AADE-22-FTCE-035

Drilling and Drilling Fluid Strategies to Minimize Impact on Local Communities

Dean Madrid, Joshua Hendrickson, and Matt Offenbacher, AES Drilling Fluids

Abstract

Community engagement is now essential as a "social license to operate" beyond conventional regulations and industry best practices. While traditional economics accounts for the cost of drilling a well, drilling fluid selection and drilling techniques must account for permission to drill the well.

The shale revolution brought oil and gas activity to areas with little to no experience with drilling activity. New energy resources introduced both excitement for new prosperity and concern and skepticism with the unfamiliar. In states like Colorado, local governments now have the authority to effectively ban drilling through their own regulations. Oil and gas development that results in a positive experience for communities rely on the alignment of recommended development activities and community concerns. These recommended guidelines should be grounded in responsible practices and lessons learned from prior experiences.

Outreach to regulatory bodies, many of whom have little experience with the oil and gas industry, requires education and simplification of complex concepts, such as environmental testing data. Waste management, primarily driven by volume disposal costs, may include new incentives to limit transportation volumes that justify additional equipment.

Noise, waste, and even odors require not only minimization, but also monitoring to demonstrate operations remain below impactful levels. Any anomaly must be traceable to the source in order to identify and eliminate future issues.

Introduction

Historically, oilfield community engagement discussions focused on remote international locations in developing countries. Initiatives addressed basic critical needs such as clean water, education, and employment of the local population.

In the United States, oil and gas development took place in rural areas or areas where oil and gas development remained part of the community for generations.

Unconventional oil and gas introduced activities to new areas, dormant fields, and closer to population centers. Operators encounter skeptical citizens concerned about negative impacts to their way of life as well as direct opposition to any form of hydrocarbon production.

In Colorado, Senate Bill 181 adds additional restrictions within the state and empowers local government to further regulate activity (National Law Review 2019). In other states, oil and gas production is subject to a complete ban (FracTracker Alliance 2017, Mulkern 2022).

As an industry, oil and gas producers are aware of their perception and the need for oil and gas for years to come. Engagement, education, and responsible actions are essential to meet global energy demand. It is no longer sufficient to maintain compliance – communities must believe their well-being improves with oil and gas activity.

In 2014, the American Petroleum Institute issued bulletin 100-3, *Community Engagement Guidelines*. The document outlines general practices for the entire well life cycle, targeting specific issues associated with unconventional drilling in the United States (American Petroleum Institute 2014).

Quantitative Measures

Quantitative measures provide clear metrics to meet regulatory limits and compare impact with other known measures. The industry will continue to rely heavily on quantitative measures, but they cannot act as the only measures for community engagement.

The technical nature and complexity of many quantitative measures fails to provide assurances to a skeptical public and local government agencies lacking the resources to interpret data sets.

Qualitative Measures

Declaring numerical compliance to specific measures is a bare minimum, but it is insufficient. Just because activity remains below a threshold, it does not mean it cannot generate opposition. Noise, truck movement, an odor, or even the visual presence of a drilling location must be taken into account before it becomes a source of opposition and skepticism.

While some community members may be entirely opposed to activity of any kind, there are also advocates and undecided residents who can ultimately support and encourage community development through oil and gas activity.

Duration of Impact

The drilling, completion, and production phases of oil and gas extraction take place over a cycle. The impact of new drilling is not the same as field maintenance and final plug and abandon operations. The size, scale, and nature of impactful investment entering a new community must account for the duration of this cycle and the taper of new investment as the field depletes.

Miller (2020) outlines a review of transferable skills where oil and gas activity can catalyze workforce development that ultimately supports other industries as different activities change during field life cycle. Cementing, construction and manufacturing jobs may thrive long after drilling activity declines with a trained local workforce available.

This paper focuses on the drilling phase. While the other phases are not to be overlooked, the drilling phase has significant visibility and requires special attention.

Visual and Sound Impacts

As oil and gas operations and local communities converge, the visual and noise impacts can become more apparent. Drilling rig derricks, flares, increased truck traffic and construction equipment all create both visual and noise pollution for local communities. Initial steps have been taken to help mitigate these impacts which include wind walls and self-contained flare stacks. Additional steps can be taken to aid in minimizing these impacts on local communities.

Land Disruption

When working adjacent to nearby property, land disruption goes beyond the scale of the operation and moves to the proximity of the neighbors. Minimizing the land area required is not only better for the environment, but it provides a buffer.

Land disruption requires optimization considering many different factors. A larger pad may eliminate a second location or allow for simultaneous drilling with two rigs, reducing the duration of the drilling campaign. Additional rig modifications can be made including stacking components to reduce the rig footprint. Such modifications have included stacking the rig generators on top of the pump house (Figure 1). Other modifications, such as special low-footprint drilling rigs, have been considered to reduce the footprint at a reasonable cost.

Figure 1: Stacked generators and pump houses reduce footprint

From a drilling fluids perspective, available area impacts fluid selection and waste management options. Water-based fluids generally provide a lower impact solution, but require larger fluid volumes, have increased dilution rates and waste volumes, and potentially slower drill rates. While there are exceptions, water-based fluids tend to increase trucking requirements and extend drilling days.

Invert emulsion fluids cost more, but tend to require less dilution, produce less waste, and facilitate faster drilling rates. When space is available, vertical cutting dryers and even electrophoresis units can improve oil recovery and minimize dilution.

Containments throughout the drilling location are placed in all areas where mud chemicals may be mixed or present aid in reducing spill risk. This includes containments for the palletized chemical which are covered on all sides (Figure 2). This both protects the sack material when not in use and reduces the likelihood of material being spilled on the ground. Additionally, containments underneath the rig pit system, hopper house where chemicals are mixed and the tank farm where various fluids are stored, all aid in minimizing spill risk onto the ground.

Figure 2: Drilling fluid chemical containments

Mitigation Walls

Mitigation walls are one of the primary mitigations that have been implemented, to aid in reducing both noise and visual pollution created by oil and gas operations. Perhaps the most well-known example of mitigation walls is the THUMS islands in Long Beach, where many passers-by remain unaware of nearby drilling activity taking place within closed buildings (Meares 2018). Permanent structures are impractical for short drilling programs, but temporary "wind walls" reduce the visual and noise impact of many drilling sites. Figure 3 shows a wind wall for a well pad in Colorado.

Figure 3: Stacked generators and pump houses reduce footprint

In addition to the noise pollution, these walls provide visual mitigations. While drilling the rig derricks can still be seen from quite a distance, but the remaining parts of the rig including the doghouse, generators, pumps, pits, and other equipment cannot be seen. In other areas throughout the US wind walls are implemented as a courtesy when drilling occurs near local communities.

In Colorado, the governing authority has mandated noise restrictions in areas nearby homes or other communities. The maximum decibel levels must not exceed 80 decibels during the day and 70 decibels at night, measured 350 ft from the wellsite. These walls are constructed with steel beams and industrial fabric which is engineered to maintain the required noise levels (Cantafio and Song PLLC 2014). Other areas have similar requirements set by governments or operator policy.

Sound monitoring is conducted to measure and quantify the sound level being emitted from operations. This monitoring is utilized to ensure sound levels do not exceed the decibel level required by the regulatory agency. Sound monitors are placed near the well site prior to any operations commencing to obtain a normal background noise level (Figure 4).

Figure 4: Air quality and sound monitoring station – note the homes in the background of the image

Flares

Natural gas flaring has created questions and controversy about the safety and environmental impacts of oil and gas operations. Excess flaring has created misunderstanding about when and where flaring is necessary. Federal, state, and local governments are restricting flaring, but narrow use cases remain as a critical safety procedure for some activities.

When flaring is unavoidable, efforts should be made to prevent alarm when this increasingly rare activity appears. One of the mitigations on drilling rigs are self-contained flare stacks, which provide visual mitigations that allow for the flames to go unseen. These flare stacks are comprised of a tall steel box 8’x8’ wide and up to 35’ high that hides the flame from sight (Figure 5).

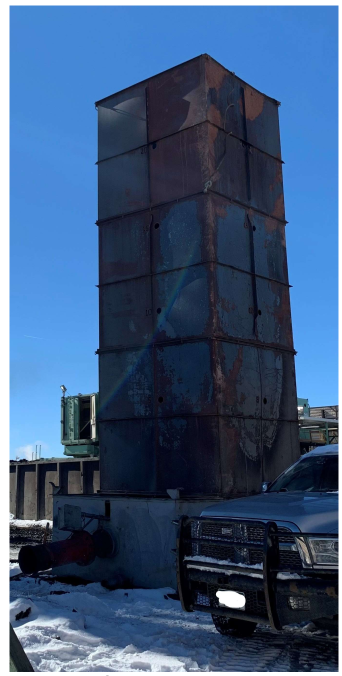

Figure 5: Self-contained flare stack

Odors and Emissions

Even in a non-toxic environment, environmental odors can make people feel sick. This list of potential symptoms vary by sensitivity and cover a broad range of general illness (Agency for Toxic Substances and Disease Registry 2017).

Base Oil Selection

Base oil is a significant cost contributor for invert emulsion drilling fluids. Base oil selection is driven by regulations, accessibility, and properties. Generally, the lowest cost, compliant base oil is selected. Where approved, diesel or similar distillate materials are common, but regardless of compliance status, they still can present noxious odors.

Base oil odor concern has created friction within communities during deliberations for permitting (Hahn 2018). While some residents may not detect an odor, it only takes one incident to create a major concern (Lim 2019b, Lopez 2019).

When an operator wanted to drill within 300 feet of a housing development in Houston, they utilized an odorless, non-toxic base oil to minimize any risk of odor (Drilling Contractor 2001). The authors recommend utilizing an effectively odorless base oil any time drilling occurs near populated areas.

After much controversy, some communities are now prohibiting certain base oils as a reaction to complaints and concerns (Town of Erie 2015). In one case, the drilling mud had to be changed during drilling to address complaints (Lim 2019a).

Expanded refinery capacity and demand for ultra-low sulfur diesel has created the ability to remove more and more hazardous components in base oil. While cost remains a concern, cleaner base oil options continue to grow (Baxter et al 2018).

Odor Reducing Chemicals

In addition to selecting a more environmentally friendly and less odorous base oil, odor reducing additives can be added to the drilling fluid to further reduce the odor. These additives work by chemically changing the molecules in the base fluid to eliminate the malodor. The application of these additives has historically been in areas near residential neighborhoods.

In some contingency measures provided to communities, these additives are cited as a first response to odor mitigation. Overall performance is uncertain, and it may not be worth the risk of failure when an alternative base oil eliminates the odor source and provides a superior environmental profile.

Emissions and Power Generation

Sensors and other monitoring systems capable of measuring and identifying the sources of a variety of emissions are readily available to establish baseline values prior to operations and for monitoring during drilling. Electronic sensors provide real-time data in the event of a large, anomalous release that may impact nearby residents. Air sample canisters are submitted to a third-party lab at regular intervals for comparison to sensor data.

When combined with meteorological data, a robust and verifiable recording and reporting system is in place to provide assurance to any concerned party that toxic emissions are well below EPA (or other governing body) limits.

Carbon emissions are primarily a focus during production; however, operators in Colorado have attempted to begin tracking and minimizing carbon emissions during the drilling process.

In the case of emission reduction, proximity to a population center makes grid power a possibility. Hydraulic fracturing operations in the Delaware Basin have already utilized grid power to eliminate emissions from diesel generators in favor of locally produced electricity, much of which is wind power (Rassenfoss 2021). In Colorado, electric drilling rigs are gaining adoption to limit emissions of all kinds while reducing noise in areas readily accessible to the grid (Hampton 2021).

Hydrocarbon monitoring has also been conducted in areas of Colorado near residential communities. These monitors are strategically placed around the well site and they monitor a wide range of volatile organic compounds (VOCs) and hydrocarbon compounds. By utilizing these air monitors operators can ensure that no hazardous air pollutants are being dispelled from the well site. When engaging with local communities this type of data can be very important at dispelling myths regarding air pollution.

Vehicle Traffic

For field personnel, driving is one of the deadliest activities in the oilfield. In populated areas, additional cars and heavy trucks creates greater safety risk and disrupt traffic. Given the cost and scarcity of truck drivers, truck transportation is minimized as part of the normal order of business, but it is far from eliminated.

Scheduling and Staging

Strategic movement of vehicles, particularly trucks, may require a staging area to control traffic loads in sensitive areas. For drilling fluids, this may require yard or warehouse space in a location close to the rigsite or accessible through less dense routes.

Self-imposed and directed curfews and route restrictions reduce the risk of accidents and avoid creating traffic jams in areas that seldom encounter long delays on roadways. In one example, trucks were authorized to pass through a village between 2 and 4 AM to place essential drilling fluid products, including kill mud, in a yard near the well site. This avoided the risk of unscheduled truck traffic through town during business and school hours.

Education and Engagement

There is significant risk in assuming what people understand about oil and gas activity and dismissing concerns as irrelevant. Identifying mutual interests and opportunities is important to create and maintain the goodwill necessary to operate.

Wall (2012) discusses the challenges of stakeholder engagement. There are no guaranteed outcomes in drilling, and it is difficult to manage expectations for a promising project. Identifying stakeholders early and offering clear communications about what is realistic is essential to positive outcomes later in a project.

Ambassador programs help to train oil and gas workers to communicate clearly and effectively. This allows the workforce to respond to concerns, empathize, and provide transparency through formal engagements, informal interactions, and social media. Ambassador programs have proven successful in California, a state notorious for resistance to oil and gas production (Lal 2018).

In remote international locations, community liaison officer (CLO) programs have been designed to identify, train, and equip CLOs to maximize engagement – particularly with indigenous peoples in the majority world (Murphy et al 2020). The scale and scope of a CLO program does not directly correlate to many areas of North America, but the documentation provides suggestions that transfer to people everywhere.

Regulatory Agencies

Regulatory agencies are heavily dependent upon the industry to explain and characterize areas of risk and operational controls tied to drilling activity. It is likely that if an activity is unclear or poorly explained to a regulator, it will be prohibited. In the area of chemicals, such as those utilized in drilling fluids, this is particularly challenging.

In many ways it is more of an art than a science of how to determine the right amount of information to convey without creating excess confusion. The Global Harmonization System (GHS) standardized hazard communications on safety data sheets (SDS) and product labels. The OSHA Hazard Communication Standard is aligned with GHS, making this documentation a requirement to work in the United States (OSHA 2022).

The substantial increase in information creates opportunities for a knowledgeable reader to have better information or an uninformed reader to respond with significant concern, regardless of the chemical. Where possible, comparing properties to known standards, such as drinking water standards, offers context, but direct comparisons are difficult to draw for most chemicals.

Site visits are an opportunity to educate and engage in real-time activities. Because these visits can be either scheduled or unannounced, it is important to always be prepared with the appropriate records and permits. If a workplace remains cognizant about the possibility of a visit, it will assure regulatory compliance. A visit from a regulatory agent does not need to be associated as a negative occurrence. The agent's purpose is to ensure the operations are performed to the standard they should be for the public's safety, both physically and environmentally.

As previously mentioned, audits from regulatory agencies can be, and are often, unannounced. These visits can therefore occur at times when an HSE professional is off-site. Company-wide implementation in the form of written and well-documented procedures on how to conduct a visit are essential. This not only allows site managers to properly execute a visit, but also requires them to have an understanding of the rules and regulations governed at the local, state, and national levels.

Following a visit, companies who have been cited with a notice of violation are required to notify the auditor on the corrective actions that will be taken. The agent will place a timeline on the completion of corrective actions, and the company must provide proof of completion.

Any corrective actions are available as public records, allowing any individual who wants more information on the safety of local operations to access the detailed action plan. It is important to remember that the general public, as it relates to drilling fluid chemicals, may react with alarm to any corrective action. Minimizing potential for and quickly respond to any corrective action is not only good practice, it is important to maintain credibility as a good steward of the environment.

Community Meetings

In many states, community meetings and open comment sessions are a requirement. Residents are given the opportunity to ask questions, identify concerns, and voice opinions. A search of publicly recorded comments highlights the controversy and, in many cases, lack of understanding associated with oil and gas activity (City of Aurora 2020). Reviewing these comments provides insight into what one may expect at a meeting and opportunities to identify unanticipated concerns and objections and respond to them.

While many people have strong and potentially inflexible views, it is important to recognize that there are concerned citizens willing to listen. These individuals may remain silent at a tension-filled community meeting, but their open-mindedness cannot be taken for granted.

Once permission to operate is granted, continued interaction and regular feedback provides insight into current and future activities. Kinslow (2014) reviews lessons and observations of community advisory panels (CAPs) where community members and government officials gather monthly to discuss a select topic associated with the activity in the area. Safety, communications, air quality, transportation, future activity, facility tours, jobs, waste, and education are some of the topics open to discussion.

Jain and Slocum (2015) discuss stakeholder engagement as a critical tool to respond during a crisis. While the oil and gas industry places tremendous values on safety and risk management, responsible planning must account for all possibilities. Continuous engagement helps to provide clear lines of communication in the midst of a serious incident.

Public Relations

Sponsorships, education, and general visibility diminishes the barriers that risk a breakdown in relationships between communities, oil and gas companies, and neighbors. The general goodwill generated from active community support is essential to preventing minor mistakes from turning into public relations crises.

No matter the scenario, it is very difficult to predict the source and scale of misinformation. Trust built in advance of bad publicity can help to address rumors and minimize concerns if an adverse event occurs.

In 2010, the documentary *GasLand* was released, suggesting, among other things, that hydraulic fracturing caused water system to become saturated with gas. Repeated scenes of igniting faucets immediately become synonymous with hydraulic fracturing – despite the fact this scenario is nearly impossible for a variety of technical reasons (Fox 2010).

The industry worked to respond through a number of channels. EnergyInDepth created a section on their webpage, "GasLand Debunked", to address many of the falsehoods in the film (EnergyInDepth 2022). In 2012, the film *Truthland* was released as another means to explain many of the misleading statements from *GasLand* (EnergyInDepth 2012). While it is always important to correct the record, public engagement is more effective when rapport is established before misinformation is released.

Case Study Archives

Sealy and Stott (2010) discuss how focused case studies provide clear incentives for stakeholders to identify and communicate impactful environmental performance to internal and external stakeholders. Accumulating these case studies, many of which are taken for granted as the usual course of good business, provide examples where the public can embrace the idea that oil and gas extraction can act as a public good beyond affordable energy.

Recently Digital Wildcatters released a 15-minute video titled "American Shale: A New Hope" capturing the story of a farmer automating his dairy farm using the proceeds from drilling on his land (2021). This video provides a human story to the local benefits of oil and gas activity. While there are hundreds of stories like this, they are not being told nearly often enough in accessible forums.

Examples

Creating a mutually beneficial relationship in local communities is a campaign that sustains itself throughout the well life cycle. The following are examples of some elements within these campaigns.

Pennsylvania Department of Environmental Protection

As the shale revolution began to have its impact in Pennsylvania, drilling returned to once-dormant locations. Even with local support, activity required approval of a number of agencies, including the Pennsylvania Department of Environmental Protection.

Diesel-based drilling fluid was not approved, and other invert emulsion options were not under consideration. This left saturated salt water-based drilling fluid as one of the only choices. At that time, a typical well required about 30 days to drill and more than 1,600 barrels of water for dilution. Drilling fluid waste generation exceeded 2,000 barrels were well. When a water based system requires disposal, ~2000 more barrels of waste is generated.

The total impact of extended drilling activity and transportation of large volumes of waste required a change in approach. Initially, Fluids Management, the predecessor to AES Drilling Fluids, approached the Pennsylvania Department of Environmental Protection with a local operator to introduce synthetic-based drilling fluid to address these issues.

Education required describing the basics of invert emulsions and the chemicals involved. Base oil properties, including PAH and BTEX, were provided (non-detect for the SBM), along with biodegradability information. The SBM was approved, and dramatic performance improvements followed:

- Fewer drilling days reduced the risk of adverse interactions between drilling operations and townspeople
- Lower waste and water usage reduced trucking volumes
- Cleaner base oil utilization prevented impact from odor and limited risks associated with spills

As a contingency for particularly sensitive areas, a chloride-free SBM was utilized to prove the feasibility and cost factors of the system. The chloride-free SBM provided similar performance benefits with improved biodegradability. Figures 6, 7, and 8 compare the drilling days, water consumption, and waste. While the chloride-free SBM had the highest cost, it was already proven and available in the event an alternative would be required for restrictive townships.

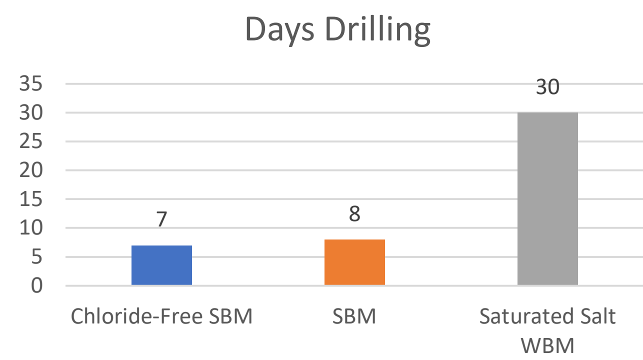

Figure 6: Drilling days by fluid type

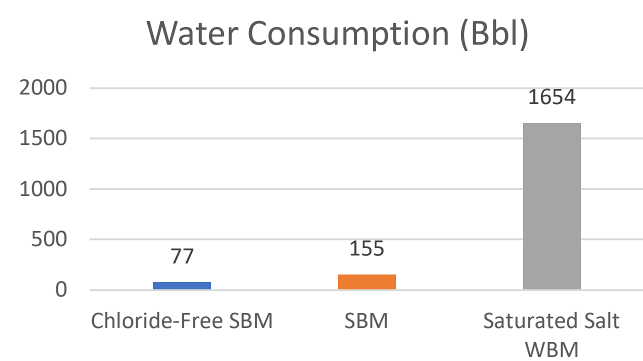

Figure 7: Water consumption by fluid type

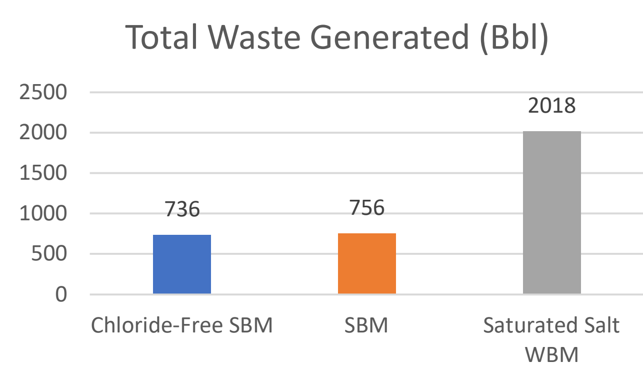

Figure 8: Total waste generated by fluid type

South Texas Ranchers

Drilling in South Texas is seldom near population centers. Lots of the drilling leases are on working ranches, where concerns about water quality and the health of livestock are central to any permission to operate.

Diesel-based drilling fluid is the standard in South Texas, and for the landowners familiar with drilling it was a primary concern. Risk of spills and questions about waste handling created uncertainty about drilling operations as rig counts grew.

Anticipating new drilling activity in the area, one operator gathered landmen, ranchers, and AES Drilling Fluids to discuss diesel alternatives and the improved environmental profile of an SBM option. This helped the ranchers and landmen craft agreements that would address concerns in advance of new drilling in a practical way.

Conclusions

To minimize impact on local communities, it is important to wholistically address:

- Measurable metrics to provide assurance
- Minimize visibility and impact of drilling operations
- Maximize visibility through education and community engagement
- Tell the story of oil and gas prosperity

Nomenclature

BTEX = *Benzene, toluene, ethylbenzene, and xylene*
PAH = *Polycyclic aromatic hydrocarbons*

References

1. Agency for Toxic Substances and Disease Registry. “Are Environmental Odors Toxic?” February 2017. https://www.atsdr.cdc.gov/odors/docs/Are_Environmental_Odors_Toxic_508.pdf
2. “American Shale: A New Hope.” Digital Wildcatters. Digital Wildcatters, December 8, 2021. https://digitalwildcatters.com/american-shale-a-new-hope-live-premiere/
3. Baxter, R., Offenbacher, M., Bedel, D., Lemaire, P., and Miano, C. “Transitions from Diesel Muds: Options, Properties, and a Proposal.” Presented at the 2018 AADE Fluids Technical Conference and Exhibition, Houston, Texas, April 10-11, 2018. AADE-18-FTCE-037
4. “Community Engagement Guidelines.” API Bulletin 100-3, First Edition. July 2014
5. “Colorado Senate Bill Signed by Governor Polis.” The National Law Review. Last modified April 17, 2019. https://www.natlawreview.com/article/colorado-senate-bill-181-signed-governor-polis
6. EnergyInDepth. “Truthland: Dispatches from the Real Gasland.” YouTube video, 34 min., June 12, 2012. https://www.youtube.com/watch?v=iTJaaeiuzSU&t=35s
7. Fox, J., director. *GasLand*. HBO Documentary Films, 2010. 1 hr., 47 min.
8. “Gasland Debunked.” EnergyInDepth. Independent Petroleum Association of America, accessed January 31, 2022. https://www.energyindepth.org/gasland-debunked/
9. Hahn, A. “Erie Rejects New Crestone Agreement with Split Vote, Extending ‘Odor’ Litigation and Company’s Core Drilling Plans.” Last Updated October 30, 2018.
10. Hampton. L. “Oil Driller Sees the Industry’s Future in Electric Rigs, Carbon Offsets.” Last modified December 20, 2021. Reuters. https://www.reuters.com/markets/commodities/oil-driller-sees-industrys-future-electric-rigs-carbon-offsets-2021-12-20/
11. “Hazard Communication.” Occupational Safety and Health Administration (OSHA), accessed February 14, 2022. https://www.osha.gov/hazcom
12. Kinslow, Carla J. "Hydraulic Fracturing: Tools for Successful Engagement With Fence-Line Communities." Paper presented at the SPE International Conference on Health, Safety, and Environment, Long Beach, California, USA, March 2014. doi: https://doi.org/10.2118/168508-MS
13. Jain, Samina , and Dean Slocum. "Social Performance in the Gulf of Mexico: Crisis-Ready Stakeholder Engagement." Paper presented at the SPE E&P Health, Safety, Security and Environmental Conference-Americas, Denver, Colorado, USA, March 2015. doi: https://doi.org
14. Lal, T.. "Engaging and Educating our Community: A Case History of the California Regulatory Environment and a Local O&G Company's Path on Building an Ambassador Program to Empower its Employees." Paper presented at the SPE Western Regional Meeting, Garden Grove, California, USA, April 2018. doi: https://doi.org/10.2118/190092-MS
15. Lim, J. “Extraction Changes Drilling Mud After COGCC Responds to Complaints.” July 11, 2019. Broomfield Concerned. https://broomfieldconcerned.org/news-releases/extraction-changes-drilling-mud-after-cogcc-responds-to-complaints/
16. Lim, J. “Is Extraction Using Carcinogenic, Odorous Drilling Mud at the Interchange Pad?” Broomfield Concerned. Last Updated May 19, 2019. https://broomfieldconcerned.org/news-releases/is-extraction-using-carcinogenic-odorous-drilling-mud-at-the-interchange-pad/
17. Lopez, M. “Broomfield Residents Complain About Weird Smell Near Oil and Gas Site.” The Denver Channel.com. Last updated May 17, 2019. https://www.thedenverchannel.com/news/local-news/it-is-impacting-our-health-broomfield-residents-complain-about-weird-smell-near-oil-and-gas-site
18. Meares, H. “Long Beach’s Deceptive Islands.” Modified September 28, 2018. Curbed Los Angeles. https://la.curbed.com/2018/9/28/17858248/history-long-beach-oil-islands-thums
19. Miller, Chad R. "Economic and Workforce Development in Rural Shale-Based Economies." Paper presented at the SPE/AAPG/SEG Unconventional Resources Technology Conference, Virtual, July 2020. doi: https://doi.org/10.15530/urtec-2020-2186
20. Mulkern, A. “Los Angeles Bans New Oil Wells and Will Phase Out Existing Ones.” E&E News. Modified January 31, 2022. https://www.scientificamerican.com/article/los-angeles-bans-new-oil-wells-and-will-phase-out-existing-ones/
21. Murphy, Helen , Valiyev, Tural , Astudillo Paredes, Diego , De Leon, Maria Divina, and Elizabeth Edwards. "Community Liaison Officers - Generating Pride and Enabling Engagement." Paper presented at the SPE International Conference and Exhibition on Health, Safety, Environment, and Sustainability, Virtual, July 2020. doi: https://doi.org/10.2118/199399-MS
22. “Oil and Gas Companies Erecting New Types of Walls Around Drilling and Frack Sites. Modified June 2, 2014. Cantafio and Song PLLC. https://www.coloradooilgaslawyers.com/oil-gas-law-blog/2014/june/oil-and-gas-companies-erecting-new-types-of-wall/
23. “Public Comments Submitted to oil&gas@aurora.gov about the Draft Oil & Gas Manual through August 23, 2020. City of Aurora. Modified August 23, 2020. https://p1cdn4static.civiclive.com/UserFiles/Servers/Server_1881137/File/Residents/Oil%20and%20Gas%20Drilling/All%20pu

blic%20comments%20on%20Draft%20Oil%20and%20Gas%20Manual%208-24-2020a.pdf
24. Rassenfoss, S. “Plug and Frac: Grid-Powered Pressure Pumping.” Modified February 11, 2021. Journal of Petroleum Technology. https://jpt.spe.org/plug-and-frac-grid-powered-pressure-pumping
25. Sealy, Ian , and Mary Louise Stott. "Communicating Environmental Performance: Engaging Internal and External Stakeholder Using a Case Study Approach." Paper presented at the SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Rio de Janeiro, Brazil, April 2010. doi: https://doi.org/10.2118/126228-MS
26. “Status of Fracking in New York.” FracTracker Alliance. Last modified October 9, 2017. https://www.fractracker.org/map/us/new-york/moratoria/
27. “Synthetic drilling mud base fluids provide options.” Drilling Contractor May/June 2001 pp 38-39.
28. Town of Erie. “Amended and Restated Operator Agreement.” November 4, 2015. https://www.erieco.gov/DocumentCenter/View/11328/Amended--and-Restated-Operator-Agreement---11-04-2018
29. Wall, Caleb "Managing Community Expectations through Strategic Stakeholder Engagement." Paper presented at the International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Perth, Australia, September 2012. doi: https://doi.org/10.2118/153330-MS
30. “WSP USA Develops Air Monitoring Equipment for Oil and Gas Facilities.” November 12, 2020. https://www.wsp.com/en-US/insights/2020-airwatch-solar-powered-air-monitoring-system