. Many companies have long-described the multiple layers of pipe and cement they use to reduce contamination risks, but they need to disclose more about the widening range of well integrity concerns.

67. See *DTF 2014*, p. 21 and associated footnotes. A study by the Pennsylvania Department of Environmental Protection released in January 2015 concluded, "there is little potential for radiation exposure from oil and gas development" while also noting that filter cakes from facilities treating wastes can have a radiological impact if spilled and pose a potential long-term disposal issue. The study also noted the need for additional research on the radiological impacts from use of oil and gas industry brine for dust suppression and road stabilization. The DEP study was based on sampling at well sites, wastewater treatment plants, landfills that accept drilling waste, compressor stations, gas processing facilities, and other locations. See DEP press release and full study at <http://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/RadiationProtection/rls-DEP-TENORM-01xx15AW.pdf>. Additionally, a recent study suggested that EPA-recommended test methods significantly underestimate the radioactivity of hydraulic fracturing waste water and the potential exposure risks related to hydraulic fracturing procedures. See "Study raises questions about measuring radioactivity in fracking wastewater", *Science Insider*, April 2015, <http://news.sciencemag.org/chemistry/2015/04/study-raises-questions-about-measuring-radioactivity-fracking-wastewater>. Also, in April 2015, researchers at Johns Hopkins University released a Pennsylvania study that found an upswing in home basement radon levels between 2004 and 2012, with higher levels in counties having 100 or more drilled wells versus counties with none. See "Study links radon levels in Pennsylvania homes to fracking", *Baltimore Sun*, 2015, <http://www.baltimoresun.com/features/green/blog/bal-study-links-radon-levels-in-pennsylvania-homes-to-fracking-20150408-story.html>. The study is available here: <http://ehp.niehs.nih.gov/1409014/>. Also note, North Carolina's 2015 regulations for hydraulic fracturing operations require testing and tracking of waste, including assessment of radioactivity. See 15A NCAC 05H.2003, <http://ncrules.state.nc.us/ncac/title%2015a%20-%20environmental%20quality/chapter%2005%20-%20mining%20-%20mineral%20resources/subchapter%20h/15a%20ncac%2005h%20.2003.pdf>.

68. SWN Corporate Responsibility Report 2014-15, p. 31, https://www.swn.com/responsibility/Documents/SWN_CR_Report_2014-15_MR_FINAL.PDF.

Air Emissions from Oil and Gas Development in the Eagle Ford

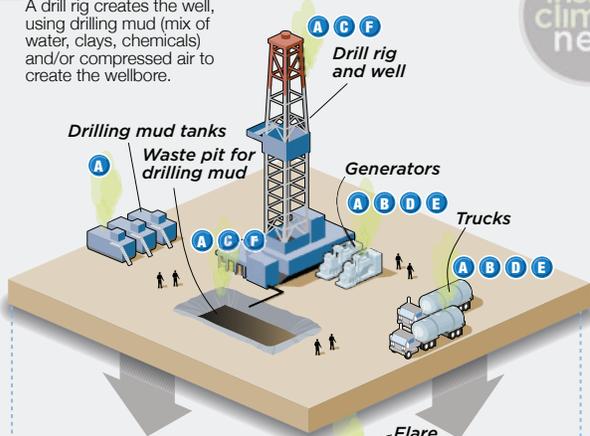
There are more than 7,000 oil and gas wells in the Eagle Ford Shale, and Texas regulators have approved another 5,500. Most of them, like the one shown here, are oil wells that also produce condensate and natural gas. Developing these resources releases various air pollutants, some of which are shown in this simplified diagram.



inside climate news

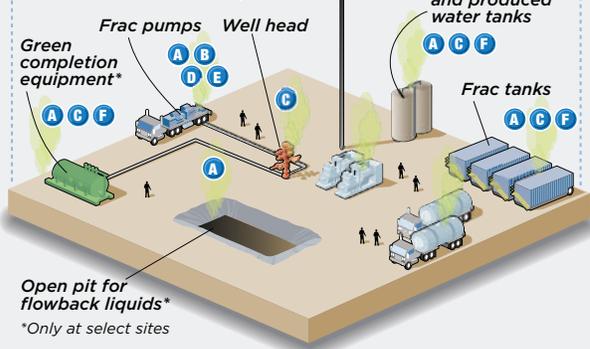
1 Drilling stage

A drill rig creates the well, using drilling mud (mix of water, clays, chemicals) and/or compressed air to create the wellbore.



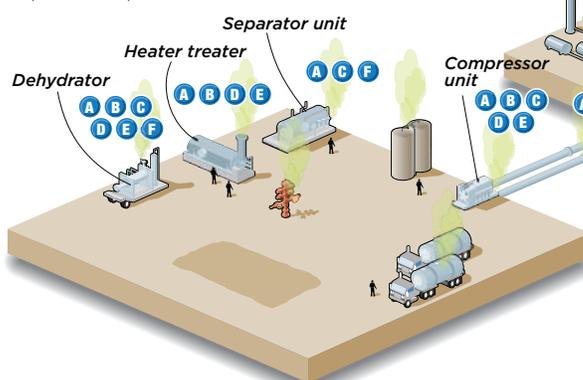
2 Hydraulic fracturing and well completion

Water, proppants and chemicals are pumped into the well to fracture the rock and release the oil and gas.



3 Production

The well begins to produce large amounts of oil and gas. The recovered oil is shipped to refineries; gas and condensates are separated and processed.



Emission Sources

The pollutants come from a number of sources, including the diesel- or natural gas-fueled equipment, the oil and gas itself, and leaks from storage devices. The emissions' actual and relative amounts vary widely based on operator practices and local geology. The emissions occur regularly in some cases, but are intermittent in others.

CHEMICAL	WHAT IT IS	WHAT IT DOES
A VOCs	Volatile organic compounds including benzene, formaldehyde	There are dozens of VOCs that make people sick. Some can cause cancer. VOCs react with NOx to form ozone, a respiratory irritant and greenhouse gas.
B PM	Particulate matter	Affects the heart and lungs.
C CH ₄	Methane	Main component of natural gas. Much more powerful than CO ₂ as a greenhouse gas.
D CO ₂	Carbon dioxide	Major greenhouse gas.
E NOx	Nitrogen oxides	Reacts with VOCs to create ozone.
F H ₂ S	Hydrogen sulfide	Toxic gas found in some gas fields. Causes illness and death at certain concentrations.

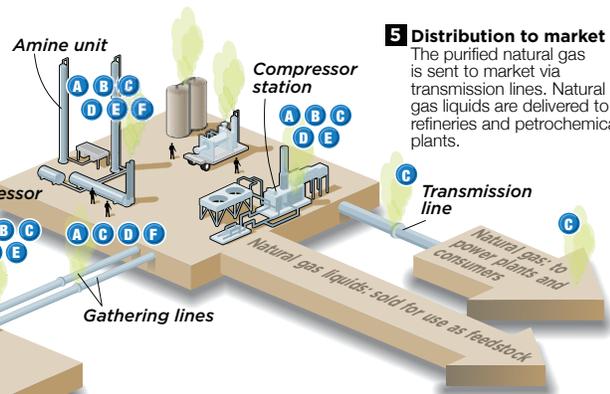
Fugitive emissions: pipelines, valves, pneumatic devices etc. leak methane, VOCs, H₂S and CO₂ throughout the entire process.

4 Dehydration, treatment and processing

Water, condensate, H₂S and other impurities are taken out of the raw natural gas. This can occur on or near the well pad or at a centralized processing facility. Additional equipment used to purify and process natural gas liquids is not shown here.

5 Distribution to market

The purified natural gas is sent to market via transmission lines. Natural gas liquids are delivered to refineries and petrochemical plants.



NOTES: the equipment and processes can vary with operator and facility. This diagram shows what the process could look like in a field with high levels of H₂S (common in the Eagle Ford Shale). Some sources, such as trucks, appear in multiple stages but their emissions are only shown once. For clarity, most pipelines are omitted, and only one well is depicted although well pads often have many wells. Not to scale.

SOURCES: EPA and Schlumberger publications; experts consulted for various aspects of the diagram include Ramón Alvarez (EDF), Richard Haut and Jay Olaguer (HARC), Alisa Rich (UNT), Jim Tarr (Stone Lions Env. Corp), engineers from industry and Cardno Entrix.

Research by LISA SONG / InsideClimate News Graphic by PAUL HORN / InsideClimate News

IMAGE: Paul Horn / Inside Climate News

3. AIR EMISSIONS

Issue and Questions

Air contaminants are emitted during multiple stages of oil and gas development. (See *Figure*, “Air Emissions from Oil & Gas Development in the Eagle Ford”). Of particular concern for their contributions to regional smog are volatile organic compounds (VOCs) and nitrogen oxides (NOx).⁶⁹ From a global perspective, emissions of the greenhouse gases methane and carbon dioxide is a key concern. Natural gas extracted from the earth, when burned to generate power, produces less carbon dioxide than coal and has negligible emissions of sulfur dioxide and mercury. However, these benefits can be offset by leakage of methane into the atmosphere in the natural gas production, transmission, and distribution life cycle.⁷⁰ These methane emissions matter because methane is a tremendously potent greenhouse gas, having a “global warming potential” at least 84 times that of carbon dioxide over a 20-year time frame. Substantial quantities of carbon dioxide can also be generated by the burning off (“flaring”) of methane gas associated with oil production, where no infrastructure has been built to capture and bring to market or otherwise make productive use of the associated gas. Federal regulations adopted in 2012 require green completions at newly completed gas wells to maximize capture of gas, and avoid flaring or venting.⁷¹ The regulations do not apply, however, to the capture of associated gas from oil wells.⁷² In August 2015, the U.S. Environmental Protection Agency released proposed regulations that would extend green completion requirements to new oil wells.⁷³

Technical experts generally agree that cost-effective emission reduction measures are currently available to substantially reduce methane and other air emissions.⁷⁴ A collaboration of several oil and gas companies and the Environmental Defense Fund (EDF) is encouraging development and pilot-testing of inexpensive leak detection and control technologies. Several states have enacted regulations requiring companies to establish leak detection and



69. See *DTF 2014*, p. 23 and notes 65-67.

70. For details on methane emission measurements and estimates, see *DTF 2014*, note 68.

71. Federal and state regulations governing green completions allow exemptions for gas wells where green completions are not feasible for technical reasons. Likewise, green completions may not always be technically feasible for associated gas at oil wells. EPA's 2012 regulations also addressed VOC and methane emissions from storage tanks, compressors, and other sources.

72. The widespread flaring of associated gas in North Dakota's Bakken Formation, visible from outer space, prompted North Dakota regulators to require companies to meet flaring reduction targets or cut back production. See *DTF 2014*, pp. 25-26.

73. http://www.epa.gov/airquality/oilandgas/pdfs/oil_well_site_summ_081815.pdf.

74. See, for example, ICF International, “Economic analysis of methane emission reduction opportunities in the U.S. oil and natural gas industries”, prepared for the Environmental Defense Fund (EDF), 2014, https://www.edf.org/sites/default/files/methane_cost_curve_report.pdf. The report estimates that the natural gas industry, from upstream production to downstream distribution, could cut methane emissions by 40% below projected 2018 levels, at an average annual cost of less than one cent per thousand cubic feet of produced natural gas, by adopting available emissions-control technologies and operating practices. The most cost-effective reduction opportunities would create over \$164 million in net savings for operators. A June 2015 ICF report focusing on emissions from federal and tribal land found that 65 billion cubic feet of natural gas—with an estimated value of \$360 million—was released into the atmosphere in 2013 alone. See ICF, Inc., “Onshore petroleum and natural gas operations on federal and tribal lands in the United States—analysis of emissions and abatement opportunities”, https://www.edf.org/sites/default/files/content/federal_and_tribal_land_analysis_presentation_091615.pdf. It has been widely observed that emission controls to reduce methane also reduce VOCs, and vice versa.

repair (LDAR) programs.⁷⁵ EPA regulations proposed in August 2015 require companies to develop leak detection and repair programs for new natural gas well sites. EPA also proposed guidelines for states to develop regulations to reduce fugitive emissions from existing oil and natural gas industry equipment in regions that are violating the national ambient air quality standard for ozone.⁷⁶ Companies can also save money and reduce emissions by powering pad operations with natural gas and/or renewable energy such as solar or wind rather than diesel fuel and by substituting pipelines for trucks when transporting water and waste fluids to and from drilling sites.

Investors have been pressing companies to set public goals for reducing methane emissions and greenhouse gases, contending that such goal-setting is increasingly a corporate best practice and is a critically important tool for adjusting to the regulatory and other challenges of a carbon-constrained world.⁷⁷ The scorecard asks for play-specific information about the percentage of wells for which a company uses green completions, by type of well; use of natural gas, or other reduced-emission methods to power well pad operations; emissions of NO_x and VOCs from well drilling, completion, and production activities; and amount of, and reductions in, NO_x and VOC emissions from emission control efforts. The scorecard also asks, on a non-play-specific basis, for the percentage of corporate vehicle fleets converted to lower emission fuels; methane emission rates from drilling, completion, and production operations; the percentage or number of high-bleed valves replaced with lower emission valves; the scope and frequency of leak detection and monitoring programs; the use of pipelines instead of trucks to transport water; and whether a company has established greenhouse gas and methane emission reduction goals.

Scores

For each shale play:

- Eight companies report on the percentage of wells for which they use green completions.⁷⁸

75. See *DTF 2014*, p. 25 and notes 69-71 and 90. Field measurements of methane emissions continue to show that, within each category, a small portion of equipment in various categories (e.g., pneumatic controllers and natural gas compressor stations) are responsible for most of the emissions. See, for example, D.T. Allen *et al.*, "Methane emissions from process equipment at natural gas production sites in the United States: pneumatic controllers", *Environ. Sci. Technol.*, 2015, 49 (1), pp. 633-640, <http://pubs.acs.org/doi/abs/10.1021/es5040156> and R. Subramanian *et al.*, "Methane emissions from natural gas compressor stations in the transmission and storage sector: measurements and comparisons with the EPA greenhouse gas reporting program protocol", *Environ. Sci. Technol.*, 2015, 49 (5), pp. 3252-3261, <http://pubs.acs.org/doi/abs/10.1021/es5060258>. The World Resources Institute provides a concise overview of state regulations requiring leak detection and repair (LDAR) and the issues related to LDAR program design in Michael Obeiter and Chris Weber, "Reducing methane emissions from natural gas development: strategies for state-level policymakers", World Resources Institute Working Paper, 2015, <http://www.wri.org/publication/reducing-methane-emissions-natural-gas-development-strategies-state-level-policymakers>. The WRI authors conclude (pp. 10-11) that widespread LDAR "can be highly cost-effective, and is needed throughout the industry to find and fix ... 'super-emitters'", the small proportion of sources contributing the most leaks. They note also that the frequency of surveys is critical, with the "sweet spot ... likely to be between monthly surveys and semiannual surveys".

76. See http://www.epa.gov/airquality/oilandgas/pdfs/natgas_well_site_summ_081815.pdf and http://www.epa.gov/airquality/oilandgas/pdfs/og_fs_081815.pdf. In May 2015, Wyoming regulators adopted new regulations aimed at limiting emissions in the Upper Green River Basin, a non-attainment area for the federal ozone standard. The regulations require companies to install best available control technology to eliminate up to 98% of emissions on wells, dehydration units, and compressor stations that release more than four tons of VOCs annually. Facilities exceeding the four ton threshold will be required to implement a leak detection and repair program, including quarterly inspections. See "Wyoming passes stricter ozone standards for Pinedale area, but questions remain", *Billings Gazette*, 2015, http://billingsgazette.com/news/state-and-regional/wyoming-passes-stricter-ozone-standards-for-pinedale-area-but-questions/article_f597af14-a2b1-52d6-a583-0e418eb2c9c5.html.

77. See, for example, the statement by the Tri-State Coalition for Responsible Investment on their 2015 resolution at ExxonMobil asking the company to set greenhouse gas emission reduction goals: <http://www.sec.gov/Archives/edgar/data/34088/000121465915003187/c421150px14a6g.htm>. For a review of climate goal setting (including in the areas of emission reductions, energy efficiency, and renewable energy) by Fortune 500 companies, see Ceres *et al.*, "Power forward 2.0: How American companies are setting clean energy targets and capturing greater business value", 2014, <http://www.ceres.org/resources/reports/power-forward-2.0-how-american-companies-are-setting-clean-energy-targets-and-capturing-greater-business-value/view>. The International Energy Agency has identified minimizing methane emissions from upstream oil and gas production as one of four key global greenhouse gas mitigation opportunities, noting that reductions in such emissions could account for nearly 15% of the total greenhouse gas reductions needed by 2020 to keep the world below a 2°C increase in temperature, a level above which catastrophic global impacts are predicted to occur. See International Energy Agency, "World energy outlook special report 2013: Redrawing the energy climate map", <https://www.iea.org/publications/freepublications/publication/weo-special-report-2013-redrawing-the-energy-climate-map.html>.

78. This question was expanded from 2014 to include oil wells.

AIR EMISSIONS

COMPANY	% Green Completions [^]	Low Emission Engines Pad Ops. [^]	% Low Emission Vehicle Conversion	NOx and VOCs Reporting [^]	NOx and VOCs Reductions [^]	Pipelines Replace Trucks	Methane Leakage	Low-bleed Controllers	Leak Detection Technology	Leak Inspection Frequency	Has Methane Goal	Has GHG Target	TOTAL
Southwestern Energy	✓	✓	✓			✓	✓	✓	✓	✓			8
BHP Billiton	✓	✓	✓			✓	✓	✓			✓		7
Noble Energy		✓	✓			✓		✓	✓				6
Anadarko	✓		✓			✓		✓	✓				5
Apache		✓	✓			✓	✓		✓				5
CONSOL	✓	✓				✓		✓	✓				5
QEP			✓			✓		✓	✓				4
ConocoPhillips	✓					✓					✓		3
Devon	✓					✓	✓						3
EQT	✓		✓				✓						3
Hess				✓		✓	✓						3
Range Resources			✓			✓		✓					3
BP						✓		✓					2
Chevron						✓					✓		2
Encana						✓	✓						2
Exco Resources		✓				✓							2
Occidental Petroleum						✓		✓					2
Pioneer			✓			✓							2
Shell						✓		✓					2
Ultra Petroleum	✓					✓							2
Chesapeake			✓										1
Continental Resources						✓							1
EOG						✓							1
ExxonMobil						✓							1
Whiting Oil & Gas								✓					1
WPX						✓							1

Companies that did not receive points for any indicator in this category are not included in this chart. They are Cabot, Carrizo, Newfield Resources, and Penn Virginia.

[^] Question requests disclosure by play.

- Six companies report on the use of natural gas, or other reduced emission methods to power well pad operations.
- One company—Hess—reports on NOx and VOC emissions from well drilling, completion, and production. No company reports on emission reductions from emission control efforts.⁷⁹

In addition, on a non-play-specific basis,

- Ten companies report the percentage of their vehicle fleets converted to lower emission fuels.
- Five companies report their methane emission rates from drilling, completion, and production operations.
- Five companies report the percentage or number of high-bleed valves replaced with lower emission valves.
- Eleven companies report the scope of their leak detection and repair programs.
- Five companies report the frequency of monitoring by their leak detection and repair programs.

79. Companies report a variety of actions to reduce NOx and VOC emissions, but this pair of questions seeks quantitative reporting of companies' NOx and VOC emissions and any reductions of such emissions achieved.

- Twenty-three companies report the use of pipelines instead of trucks to move water.
- No companies report having established public methane emission reduction goals.
- Three companies report having established greenhouse gas emission reduction goals.

Notable Practices

Greenhouse Gas Emission Reductions

- *Southwestern Energy* has led efforts to establish Our Nation's Energy (ONE) Future Coalition, a collaborative effort of eight companies with operations throughout the natural gas supply chain to reduce emissions below 1% of total natural gas gross production across the supply chain.⁸⁰ The exploration and production companies joining *Southwestern Energy* in this initiative include *Apache*, *BHP Billiton*, and *Hess*.⁸¹ The coalition expects to set targets for each sector in the supply chain between 2016 and 2018. Each company will then set their own targets based on the company's proportional share that can be abated cost-effectively. Also, under the agreement, methane emissions, together with other health, safety, and environmental goals, will be taken into account when evaluating operating performance and determining bonuses for management and staff.
- *Chevron* has instituted a leak detection program, including annual inspections with infrared technology. The company reports that less than 0.1% of the equipment on its well pads was identified as leaking during inspections; these leaks were identified (and then repaired) across nearly 100 well pads and thousands of components.⁸²
- *Southwestern Energy* implemented a leak detection and repair program across its operations in 2014. The company conducted FLIR camera surveys on more than 3,000 wells (approximately 65% of its operated wells), and more than 70 compressor stations (100% of the stations operated by its midstream subsidiary). The program identified and fixed more than 1,000 leaking components, resulting in the recovery of an estimated 350 million cubic feet of methane.⁸³

Other Air Quality Actions

- *QEP Resources* has been implementing a "Zero Emissions Liquids Transfer System" in eastern Utah. It has electrified well pads and reduced on-site emissions by eliminating pneumatic pumps. The company pipes water for fracturing to the pad and flowback water is transported to a central processing facility through a pipeline. Additional technologies have been deployed to reduce or eliminate emissions associated with the project.⁸⁴
- *Occidental Petroleum* started up four new wellhead gas-fueled electric power generators in North Dakota's Bakken Formation in late 2014, and intends to expand the gas-fired generator program in 2015 in North Dakota as well as other operating regions. In North Dakota, approximately 50% of the gas consumption—roughly seven thousand cubic feet per day per generator—would otherwise be flared.⁸⁵

80. <http://www.swn.com/responsibility/pages/air.aspx>. EPA, as part of its Methane Challenge Program, a proposed voluntary framework to encourage oil and gas producers to commit to methane emissions reduction and reporting targets, said it would recognize ONE Future participants' emission reduction commitments and provide a reporting platform for transparently tracking company progress against commitments. See U.S. Environmental Protection Agency, "Natural Gas STAR Methane Challenge Program: Proposed Framework", 2015, http://www3.epa.gov/gasstar/documents/methane_challenge_proposal_072315.pdf. The other parts of the supply chain include processing plants, transmission and storage companies, and utilities.

81. <http://www.onefuture.us/who-we-are/leadership/>.

82. "Chevron in Appalachia: Managing Performance, Measuring Results", p. 16, <http://www.chevron.com/Documents/Pdf/cvx-ambu-report.pdf>.

83. *Southwestern Corporate Responsibility Report 2014-15*, p. 31, https://www.swn.com/responsibility/Documents/SWN_CR_Report_2014-15_MR_FINAL.PDF.

84. <http://www.qepres.com/environment/case-study-zero-emissions-liquids-transfer-system/>.

85. <http://www.oxy.com/SocialResponsibility/Environmental-Stewardship/Pages/Methane-Capture.aspx>.

- Hess began using flexible hoses in North Dakota in 2013 to transport fresh water, reducing the emissions associated with trucking water. The company reports that in 2014 “our North Dakota frac team piped 43 percent of the water used for fracturing, exceeding its 25 percent target. Approximately 4.5 million barrels of water were piped, removing approximately 41,174 truckloads from the road”.⁸⁶



IMAGE: Energy Media Group

Pipes transport water, avoid truck emissions

- Continental Resources reports that a recently approved project will install 13 miles of water gathering lines to serve 67 operated wells in North Dakota. A second approved system will include 150 miles of water gathering lines to serve as many as 600 wells covering 500 square miles of the state.⁸⁷

- Noble Energy has invested \$50 million to construct a 100,000 gallon/day liquid natural gas (LNG) plant in Colorado. More than half the production will be used to power dual-fuel drilling rigs used in Noble’s operations and the balance will be sold to local users.⁸⁸

- Hess reports that it converted 7 of its 14 drilling rigs in the Bakken Formation to dual-fuel use.⁸⁹

- Apache reports that it has converted approximately 50% of its vehicle fleet to compressed natural gas (CNG).⁹⁰

- Noble Energy has converted more than 20% of its vehicle fleet in Colorado to CNG en route to conversion of its entire fleet as access to fueling stations improves.⁹¹



IMAGE: Earthworks

Pad emissions, Texas

Progress and Prospects

As concern over global climate change has accelerated in recent years, so too has focus on emissions of greenhouse gases associated with production of natural gas, especially methane released to the environment rather than captured for sale via a pipeline. In contrast to the realm of water sourcing and wastewater management, where technological innovations have driven performance improvements, substantial reduction of air emissions can be accomplished largely by more widespread, systematic application of existing technologies. To the extent that emerging federal and state regulations will be drivers of this emission reduction effort, the companies likely in the best position to adapt to the new regulatory environment will be first movers who have already implemented monitoring and control measures. These companies have already garnered the bottom line benefits from reduced loss of saleable methane through early adoption of green completion technologies and development of robust

86. Hess 2014 CSR Report, p. 41, <http://www.hess.com/docs/default-source/sustainability/2014-sustainability-report.pdf?sfvrsn=2>.

87. Continental Resources 2015 CSR Report, p. 21, accessible via <http://investors.clr.com/phoenix.zhtml?c=197380&p=irol-governanceinfo>.

88. Noble Energy 2013 Sustainability Report, p. 7, <http://sr.nobleenergyinc.com/wp-content/uploads/2015/08/Noble-2013-Sustainability-Report1.pdf>.

89. Hess 2014 CSR Report, p. 40, <http://www.hess.com/docs/default-source/sustainability/2014-sustainability-report.pdf?sfvrsn=2>.

90. http://www.apachecorp.com/Sustainability/Environment/Energy/Fueling_efforts_to_promote_natural_gas/index.aspx.

91. Noble Energy 2013 Sustainability Report, p. 7, <http://sr.nobleenergyinc.com/wp-content/uploads/2015/08/Noble-2013-Sustainability-Report1.pdf>.

leak detection programs. However, bottom line and environmental benefits have not been driven solely by wider use of existing technologies. Dual-fuel rigs, solar-powered equipment, and new generations of vehicle engines exemplify innovative technologies contributing to these benefits.

Continuing technological innovations have the potential, beyond the broader use of existing technologies, to dramatically enhance companies' ability to detect and remedy methane losses in their operations. EDF's methane detection technology study, conducted collaboratively with industry, seeks to identify and test relatively inexpensive emerging technologies. Development and deployment of drone technology could also provide for less expensive, and more timely and accurate leak detection.⁹²

Companies' disclosures about their air emission control initiatives provide investors with insight into the quality of corporate management and the potential for companies to reap the benefits from wise use of existing and new technologies. As is the case in other areas, however, too few companies are providing quantitative disclosures and far too many companies are leaving investors in the dark across a range of important indicators.

4. COMMUNITY IMPACTS

Issue and Questions

The exponential increase in horizontal drilling and hydraulic fracturing since just after the beginning of this century has generated enormous public controversy in many locations. Communities have expressed concerns about harm to air, water quality, and human health, as well as about disruptions to community life through increased traffic congestion,⁹³ road damage, impacts on community facilities and services, shortages of affordable housing, and nuisances such as light, noise, and dust. The debate over horizontal drilling and hydraulic fracturing is part of a larger national debate about alternative future energy paths for the United States and the relative roles of fossil, renewable, and nuclear fuels as sources of supply in addition to the employment of energy efficiency to lower demand.⁹⁴



IMAGE: Bill Hughes/ FracTracker Alliance & OVEC
Trucks can create dust problems, West Virginia

The industry's failure to adequately respond to local concerns has prompted backlash and opposition culminating in state and local bans and moratoria on hydraulic fracturing across the U.S.⁹⁵ For example, in late 2014, citing health

92. See "Could drones detect leaks at oil and gas sites?", 2015, <http://michiganradio.org/post/could-drones-detect-leaks-oil-and-gas-sites#stream/0> and "Methane-sniffing drones in fracturing operations", 2015, <https://www.asme.org/engineering-topics/articles/energy/methanesniffing-drones-in-fracturing-operations>.

93. New North Carolina regulations governing hydraulic fracturing applications require companies to submit a road impact plan that includes procedures to restore roads to their pre-drilling condition, identify trucking routes that minimize road surface travel, and set travel hours "that avoid otherwise heavy traffic volume, including avoidance of hours during which school buses will be traveling on the roads". See Subchapter 05H—Oil and Gas Conservation, 15A NCAC 05H.1304(c)(8), <http://ncrules.state.nc.us/ncac/title%2015a%20-%20environmental%20quality/chapter%2005%20-%20mining%20-%20mineral%20resources/subchapter%20h/15a%20ncac%2005h%20.1304.html>.

94. The debate over hydraulic fracturing has also been framed as a human rights issue. See, for example, Sisters of Mercy, Mercy International Association, *A guide to rights-based advocacy: international human rights law and fracking*, 2015, http://www.mercyworld.org/_uploads/_ckbl/files/2015/Final%20Fracking%20Guide%202015.pdf. See also DTF 2014, note 103 and related text and *Extracting the Facts*, note 73.

95. Developments in the U.S. are also being watched overseas. In July 2015, the Dutch government introduced a five-year moratorium on shale gas exploration, indicating that existing licenses will not be renewed and no new exploration permits will be granted. See "Dutch government bans shale gas drilling for 5 years", *Reuters*, July 10, 2015, <http://uk.reuters.com/article/2015/07/10/netherlands-energy-shale-idUKL8N0ZQ2S720150710>.

concerns, New York State banned hydraulic fracturing.⁹⁶ There has also been a continuing tug-of-war between state and local governments in several states regarding whether local authorities should have the right to determine where and under what conditions horizontal drilling and hydraulic fracturing can occur.⁹⁷ In 2015, Maryland's governor did not veto, and therefore allowed to take effect, a two-year legislative ban on fracturing.⁹⁸ In Colorado and Ohio, where considerable drilling and fracturing is under way, state court judges have overruled local fracturing bans, but litigation continues.⁹⁹ In Colorado, a multi-stakeholder panel appointed by the governor as a means of addressing this jurisdictional tug-of-war was able to agree (by more than a two-thirds vote) on nine recommendations to enhance governance, but was unable to agree on others that would have had the effect of strengthening local government regulation.¹⁰⁰ In 2015, in response to a local ban on drilling and fracturing in Denton, Texas, the state of Texas enacted legislation that limits the reach of municipal ordinances to surface (rather than below-ground) activities, requires that their provisions be “commercially reasonable” and not prevent an oil and gas



IMAGE: Bill Hughes/ FracTracker Alliance & OVEC

School bus and trucks sharing two-lane road, West Virginia

96. See “New York State Department of Health Completes Review of High-volume Hydraulic Fracturing”, NY State Dept. of Health, 2015, https://www.health.ny.gov/press/releases/2014/2014-12-17_fracking_report.htm. See also “New York State Officially Prohibits High-Volume Hydraulic Fracturing”, NY State Dept. of Environmental Conservation, June 29, 2015, <http://www.dec.ny.gov/press/102337.html>. The ban officially took effect in December 2015.
97. In a report requested by state officials, the University of Michigan provides an instructive review of three types of policies that states can adopt to address the scientific uncertainties surrounding horizontal drilling and hydraulic fracturing. The report labels these as precautionary (which in their strongest form ban activities that could potentially result in severe harm), adaptive (which take some regulatory action and then refine the policy as more information becomes available), or remedial or post-hoc (which allow the activity and rely on containment measures and private and public liability actions to address any harm). See University of Michigan Graham Sustainability Institute, “Executive summary: Hydraulic fracturing in Michigan integrated assessment final report”, 2015, p. 10, <http://graham.umich.edu/media/files/HF-IA-Final-Exec-Summary.pdf>.
98. “Md. fracking moratorium to become law without Hogan’s signature”, *Washington Post*, 2015, http://www.washingtonpost.com/local/md-politics/md-fracking-moratorium-to-become-law-without-hogans-signature/2015/05/29/e1d10434-062c-11e5-a428-c984eb077d4e_story.html.
99. See *DTF 2014*, note 101 and “Judge overturns Broadview Heights ban on drilling”, *Cleveland Scene*, 2015, <http://www.clevescene.com/scene-and-heard/archives/2015/03/17/judge-overturns-broadview-heights-ban-on-drilling>. In September 2015, Colorado’s Supreme Court agreed to hear two cases in which lower court judges overturned a local ban and moratorium. See “Colorado Supreme Court will hear cases on fracking bans”, *Denver Post*, 2015, http://www.denverpost.com/news/ci_28851657/colorado-supreme-court-will-hear-cases-fracking-bans. Also in September 2015, Ohio’s Supreme Court upheld the Ohio Secretary of State’s decision to keep three anti-fracking measures off the November 2015 electoral ballot. See “OH Supreme Court rejects local ballot protest”, *WOUB Digital*, 2015, <http://woub.org/2015/09/16/oh-supreme-court-rejects-local-ballot-protest/>.
100. See “Colorado Oil and Gas Task Force Final Report”, 2015, <http://www.cpr.org/sites/default/files/oilgastaskforcefinalreport.pdf>. In Colorado, companies and local communities are continuing to seek common ground through execution of memoranda of understanding regarding company operations. For example, an August 2015 agreement between the town of Erie and Encana calls for the company to respect larger setbacks and stricter noise limits, conduct additional leak inspections, meet quarterly with town officials, and seek public comments on each of its proposed wells from neighbors within a half mile of the proposed sites. In exchange, the five-year agreement allows the company to bypass some local regulatory approvals. See “Encana, Erie reach groundbreaking agreement on oil and gas operations”, 2015, *Denver Business Journal*, http://www.bizjournals.com/denver/blog/earth_to_power/2015/08/encana-erie-reach-groundbreaking-agreement-on-oil.html. Eight MOUs between local governments and companies executed in 2012 and 2013 required or strongly preferred closed loop systems instead of pits for waste water. The MOUs addressing facility location provide for specific setbacks that are at least as far as those in state regulations or require that the operator “maximize setbacks” from occupied businesses and residences. The eight agreements are summarized in “Common Elements of Local Government-Operator Agreements”, 2015, prepared for the governor’s task force by the Colorado Oil & Gas Commission.

operation from occurring, and not be preempted by state or federal law.¹⁰¹ One week after Texas's action, Oklahoma adopted a state law indicating that municipal regulation of oil and gas operations is limited to traffic, noise, odors, and "reasonable" setbacks from homes, reserving all other regulation, including disposal of waste water, to the Oklahoma Corporation Commission.¹⁰²

Recognizing that the industry faces a material threat to its social license to operate, and that concerns regarding human health and welfare and the environment are mounting, investors have increasingly pressed companies to implement the most effective mechanisms to record, track, and respond to community concerns and to disclose the outcomes of those processes.

The scorecard asks whether a company discloses major identified community impact concerns and company responses on a play-by-play basis; internal processes for gathering and reporting community concern statistics upward within the company; and clearly stated policies to adjust activity schedules to prevent or reduce traffic congestion and to reimburse state and local authorities for road damage caused by operations.

COMMUNITY IMPACTS						
COMPANY	Disclose community impact concerns, company response [^]	Aggregate statistics for local concerns	Upward reporting of local concern statistics	Traffic congestion policies	Road damage payment policies	TOTAL
BHP Billiton	✓	✓	✓	✓	✓	5
EOG		✓	✓	✓		3
EQT		✓	✓	✓		3
BP		✓		✓		2
Cabot				✓	✓	2
ConocoPhillips		✓	✓			2
CONSOL				✓	✓	2
Encana		✓		✓		2
Hess				✓	✓	2
Shell		✓		✓		2
Anadarko		✓				1
Apache				✓		1
ExxonMobil				✓		1
Newfield Resources				✓		1
Noble Energy				✓		1
Range Resources				✓		1

Companies that did not receive points for any indicator in this category are not included in this chart. They are Carrizo, Chesapeake, Chevron, Continental Resources, Devon, Exco Resources, Occidental Petroleum, Penn Virginia, Pioneer, QEP, Southwestern Energy, Ultra Petroleum, Whiting Oil & Gas, and WPX.

[^] = Question requests disclosure by play.

101. See "Abbott signs law to restrict local fracking regulations", *Dallas Morning News*, 2015, <http://www.dallasnews.com/news/politics/state-politics/20150518-abbott-signs-law-to-restrict-local-fracking-regulations.ece>. The text of the bill, H.B. 40, is available at <http://www.legis.state.tx.us/BillLookup/Text.aspx?LegSess=84R&Bill=HB40>. State laws to ban local controls are significant for possibly withdrawing traditional local authority to regulate traffic and create limits on noise and light pollution, none of which are addressed by state regulations. See Scott Anderson, "What Texas' elected officials should know about House Bill 40", <http://blogs.edf.org/energyexchange/2015/04/23/what-texas-elected-officials-should-know-about-house-bill-40/>.

102. See "Oklahoma outlaws local fracking bans", *Longview News-Journal*, 2015, <http://www.news-journal.com/news/2015/may/29/oklahoma-outlaws-local-fracking-bans/>. The text of Senate Bill 809 is available here: <http://www.oklegislature.gov/BillInfo.aspx?Bill=SB809&Session=1500>. The bill states that setbacks "may not effectively prohibit or ban any oil and gas operations".

Scores

- One company—BHP Billiton—reports major identified community impact concerns and company responses on a play-by-play basis.
- Eight companies report their internal processes for capturing and addressing local concerns.
- Four companies report internal processes for reporting community concern statistics upward within the companies.
- Fifteen companies disclose clearly stated policies to adjust activity schedules to prevent or reduce traffic congestion from operations.
- Four companies report clearly stated policies to reimburse state and local authorities for road damage caused by operations.



IMAGE: Bill Hughes/ FracTracker Alliance & OVEC

Trucks jam roads, emit diesel pollution, West Virginia

Notable Practices

- *Anadarko Petroleum* created its Colorado Response Line in 2014 to provide a dedicated grievance mechanism. The company created a toll-free phone line for stakeholders, whose number is posted at all drilling and fracturing locations and in corporate correspondence. The company tracks each phone and email contact, with the goal of resolving concerns by adjusting operations to avoid similar feedback in the future. In 2014, the company reports receiving 385 phone calls and emails, with most frequent grievances relating to noise, communication, property damage, and light. On average, grievances were resolved in roughly one week.¹⁰³
- *Southwestern Energy* reports that it recorded a total of 180 instances in Arkansas and northeast Pennsylvania, its primary shale plays, where residents have raised concerns about the effects of the companies' drilling activities on their groundwater wells. These complaints relate to 3.6% of Southwestern's nearly 5,000 wells. The company also discloses the outcomes of its investigations.¹⁰⁴
- *Apache* is piloting a software system in its Permian Basin and Eagle Ford shale operations that will allow it to track its stakeholder engagements and responses. The system includes a proprietary mobile app to simplify the documenting process for field staff. After being aggregated, each region's results are reported to the regional vice-president and, as necessary, further upward within the company.¹⁰⁵
- *Hess* reports that, in partnership with other companies, in 2014 it participated in a voluntary pilot project on grievance mechanisms in one of its shale energy asset locations. It also developed an internal database to support implementation and management of its stakeholder engagement and grievance mechanism processes.¹⁰⁶
- *BHP Billiton* reports that community concerns and complaints "are acknowledged, documented, investigated, and resolved, and reported back to the complainant in each of our shale play operations." The company tracks all community complaints in its database system, allowing local concerns to be aggregated and reported upward via weekly reports to the leadership of the company, including the President."¹⁰⁷

103. <http://www.anadarko.com/Responsibility/Sustainable-Development/Stakeholder-Engagement/Grievance-Mechanisms/>.

104. See Southwestern Energy 2014-15 Corporate Responsibility Report, p. 23, https://www.swn.com/responsibility/Documents/SWN_CR_Report_2014-15_MR_FINAL.PDF. Southwest's investigation into complaints concluded that the majority of claims were ultimately attributable to naturally occurring conditions.

105. http://www.apachecorp.com/Sustainability/Society/Communities/Community_involvement/index.aspx.

106. Hess 2014 CSR Report, p. 20, <http://www.hess.com/docs/default-source/sustainability/2014-sustainability-report.pdf?sfvrsn=2>.

107. BHP Billiton 2015 Hydraulic Fracturing Case Study, p. 6, http://www.bhpbilliton.com/~media/bhp/documents/society/reports/2015/150922_society_environment_responsiblymanaginghydraulicfracturing.pdf?la=en.

- *BHP Billiton* also describes its legislative efforts to increase funding for county roads in Texas and its efforts to reach cooperative agreements with local authorities on its share of road repair costs. It provides data on its road payments in the Eagle Ford and Haynesville Shales and notes no such payments in the Permian Basin and Fayetteville Shale because of its reduced operations in those locations.¹⁰⁸

Progress and Prospects

Development of more sophisticated community concern tracking systems by companies appears to be another area where investor requests for increased disclosure are driving corporate behavior. Investor requests to understand what systems are in place to track community concerns, and for disclosure of statistics about community concerns raised and their resolution, have driven more granular disclosure of these issues, but so far only by a small number of companies.

Health impacts are another area where substantial improvement in disclosure is needed. Both companies and investors must pay greater attention to the short- and long-term human health effects associated with air and water pollution. We now have several scientific studies and incident reports documenting adverse health effects associated with fracturing operations.¹⁰⁹ And regulators are responding. For example, New York State has banned shale development on the basis of health concerns.¹¹⁰

A recent review of studies associating shale development with environmental health impacts concludes that many of the studies lack scientific rigor. Nevertheless, the authors note that there is no evidence to rule out association with severe health effects.¹¹¹ Another literature review cites major uncertainties such as the paucity of baseline data for making before and after comparisons and the unknown frequency and duration of human exposure. The authors conclude that research is needed to address these uncertainties “before we can reasonably quantify the likelihood of occurrence or magnitude of adverse health effects associated with [hydraulic fracturing operations] in workers and communities”.¹¹²

The Health Effects Institute (HEI), a respected research organization originally organized by the U.S. government and the auto industry to generate credible scientific research for the purpose of developing automobile-related regulatory standards, has developed a research agenda for closing the data gaps related to human health effects and other impacts of shale development.¹¹³ An HEI-like research institute co-funded by government and the oil and gas industry could execute the research agenda, helping to clarify the health risks associated with fracturing operations and enabling industry, investors, and communities to better understand the magnitude of health risks and develop precautionary measures to address them.



IMAGE: Bill Hughes/ FracTracker Alliance & OVEC

Minimizing school bus and truck conflicts, West Virginia

108. *Ibid.*, p. 7.

109. See, for example, “Perinatal Outcomes and Unconventional Natural Gas Operations in Southwest Pennsylvania”, *PLOS One*, 2015, <http://journals.plos.org/plosone/article?ID=10.1371/journal.pone.0126425>. This study, which indicated an association between low birth weights and nearby fracking operations, did not demonstrate a causal link. As noted by the authors, more research into the issue is merited.

110. New York State’s Department of Health released a study that provided a health-based rationale for the state ban. It found that the weight of the evidence demonstrated significant uncertainties about the kinds of adverse health outcomes that might be associated with hydraulic fracturing, the likelihood of the occurrence of adverse health outcomes, and the effectiveness of mitigation measures to reduce adverse environmental impacts that could affect public health. The department recommended that hydraulic fracturing not move forward in New York State until sufficient scientific information becomes available to determine the level of risk to public health and whether risks could be adequately managed. See New York State Department of Health, “A public health review of high volume hydraulic fracturing for shale gas development”, 2014, http://www.health.ny.gov/press/reports/docs/high_volume_hydraulic_fracturing.pdf.

111. Angela K. Werner et al., “Environmental health impacts of unconventional natural gas development: A review of the state of the evidence”, *Science of the Total Environment* 505, 2015, 1127-1141, <http://www.sciencedirect.com/science/article/pii/S0048969714015290>.

112. John L. Adgate et al., “Potential public health hazards, exposures and health effects from unconventional natural gas development”, *Environmental Science and Technology* 48, 2014, 8307-8320, <http://pubs.acs.org/doi/abs/10.1021/es404621d>.

113. Health Effects Institute, “Final strategic research agenda on the potential impacts of 21st century oil and gas development in the Appalachian basin and beyond”, 2015, <http://www.healtheffects.org/UOGD/UODG-Research-Agenda-Nov-4-2015.pdf>.

5. MANAGEMENT AND ACCOUNTABILITY

Issue and Questions

In October 2015, *Harvard Business Review* released its list of the world's 100 best-performing CEOs. For the first time, it allocated a 20% weighting to the environmental, social, and governance (ESG) performance of a CEO's company, complementing an 80% weighting to long-term financial performance.¹¹⁴ Meanwhile, corporate governance analyst and proxy voting service provider Glass, Lewis & Co. has reported a significant growth in companies linking compensation to sustainability, growing in 2014 to 40% of all companies reviewed compared to 29% in 2010.¹¹⁵ BlackRock, the world's largest investment management firm with \$4.5 trillion assets under management, has said ESG "is not just about saving the planet or feeling good. We view ESG excellence as a mark of operational and management quality".¹¹⁶ The firm adds that ESG excellence also encompasses responsiveness to evolving market trends, resilience to regulatory risk, and a more engaged and productive workforce. BlackRock further notes, "It can be costly to underestimate environmental risks. Just ask BP's equity and debt holders".¹¹⁷ BlackRock's declaration adds to the growing list of indicators that ESG factors are becoming mainstream in U.S. finance.¹¹⁸

It is within this context that investors are seeking disclosures demonstrating that companies have systems in place to assure that CEOs and corporate boards of directors are receiving regular, appropriate accounting from senior managers about the results of corporate policies and practices and the extent to which these policies and practices align with best practices. Policies and systems for reducing risk should include metrics to track impacts, incentives for good performance on health, environment, and safety goals, and tracking of regulatory compliance.

Complementing internal accountability systems, independent third-party assessments of company practices provide both boards and investors with a relatively high level of assurance that companies are in fact implementing their stated policies and programs. Third-party assessors can play an important role in assessing implementation of policies in the field. Third parties can also play an important role in qualifying the contractors who perform most of the jobs servicing well sites, both on the pad itself and transporting material to and from it. At the end of the day, it is the company that hires the contractors and holds land leases that is publicly held responsible for use of best practices, avoidance of fines and penalties, and avoidance of health and environmental impacts. Therefore, accountability of contractors is a critical component of risk management.

Fines and regulatory notices of violations (NOVs), including their number and frequency, are also an important indicator of company oversight and quality of operational management. They can reveal, for example, patterns of equipment failures, contractor errors, reporting failures, and episodes of environmental contamination. They further provide insight into a company's continual improvement processes or lack thereof.

The scorecard asks whether companies report policies to provide compensation and incentive packages for senior management linked to health, safety, and environment (HSE) and social impact performance and results; employ third-party independent auditing of HSE functions for operations; rely on third-party databases for information to evaluate potential contractors before hire; disclose the number of NOVs or equivalent administrative actions and number and amount of fines related to operations; and report changes, if any, in the number of NOVs received year over year.¹¹⁹

114. <https://hbr.org/2015/11/the-best-performing-ceos-in-the-world>.

115. Glass Lewis, "Greening the green: Linking executive pay to sustainability", <http://www.glasslewis.com/blog/glass-lewis-publishes-greening-green-2014-linking-compensation-sustainability/>.

116. BlackRock, Inc., "The price of climate change: Global warming's impact on portfolios", 2015, p. 2, <https://www.blackrock.com/investing/insights/blackrock-investment-institute/global-insights>.

117. *Ibid.*, p. 6.

118. See, for example, Morgan Stanley's creation of its Institute for Sustainable Investing, <http://www.morganstanley.com/what-we-do/institute-for-sustainable-investing/>.

119. For the rationale underlying these indicators, see DTF 2014, pp. 38-40. In Pennsylvania, violations at unconventional wells have dropped over the last several years, even as inspections have increased. See "Shale gas violations down as DEP steps up inspections", *Pittsburgh Tribune-Review*, 2015, <http://triblive.com/business/headlines/8942973-74/shale-wells-conventional#axzz3kbUUF7Kx>. For a capsule listing of the many ways this trend can be explained, see Samantha Malone Rubright, "What can violations data tell us?", FrackTracker Alliance Blog, 2015, <http://www.fracktracker.org/2015/03/violations-data/>. For a review of regulators' disclosure and nondisclosure practices for violations and an assessment of companies in those three states where violation information is readily available, see Natural Resources Defense Council and FrackTracker Alliance, "Fracking's most wanted: lifting the veil on oil and gas company spills and violations", 2015, <http://www.nrdc.org/land/drilling/files/fracking-company-violations-IP.pdf>.

MANAGEMENT & ACCOUNTABILITY

COMPANY	Senior management pay tied to HES	3rd party audit for HES	3rd party information prior to hiring contractors	NOVs and fines [^]	NOV trends [^]	TOTAL
BHP Billiton	✓		✓	✓	✓	4
ConocoPhillips	✓		✓	✓		3
CONSOL	✓	✓	✓			3
Anadarko	✓		✓			2
Apache	✓		✓			2
Cabot		✓	✓			2
Chevron	✓	✓				2
Devon	✓		✓			2
Exco Resources		✓	✓			2
Hess	✓		✓			2
Newfield Resources	✓		✓			2
Noble Energy		✓	✓			2
Penn Virginia		✓	✓			2
QEP	✓		✓			2
Shell	✓	✓				2
BP	✓					1
Chesapeake	✓					1
Encana			✓			1
EQT			✓			1
ExxonMobil	✓					1
Occidental Petroleum	✓					1
Southwestern Energy			✓			1
Whiting Oil & Gas				✓		1

Companies that did not receive points for any indicator in this category are not included in this chart. They are Carrizo, Continental Resources, EOG, Pioneer, Range Resources, Ultra Petroleum, and WPX.

[^] = Question requests disclosure by play.

Scores

- Fifteen companies report that they provide compensation and incentive packages for senior management linked to HSE and social impact performance.
- Seven companies report requiring third-party independent auditing of HSE operations.
- Sixteen companies report relying on third-party databases for information to evaluate potential contractors before hire.
- Three companies disclose, on a play-by-play basis, NOVs received and numbers and amounts of fines.
- One company—BHP Billiton—discloses, on a play-by-play basis, changes, if any, in the numbers of NOVs received compared to the prior year.

Notable Practices

- *CONSOL Energy*, *Shell*, and *Chevron* received certification of their risk management practices in the Appalachian Basin based on independent third-party audits. The audits are based on standards established by the Center for Sustainable Shale Development (CSSD). As discussed in greater detail in *DTF 2014*, CSSD was founded by a consortium of companies, foundations, and environmental groups to develop third-party

certification standards.¹²⁰ The CSSD has developed 15 performance standards for shale operations in the Appalachian Basin (which includes the Marcellus, Utica, and other shales) and recruited an independent auditing firm. The CSSD standards include a sizeable number of practices highlighted in this scorecard, such as water recycling; closed-loop systems for drilling waste and flowback water; identifying and addressing risks from offset wells and faults; conducting pre- and post-drilling groundwater monitoring; avoiding use of diesel fuel in fracturing fluids; using green completions where technically feasible; using low-bleed pneumatic controllers; and conducting an inspection and maintenance program on a regular basis. The CSSD has had to deal with skeptics in both industry, who see it as a forerunner of regulation, and environmental groups, who believe the standards fall short of what is needed.

- *CONSOL Energy* has begun tying its contractors' safety and compliance performance to their compensation. In the past, only performance-based incentives were linked to compensation. Now, key performance indicators (KPIs) used by CONSOL internally for safety, compliance, and productivity improvements are being equally weighted to determine contractor compensation.¹²¹
- *BHP Billiton* ties 20% of senior management's compensation to achievement of Health, Safety, Environment, and Community (HSEC) goals. These KPIs are linked to BHP's public five-year targets laid out in the company's sustainability report. KPIs measured when making compensation decisions include fatalities, injury frequency rate, significant environmental and community incidents, and achievement of water, greenhouse gas, and local procurement goals.¹²²
- *QEP Resources* added an HSE component to its executive annual incentive program in 2014. Measures include the near-miss reporting rate, total recordable injury rate, environmental release rate, and progress on developing HSE systems and processes.¹²³
- *BHP Billiton* reports there were seven enforcement actions against its shale operations between 2013 and 2015, five in the Eagle Ford Shale and two in the Haynesville Shale. The company provides details of the violations and how they were resolved, noting a downward trend in the number of violations since 2013.¹²⁴
- *Whiting Petroleum* reports in its FY2014 10-K report one well control incident in 2014 about which it notified authorities but "other than this incident, we are not aware of any environmental incidents or citations or suits that have occurred during the last three years related to hydraulic fracturing operations involving oil and gas properties that we operate or in which we own a non-operated interest".¹²⁵ Whiting is very unusual among companies in reporting this detail in its 10-K; most companies limit such disclosures to SEC-mandated reporting of fines greater than \$100,000.

120. Major U.S. investment banks have been overlaying their traditional financial analyses of energy companies with extra environmental, social, and governance (ESG) questions regarding hydraulic fracturing operations. For example, JPMorgan Chase developed a detailed risk assessment framework covering well integrity, water, air, community impact and regulatory compliance issues. See JPMorgan Chase & Co. 2012 Corporate Social Responsibility Report, page 53, http://www.jpmorganchase.com/corporate/Corporate-Responsibility/document/JPMC_Full_CR_Report_2013.pdf. Goldman Sachs's enhanced due diligence process looks at many of these same issues, "in addition to normal course EHS related questions, regulatory and legal compliance, and governance requirements". See <http://www.goldmansachs.com/citizenship/environmental-stewardship-and-sustainability/environmental-markets/business-selection-and-environmental-advisory.html>. Citigroup follows suit. See http://www.citigroup.com/citi/environment/data/1160848_Sector_Brief_Shale_Oil_and_Gas.pdf. Major pension fund advisor Mercer Investments views ESG issues as an extra layer of due diligence, part of a "responsible investment" approach with the goal of maximizing risk-adjusted returns. Mercer reports that "a significant number of studies support the belief that the quality of a company's governance practices positively correlates with market-based outperformance and a strong link between poor corporate governance and underperforming companies". Governance practices cited by Mercer include accounting and audit quality, compensation, and transparency. See <http://www.mercer.com/insights/view/2014/the-evolution-of-responsible-investment.html#>.

121. CONSOL 2014 Corporate Responsibility Report, p. 44, <http://www.consolenergy.com/media/28541/2014-consol-energy-corporate-responsibility-report.pdf>.

122. BHP Billiton 2014 Annual Report, p. 189, <http://www.bhpbilliton.com/~media/bhp/documents/investors/annual-reports/bhpbillitonannualreport2014.pdf>.

123. QEP 2015 Proxy Statement, p. 36, <http://www.sec.gov/Archives/edgar/data/1108827/000110882715000018/qep-proxy2015xfinal.htm>.

124. "Responsibly managing hydraulic fracturing", p. 7, http://www.bhpbilliton.com/~media/bhp/documents/society/reports/2015/150922_society_environment_responsiblymanaginghydraulicfracturing.pdf?la=en.

125. Whiting FY2014 10-K Report, p. 38, available at <http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9MjgwNjA4fENoaWxkSUQ9LTF8VHlwZT0z&t=1>.

Progress and Prospects

One half of the companies assessed link executive compensation to environmental, health, safety, and societal impact criteria, as detailed in the executive compensation sections of their annual proxy statements. The degree to which compensation is linked to these criteria varies among companies, with BHP Billiton's system standing out for its significant contribution of ESG indicators to compensation (20%). Most ESG compensation linkages are still limited to safety performance (e.g., injuries and lost days) and spills records; only a few incorporate broader environmental indicators.

Research indicates that fatality rates for the oil and gas extraction industry are 2.5 times higher than for the construction industry and seven times higher than for general industry.¹²⁶ Vehicle accidents are the number one cause of fatalities, which may explain why some companies provide highly detailed descriptions of their driver training and monitoring programs. Higher fatality rates have been found to be correlated with company size—with smaller companies recording higher fatality rates—and employee experience. Additionally, fatalities have been found to be associated with growth in drilling rig deployment, which reflects industry expansion and entry of newer, less experienced employees into the workforce.

In contrast to fatality rates, injury rates for oil and gas extraction (which many companies publish on their web sites) are lower than those in the construction industry, leading some to question whether injuries in the oil and gas industry are fully reported. Regardless of whether injuries are included in executive compensation decisions, injury reporting practices appear to be an area meriting closer scrutiny.

As companies increase their consideration of adding broader sustainability indicators to their compensation calculations, including evaluating the integrity of employee and contractor injury reporting systems, they should consider inclusion of environmental metrics beyond just numbers and volumes of spills. Such metrics might include various measures for reducing companies' environmental or fracturing footprint, for example, implementation of leak detection and repair programs, air emission reductions, and water recycling rates.

Third-party auditing and certification provide investors with enhanced assurance that company policies and best current practices are being implemented in the field. Through CSSD certification, three of the four founding companies of the CSSD have secured third-party audits of a number of their systems. For example, Chevron's certification led to substantially increased disclosures about its Marcellus Shale operations. EQT, the fourth founding company, has indicated its intent to seek certification but not yet secured it.¹²⁷ Though certification is viewed with suspicion by some environmental activists and some companies may fear the CSSD as a forerunner of regulation, companies operating in the Appalachian Basin may be well-served by seeking this third-party certification. Companies operating in other areas might explore with regional stakeholders creation of third-party auditing and certification schemes.

Although the current depressed financial state of the industry may discourage companies from incurring the expense associated with securing certification or third-party audits, investors believe the short-term costs are outweighed by the benefits of ensuring safe and efficient operations, especially because contractors and companies under pressure to slash costs may be tempted to cut health, safety, or environmental corners.

More companies should follow the example of BHP Billiton (and of Talisman Energy prior to its acquisition by Repsol) in reporting details of its received NOV's and their resolutions. Since regulatory agencies generally do not do a good job of providing easy access to compliance records, companies that fill this void demonstrate a willingness to be publicly accountable on compliance; as those compliance records improve, companies can trumpet their progress.

126. Roxana Witter et al., "Occupational exposures in the oil and gas extraction industry: State of the science and research recommendations", *American Journal of Industrial Medicine*, 2014, pp. 847-856, <http://onlinelibrary.wiley.com/doi/10.1002/ajim.22316/abstract>.

127. EQT 2014 CSR Report, p. 14, <https://www.eqt.com/-/media/sites/eqt/files/corporatesocialresponsibility/2014%20eqt%20csr%20report.ashx?la=en>.

CONCLUSION

The rising scores of leadership companies, a trend that began with the second edition of this scorecard in 2014, show that at least for a segment of the oil and gas industry, the scorecard is having its desired effect of triggering a “race to the top” in improved disclosure. The proliferation of corporate scoring systems for tracking reduced chemical toxicity and for tracking corporate response to community concerns demonstrate that investor requests for increased disclosure are also yielding positive changes in corporate behavior. These in turn should lead to enhanced quantitative, play-by-play disclosures in the future.

Despite this leadership, a significant portion of the industry continues to miss opportunities to address issues of public concern that feature prominently in media reports and activist advocacy critical of hydraulic fracturing operations. These issues include, for example, potential water pollution, use of diesel fuel in fracturing fluids, radioactive waste, and induced seismicity (earthquakes). While some companies have begun discussing improved operational practices to reduce potential for groundwater contamination, most companies have not yet adopted routine and quantifiable reporting. Diesel fuel does not appear to be widely used for fracturing, yet many companies are silent on whether they have a policy to avoid it. Naturally occurring radioactive material waste has surfaced as an issue, especially in Pennsylvania and North Dakota, but few companies discuss straightforward procedures for reducing radioactivity risks. Seismicity has also surfaced as a hazard, and while companies increasingly acknowledge the risk, few disclose specific steps implemented to mitigate the risk.

The “Shale Revolution” has been propelled by extraordinary innovation, as exemplified by the perfecting of combined horizontal drilling and hydraulic fracturing. Innovation has also driven progress in sourcing non-potable water and developing chemicals enabling lower quality water to be used for fracturing. The industry has also innovated in adopting easily deployed pipelines instead of trucks to move water and waste water and using dual-fuel rigs and field gas instead of diesel fuel for pad operations. Future innovations are likely to enhance the cost-effectiveness of leak detection and repair programs.

The vital role of innovation notwithstanding, much progress in reducing companies’ environmental impact can be accomplished through broader utilization of existing technologies, especially in the area of methane. Technologies include increased monitoring and use of infrared cameras for identifying “super-emitter” methane leaks and adoption of low- and no-bleed pneumatic valves. Companies should improve their reporting on the extent to which they are adopting both new and existing technologies to reduce their impacts.

Energy markets are changing. During a time when social pressure is increasingly being applied to avoid use of fossil fuels and the costs of renewable energy alternatives are falling, more companies should follow the example of industry disclosure leaders to demonstrate that their operations are managed responsibly. They should show that health and environmental impacts from their operations are not only being addressed but are decreasing in number and intensity and that methane and other greenhouse gas emissions from operations are decreasing. Even current disclosure leaders fall short on quantitative reporting; they can sustain leadership by expanding disclosures to include more quantitative data demonstrating reduced environmental and community impacts.

APPENDIX A: SCORECARD QUESTIONS*

Toxic Chemicals

1. Does the company provide quantitative reporting on progress in reducing the toxicity of hydraulic fracturing fluids?
2. Does the company state a practice to not use diesel in hydraulic fracturing fluids?
3. Does the company state a practice to not use BTEX in hydraulic fracturing fluids?
4. Does the company clearly state on its website that FracFocus (or its own reporting) may exclude chemicals protected by claims of confidential business information?

Water Management: sourcing, well integrity, waste management, and monitoring

1. Does the company report principal practices used to test cement integrity, such as use of cement evaluation logs, or temperature, acoustic, or ultrasonic measures?
2. ***Does the company report steps it takes when planning to drill and complete new wells to assure that nearby offset oil and gas wells (both active and inactive) and known natural faults and fractures will not provide pathways for fracturing fluids, hydrocarbons, and other contaminants?*
3. ***When planning completion of new production wells, or drilling and operating its own deep disposal wells, does the company report steps it takes to identify and avoid inducing seismic activity of a magnitude that creates risk of damage to life and property?*
4. For each shale play does the company disclose whether it routinely assesses groundwater quality before it drills?
5. For each shale play does the company disclose whether it routinely assesses groundwater quality after it drills?
6. For each shale play does the company disclose the percentage of flowback water managed and reused for subsequent well completions?
7. For each shale play does the company report the aggregate quantity of water used for operations?
8. For each shale play quantity reported in response to the question immediately above, does the company report the share of water sourced from various types (e.g., x% groundwater, y% surface water, z% flowback water, etc.)
9. Does the company state it has a policy of using non-potable water sources to the fullest extent technically practicable?
10. For each shale play does the company report the intensity of its water use—the amount of water required to produce measurable units of energy (e.g., gallons/million BTU[MMBTU])?
11. For each shale play does the company disclose a policy to store flowback water in closed tanks?
12. For each shale play does the company report whether it routinely uses closed loop systems for management of drilling residuals?
13. Does the company report its practices for identifying and managing the hazards from naturally occurring radioactive materials (NORMs)?

Air Emissions

1. For each shale play does the company report the percentage of wells, both gas wells and other types, for which it used green completions or explain why it does not?
2. For each shale play does the company report it uses any of the following—natural gas, low emission diesel engines, or other reduced-emission methods—to power well pad operations?

3. Does the company report the percentage of its vehicle fleet converted to lower emission fuels?
4. For each shale play, does the company disclose data or estimates for NOx and VOCs emitted from well drilling, completions and production operations?
5. For each shale play, does the company report reductions in NOx and VOC emissions from emission reduction efforts?
6. Does the company report when pipelines have been used to replace trucks in transporting water used for fracturing operations?
7. **Does the company report the percentage emissions rate for methane from its drilling, completion, and production operations?*
8. **Does the company report the percentage or number of high-bleed controllers replaced with low-emission alternatives, or a policy for their replacement?*
9. **Does the company describe its program of leak detection and repair for fugitive emissions, including the technologies used for leak detection and the scope of monitoring conducted?*
10. **Does the company report with what frequency it conducts monitoring for fugitive emissions?*
11. ***Does the company have an active methane emissions reduction target in place?*
12. ***Does the company have an active greenhouse gas emissions reduction target in place?*

Community Impacts

1. For each shale play does the company describe major identified community impact concerns and the company's response or actions to resolve such concerns?
2. Does the company disclose its internal processes for capturing and addressing local concerns?
3. Does the company disclose its internal processes for reporting local concerns, and data about resolving those concerns, upward within the company?
4. Does the company disclose a clearly stated policy to adjust activity schedules to prevent or reduce traffic congestion from operations?
5. Does the company have a clearly stated policy to reimburse state and local authorities for road damage caused by its operations?

Management and Accountability

1. Does the company report it provides compensation and incentive packages for senior management linked to HSE and social impact performance and its results?
2. Does the company require third party independent auditing of HSE operations?
3. Does the company rely on third party databases for information to evaluate potential contractors before hire?
4. For each shale play does the company disclose notices of violation numbers (or equivalent administrative actions) and numbers and amounts of fines related to its operations?
5. For each shale play does the company report reductions, if any, in numbers of notices of violations received over the past year?

** Italicized questions with a single asterisk were introduced in the 2014 scorecard and*

*** italicized questions with a double asterisk are new to the 2015 scorecard. Unitalicized questions have been asked in all three scorecards since 2013.*

APPENDIX B: METHODOLOGY

Scorecard Goals

Disclosing the Facts 2015 has three goals: (1) assess the overall state of industry disclosure; (2) identify those issues about which most disclosures are made; and (3) distinguish industry leaders from laggards with regard to disclosure.

Company Selection

The scorecard reports on 30 publicly traded companies producing shale gas and oil in the U.S. and Canada. Twenty-nine (29) companies were carried over from the second edition of this scorecard based on their gas production and their prominent position in major shale plays in the U.S. For the 2015 edition, Pioneer Natural Resources, the largest oil producer in the Spraberry/Wolfcamp Shales of the Permian Basin was added to replace Talisman (which was acquired by Repsol, S.A.), to maintain a sample size of 30 companies.

Geographic Coverage

The scorecard addresses onshore operations in the U.S. and Canada.

Chronological Coverage

The scorecard addresses reporting on specific, identified metrics principally from October 1, 2014 to October 30, 2015, while also accounting selectively for disclosures in prior years.

Indicator Selection

Indicators are both qualitative and quantitative. The goal was to select indicators that would enable clear “yes/no” answers, with minimal interpretation. This third edition of the scorecard contains refinements of the reporting indicators in the water and air sections; two questions were added to each.

Company Scoring

Each company was scored based solely on documents and information available through its public website, including SEC proxy and annual report filings, climate change and water management reports submitted to the CDP and posted directly on the company website, and sustainability/social responsibility reports. Companies were scored independently by two project staff. Companies received a copy of the questions on which they were scored, the corporate disclosures found pertinent to the questions, and their scores. Companies were given an opportunity to both provide feedback on the accuracy of the scorecard information compiled and to update their public disclosures. Final scoring was based on staff reviews of corporate disclosures publicly disclosed by October 30, 2015.

The report text cites examples of exemplary disclosures by numerous companies even where particular disclosures did not earn credit on the scorecard. Some low-scoring companies may in fact be broadly implementing best management practices to manage and reduce risks, but absent play-by-play disclosures sought by the scorecard, investors and communities remain unaware of these activities.

Play-by-play Reporting

The scorecard emphasizes play-by-play reporting. Such reporting is critical to understanding corporate risk management because most impacts of concern are regional and local. Atmospheric, geological, demographic, and other pertinent characteristics vary greatly among plays. We emphasize plays as the appropriate unit of analysis, but this term is not intended for literal use; rather, it is intended as a proxy for appropriate regional reporting. For example, plays can comprise thousands of square miles and conditions can vary dramatically within plays. Furthermore, shale and other formations accessed by horizontal drilling and hydraulic fracturing can be stacked on top of one another, such as in the Appalachian Basin in Pennsylvania and the Permian Basin of West Texas.

NOTES

NOTES

NOTES

A COLLABORATIVE PROJECT OF:



1611 Telegraph Ave., Ste. 1450 · Oakland, CA 94612 · 510.735.8158

www.asyousow.org



84 State St., Ste. 940 · Boston, MA 02109 · 617.720.5557

www.bostoncommonasset.com



201 Park Washington Court · Falls Church, VA 22046 · 703.532.2929

www.iehn.org