Managing Hydraulic Fracturing: Approaches to Assessing and Addressing Transportation Impacts

By

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To my extraordinary daughters, Emma and Erin, who always inspire me to be better.

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TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

Figures Page

CHAPTER I

INTRODUCTION

Outline of the Project

During this work, the owner of an oil company said, "no one loves an oil or gas well as much as the property owner where the well is located, and no one hates it as much as his neighbor." This statement perhaps best reflects some of the acrimony that has arisen between different stakeholders as the use of hydraulic fracturing and horizontal drilling have dramatically increased over the last decade, providing access to vast reserves of oil and gas that were not economical to produce previously. Advances in these old technologies (hydraulic fracturing and horizontal drilling) has catapulted the U.S. to surpass both Russia and Saudi Arabia to become the world's largest producer of both oil and gas since 2014 (EIA, 2016b). Indeed, the energy impacts have been so profound that modern oil and gas development enabled by fracturing has been referred to as the "shale revolution" and "one of the landmark events in the 21st century" (Wang, *et al.*, 2014).

Certain states have seen the largest increases in drilling activities over relatively short time periods, and local planners have struggled to address impacts, especially to transportation infrastructure. New tools have emerged to help state regulators assess concerns raised by large scale oil and gas development, and many studies have now evaluated and quantified the impact of oil and gas development on roads. However, the available data from existing work remains disparate and underutilized, especially by small, local governments where road impacts are typically felt the most. Newly emerging national tools also have not been examined in a rigorous way to determine their utility, and certain stakeholder perspectives remain unrepresented. Finally, there remains tremendous opportunity to leverage newly emerging data and information

and share best practices between states to better manage and prepare for the benefits and challenges that accompany responsible development of hydrocarbon resources. This work seeks to accomplish some of these objectives.

Chapter Two of this dissertation represents the first comprehensive national survey of state regulators on the effectiveness of FracFocus, a tool developed by oil and gas and water regulators from across the country to address chemical disclosure in hydraulic fracturing operations. The work reflected in Chapter Two provides a needed assessment of a widely used tool and offers important visibility to the (often novel) ways states are using FracFocus to augment state regulatory programs. The project revealed that there is significant potential for sharing valuable approaches between states. In Chapter Three, important data and information emerging from the FracFocus study described in Chapter Two was then leveraged to develop a methodological approach for local planners addressing impacts from oil and gas development. With a focus on local transportation infrastructure, the methods developed were applied in a case study to the Tuscaloosa Marine Shale Oil Play in Mississippi, and included the views of local operators, a perspective largely missing from the literature. Chapter Four of the dissertation provides a legal and policy analysis for local planners to better understand potential approaches, and likely challenges, to maintaining transportation infrastructure in the face of large scale hydraulic fracturing. Finally, Chapter Five summarizes the contributions of this dissertation in the form of concluding remarks.

Overview of Hydraulic Fracturing and Horizontal Drilling

The basic technique of hydraulic fracturing as a method by which to stimulate oil and gas wells to increase production has been around for over a century, with more modern methods in use since the late 1940s and 1950s. Horizontal drilling on a commercial scale began in the

1980's, and combined with the advances in hydraulic fracturing techniques, have been the leading force in the country's domestic energy boom.

Despite the long and continued use of the technology in the U.S. and around the world, and the relative safety record, the vast majority of the American public is not familiar with oil and gas drilling technology. Fear of the unknown coupled with the rapid expansion of drilling understandably has raised concern. Accordingly, hydraulic fracturing has become one of the major environmental controversies of the day and activists across the country have called for complete bans on the well-stimulation technique. Townships and localities have spent substantial public funds litigating their authority to ban the technology, most with little success.

Oil and Gas

Oil and gas are created by organic and geologic processes over millions of years. Organic matter – such as bacteria, and other microscopic plants and animals that live in the sea – ultimately die and fall to the sea floor where they are covered in additional organic material and sediments, which ultimately form rock layers over the remains. As more layers accumulate over the material, the pressure (from the weight of the layers above) and heat over geologic time convert this matter to kerogen, which in turn is converted to oil and gas as temperature and pressure increase. Oil will form generally between 50°-100°C whereas higher temperatures (generally above 100°C) will also produce natural gas (Chernicoff & Whitney, 2007). Because natural gas requires higher temperatures to form, it is generally found in deeper formations than crude oil, necessitating deeper wells to access.

Conventional and Unconventional Sources of Oil and Gas

Crude oil and natural gas consist of tiny droplets that are smaller and less dense than the porous rock in which they are found; accordingly, if the rock is both porous and permeable, the

oil or gas will migrate upwards until something stops that migration, such as an impermeable layer of rock (e.g., clay), otherwise it will migrate all the way to the surface (Chernicoff & Whitney, 2007). The oil or gas that is contained in permeable and porous rock and collects or pools just beneath the impermeable layer is known as a "conventional" oil or gas reservoir (Figure 1). These "conventional" reservoirs are generally easier and less costly to produce, because once the impermeable barrier is penetrated by drilling a well, the oil or gas will flow naturally or can be pumped to the top of the well where it is collected. Most of the oil and gas produced in the U.S. has come from conventional sources (Whitney, 2010).

Unconventional sources of oil or gas are hydrocarbons that are more difficult to access and costlier to produce because they consist of smaller pockets of oil or gas that are distributed and trapped throughout a geologic formation, such as in a layer of shale rock (Figure 1). These

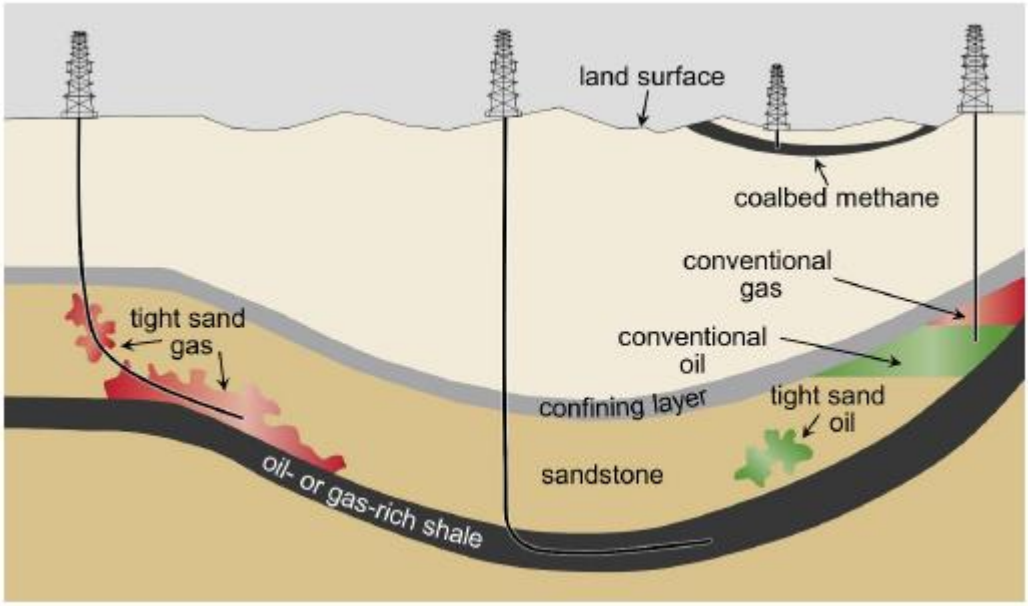

Figure 1. Representation of conventional and unconventional oil and gas. Vertical well shown tapping the conventional oil deposit; horizontal and directional wells shown entering the unconventional "oil or gas rich shale" layer and the "tight sand gas."
Source: United States Environmental Protection Agency Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drilling Water Resources, External Review Draft, EPA/600/R-15/047a, June 2015.

"unconventional" sources of oil or gas are referred to as "tight oil" or "shale gas" because the hydrocarbons are trapped in impermeable rock layers and therefore cannot freely pool or flow to the surface as with "conventional" sources of oil (Figure 1). Sources include shale gas, which is natural gas trapped in impermeable shale rock, shale oil (such as that found in the Baaken formation in North Dakota) and oil sands, where the grains of sand are surrounded by bitumen, a hydrocarbon that can be refined to produce fuel (Chernicoff & Whitney, 2007). "In general, conventional oil is easier and cheaper to produce than unconventional oil. However, the categories 'conventional' and 'unconventional' do not remain fixed, and over time, as economic and technological conditions evolve, resources hitherto considered unconventional can migrate into the conventional category" (EIA, 2017).

Drilling and Fracturing

Wells can be drilled either vertically, or vertically and then horizontally. Horizontal drilling is a technique in which the drill bit first moves down vertically through the rock formation, but then angles off horizontally and continues to drill laterally through the formation (Figure 1). Because the well runs laterally through the formation, horizontal wells can access significantly more of the oil bearing formation than vertical wells from one surface well pad, substantially increasing the well's production while at the same time reducing surface area footprint as compared with vertical wells (U.S. EPA, 2016). Horizontal wells also can safely reach oil or gas that may be located under sensitive areas where a surface well could not be drilled, such as beneath populations centers, lakes, or natural areas (Seeley, 2015).

After a well is drilled, the hydraulic fracturing process begins. Hydraulic fracturing is a process by which the well is stimulated to produce viable quantities of oil or gas. The process involves pumping a mixture consisting primarily of water and sand, and approximately 0.5-2%

chemicals, at high pressure down the well and creating fractures in the rock where oil or gas is trapped, allowing it to more freely flow or be pumped to the surface for collection (FracFocus, 2016).

Both horizontal drilling and hydraulic fracturing are old technologies, but together with recent advances, they have enabled companies to access "unconventional" domestic oil and gas resources that were previously uneconomical to produce. Because the more easily accessible, conventional sources of domestic oil and gas may near depletion or already producing, it is well accepted that hydraulic fracturing and horizontal drilling to reach unconventional sources are necessary components to a continued and robust domestic oil and gas industry. As Hughes noted, in 2004 less than 10% of U.S. oil and gas wells were produced using horizontal drilling and hydraulic fracturing, by 2013 over 61% of wells were drilled horizontally (Hughes, 2013). One year later that number had climbed yet again: In 2014 79% of wells drilled in the United States were either horizontal (67%) or directional (12%) with vertical wells accounting for only around 20% of new U.S. wells drilled (Selley, 2014). In some areas, the reliance on hydraulic fracturing and horizontal drilling is even higher. With respect to hydraulic fracturing for example, in Colorado "[m]ost of the hydrocarbon bearing formations . . . have low porosity and permeability. These formations would not produce economic quantities of hydrocarbons without hydraulic fracturing." (Colorado Oil and Gas Conservation Commission, 2015). In the Barnett shale in Texas, horizontal wells account for 90% of the total natural gas production (EIA, 2011).

Because oil or gas "booms" are likely to continue as oil prices and technology advances enable drilling in new areas, research promoting responsible development and better management is important.

CHAPTER II

THE VALUE OF FRACFOCUS.ORG AS A REGULATORY TOOL: A NATIONAL SURVEY OF STATE REGULATORS

Introduction

The oil and gas boom over the last decade has generated a wave of new state laws and regulations, especially addressing disclosure of fracturing chemicals. In 2011 the chemical disclosure registry FracFocus.Org was launched to provide well-by-well chemical information to the public. Many states adopted FracFocus for chemical reporting. In 2013, Harvard Law School researchers issued a report concluding that FracFocus "fails as a regulatory compliance tool." The report made serious criticisms regarding the utility of the registry; however, the report was deficient because its authors never interviewed state regulators. This research activity remedies that oversight. In this Chapter, the results of a survey of oil and gas regulators in twenty oil and gas producing states are presented. The aim of the study was to determine how state regulators view FracFocus.Org and how (or whether) they are using it to support state regulatory programs. The results contradict the most crucial claims of the Harvard report and indicate that states are quite positive about FracFocus and are using it in novel ways that go beyond the registry's original purpose. This work is the first comprehensive survey of state regulators and the first attempt to obtain a data-driven analysis of how FracFocus is being used and whether it is effective as a regulatory tool.

In the past decade, the issue of the safety of the hydraulic fracturing process has been the subject of numerous government, industry, and academic studies. The EPA is currently completing a comprehensive, multi-year study on the impact of hydraulic fracturing on drinking water resources (Environmental Protection Agency, 2015a). However, the environmental impact of oil and gas development is beyond the scope of this dissertation.

This dissertation focuses on a narrow, but key area of the controversy: disclosure (to the public or to regulators) of the chemicals used in in the hydraulic fracturing process. The driving fear in the recent history of fracing is the nature of these chemicals and whether they should be disclosed in ways that go beyond longstanding federal regulations governing disclosure of hazardous chemicals.

Disclosure of Hydraulic Fracturing Fluid Information

Like chemicals used across many industries in the United States, the precise chemical formula of some widely-used hydraulic fracturing fluids are entitled to trade secret protection under state and federal laws (CRS, 2012). However, when trade secrets are at issue in any industrial workplace setting, federal laws provide for a modified form of disclosure of chemical information that balances the need to protect workers and the environment against the need to protect proprietary information. The Emergency Planning and Community Right to Know Act (EPCRA) (42 U.S.C. § 11021) and the Occupational Safety and Health Administration's Hazard Communication Standard (29 C.F.R. § 1910.1200(g)) require identification of hazardous chemicals on Material Safety Data Sheets (MSDS) (CRS, 2012). The MSDSs must be submitted to local emergency personnel and be made available to employees at worksites (EPCRA, 1986a and OSHA, 1994a). However, these laws and regulations allow manufacturers of hazardous chemicals to make a claim of trade secret, and thereby withhold from the MSDS the specific chemical constituents that are trade secrets (EPCRA, 1986b and OSHA 1994b). In these cases, chemical manufacturers must still report the "generic class or category" of the hazardous or toxic chemical so that first responders and medical personnel have the information they need to respond in the event of an accident, but the often substantial investment in developing those chemicals remains protected under trade secret laws (EPCRA, 1986c).

This mechanism to balance trade secret protection with worker safety and the public's right to know has been in place since the 1980s, when EPCRA was enacted and OSHA's Hazard Communication Standard was established. However, since the early to mid-2000s, when the number of wells using hydraulic fracturing technology increased rapidly, environmental groups have argued that increased disclosure of hydraulic fracturing fluids is necessary, even if private property rights (trade secrets) are infringed. Activists, environmental groups, and concerned citizens have at times demanded full disclosure of the chemical formulae found in hydraulic fracturing fluids at well sites, even where that information constitutes a protected trade secret under existing law. Although OSHA and EPCRA have nearly exclusively governed hydraulic fracturing chemical disclosure since the 1980s (CRS 2012), in the last decade states have reacted to the demands for more transparency and many have enacted laws or regulations that address the disclosure of hydraulic fracturing chemicals.

FracFocus.Org

It was in the midst of this intense debate that, in 2011, the Ground Water Protection Council (GWPC) and the Interstate Oil and Gas Compact Commission (IOGCC) launched a new tool, the FracFocus.org Chemical Disclosure Registry (FracFocus or Registry), aimed at providing a single, on-line database where members of the public could access information on the chemicals used in the hydraulic fracturing process on a well-by-well basis. The GWPC is a nonprofit organization "whose members consist of state groundwater regulatory agencies which come together within the GWPC organization to mutually work towards the protection of the nation's ground water supplies. . . . [Its] mission is to promote the protection and conservation of ground water resources for all beneficial uses, recognizing ground water as a critical component of the ecosystem." (Ground Water Protection Council, 2015a). The IOGCC is a

"multi-state government agency" that "works to ensure our nation's oil and natural gas resources are conserved and maximized while protecting health, safety and the environment" (IOGCC, 2015). IOGCC members consist of the governors of oil and gas states and their appointed representatives. There are over two dozen member states, eight associate member states, and numerous foreign and domestic affiliates.

The Registry had the support of industry, which agreed to more transparency in chemical disclosures provided trade secret protections were in place. Industry has substantial investment in well stimulation technologies and remaining competitive in the marketplace hinged on protecting those investments.

Well operators and service providers across the country began submitting well data to the site voluntarily. If the identity of a chemical was a protected trade secret, the words "trade secret," "confidential," or similar indicator would be entered on the FracFocus form, so that anyone searching for well information on the Registry would be aware that specific information was being withheld under a claim of trade secret.

While FracFocus grew, so too did the debate regarding hydraulic fracturing. Oil and gas producing states across the country began adopting new regulations specific to hydraulic fracturing, primarily to assure well-bore integrity and promote transparency in fracturing fluid information. Indeed, within just a few years, virtually all of the oil and gas producing states enacted legislation or regulations specific to hydraulic fracturing (Hall, 2013). Vigorous debates ensued regarding trade secrets. Trade secrets are valuable and legally protected private property; these property rights in trade secrets serve to encourage the development of more efficient and "greener" fracturing technologies. And yet, also true is that environmental regulators, first

responders, and medical personnel need access to the information that is essential to protect human health or the environment in the event of an incident.

As state legislatures and regulatory agencies struggled to draft laws and regulations that would strike the right balance (and appease the lobbying efforts on both sides), industry advocated for the use of FracFocus by state regulators in order to serve the goals of transparency, but also to lessen the burden of complying with a patchwork of different reporting obligations across the country. States and the federal government ultimately took a variety of approaches (and are continuing to do so), with most adopting FracFocus as a mandatory method of compliance with the state (or federal) fracturing fluid disclosure obligations.

In the first two years of operation, data on tens of thousands of wells across the country were reported to FracFocus and FracFocus quickly became a critical information source. EPA "compiled and analyzed over two years of data" from FracFocus to support its study on the impacts of fracturing on drinking water resources (EPA, 2015b). The Department of Energy set up a task force to evaluate FracFocus (Department of Energy, 2014a). The consultants that developed the FracFocus database presented papers highlighting how analysis of the data available on FracFocus could be used to "bring a scientific approach to addressing many of the concerns expressed by the public, NGOs, and regulatory agencies regarding hydraulic fracturing" (Arthur, 2014a). Indeed, as of April 23, 2013 (the date of the Harvard study, discussed below), FracFocus had data on 41,239 wells (Ground Water Protection Council, 2015b). As of July 2015, there is now data on 99,734 wells available on FracFocus (FracFocus, 2015b). Even at the time of the publication of the Harvard report, FracFocus appeared to be an important tool for the public to access fracturing fluid information and for regulators to implement chemical disclosure laws.

FracFocus continues to evolve and respond to the recommendations of regulators and other stakeholders. In spring 2013, new upgrades were made to FracFocus, which became known as "FracFocus 2.0." These upgrades included, among other things, the ability to search the site by Chemical Abstract Service (CAS) numbers or date ranges, a location on the chemical disclosure forms for "ingredients not listed on MSDS," as well as internal processes to check for errors as data is submitted (FracFocus, 2013; Department of Energy, 2014a). FracFocus 3.0 is expected to launch in 2015 with additional upgrades aimed at increasing reporting accuracy, expanding search capabilities, potentially decreasing the number of trade secret claims that are submitted, and allowing easier access by regulators and the public (FracFocus 2015d).

The Harvard Report noted some of the changes made in FracFocus 2.0, for example the inclusion of non-MSDS chemicals on the FracFocus disclosure form, but concluded that the FracFocus reporting forms did not go far enough (for reasons that are beyond the scope of this dissertation work). At the time of the survey that is the subject of this dissertation, FracFocus 2.0 was in use and FracFocus 3.0 had not yet been released.

The Harvard Law School Report

On April 23, 2013, researchers at Harvard Law School's Environmental Law Program, Policy Initiative, published a white paper titled "Legal Fractures in Chemical Disclosure Laws: Why the Voluntary Chemical Disclosure Registry FracFocus Fails as a Regulatory Compliance Tool" (Konschnik, 2013) (hereinafter referred to as the "Harvard Report"). The Harvard Report cited three primary failings in the FracFocus tool: 1) the timeliness of FracFocus' notification to state regulators when a submission is made to FracFocus; 2) the lack of state-specific submission forms that take into account the varied state disclosure requirements; and 3) the lack of a

mechanism within the Registry by which to challenge trade secret claims made on submissions to FracFocus.

The Harvard Report spread swiftly through the environmental and industry communities, and garnered widespread national media attention. The report itself, however, soon attracted negative attention. Media, industry representatives, and state regulators recognized a major shortcoming: the Harvard Law School researchers reached their conclusion about the value of FracFocus to state regulatory programs without interviewing regulators who were actually using the tool to support their regulatory programs. The report cites one telephone interview by a law student with a Colorado regulator as to whether he was aware of the requirement that forms be submitted to the state *and* to FracFocus, and one interview with a Pennsylvania regulator regarding the information that is submitted to the state on state forms, apart from FracFocus forms (Harvard Report, 2013). There apparently were no discussions regarding timeliness of reporting, trade secret claim procedures, or state-specific forms with these two or any other state oil and gas regulators.

Fundamental questions remained: Were state regulators in fact limited in their regulatory programs by the lack of state specific forms, the timing of disclosures, or the absence of a method for challenging trade secret claims within the Registry? The experience of the government regulators is absolutely central, and that is precisely the question this dissertation work sought to address: What do regulators across the country think of FracFocus and how are they actually using it? Has it in fact "failed as a regulatory compliance tool" as the Harvard Report claims?

National Survey of State Regulators

The most appropriate way to find out how states are using FracFocus and their impression as to its utility is to directly survey the regulators. Accordingly, a survey was developed consisting of eleven questions aimed at discovering how states were using the tool, their general impression of the tool, and to elicit open ended feedback from state regulators regarding FracFocus.

The survey was sent to regulators in twenty states with oil and gas development and listings on FracFocus, with fourteen states responding, a response rate of 70%. Regulators with responsibility for enforcement and compliance with chemical disclosures rules, well reporting rules, or FracFocus submissions in their respective states were targeted for receipt of the survey. All written and oral contacts with the state regulators were neutral to avoid imparting any bias regarding the researchers own evaluation of FracFocus.

Overall, the data contradicted the Harvard Report's conclusion that FracFocus 'fails as a regulatory tool.' Regulators had a positive view of FracFocus and indicated it was a useful tool in regulatory programs. Different states are using FracFocus in different ways. Indeed, regulators indicated they were using the information available on FracFocus to support their regulatory programs in novel ways perhaps not imagined by FracFocus' creators. The remaining sections of this Chapter discuss the results of that survey, how states are using FracFocus, and the impressions regulators have of FracFocus as a regulatory tool.

Developing the Survey

The survey was compiled using Qualtrics online software and sent via email to the targeted regulatory officials for each state in which more than ten wells appeared on FracFocus as of spring 2014. These included Alabama, Alaska, Arkansas, California, Colorado, Kansas,

Louisiana, Michigan, Mississippi, Montana, New Mexico, North Dakota, Ohio, Oklahoma, Pennsylvania, Texas, Utah, Virginia, West Virginia, and Wyoming. A minority of these states currently do not require mandatory reporting to FracFocus in their regulatory programs (although they do require disclosure of fracturing fluid information), and approximately two states were in the process of adopting regulations that would require the use of FracFocus, which had not yet taken effect at the time of the survey. However, these states were intentionally included in order to capture any use that state regulators may be making of the then voluntary reporting to FracFocus that was already occurring in those states. Importantly, the states surveyed included the top oil and gas producing states in the nation (EIA, 2013) and those with the most proven hydrocarbon reserves (EIA, 2014).

Prior to sending out the survey, the states were contacted by phone and e-mail to assure that the survey was directed to the regulator with the most familiarity or experience with FracFocus or chemical reporting from well operations in that state. The states were informed that more than one person in the agency could take the survey, but the state agency ultimately made the determination to identify the appropriate person(s) to take the survey. The survey was anonymous in order to encourage frank answers and protect the individual respondents.

The survey asked specific questions, but also allowed room for regulators to draft their own reactions to FracFocus. Many contributed substantial detail regarding their programs and their use of FracFocus. Some of them included identifying information in their answers which have been omitted from the results to protect the privacy and identity of those responding. Some respondents chose not to answer specific questions and that was taken into consideration in reporting of results.

The intention of this work was to obtain comparable data on such critical factors as the timeliness of FracFocus' notice to states when it receives reports on wells, the use of FracFocus to support regulatory programs, the states' views of the role FracFocus plays with respect to trade secrets, integration of FracFocus data with state maintained data, and the overall sense of the utility of FracFocus for state regulators charged with enforcing state chemical disclosure rules. A list of the survey questions and response options is included in Appendix A.

Results

Timeliness of State Notification

The question of whether FracFocus provides timely notice of data submission to the states may be critical to the usefulness of the data and certainly to the state's ability to determine if time sensitive disclosure obligations are being met. Accordingly, the survey asked the state regulators if FracFocus notified them when FracFocus received submissions from well operators and if that notification is timely.

The survey gave respondents a choice of "very timely," "timely," "not so timely," "extremely poor," and "other," with this last option allowing respondents to enter a written explanation. Nine states answered this question. The results of this survey question are shown in Figure 2. Four replied that it was "very timely," one that it was "timely" and four states answered "other." No state indicated FracFocus' was "not so timely" or "extremely poor." In the "other" category, multiple states explained that they pull the information directly from FracFocus and do so on their own schedule. Hence, as one state explained, "so it is timely, but on our schedule." Another state in the "other" category which responded to this question did not use FracFocus.

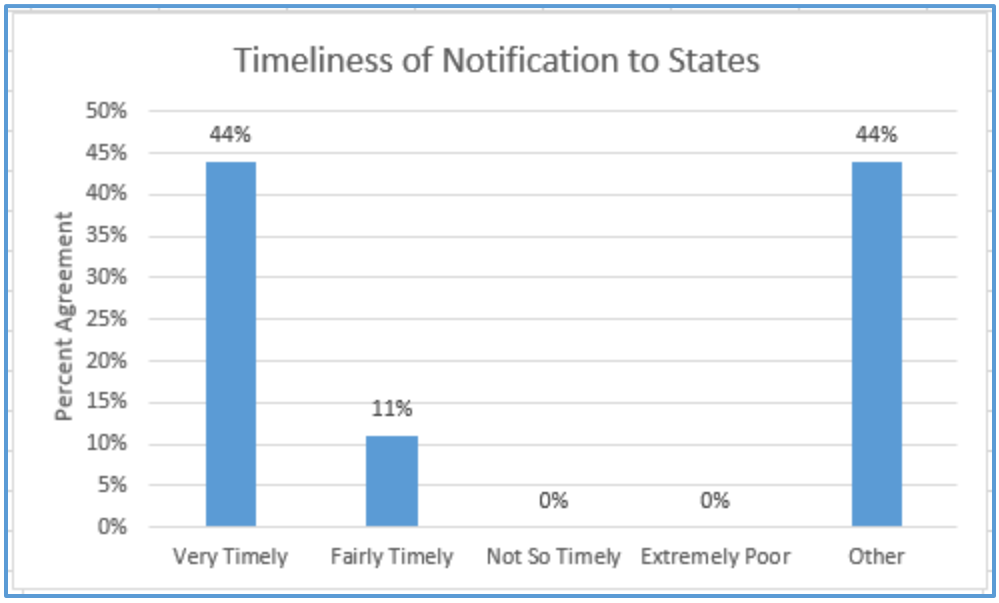

Figure 2
Total Number of States Responding: 9

These results appear to be in direct conflict with the Harvard Report's opinion that "FracFocus does not notify a state when it receives a disclosure from a company operating in that state. Nor can most states readily determine when a disclosure is made" (Konschnik, 2013).

Use of FracFocus to Support State-Specific Regulatory Programs

The second conclusion of the Harvard Report was that the lack of state-specific reporting forms on FracFocus "creates barriers to compliance" because "companies are left to figure out how to account for state requirements not requested by FracFocus" and "too often . . . do not provide the additional information." (Harvard Report p.5). The survey developed for this work was aimed at state regulators and their use of FracFocus, not the reporting oil and gas companies; accordingly, the survey did not ask states about the FracFocus forms themselves, but instead sought information from the states regarding whether and how they were able to make use of data that

was being reported to FracFocus (on the current, generic forms) to support the regulatory programs (that may vary from state to state).

The survey asked states whether they use FracFocus to download well data directly from FracFocus to state computer systems for use in individual state regulatory programs. As shown in Figure 3, half of the respondents indicated that they use FracFocus in this way.

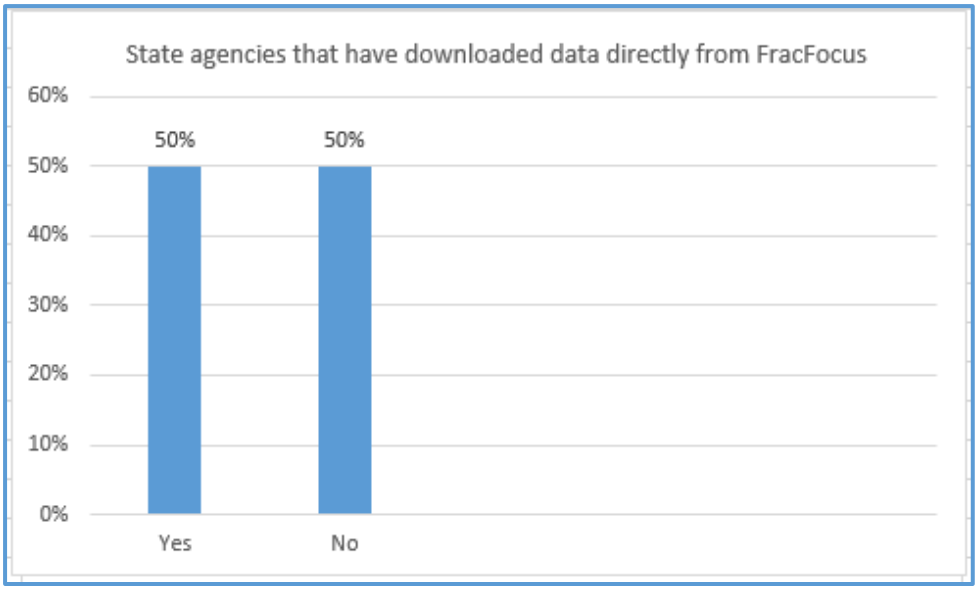

Figure 3
Number of States Responding: 14

The survey also asked state regulators if they used FracFocus to gather information regarding the chemicals or water volumes used in the fracturing process. With respect to chemicals, 57% indicated that they do use FracFocus to gather such information, 29% answered they did not, and 14% answered they did not know or were not sure (Figure 4). Data on water volume was less represented. Thirty-six percent of the states indicated they used FracFocus to obtain such information, 43% indicated they did not, and 21% indicated they did not know or were not sure. See Figure 5.

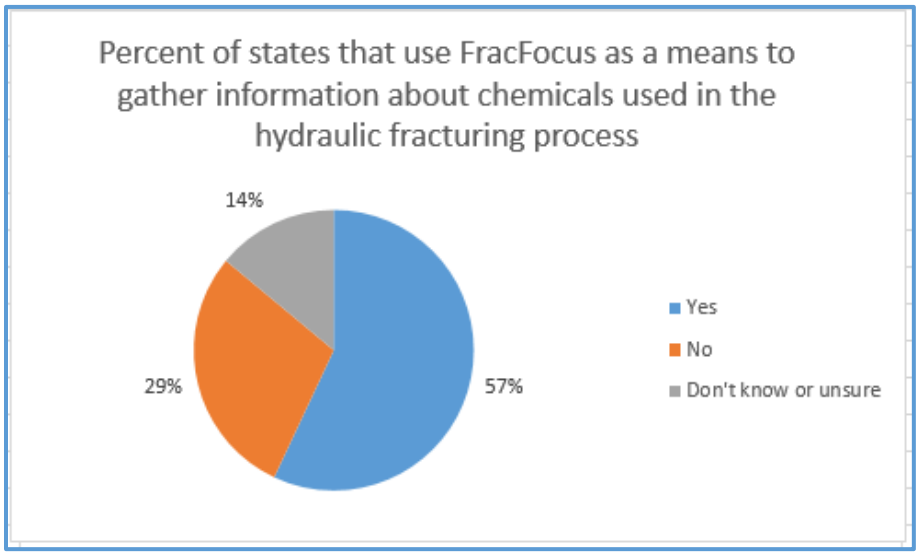

Figure 4
Number of States Responding: 14

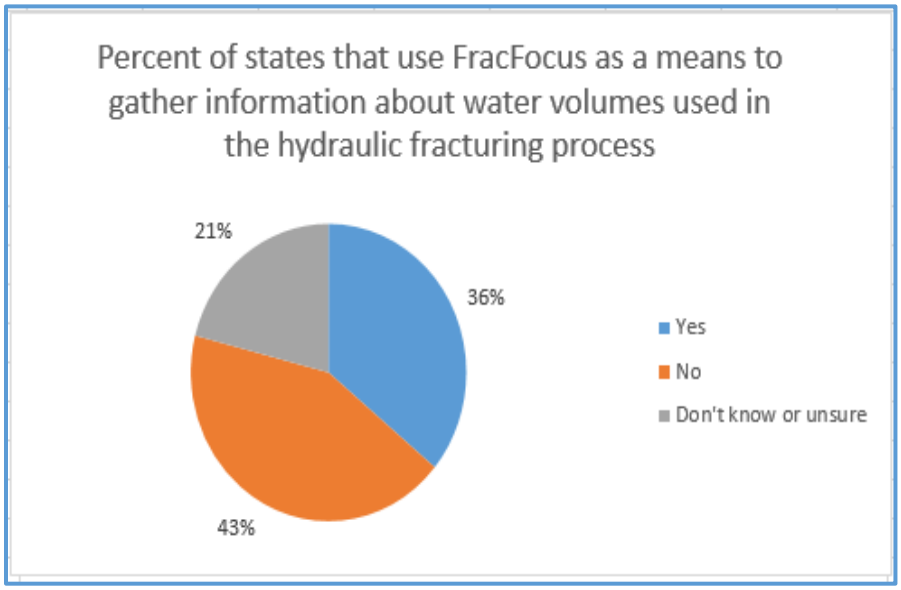

Figure 5
Number of States Responding: 14

State Responses

In addition to asking prescribed questions, the survey asked open ended questions aimed at understanding how states have used FracFocus to support their regulatory programs. The following responses indicated that states have used FracFocus in ways that often go beyond chemical reporting compliance. Indeed, these findings may be some of the most significant and surprising of this work. The responses have been edited to correct minor spelling and grammar mistakes. Ten separate states, indicated by paragraph breaks below and key statements highlighted in bold, reported that:

> "FracFocus has been a tool to provide information to the public about different hydrological fracturing processes throughout our state. It is also useful when public record requests come in to generate all important information for each citizen."
>
> "**Our state required documents do not tell us the date or dates of Frac treatment, FracFocus captures that information and our state has found that information helpful in studies of earthquake issues in our state. The information will also be utilized in the reports to our agency regarding complaints of water contamination**."
>
> "**FracFocus provides a readily available resource to provide hydraulic stimulation data to interested parties**."
>
> "**Our technical staff use Fracfocus to cross-check the validity of the data submitted to us by the operator**."

"MSDSs have been submitted to our agency directly; however, a few companies . . . submit their information to FracFocus.org. It has been helpful for us to direct concerned citizens to FracFocus to view MSDS that have been posted on the website. . . . **I personally have obtained information from FracFocus to create an informational pie chart regarding the chemical constituents of hydraulic fracturing fluids**."

"**We . . . use FracFocus to verify compliance with our rules**."

"**[The agency] has used FracFocus to determine compliance with the requirement under the Safe Drinking Water Act to require an Underground Injection Control permit for hydraulic fracturing using "diesel fuel" as defined by EPA**. EPA provided a definition through guidance and interpretive memo (not rulemaking) for the term "diesel fuel" in May of this year. The [agency] has enforced against one operator using information obtained through FracFocus."

"[**This state uses FracFocus to] determine reporting and notification compliance with the state's . . . statutes and regulations. It is the only electronically available source of hydraulic fracturing chemicals data that the state can access to consider types of formulations or in cases of a spill**. Very few of the [agency's] environmental programs have access to electronically available chemical data for the activities they regulate."

"**We have used FracFocus to check databases of chemicals used**."

"**We usually just verify reporting compliance**."

In addition, several states indicated that they cross-reference state reporting forms with the list of wells they obtain from FracFocus to verify that operators are in compliance with state reporting obligations. Moreover, they will contact an operator if the submissions to FracFocus do not match the submissions to the state.

Finally, one state wrote that it routinely runs reports from FracFocus "through the tools for the state regulator role." This state noted that it found valuable the feature of FracFocus that allows oil and gas inspectors to "select any specific report, anytime they need to for review" and that the FracFocus reports "can be run anytime by the regulators to check operator compliance."

Trade Secrets

The Harvard Report vigorously criticized FracFocus for its omission of legal procedures to challenge and defend claims of trade secret. From my own perspective, I do not believe FracFocus has the authority, nor was it intended, to establish any such mechanisms. State law generally defines what a trade secret is and states will have different mechanisms in place by which claims of trade secret are made or can be challenged. In any case, it was important to understand regulators' views on whether FracFocus could be doing more to assist the states with respect to this issue.

The survey asked states whether they were satisfied with FracFocus' approach to identifying when claims of trade secret have been made on a submission to FracFocus. As shown in Figure 6, all of the states responding indicated that they were either neutral, satisfied, or very satisfied. No state indicated it was dissatisfied.

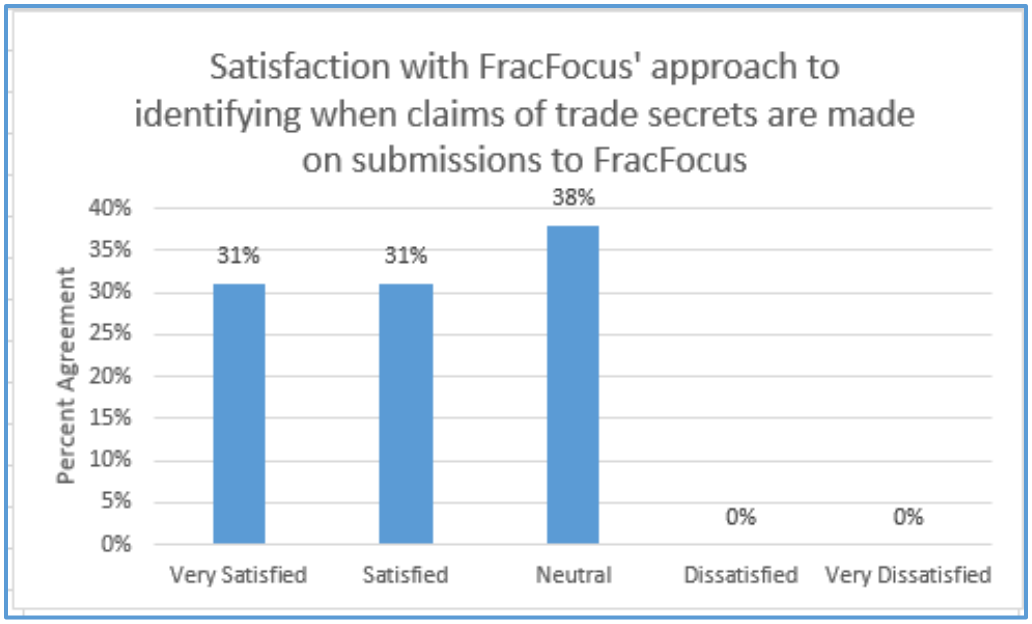

Figure 6
Number of States Responding: 13

In response to this particular question, the survey did not allowed respondents to draft their own statements; however, two states used other comment areas to specifically address the trade secret issue. One state commented, "we have a trade secret process -- that is not FracFocus's purview." Another state noted that "[a]lthough FracFocus provides the capability to list legislatively protected trade secret and proprietary business information chemicals in a systems approach, each state has their own requirements for protection of this information."

Overall Satisfaction and State Views Regarding FracFocus

Because it was expected there would be aspects of FracFocus and the states' use of it that went beyond the specific questions asked, the survey asked respondents how satisfied they were with the Registry overall. Forty-six percent responded that they were "very satisfied," 38% indicated they were "satisfied," and 15% indicated they were "neutral." See Figure 7. Not one respondent replied that they were "dissatisfied" or "very dissatisfied."

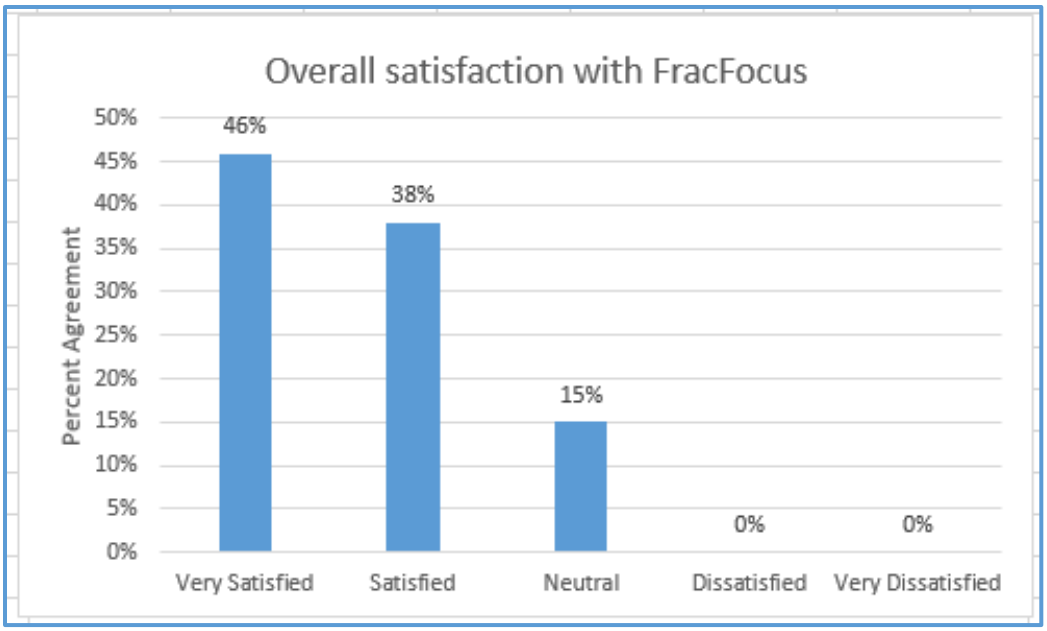

Figure 7
Number of States Responding: 13

These results are significant because these respondents are the very ones charged with enforcing the hydraulic fracturing regulations. Surely if FracFocus was anything like the "fail[ure]" described in the Harvard Report, these respondents would have been the first to notice it. On the contrary, the survey results demonstrate that state regulators overwhelmingly find the site a useful and important regulatory tool.

Interestingly, the question that received perhaps the most robust response from regulators was one asking states to write anything they would like the researchers to know about how regulators view FracFocus. The comments from the regulators appear below (with any identifying information deleted). Each paragraph represents a different state's response, with minor typos or grammatical errors corrected and key comments highlighted in bold.

"The issue of trade secret status of chemicals used in hydraulic fracking is probably the most important issue regarding the hydraulic fracking debate."

"It appears to offer some queries that provide[] useful information."

"In the past, it has been helpful to direct citizens to the website when they have concerns regarding chemical disclosure of fluids used for hydraulic fracturing"

"I think the overall opinion of regulators is positive. My only suggestion would be to allow bigger data dumps by regulators. We are currently limited to a six-month period"

"**FracFocus has been a very handy tool to identify what types of chemicals companies are using in their hydraulic fracturing stimulations in our state**. I am able to use the information we get from the query that our database creates to determine which companies are using diesel fuel in their stimulations, and to cross reference that with the information that is on FracFocus pretty easily. . . . **I use FracFocus at least twice a week to determine which companies are out of compliance with our regulations**, so I am pretty familiar with the site and how easy it is to use. **The information that is provided is also great because it lets a person know what most of the chemicals are that are being used for a specific well**, and the information is generally pretty user friendly to read. In my experience, I feel like some companies feel as if reporting to the FracFocus website is a joke, but once they have to hear from me, they quickly understand that this is not a joking matter and that it is important to report not only because it is a state regulation, but because the people want to know as well."

"**It is quite effective and an efficient way to access, in a consistent format, hydraulic fracturing chemical data; and, to make that data readily available to the public**. Although **FracFocus provides the capability to list legislatively**

protected trade secret and proprietary business information chemicals in a systems approach, each state has their own requirements for protection of this information."

"We believe **FracFocus has been a positive tool to assist in the disclosure of hydraulic fracturing information**."

Increasing Use of FracFocus

In the four calendar years FracFocus has been active or accepted submissions (January 1, 2011 through December 31, 2014), the website has received 1,090,512 hits, with 744,649 of these representing unique hits (Ground Water Protection Council, 2014). These numbers have been trending upwards each year, as Figure 8 shows.

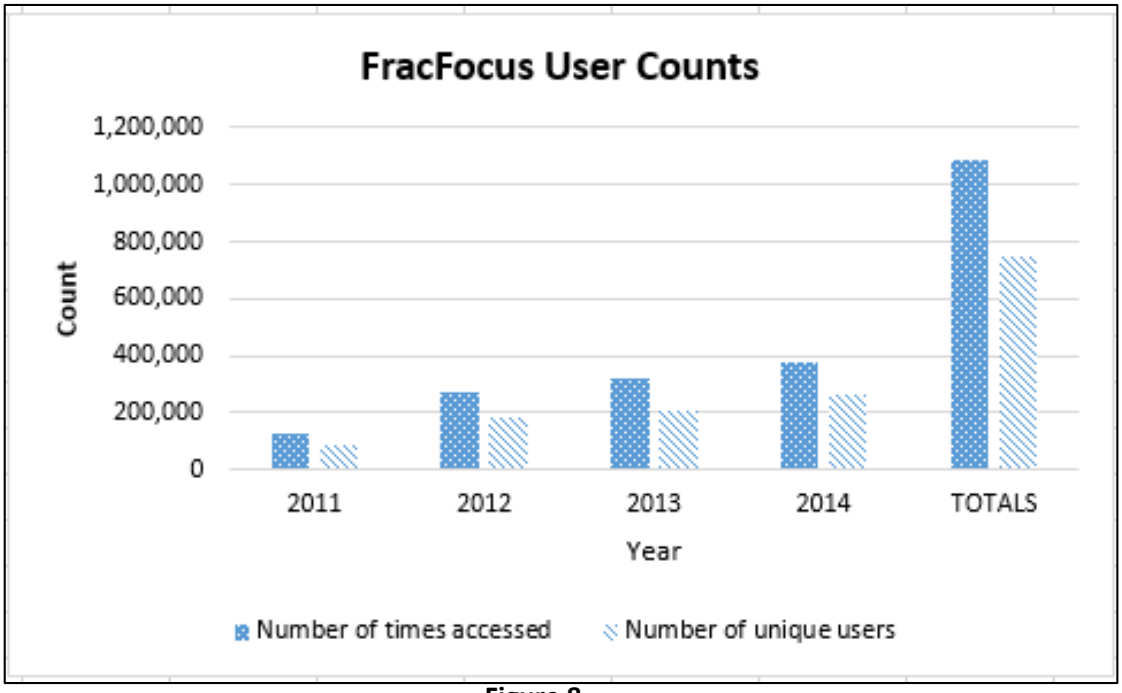

Figure 8

Discussion

States overall have a very positive view of FracFocus and are using it in their regulatory programs in robust and even novel ways. They overwhelmingly responded that the timing of

submissions is either quite good or not an issue, with no states expressing dissatisfaction with the time in which they are notified of submissions to the site. These findings directly contradict the opinion set forth in the Harvard Report regarding the timeliness of submissions. The Harvard Report concluded that "FracFocus does not notify a state when the site receives a disclosure form about a well in that state. Nor can most states readily determine when a disclosure is made" (Konschnik, 2013). It is not clear how the Harvard Law School researchers reached this conclusion regarding FracFocus, but it is not supported by the experience of the regulators.

The states also viewed the Registry's approach to identifying trade secrets positively, with no states objecting to the way FracFocus handles submission of trade secret information. The Harvard Report's critical view, claiming that FracFocus failed because it did not contain a "robust trade secret regime" (Konschnik, 2013), does not fit with the regulators' perspectives. In written comments, many states make clear that they never expected FracFocus to address the issue of trade secrets and the public's right to information because this was a responsibility of state law, not a failure of the chemical disclosure registry. Indeed, many fail to see how a national registry such as FracFocus would have the capability or the jurisdiction to address trade secret claims in the way that the Harvard Law School researchers appeared to demand. As the states surveyed were apparently well aware, each state has its own laws regarding what constitutes a trade secret and what procedural mechanisms for making or challenging a trade secret claim are available, as well as differing courts or administrative bodies for interpreting the law and ruling on trade secret disputes. This kind of "robust trade secret regime" is well beyond

the purview of a national chemical disclosure registry. As one state regulator succinctly wrote, "we have a trade secret process – that is not FracFocus' purview."

States also made no objections regarding the need for state specific forms. Some regulators indicated they often compared submissions to FracFocus with submissions made to the state to ascertain compliance. Other states made their own pie charts with the data that is available on FracFocus, but the lack of forms that are targeted to individual states was not an issue raised by the state regulators and did not appear to impact their generally positive view of the utility of the Registry.

Finally, the results of the survey indicate that FracFocus has provided an extra measure of accountability for operators, in that several states are using the site to double check submissions that are made to the state against submissions made to FracFocus, and are promptly following up with operators when compliance issues come to light. Some have even used information obtained from FracFocus to support enforcement actions. As one of the regulators effectively stated, "I feel like some companies feel as if reporting to the FracFocus website is a joke, but once they have to hear from me, they quickly understand that this is not a joking matter." State regulators are also downloading data from FracFocus and creating their own spreadsheets and graphics with data they deem important to their own state programs. States are using FracFocus features that allow oil and gas well inspectors to quickly access well information when they need it. Indeed, states are using FracFocus in ways perhaps not even dreamed of by its creators: to monitor earthquake issues or the illegal use of diesel fuel in fracturing treatments.

Conclusions and Policy Implications

Where the Harvard Report Went Wrong

The national attention received by the Harvard Report has surely been harmful to a serious effort to strike a balance between the needs of the public and regulators, and the property rights of oil and gas service companies. This dissertation work has demonstrated that far from being a "fail[ure]," FracFocus actually does an excellent job with respect to the very issues on which the Harvard Report expressed concern: in general, FracFocus delivers information on a timely basis, provides data on the crucial issues of the nature of the chemicals used in fracturing, and supports states in their efforts to enforce state specific chemical disclosure laws while providing a mechanism to identify and maintain trade secret protection to an acceptable degree. This work is the first comprehensive survey of state regulators and the first attempt to obtain a data-driven analysis of how FracFocus is being used and whether it is effective as a regulatory tool. The survey had a very high response rate for a study of this kind at 70% (Sheehan, 2001), increasing confidence in the results.

In the national debate regarding hydraulic fracturing, discussions are often driven by emotions rather than facts; the Harvard Report, a paper from a prestigious research university, was never subjected to peer-review and yet was well covered by the press, was used to inform the Department of Energy's Task Force Report on FracFocus 2.0 (USDOE, 2014a), and inevitably increased the heat of the debate without an underlying factual basis to do so. This is unfortunate because, as this research shows, websites like FracFocus are an important tool for regulators in the responsible development of domestic oil and gas resources and for keeping the public informed. At present, I am not aware of another chemical disclosure registry such as FracFocus which allows such easy access to information regarding chemicals used across an

entire industry and searchable by specific location. At least one regulator also noted the uniqueness of this registry: "Very few of [the state agency's] environmental programs have access to electronically available chemical data for the activities they regulate."

The use of FracFocus continues to increase every year. Additional oil and gas producing states and the federal government continue to adopt FracFocus as a legally required mechanism for the reporting of fracturing fluid information. Kentucky became the most recent state do so, with its law taking effect in June 2015, and Michigan's rules requiring the use of FracFocus took effect in March 2015. The U.S. Environmental Protection Agency used FracFocus data to generate certain state-level summaries on chemical data and water usage (EPA 2015b). EPA also is relying on FracFocus data to support its study on the impacts of oil and gas development on drinking water resources (EPA 2015b), the draft of which was released in June 2015 (EPA 2015c). Finally, in May 2014 EPA issued an Advance Notice of Proposed Rulemaking (ANPR) soliciting comments as to whether EPA should develop regulations under its Toxic Substances Control Act (TSCA) authority governing the reporting of chemicals used in hydraulic fracturing, including whether the FracFocus registry should be included in any proposed rule (EPA, 2014). The ANPR received over 235,000 comments that are currently under review by EPA.

FracFocus continues to evolve and has been responsive to changes suggested by the federal government, authors of the Harvard Report, and other stakeholders. The third version of the Registry, FracFocus 3.0, is expected to be released soon and will adopt many of the recommendations set forth in the Secretary of Energy Advisory Board (SEAB) report (Department of Energy, 2014b), including improved quality control and improved data and search functions (FracFocus, 2015d).

The results of the survey show how third party data collection sites such as FracFocus can provide considerable support to regulators, inform the public, as well as provide consistency to a regulated community that operates nationwide.

The data demonstrate that FracFocus is a strong regulatory tool that is being used by the majority of the largest oil and gas producing states to support their programs. The results of this work may be used to share information among states regarding additional ways to use FracFocus to augment existing regulatory programs. For example, the survey results indicate that states may be able to make more use of the water volume usage being reported to FracFocus. Indeed, water volume use in hydraulic fracturing operations is a critical component of potential impacts to transportation infrastructure, and this data source could be leveraged by local planners, as discussed in Chapter Three.

It is likely that states will continue to develop new ways to use the significant data available on FracFocus and it would be helpful for states to have the benefit of other states' efforts. The results of this work may facilitate such an exchange. As other oil and gas producing states consider how to manage chemical disclosure, FracFocus should receive serious consideration, not only for its chemical disclosure attributes, but for the varied beneficial uses that regulators (and potentially others) will continue to make of the available data. Operators and service companies often operate across state lines (some across many state lines) and consistency of disclosure obligations between states make accurate reporting more likely and lessens regulatory burdens. The data obtained in this study support the continued use of FracFocus.

CHAPTER III

ASSESSING IMPACTS TO TRANSPORTATION INFRASTRUCTURE FROM OIL AND GAS EXTRACTION IN LOCAL COMMUNITIES: A CASE STUDY IN THE MISSISSIPPI TUSCALOOSA MARINE SHALE OIL PLAY

Introduction

Oil and gas, like some other resource extraction activities, is unique among typical manufacturing contributors to the economy because of the decentralized location of the sources of economic activity – the well. When a major business, such as a factory or corporate headquarters, decides to locate in a county, town, or municipality, it is easier for state legislators to see the benefits of investing in surrounding infrastructure, and as a result many states are more willing to provide local and rural governments with transportation related grants or financial assistance programs designed to attract "brick and mortar" businesses. For example, Florida has developed an Economic Development Transportation Fund (the "Road Fund") which will give up to $3 million to local governments to improve public transportation for a specific company's new location or expansion at an existing location (Enterprise Florida, 2016). The Appalachia Regional Commission provides grants for access roads, rail spurs, and dock facilities (Appalachian Regional Commission, 2016) associated with business. Iowa has a Public Facilities Set Aside program that provides grants to counties and townships with less than 50,000 residents that includes roads and road maintenance for businesses that need the improvements to create jobs (Toyer, 2013).

However, in the case of oil and gas, it has proved more difficult in some states to convince state lawmakers to invest in transportation infrastructure and maintenance at the local level. Apart from issues of the separate jurisdiction over state and local roads in most states, some local officials surveyed in this work believed the lack of a central location (such as a new

factory building that would attract hundreds of employees and services to one location) makes it more difficult to convince some legislators to support the case for increased funding. Rather, oil and gas wells --- and the heavy trucks that service them -- tend to be spread out within a county, mostly dotting the rural landscape on private property, often not visible from public roads. This is especially the case in the Tuscaloosa Marine Shale (TMS) oil play in Mississippi, which does not have a history of the large-scale high-volume hydraulic fracturing and horizontal drilling that other communities have seen.

The data collected during this project supports existing knowledge that in home-rule states such as Mississippi, the roads most negatively impacted by traffic associated with high-volume hydraulic fracturing and horizontal drilling are those local and county roads that are outside of the federal or state system. State and federal highways are primarily maintained by a state's Department of Transportation and generally receive revenue generated by the gas tax and from the federal government. State and federal roads, unlike county and rural roads, are therefore generally built to support the high volume of heavy truck traffic that modern oil and gas development demands. Accordingly, truck traffic associated with hydraulic fracturing does not damage state roads as significantly as it impacts local roads. This presents a special bind for the counties or townships that are responsible for the rural roads: counties and rural communities have less money than the state to address maintenance and repair, often do not get a share of the fuel tax that the state receives to provide for roads, and yet their roads are the most severely impacted and far more in need of funding during oil and gas operations.

This chapter describes road impacts to rural communities, using the Tuscaloosa Marine Shale as a case study, and potential strategies to address these issues. Drawing from existing literature and the data gathered in my study of the counties in the Mississippi TMS, I present a

methodology that states and under-funded counties may employ to maintain local road quality if drilling dramatically increases in the future, as it is likely to do when oil prices or technological advances support renewed investment in the area. The current decline in drilling activity across the country presents an optimum time for counties, townships, and states to assess their approaches to road maintenance.

The Mississippi Tuscaloosa Marine Shale Oil Play

The Mississippi Tuscaloosa Marine Shale (TMS) is predominately a tight oil play located mostly in central Louisiana but also spans several counties in Southwest Mississippi (Figure 9).

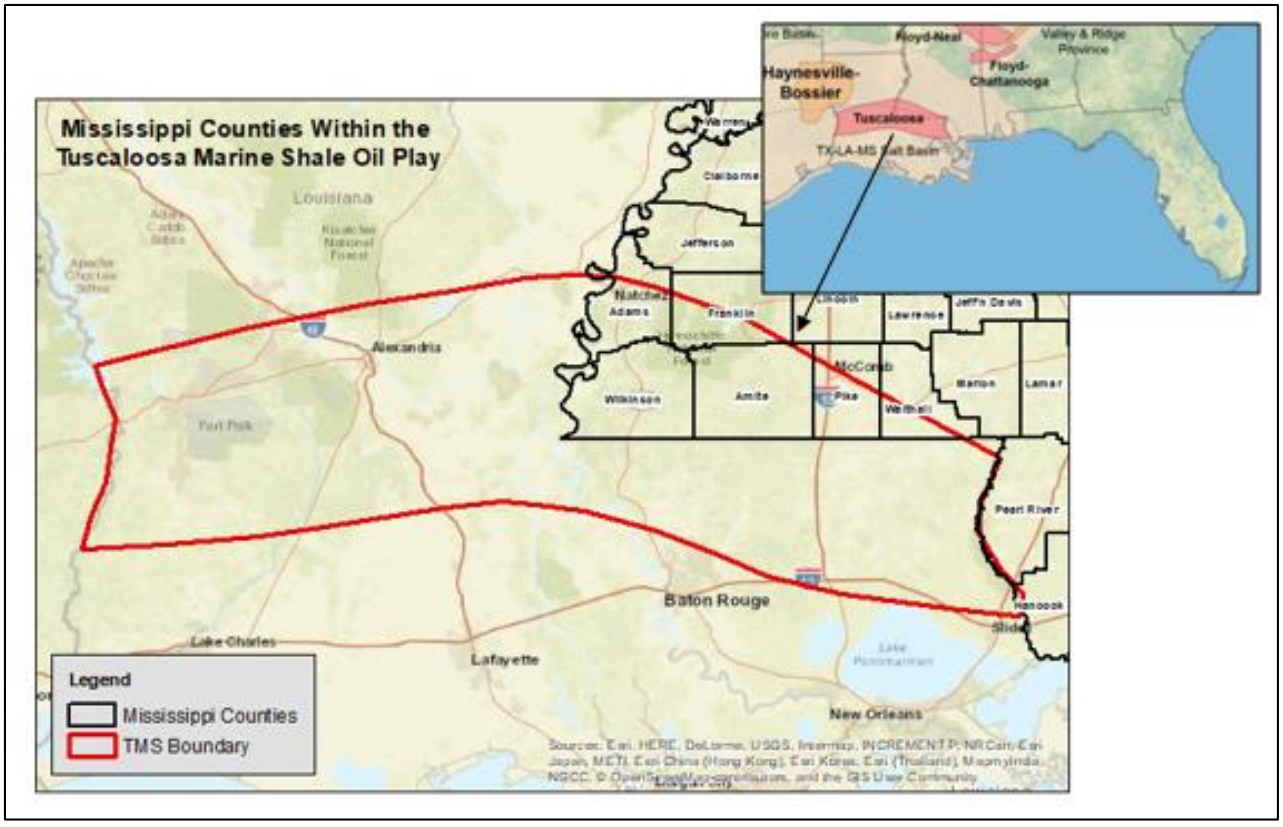

Figure 9. Boundaries of Tuscaloosa Marine Shale (TMS) oil play (red outline) and Mississippi counties within the TMS; inset of TMS location (labeled "Tuscaloosa") near Gulf of Mexico Coast

An oil or gas "play" describes a series of oil or gas fields in the same area that share similar geology (e.g., depth, geological characteristics, etc.). The focus of this research is on two

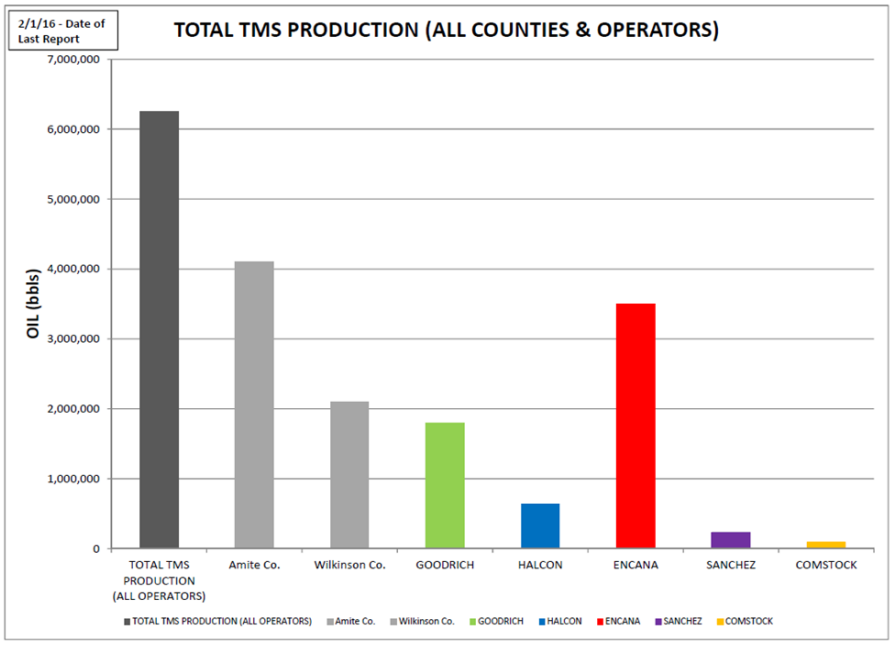

Figure 10. Total Mississippi TMS Oil Production by County and Operator. Source: Mississippi Oil and Gas Board

counties in Mississippi that have experienced most of the TMS drilling operations: Amite County and Wilkinson County. As of February 2016, the Mississippi TMS had produced a total of approximately 6,200,000 barrels of oil, with virtually all of that production occurring in Wilkinson and Amite Counties (Figure 10).

In 2013, the State of Mississippi took steps to attract large-scale horizontal drilling in the TMS by reducing the severance tax on oil (through 2018) from 6% to 1.3% for horizontal wells (Mississippi Code Annotated, § 27-25-503(1)(c) (2016)). However, while state governments seek to attract oil business, there have been few major efforts at the state level to pro-actively address the impacts to rural roads that will accompany any significant increase in drilling in the TMS. Any efforts that were underway largely stopped when drilling activities slowed given the drop in oil prices.

Currently, Mississippi's proven reserves of oil are considered small in comparison to other U.S. states (Figure 11). However, there are studies suggesting that the TMS may hold as

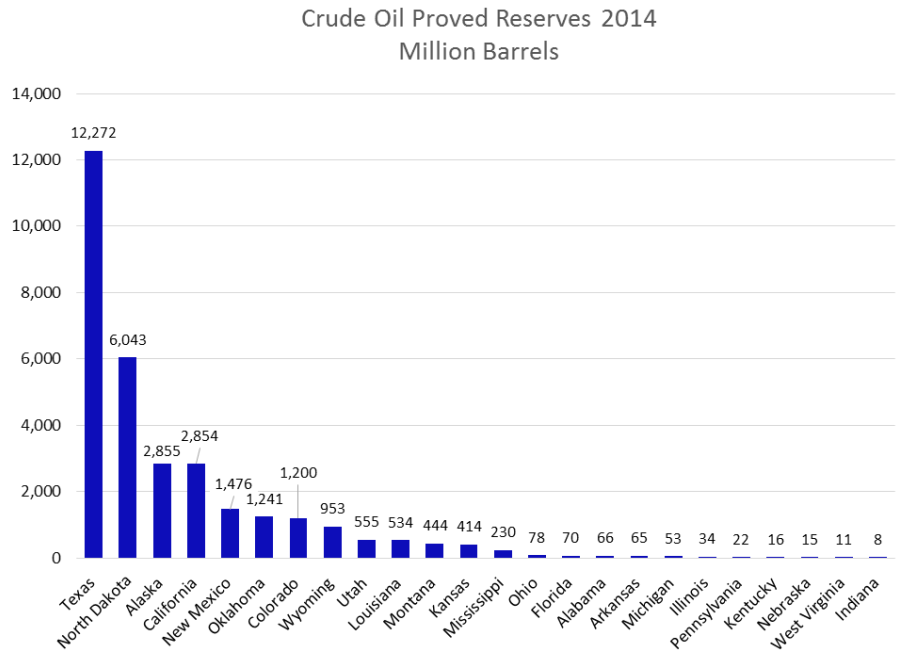

Figure 11. Proven Oil Reserves by State. Data compiled from the U.S. Energy Information Administration

many as 7 billion barrels of recoverable oil (John, 1997), or as many 9.1 billion barrels (Amelia Resources, 2014), larger than the Baaken in North Dakota. Accordingly, the TMS has tremendous growth potential (Chacko, 2005).

Several converging factors also suggest that Mississippi may experience a boom in oil production in the future if oil prices rise sufficiently to support renewed investment. These include the state's attractiveness to oil companies from a barriers perspective, the low severance tax on horizontal wells, the proximity to major downstream processing facilities, and the potential oil resources. In surveys of petroleum executives, Mississippi has consistently ranked among the states with the least barriers to investment, placing most recently in the top three world-wide small-reserve jurisdictions to invest in, the top five areas in the world for "most

attractive for investment in petroleum exploration and development," and the top ten U.S. states for oil investment generally (without regard to reserve holdings) (Jackson, 2015).

The TMS was selected as a case study in order to better understand impacts from energy development and to develop a methodology that rural counties and townships can use to begin to address those impacts. The TMS has not been the subject of most of the recent research into transportation impacts (so it has more potential to benefit from this project), yet it potentially holds huge resources and at the height of the drilling "boom" counties in the TMS were already beginning to see considerable impacts to roads.

Assessing Transportation Impacts of Hydraulic Fracturing

Data Collection

To gather data on estimating impacts to roads from oil and gas development and identify best practices for rural communities to address those impacts, a literature review of the primary studies was first conducted. Numerous studies have addressed the impacts of oil and gas development on transportation infrastructure (Bierling, 2014; Nagle, 2011; UGPTI, 2010; UGPTI, 2014; Belcheff and Associates, 2010; Quiroga, 2012; NYEIS, 2015; Brown, 2013; Prozzi, et al., 2011; RPI Consulting, 2008; Banerjee, et al., 2014; Hefley, 2011; Randall, 2010; Nagle, 2011; Ksaibati, 2011; Huntington, 2013; Mason, 1982 & 1983; Abramzon, 2014; Rahm et al.; Muehlenbachs et al., 2013; Gilmore, 2014; Wilke, 2011; McCarthy, 2015). Many of these studies provide important data, impact equations, and methodologies; but, to implement, often require sophisticated data on local road conditions using video or other monitoring equipment or personnel that may not be available in rural communities.

To develop a methodology to address this gap, I attended meetings of the "Transportation Pooled Fund Project: State Responses to Energy Sector Developments," a multi-

state effort funded by eight state Departments of Transportation (DOT), which included meetings and roundtable discussions among State DOT representatives from Montana, Pennsylvania, Ohio, Texas, North Dakota, Louisiana, Washington, and California (Transportation Pooled Fund Program, 2015. I conducted follow up interviews with several of these states.

To better understand transportation impacts in the TMS, field research was conducted to observe the impacted roads in the TMS, local property owners with leased wells on their land were interviewed, along with interviews of local officials in Pike, Amite, and Wilkinson counties. The research also included interviews with members of the County Boards of Supervisors with responsibility for roads, attorney advisors to the Board of Supervisors, port officials, and county economic development authorities. Data and information was obtained from the Mississippi Oil and Gas Board (MOGB), and officials were contacted from the Mississippi Department of Transportation (MDOT) and the MDOT Office of State Aid Road Construction. County road ordinances also were reviewed, which had been developed in response to the initial "boom" that the TMS began to experience before oil prices dropped and drilling slowed substantially. All interviewee's names or positions were kept confidential to respect privacy and confidentiality.

By combining data from different sources, I was able to develop a methodology that can be used by local planners in underfunded communities as a screening tool to convey important information about the magnitude and potential locations of impacts from increased drilling. These include data on water volumes used to fracture wells in a particular area obtained from FracFocus.org, data on the condition of local bridges, data on county road segments and the government entity responsible for maintenance on that segment, data identifying the locations of existing and potential well sites, and data identifying the locations of disposal wells where

flowback and produced water will likely be trucked from well sites. These data can be combined spatially to assess and quickly convey to planners the areas of a county or specific road segments that may see more heavy truck traffic than others, and therefore which areas or roads may warrant the more detailed approaches discussed in the literature to quantify impacts to roads. This approach also may assist planners in mitigating impacts by reducing truck loads by, for example, encouraging surface or ground water use that can be piped (rather than trucked) to the well site, or designating alternate routes.

Study Synthesis

Much of the important work governing oil and gas development's impacts on transportation infrastructure is dispersed and underutilized by those who may most benefit from it. Other relevant work exists outside of transportation literature (such as in environmental impact statements) and therefore is rarely accessed by transportation professionals but could be of substantial benefit. This project synthesized the available work into an easily accessible format so planners can quickly discern needed and relevant information.

Estimating truck trips per well

As Abramzon (2014) has noted, estimating road damages is well understood and "relatively straightforward once full information is obtained regarding truck trips, roadway types and roadway reconstruction and maintenance costs." County and local planners generally have data regarding their roadway types and maintenance costs; however, estimating the number of truck trips associated with wells in a particular area has been more difficult but is arguably the most critical data needed to accurately assess impacts. The number of truck trips required varies depending on factors such as the depth of the well, the type of well (horizontal or vertical), the

geology of the formation, types of drilling or fracturing technology used, and the water volume use per well and how that water is transported to the well (by truck or pipe) (Quiroga, 2012).

These data can be difficult to obtain in rural communities, but there are studies now from which planners can make reasonable estimates of truck trips, which I have collected and summarized in Table 1, with results ranging from 1,184 to 3,399 trucks. Many of the study estimates in Table 1 also contain specific break downs of truck numbers by material moving to and from the well. Patterson & Maloney have estimated the number of trucks leaving the well associated solely with the movement of waste products (Patterson & Maloney, 2016). However, the product that generates by far the largest number of truck trips is water (water is used to hydraulically fracture the well and is a product of the well along with oil or gas). Different formations will result in varying amounts of water that will need to be trucked to or from the well.

Table 1. Estimates of Number of Truck Trips Required for a Single Hydraulically Fractured Well

Estimates of Total Truck Trips Per Well (hydraulic fracturing and horizontal drilling)		
Source	Number of Truck Trips	Assumptions
Upper Great Plains Transportation Institute (UGPTI), 2010 (9).	2,024	Estimate is total round trips (1,012 one-way loaded trips). Estimate is well-pad preparation through completion of the drilling and hydraulic fracturing operations only.
Upper Great Plains Transportation Institute, November 24, 2014 (10).	2,300	Estimate is total round trips (1,150 one-way loaded) for drilling / fracturing related trips.
Quiroga, C., Fernando, E., and Oh, J. 2012. Texas Transportation Institute (7).	1,184	Estimate assumes 187 one-way truck loads during well pad and well construction, 997 truckloads during hydraulic fracturing (over 25 days) and assumes 3.8 million gallons of water used for fracing. (This estimate does not include an

		estimated additional 88 truckloads per year for maintenance and 997 trucks every 5-10 years for re-fracing)
Nagle, J. (2011).	3,399 (this data was used for the New York state Environmental Impact Assessment and therefore contains the same estimates).	Assumes 1,148 heavy trucks and 831 light trucks in early well pad development; 625 heavy trucks and 795 light trucks in peak well pad development with some water moved by pipelines.
Belcheff and Associates 2010 (12).	1,528 – 1,948	Range differs with 4 case scenarios depending on water source and handling of produced and flowback water.
New York State Department of Environmental Conservation, 2015 (13).	1,773 heavy trucks (one way loaded) 1,626 light trucks (one way loaded)	Estimates are for horizontal wells in the Marcellus

The American Association of State Highway and Transportation Officials (AASHTO) has developed generally accepted equations to estimate load impacts based on an expression of "Equivalent Single Axel Loads" or ESAL (AASHTO, 1993). With knowledge of potential truck trips on a road segment, the remaining life of a particular road can be estimated in total number of ESAL for which the road was designed – once that threshold number of ESALs has occurred, the road will require reconstruction (Abramzon, 2014)). For example, using data in Pennsylvania, Abramzon estimated increased road costs per well to be approximately $13,000 - $23,000 (Abramzon, 2014). Wilke (2011) has additionally proposed a non-resource intensive seven step process by which local governments may estimate impacts to local and rural roads.

Study synthesis of oil and gas development impacts to transportation infrastructure

Interviews with state DOT representatives indicated that even in areas of the country accustomed to heavy truck traffic from activities such as logging, agriculture, or even conventional, vertical well development, the transportation impacts were manageable until the relatively recent increase in drilling

with large scale hydraulic fracturing and horizontal drilling. As a result, a plethora of studies and reports regarding estimating impacts to transportation infrastructure have emerged in recent years.

I conducted an extensive literature review of available studies regarding impacts to roads from oil and gas development, with a particular emphasis on studies that could best be utilized by small county, town, or municipal governments. These studies come from peer-reviewed journals, major transportation institutes, consultants, conference papers, and environmental impact statements. In Appendix B these twenty-one studies are organized with summary discussions of the methods and important findings so that planners may easily review the available work while assessing their utility given local circumstances and needs. Our attendance at meetings of the "Transportation Pooled Fund Project: State Responses to Energy Sector Developments," revealed that the information contained in these studies has been underutilized; collecting and synthesizing the information and data in this way may better help inform future decision making, especially in rural communities and on low volume roads.

Water Volume

The amount of water used in a fracturing job and how that water is transported to and from the well site is arguably the largest predictor of heavy truck trips and consequent road impacts (Belcheff and Associates, 2010). It is therefore important for any community concerned about road impacts to better understand water use. Water data used in the fracturing process is now collected as part of mandatory and voluntary reporting to FracFocus.Org and as a result can be more easily accessed by planners than in the past. FracFocus.Org is a hydraulic fracturing chemical disclosure registry established to provide the public with information, on a well-by-well basis, of the chemical constituents used in the hydraulic fracturing process, and is discussed more fully in Chapter Two. Many states have now adopted mandatory reporting to

FracFocus.Org for hydraulic fracturing operations including Mississippi (Dundon, 2015). Although FracFocus.Org is primarily considered a chemical disclosure reporting site, many transportation planners may not be aware that the forms submitted to FracFocus contain information regarding the total volume of water used to hydraulically fracture a well. Accessing FracFocus data is also free, and can be an important resource for local planners.

I mined data from FracFocus.Org for every available TMS well in Wilkinson and Amite counties. I recorded the water volume used per well by well name, and then compared these with the well names in the data obtained from the MSOGB on currently producing TMS wells to assure I only included well and water data on the wells located in the Mississippi TMS. Using this process, I was able to verified that fifty-two of the fifty-four TMS wells listed with the MSOGB were also listed on FracFocus.

Roads and Bridges

To obtain bridge condition data for Wilkinson and Amite counties, I used GIS shapefiles from the National Bridge Inventory (NBI). The NBI ranks bridges according to a rating scale for various bridge elements. Three of these elements, the superstructure, substructure, and deck are the primary structural components of a bridge (FHWA, 1987), and are most indicative of the ability of the bridge to withstand increased heavy truck loads. The NBI's rating scales for deck, superstructure and substructure conditions are the same (Items 58, 59 and 60 in the NBI elements). If any one of these elements has a low rating, the bridge may be vulnerable if heavy truck loads increase. The NBI rating scales for superstructure, substructure, and deck are the same and are indicated in Table 2.

Table 2. National Bridge Inventory rating scales for superstructure, substructure, and deck conditions.

NBI Rating	Rating Description
N	NOT APPLICABLE
9	EXCELLENT CONDITION
8	VERY GOOD CONDITION - no problems noted.
7	GOOD CONDITION - some minor problems.
6	SATISFACTORY CONDITION - structural elements show some minor deterioration.
5	FAIR CONDITION - all primary structural elements are sound but may have minor section loss, cracking, spalling or scour.
4	POOR CONDITION - advanced section loss, deterioration, spalling or scour.
3	SERIOUS CONDITION - loss of section, deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present.
2	CRITICAL CONDITION - advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.
1	"IMMINENT" FAILURE CONDITION - major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put it back in light service.
0	FAILED CONDITION - out of service; beyond corrective action

Bridges rated as "N" (which were most often culverts) were excluded, and by reference to design loads in Item 31 of the NBI, I excluded all bridges in the study area not designed for heavy truck traffic such as pedestrian, railroad, or "unknown" bridges. The bridges were then ranked using the lowest of the NBI ratings for deck, superstructure, and substructure conditions for each bridge to obtain a final bridge condition score. Three rating colors were utilized for purposes of mapping these bridges and displaying their conditions, as set forth in Table 3. Bridge colors displayed in Figures 13-15 correspond to these condition ratings.

Table 3. Color Display Scale for Final Rating Score

Bridge Point Color	Range of Final Bridge Condition Score	Condition ratings scale (from NBI)	
Red ●	0-4	0 = failed	5 = fair
Yellow ●	5-6	1 = imminent failure	6 = satisfactory
Green ●	7-9	2 = critical	7 = good
		3 = serious	8 = very good
		4 = poor	9 = excellent

Dividing the bridge conditions into three color-coded rating levels allows planners to more easily assess priorities, and the division points were chosen to most accurately reflect the level of risk presented by the bridge if heavy truck traffic substantially increased. Bridges that ranked below "Fair" (score of 4 or lower) could reasonably be assumed to be at the highest risk of impacts if major increases in heavy truck traffic occurred and should therefore generally be given priority by planners. Bridges ranked "good" or better (score of 7 and above) generally could be expected to have a greater ability to withstand increased truck traffic. Bridges colored yellow (scores of 5-6) are considered "fair" or "satisfactory" and fall within an area of caution if truck traffic increased.

For road data, members of the MDOT and MDOT's Office of State Aid Road Construction were interviewed. MDOT provides funding for some county roads. I also interviewed county government officials in Wilkinson, Amite, and Pike counties to better understand local funding for road repair and maintenance. Functional class data from MDOT in the form of GIS shapefiles were obtained, which were extracted by county. For Amite and Wilkinson counties, I selected road segments by the entity responsible for maintenance and repair, and color-coded these segments to distinguish the responsible county government.

Operator Survey Data

With the rapid increase in hydraulic fracturing in the early 2010's, many rural communities faced urgent challenges to address road impacts. Road ordinances were one approach that some townships across the United States adopted, including counties in Mississippi. Amite County adopted "The Heavy and Oversized Load Regulations Ordinance for the County Roads and Bridges of Amite County, Mississippi", which took effect July 1, 2014. A gap in the literature exists with respect to operator's perspectives of the effectiveness of various approaches. Accordingly, I conducted an anonymous survey of oil and gas operators in the Mississippi TMS. The survey was developed using Qualtrics software and a copy of the survey questions and answers appears in Appendix C. The survey was sent to all five operators in the Mississippi TMS, which are listed in Figure 10. To protect individuals' privacy, the survey was anonymous in that no company or individual name was linked to any particular survey response. Prior to sending the survey by email each company was contacted by phone using numbers listed on drilling permits filed with the Mississippi Oil and Gas Board. I was able to personally speak with four of the five companies. The four companies reached by phone indicated a willingness and desire to participate in the survey, but several companies had trouble reaching the correct personnel to prepare the response given the slow-down in drilling in the year prior to the survey, which especially affected drilling in the MS TMS. For example, one company informed us that some of the individuals with the best knowledge for our survey were no longer with the company.

There are only five operators in the TMS, and two of them responded to the survey. As noted, the dramatic slow-down in drilling in the area is likely the reason that only two companies responded, especially because four companies during phone interviews indicated a desire to

provide feedback but needed to locate the individuals who had been personally involved in addressing these issues in the local area when the "boom" in drilling occurred. Although the two companies that responded are likely representative of MS TMS operator perspectives because all the operators share common goals and operations, share utilization of county roads, and are all subject to the same local ordinances, further research regarding operator perspectives across the country is needed.

Results and Discussion

Water Volume Used in Hydraulic Fracturing in the MS TMS

One of the most surprising findings of this work was that the water volumes being used in the TMS for hydraulic fracturing are dramatically larger than the national average, which has serious implications for road impacts. A preliminary draft of a U.S. Environmental Protection Agency (EPA) study concluded that the national median volume of water used during hydraulic fracturing operations at a single well is 1.5 million gallons (EPA, 2015), but this estimate includes vertical wells, which typically use less water than horizontal wells. Looking only at hydraulically fractured horizontal oil wells, a recent study found the national median water volume is approximately 4.0 million gallons per well (Gallegos, et al., 2015). By contrast, I found that the median water volume used to fracture an oil well in the TMS is 11.9 million gallons, nearly three times the national median (Figure 12). Figure 12 also shows the range between the maximum and minimum volume of water used per well.

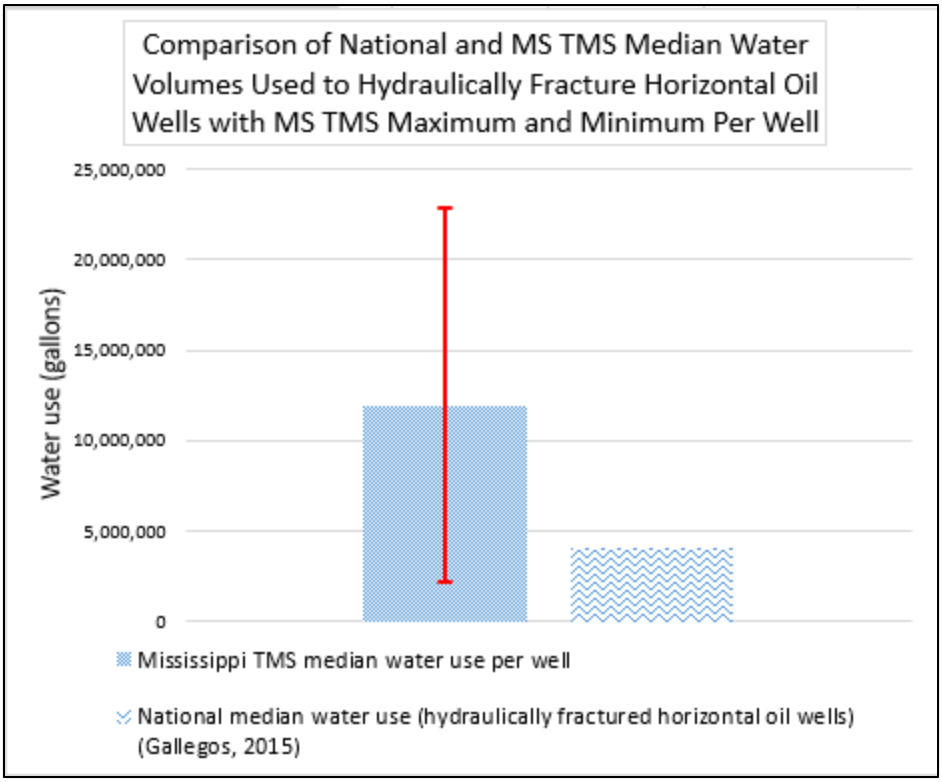

Figure 12. Comparison of median water volumes used to hydraulically fracture an oil well in the Mississippi TMS and nationally. Red bar indicates maximum and minimum water use per well.

This finding is significant because water management practices (such as piping rather than trucking fresh water to well sites), are the most important approaches to mitigating road impacts in rural communities, especially where per-well water use is so high. Factors that influence the volume of water needed tend to be local in nature, such as the geology of the formation and the technology used at the well (Kuwayama, et al., 2015), so this data is especially important to local transportation planners.

Even if all the fresh water used in the fracturing process in the MS TMS is piped to the well (which it is not), EPA estimates that 5-75% of this water will return to the surface as flowback water and must be managed (EPA, 2015). In Mississippi, and in many other states, all of this flowback water is being trucked, along with produced water, to SWD wells for disposal.

If only 10% of the median water used in a horizontal TMS fracturing job flows back to the surface for disposal, approximately 1.2 million gallons would be transported in almost 200 tank trucks (assuming 6,000-gallon truck capacity), each weighing upwards of 88,000 pounds over a matter of days or weeks (Wilke & Harrell, 2011).

Accordingly, water should be one of the first areas assessed to address road impacts and important information is now available from FracFocus, which is not yet being used by transportation planners. Planners could also use the available data to compare water volumes used in emerging plays in their area to existing plays to better anticipate how much additional traffic may be associated with an emerging play as compared to what a community may be already experiencing.

Methodology to Assess Projected Areas of Impact

Understanding the location of permitted well sites enables a better assessment of which roads may experience increased truck traffic and the potential magnitude of those increases, yet our findings indicate that local planners are often not aware of or utilizing information in this way. Combining spatial data regarding the location of: 1) producing and permitted wells; 2) underground injection wells where produced and flowback water from wells will be trucked for disposal (SWDs); and 3) county roads and bridges with indicators of bridge conditions, can quickly inform planners of which road segments or bridges may experience an increase in heavy truck traffic and where more detailed analysis of vulnerability to the increased loads may be warranted.

I assembled these data for both Wilkinson and Amite counties; Figure 13 is an example of the spatial results compiled for Amite County. County roads are indicated in purple and are

the responsibility of counties to maintain and repair. State roads are indicated in black and are built to higher standards with more funding for repair.

Figure 13 shows that in Amite County, the vast majority of the prospective, permitted, and currently producing TMS wells are in the southern half of the county. In Wilkinson County (not shown), the southeastern portion of the state has more concentrated well activity (both currently producing wells and potential wells based on the locations of permitted wells). In Amite County, the SWD wells tend to be concentrated in the northeastern and southwestern parts of the county (Figure 13), whereas in Wilkinson County SWD wells are both more numerous and more dispersed throughout the county, with clusters near the Mississippi River on the western border and in the northeastern part of the county. Accordingly, routing trucks to particular SWD wells may be one method to mitigate road impacts. Planners can also take into account general

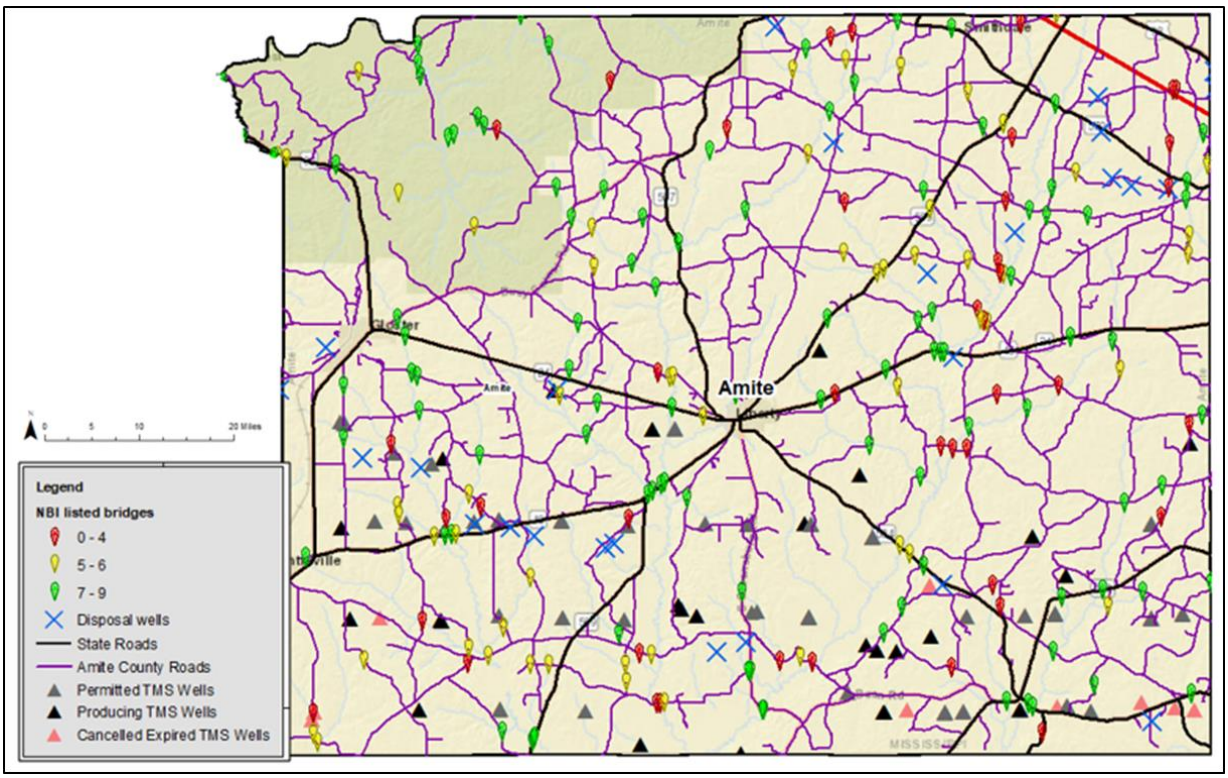

Figure 13. Amite County, Mississippi; Active and potential oil well sites, waste water disposal wells, county and state roads, and bridge conditions.

directional flow of oil and water leaving a well to better understand what routes may be most impacted. Water will be going to the SWD wells, but oil will often be going to pipelines, ports, or trucked directly to refineries on the nearby Gulf Coast.

This methodology can also aid in identifying areas where the quickest route to a state road (which operators seek for higher speeds and better roads) is one which involves traversing a bridge that may not be capable of withstanding increased truck loads (Figure 14), or areas where producing and permitted wells indicate a potential for future growth but coincide with a substantial number of vulnerable bridges (Figure 15).

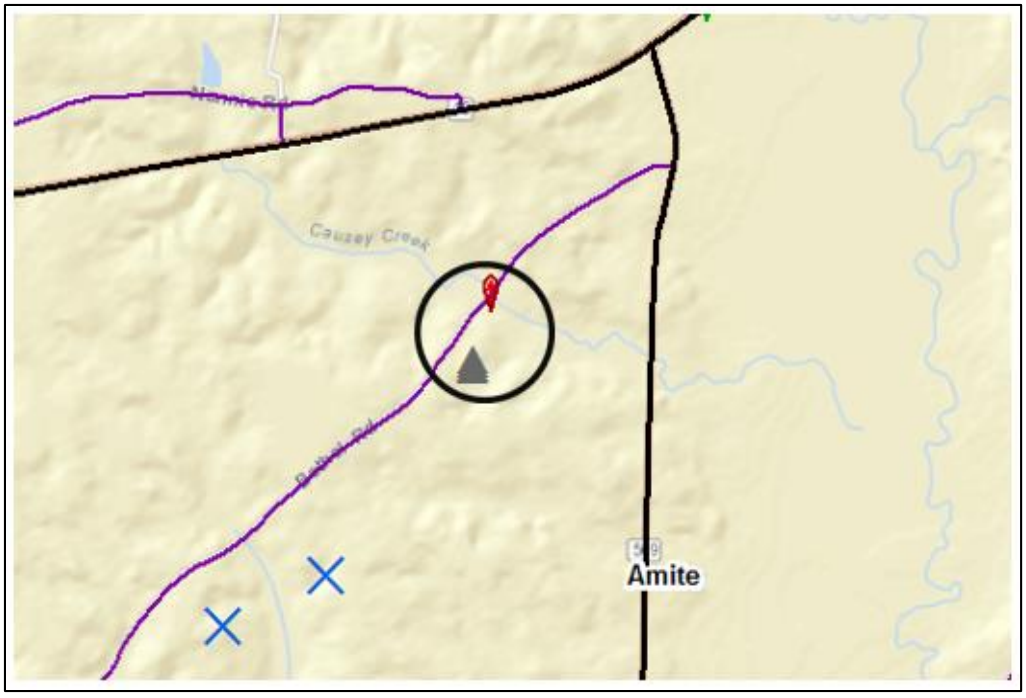

Figure 14. Amite County prospective well locations (gray triangles shown in circle) where shortest route to a state road requires travel over sub-standard bridge.

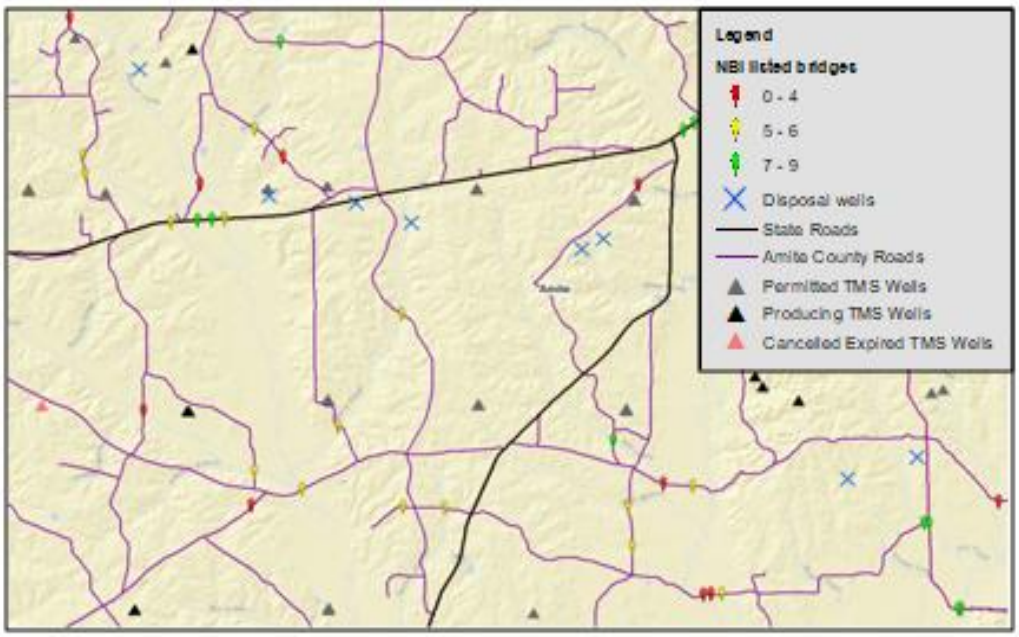

Figure 15. Amite County area with significant numbers of potential or already producing wells along county roads with numerous vulnerable bridges.

Planners can quickly extrapolate the damage they may face if each permitted or potential well (denoted by pink or gray triangles) represents an additional 2,000 – 3,000 heavy trucks on the nearby county roads and bridges. Although, with respect to roads, a baseline assessment of current pavement conditions is an important component of understanding what impact any increase in truck volume will have (NYDEC, 2015; Huntington, 2013; Wilke & Harrell, 2011), local governments with limited resources often must prioritize repairs and maintenance rather than planning. Understanding what routes and bridges are likely to be most impacted is a critical first step that can serve to better direct scarce resources and develop response strategies. If information of well development is communicated from the oil and gas authorities to those with responsibility for local roads early in the process, local and rural planners may have more time to analyze potential impacts to roads around a particular well site and react. For example, if planners had the information demonstrating the location of the wells and the deficient bridges as

illustrated by Figure 14, planners could restrict truck traffic to certain routes based on the locations of vulnerable bridges.

Local governments with this type of advance information would also have more of an opportunity to work with operators to achieve results desired by both the operator and the local government (passable roads and bridges). For example, the local government could meet with the well operator in Figure 14 and discuss whether the operator could contribute to bridge repair or whether that bridge should be closed to trucks. The local government would thereby have at least the opportunity to demonstrate the benefit to the operator of sharing the cost of a particular bridge repair.

With respect to bridges, it is also critical to understand the current load carrying capacity of the bridge. As one DOT representative cautioned during this work, it only takes one vehicle over the weight limit for the bridge to fail. Although truck volumes pose substantial risk to road and pavement integrity, the overweight trucks pose one of the biggest threats to the bridges' structural integrity. A detailed understanding of local bridge load carrying capacity and the weights of the trucks that will be traversing them is critical to a local government's ability to plan.

Operator Survey Results

Abramzon has identified three primary approaches that local governments (city, county, or state) across the country have taken to address impacts to roads from rapid energy development (Abramzon, 2014). These include taxation or fees, regulations (e.g., weight limits), or upgrading infrastructure. Amite County, Mississippi adopted a road ordinance which requires a permit for any vehicle loads that weigh greater than 18,000 pounds per axle or with a gross weight over 58,000 pounds. There is no charge for the permit, but it enables county officials to

monitor which companies are operating on particular routes, making enforcement easier if there is damage on a road segment. The ordinance requires the operator to inspect the existing conditions of their proposed routes, but makes the operator responsible for repairing the road to a passable condition if any permit holder's vehicles cause the road to become impassable or "weakened," even if the road was already in bad condition (Amite Ordinance, 2014). Interestingly, the oil company must conduct or arrange for the repair work, not the county. Counties and towns across the country have taken similar approaches (McCarthy, 2015).

Although there have been a substantial number of studies examining these approaches and their effectiveness from the local, city, or state government perspective, there is a gap in the literature regarding any studies or surveys directed to the regulated community – the oil and gas operators that are subject to these approaches. Accordingly, I surveyed the five operators in the MS TMS as to their view of the TMS county road ordinance. The survey questions were open ended and the results are reported in Appendix C. Names and any identifying information have been removed to protect privacy. Although only two of the five companies were able to respond to the survey, the results are likely indicative in the area and, although more research is needed, serve as an important first step to including operator perspectives in the literature.

The results reflected in Appendix C are consistent with reports of operator perspectives given by some state DOT representative participants in the Transportation Pooled Fund Project and, although the small response size should be noted, the comments may be considered by planners as approaches to road maintenance are adopted. In many states, operators are willing to pay for the excess damage they cause, but are often asked to pay more than what they see is their fair share if the roads were not maintained previously or damage cannot be fairly attributed to their use.

Conclusions

Rural governments could benefit from a spatial analysis that utilizes the locations of permitted and existing wells as a proxy for understanding where development is likely to continue and therefore what routes and bridges may be most vulnerable to increased heavy truck traffic. Figure 16 summarizes the methodology for identifying roads and bridges most likely to be impacted by increased energy development. Knowledge regarding the volume of water used per well in a locality is especially essential for planners to reduce truck traffic by focusing on water management practices, such as piping fresh water to wells or treating and disposing of waste water on site. Recycling water on site is also beginning to emerge as a useful strategy. Operators with several wells can use the flow back water from one well to hydraulically fracture nearby wells, reducing the amount of freshwater that must be trucked to a well site (Arthur, 2014b). Figure 17 summarizes a method by which planners can access and use water volume data to better assess impacts to transportation infrastructure. FracFocus is a new and important source of data regarding water volumes that local planners could utilize. For underfunded local governments, these are relatively small investments that could provide important benefits.

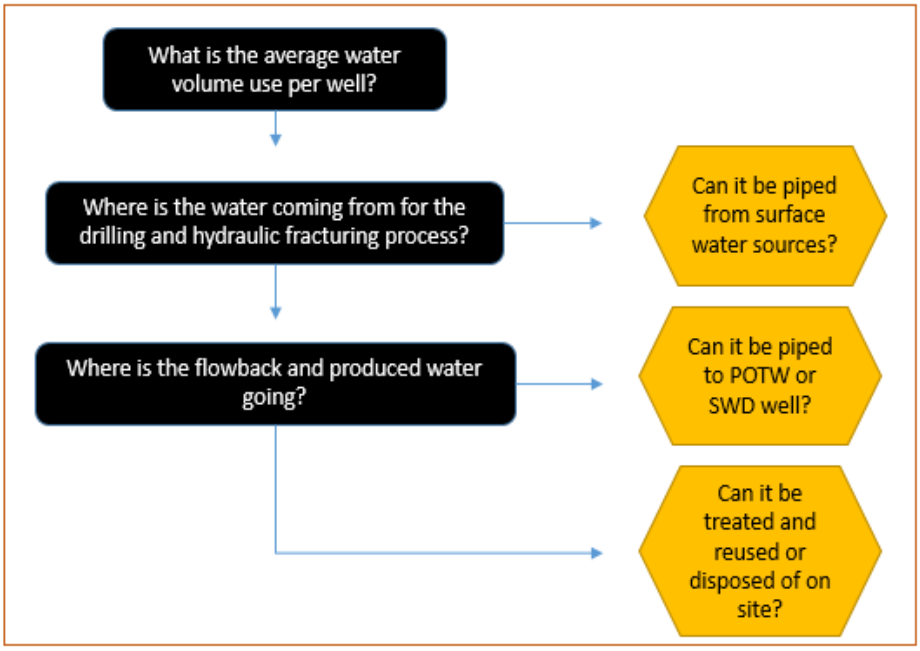

Figure 16. Using knowledge of water volume use and transport to reduce truck traffic on local roads

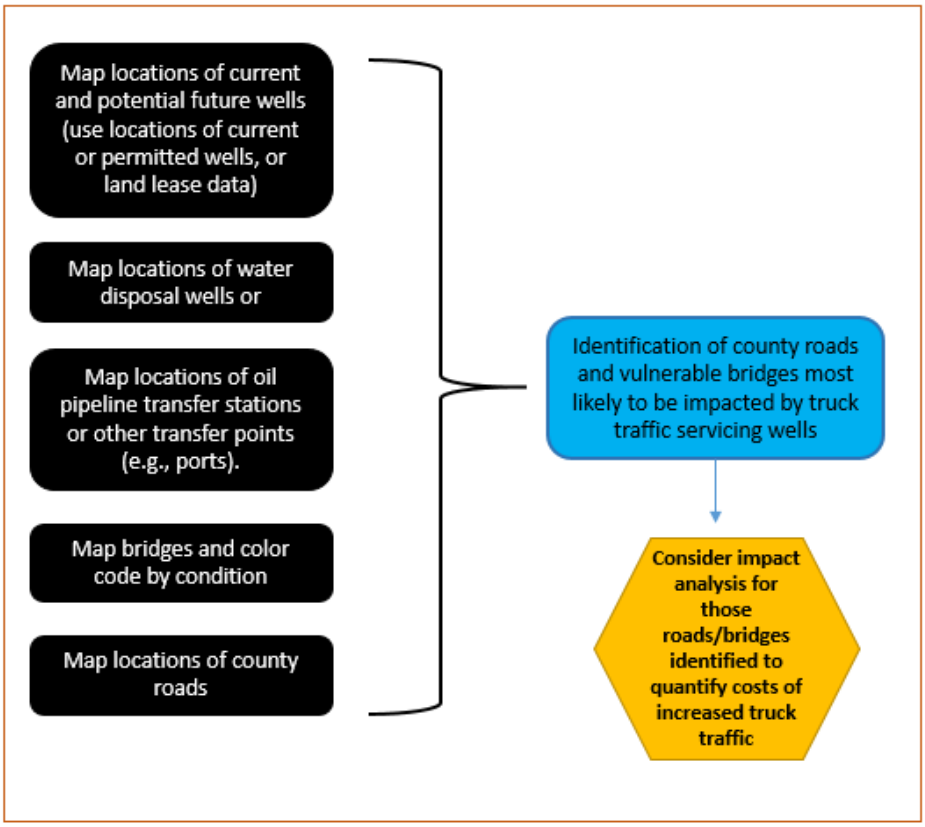

Figure 17. Method for identifying roads and bridges most likely to be impacted by increased energy development.

States – especially poor states such as Mississippi – could be doing more to offset the significant burden to local roads that high volume hydraulic fracturing and horizontal drilling can bring to rural areas. Roads are expensive and counties are generally not funded sufficiently to maintain roads beyond the "farm-to-market" types of trucking activity for which their roads were originally designed. Access to well sites is critical for a robust energy sector, and where states seek to encourage responsible development of these resources to promote economic growth, states should direct funding at levels sufficient for local governments to provide adequate infrastructure.

One of the most salient factors observed during this project as to whether a state DOT was satisfied with the approach to local road maintenance in high-drilling areas was the quality of the relationship with industry. In states where the DOT saw the relationship with industry as collaborative, companies appeared more willing to compromise and work with states and towns to assure roads were maintained adequately. States that reported a negative relationship with industry also reported difficulty in maintaining local roads. This finding is based on oral interviews and round table discussions with state DOT participants in the Transportation Pooled Fund Program; however, more work is needed to contribute operator and state DOT perspectives to the literature and better understand synergies between these two stakeholder groups that reduce road impacts and promote responsible development of oil and gas resources.

CHAPTER IV

REGULATORY AND PRIVATE APPROACHES TO ADDRESSING IMPACTS TO TRANSPORTATION INFRASTRUCTURE FROM OIL AND GAS OPERATIONS IN RURAL COMMUNITIES: A POLICY APPROACH FOR LOCAL PLANNERS

Introduction

The role of local planners across the country can vary, but they are often – especially in rural communities – unpaid, volunteer or elected positions with little in the way of support staff or technologically advanced equipment. With respect to the transportation system, these local planners are generally responsible for the maintenance and upkeep of local and rural roads, with varying degrees of financial support from the state to do so. While federal and state highways are generally built to accommodate heavy truck traffic, local and rural roads are more often designed for agricultural, "farm to market" types of loads and, as recent experience has shown, have been unable to withstand the intense heavy truck traffic that modern oil and gas development necessitates. For example, one study estimated 3,700 - 4,400 truckloads needed *per year* for cattle shipments, which is close to the number of truck trips occurring *over a matter of weeks and months* during some well development (Bai, *et al.*, 2010).

With the rapid rise in drilling across the country that began in the mid-2000s, many rural communities faced substantial challenges maintaining their road infrastructure. Figure 16 illustrates the dramatic increase in drilling over a relatively short period, providing little time for local planners to develop effective strategies.

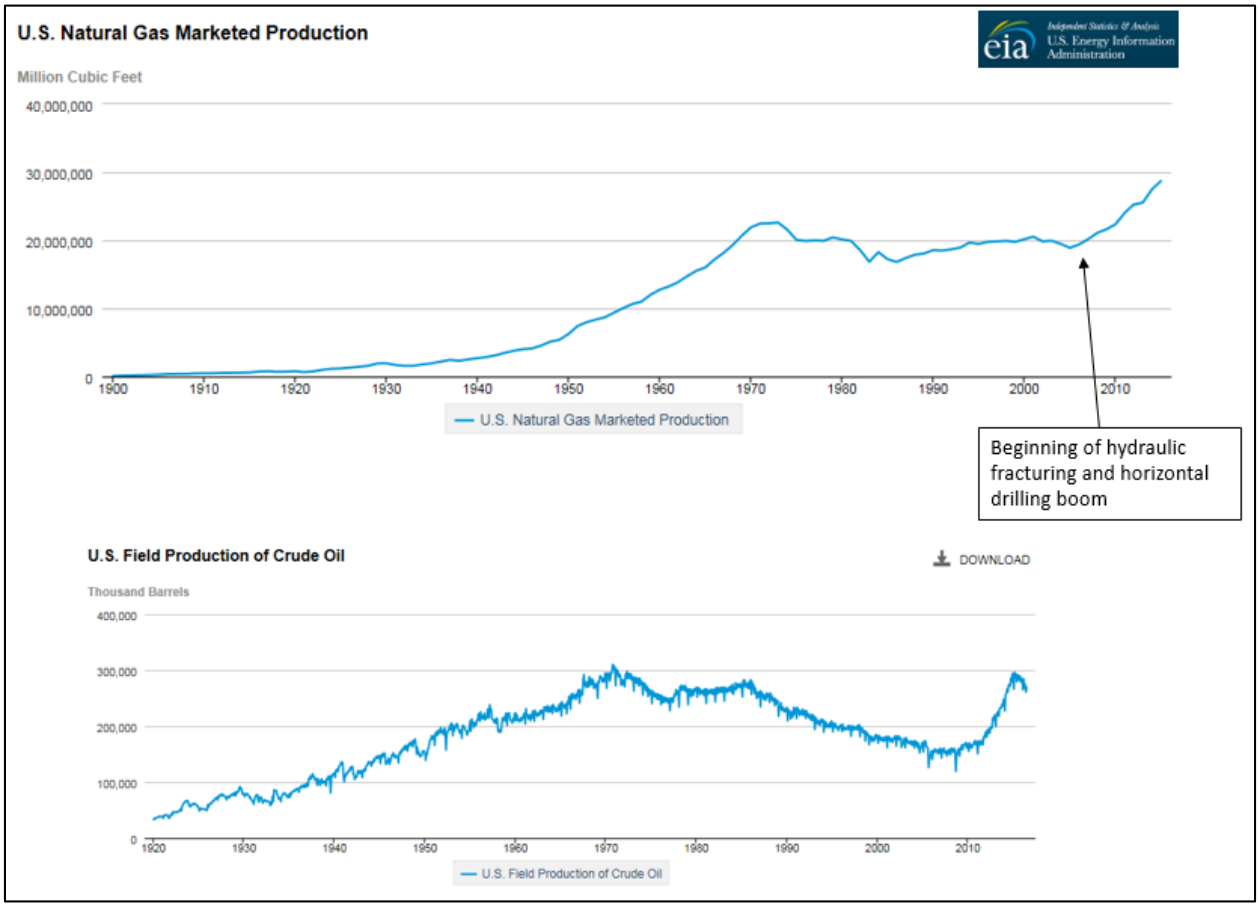

Figure 18. U.S. oil and gas production over time. Source: U.S. Energy Information Administration

North Dakota perhaps best exemplifies the rapidity with which oil and gas development can increase in a region. Between 1981 and 2005 the average annual oil production was 101,000 barrels per day. From 2013 to 2016 the average was 1,057,500 million barrels per day, a more than ten-fold increase in just a few years, and moved North Dakota to second place among the largest oil and gas producing states in the nation (U.S. EIA, 2017). Likewise, in Pennsylvania over 6,700 wells were drilled between 2004 and 2013 (Patterson & Maloney, 2016). Road and bridge infrastructure degradation can occur very rapidly - years of damage can be experienced within a few weeks (Bierling, 2014).[1] Accordingly, maintaining roads and bridges is often one

[1] How much damage a road will experience from increased truck traffic is based on many factors, including the design of the road, the types and frequencies of loads on the roads, and even environmental

of the largest challenges facing these local governments when large scale oil and gas drilling moves into an area.

Transportation infrastructure is the lifeline of a community, providing access to jobs, markets, emergency and other services, and social connection and cohesion. While there is much debate today regarding the role of government in society, the vast majority of Americans still see maintaining infrastructure as a "major role" of the government (Pew Research Center, 2015). If local planners cannot maintain their local roads and bridges, both the oil and gas operators and local residents will experience negative impacts, and are likely to blame the government.

In addition to financial considerations, the approaches available to local governments to address these issues are limited by the amount of power the local government has been allocated by the state, which varies across the country. Most states operate under a version of "home-rule" authority, which means that the state gives local governments the authority to run their own affairs and generally exercise the power of the legislature, as long as doing so does not conflict with state law. Even within a state, some local governments (such as counties) may have more authority than others (such as towns).

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factors. (Abramzon, 2014). To estimate road damage, the primary approach recognized by AASHTO is to convert all loads to Equivalent Single Axle Loads (ESAL), with one axle load equal to 18,000 pounds (Abramzon, 2014). Then, taking into account the type of road and its design, truck weights and number of axles, a load equivalency factor (LEF) is derived which expresses "the roadway damage caused by a single pass of each vehicle relative to the damage per single pass of an ESAL," (Abramzon, 2014; AASHTO (1993). The design life of the roadway can then be calculated in total ESALs, which will relate to the number of trucks and their weight passing over the roadway (Abramzon, 2014). Local roads in rural areas are typically designed for low traffic volumes, some estimates are fewer than 50 heavy trucks per day (Bierling, 2014). When these numbers increase rapidly -- to many hundreds or even thousands of trucks per day – the design life of the road is reached quickly, even within a matter of weeks, and total degradation can occur (Bierling, 2014). Accordingly, the temporal factor is only relevant because the design capacity is being exceeded within a matter of weeks, rather than many years or even decades as was expected when the road was designed and constructed.

While numerous studies have now addressed road impacts, development of practical solutions or methodologies aimed at local and rural planners are largely missing, especially those that take into account the relationship between local and state governments and the power of the local government to act. Many papers have addressed legal challenges to hydraulic fracturing, but largely from the perspective of environmental concerns. This dissertation research revealed that the legal analysis is different when the underlying concerns being addressed by potential regulation of fracturing are related to preservation or maintenance of local infrastructure. A local government may have greater leeway to act in the interest of road or bridge protection than it would to address generalized environmental grievances or opposition to fracturing. In this Chapter, I have developed a legal and policy survey of various regulatory actions local governments may take to address impacts to transportation infrastructure, and an assessment of potential legal challenges to those regulations. The analysis is intended to be useful to local planners who may not be aware of the many and varied approaches that are available to them to respond to developments' impact on local infrastructure, as well as potential challenges that could arise to selected measures.

Managing Oil and Gas Development: Local Governments

The United States Constitution establishes the form and powers of the nation's government. It creates the three branches of the federal government, enumerates their limited powers, and expressly provides that "powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people" (U.S. Const. U.S. Const. amend. X). As a sovereign in its own right, each state in the Union is vested with broad powers to govern and regulate its own affairs.

While the federal government must point to a specific constitutional grant of power in order to act, the states can generally act as long as doing so is not expressly prohibited.[2] The legislature of a state can adopt a state constitution, enact laws to promote the welfare and livelihood of its citizens, and has inherent authority to manage and regulate certain intra-state behavior. The source of this authority is often referred to as the State's "police power," which stems from English common law and has been subsequently recognized in a long line of Supreme Court cases.[3] The police power includes zoning authority, criminal law enforcement, health and building codes, education, and more. The state's power to regulate is only circumscribed by the U.S. Constitution, and where it conflicts or is otherwise preempted by federal law in a sphere where the federal government has the authority to act.

The Power of Local Governments

The Constitution does not make any reference to political subdivisions of a state, such as counties, cities, or townships. However, since the founding of the country, state delegation of power to smaller, local entities for the expedient and efficient running of government has been part of the American system.[4] "Recognizing the advantages of dividing power into more convenient units of political authority, every State in the Union has delegated general police powers to cities in one way or another."[5] Nevertheless, political subdivisions of a state, such as cities, municipalities, townships, or counties, are created by the state, and are entitled to no more

[2] *See Nat'l Fed'n of Indep. Bus. v. Sebelius,* 567 U.S. 519 (2012).
[3] *Bond v. United States*, 134 S. Ct. 2077, 2086 (2014) ("The States have broad authority to enact legislation for the public good—what we have often called a 'police power.'").
[4] *State of Maryland v. Baltimore & O.R. Co*., 44 U.S. 534, 550 (1845) ("The several counties are nothing more than certain portions of territory into which the state is divided for the more convenient exercise of the powers of government. They form together one political body in which the sovereignty resides."); *United States v. Baltimore & Ohio R.R. Co.,* 84 U.S. 322, 329 (1872) (local governments are "representative not only of the State, but … a portion of its governmental power").
[5] *City of Columbus v. Ours Garage & Wrecker Serv., Inc.*, 536 U.S. 424, 428–29 (2002), Brief for Petitioners City of Columbus at p.19.

power than the state elects to provide them whether through delegations found in state statutes or the state constitution.[6] "Municipalities are ultimately state creations, having only as much authority as the state elects to provide" (Bukac, 2015).

A legal doctrine that originated in the common-law and later came to be known as "Dillons Rule" provides that local governments, because they lack any inherent sovereign authority, cannot act at all without express legislative permission. Indeed, Chief Justice John Forest Dillon of the Iowa Supreme Court, for whom the rule was named in 1868, called local governments the "tenants at will of the legislature."[7] This resulted in significant time spent by many towns and cities in lobbying state legislatures for specific powers to act. "In Florida, for example, it was not uncommon for more than 2,000 special acts to be filed by municipalities in a single session of the state legislature" (National League of Cities, 2017).

To alleviate this situation, many states adopted what are now known as "Home Rule" statutes or included Home Rule provisions within state constitutions. These statutes or state constitutional provisions grant some form of blanket authority to local governments to adopt laws and regulations, as long as they do not conflict with or are not otherwise pre-empted by state law. Every state has delegated some form of this "Home Rule" authority to certain local governments, but the extent of that authority and the level of local government selected to wield

[6] *City of Columbus v. Ours Garage & Wrecker Serv., Inc.*, 536 U.S. 424, 428–29 (2002) ("Ordinarily, a political subdivision may exercise whatever portion of state power the State, under its own constitution and laws, chooses to delegate to the subdivision."); *Hunter v. Pittsburgh*, 207 U.S. 161 (1907) ("Municipal corporations owe their origin to, and derive their powers and rights wholly from, the legislature. It breathes into them the breath of life, without which it cannot exist."); *XO Missouri, Inc. v. City of Maryland Heights*, 362 F.3d 1023, 1027 (8th Cir. 2004) (Inherent police power belongs to the states. Political subdivisions of a state have no inherent claim to such power.)

[7] *Sheffield v. City of Fort Thomas, Ky*., 620 F.3d 596, 609 (6th Cir. 2010) (quoting *City of Clinton v. Cedar Rapids & Mo. River R.R. Co.,* 24 Iowa 455 (1868)).

it vary widely among the states. Appendix D sets forth state home rule statues and constitutional provisions delegating authority to local governments.

Home Rule is often held up as antithetical to Dillon's Rule, and as such local planners and others may assume that if the state in which they operate is considered a "home rule" state, then local governments have broad authority to regulate local matters around hydraulic fracturing. However, the reality is that the level of discretion and authority a local government has is more a matter of state constitutional and statutory law than any formalistic notion of whether the state purports to follow Dillon's Rule or Home Rule (Russell, 2016).[8] For example, Virginia follows Dillon's Rule to construe grants of authority to local governments strictly and narrowly,[9] but has also been recognized as a state which provides significant discretion and authority to local governments (U.S. Advisory Commission, 1981). "Local governments in some states are not much more than appendages of the state government, whereas other states have granted local governments extensive authority to make their own policy decisions" (Krane, 2001).

In practice, determining the extent of local government power and authority can become quite complex to decipher, with some states granting authority only to municipalities, only to counties, only to certain types of local units that meet minimum population requirements, or to some combination of an endless variety of approaches (U.S. Advisory Commission, 1981). By way of some examples, the Arizona constitution applies Home Rule to cities with at least 3,500 people, but Dillon's rule applies to cities with populations below 3,500 (Ariz. Const. art. XIII, § 2; Russell & Bostrom, 2016). Alabama grants home rule authority only to "municipal

[8] Indeed, this may explain why the number of states credited with following Home Rule, while clearly the majority of states, depends largely on a writer's view and is rarely consistent among publications.
[9] *W.M. Schlosser Co. v. Sch. Bd. of Fairfax Cty., Va.*, 980 F.2d 253, 256 (4th Cir. 1992).

corporations" (Ala. Code § 11-45-1 (1975)), and not counties, while Alaska's constitution "provide[s] for maximum local self-government" with a "liberal construction given to the powers of local government units" (Alaska Const. art. X, § 1).

The federal government has traditionally had a very limited role when it comes to regulating oil and gas extraction, with the states being the primary source of regulatory authority. Local governments have also played a more limited role but as increases in development have intensified in recent years thanks to the advances in hydraulic fracturing and horizontal drilling, especially in certain areas, local governments have sought a greater role in regulating development. A solid understanding of the source and extent of local government power -- whether in counties, cities, or townships -- is a necessary first step to determining what a local government can do to respond to activities taking place within its borders that it would like to encourage, prohibit, benefit from financially, or simply regulate in some way. This is especially critical to issues surrounding oil and gas drilling, which as described above, often occur in rural communities where the most immediate impacts, both positive and negative, are first felt. As Krane aptly noted, "[u]sually, a pressing problem or contentious issue must arrive before citizens discover their locality does not possess the power to act . . . . " (Krane, 2001).

Local Strategies

It may appear axiomatic that local governments should be able to regulate road repair and maintenance (or other local concerns) in a reasonable manner on the roads for which they are responsible, but the influx of oil and gas development, especially to rural areas not accustomed to a robust oil and gas sector, has tested this assumption. Instead, local planners often are faced with addressing impacts to transportation infrastructure, frequently without sufficient financial resources to do so or the power to act. In many cases, towns enact ordinances addressing the

problem only to find themselves unsuccessfully defending the measures in court, often at considerable taxpayer expense.

Transportation focused literature has addressed these issues largely from an engineering perspective (Patterson & Maloney, 2016; Appendix B) but this dissertation work aims to fill a gap in the literature by providing a policy framework of defensible methods for addressing or preventing those impacts. As discussed herein, no single approach will benefit or be available in every community, as state law and policy will provide the foundational context within which local communities operate and will vary from state to state. Nevertheless, understanding the primary legal and policy options available, as well as potential challenges, can serve as an important resource to local planners in selecting specific strategies that reflect the goals of the community. Figure 18 provides an accessible diagram of the framework discussed in this Chapter, which may be utilized to improve future planning.

Zoning or Land Use Restrictions

The power to determine where certain uses of land (such as residential or industrial) may be appropriate or prohibited within a community is the power to zone. Zoning perhaps best represents the classic police power of the state, and "enjoys a revered place in constitutional jurisprudence" (Ritchie, 2014) among all of the traditional police powers. The power of local governments to control land use -- to determine *where* certain uses could take place -- was first recognized by the Supreme Court in *Village of Euclid v. Ambler Realty Company*, 272 U.S. 365 (1926), in which the Court determined that even if a local zoning ordinance diminishes or even destroys the value of private property, that does not conflict with fundamental notions of property and liberty under the Due Process Clause.

Local governments across the country have attempted to use their zoning authority to address negative impacts (including road degradation) by prohibiting oil and gas drilling or hydraulic fracturing in certain areas (such as residential areas) or to ban it from the locality altogether. Zoning and land use restrictions are one method localities could utilize to address local road impacts. However, even where local jurisdictions are given broad Home Rule authority by the state, local governments generally cannot regulate activities in areas where the state has chosen to exercise control or in areas that traditionally implicate state-wide, as opposed to wholly local, concerns. Local efforts to do so are likely to be "preempted" by state law, and invalidated by the courts. However, unlike federal preemption jurisprudence which is well developed and applied relatively consistently across all jurisdictions, "each state has its own legal framework for local authority and its own preemption jurisprudence" (Outka, 2015). Consequently, an important aspect of determining the reach of a locality's authority to regulate an activity that also touches state concerns will be at least some understanding of state preemption law.

Although state law varies, generally a local law will be pre-empted if it falls within one of three types of preemption: express preemption, conflict (or implied) preemption, or field preemption. A local law is said to be expressly preempted if a state law explicitly provides that the intent of the law is to preempt local efforts to control or regulate the activity addressed in the state statute. Conflict preemption occurs when a local regulation would conflict with the letter or policy of a state law (e.g., compliance with both state and local law would be impossible), even if the state law does not state any express intent to preempt local law. Finally, field preemption occurs when the state has so regulated an entire area that the state concerns are said to occupy the entire field, leaving no room for local control, even if the local law does not conflict with any

state law. As noted, however, each state's interpretation and application of preemption analysis regarding local versus state law conflicts will vary and should be understood by localities attempting to regulate in areas where state policy may be implicated.

In every case I am aware of in which local governments have attempted to use the power to zone to impact oil and gas development, courts have found that oil and gas implicates at minimum both state and local concerns, raising important repercussions for local efforts to address well development (Vann, *et al*., 2013). However, local land use and zoning authority (at its most basic, the power to determine *where* certain activities may take place within local boundaries to safely separate, for example, homes, factories, and schools) also has long been recognized as specially within the province of local governments, and some courts will defer to local land use decisions even where state oil and gas law may be implicated. Accordingly, one of the overarching questions courts have grappled with where state oil and gas law is found to preempt local law (whether express, implied, or by conflict) is whether traditional local land use ordinances may nonetheless regulate some aspects of oil and gas development. The Colorado Supreme Court recognized this inherent tension between state regulation of oil and gas and local control over zoning and land use, stating

> We also recognize[], however, that home-rule cities are authorized to control land use through the exercise of zoning authority. . . . for example, [Colorado law] grants local governments broad authority to plan for and regulate the use of land. Fracking touches on both traditions—the state's regulation of oil and gas development and [the City's] regulation of land use.[10]

Indeed, even where the state legislature evidences an express intent to preempt local control, some courts nevertheless do not extend such preemption to local zoning and land use

[10] *City of Longmont v. Colorado Oil & Gas Association,* 369 P.23d 573, 581 (Colo. 2016).

regulation, allowing local governments to determine *where* drilling may appropriately occur, just now *how* it occurs. Other courts, however, have found that state intent to regulate oil and gas (whether express or implied) is sufficient to invalidate even local zoning ordinances.

A number of illustrative examples make clear this tension and the differing outcomes that can obtain dependent on the state a local government happens to be in. In *St. Tammany Par. Gov't v. Welsh*, 199 So. 3d 3, 8 (La App. 1st Cir. 2016), a local government's effort to zone certain areas residential and prohibit drilling was preempted by a state law providing that local governments were "expressly forbidden . . . to prohibit or in any way interfere with the drilling of a well . . . by the holder of . . . [a state issued] permit." La. Rev. Stat. Ann. § 30:28. In *St. Tammany Par. Gov't* the court found the statute's language to be a clear statement of express preemption, but found further that the "pervasiveness of the legislation" indicated intent to impliedly preempt any local control over drilling, even local zoning and land use controls.[11]

Colorado, like Louisiana, has a robust energy sector and recent development there has also resulted in numerous local government efforts to limit, control, or ban large scale hydraulic fracturing. The Colorado courts have consistently invalidated local attempts to do so, even when the efforts are exercises of local land use and zoning authority. For example, In *City of Longmont*, the court found no express or implied intent by the state to pre-empt local land use authority in the state oil and gas law, but enjoined a home rule city's ban on hydraulic fracturing and the storage of fracing wastes in the city limits on the basis of an operational conflict between state law and the local zoning ordinance. The Court overturned the local ordinance despite recognizing the Colorado constitution's broad grant of home rule authority to municipalities,

[11] *St. Tammany Par. Gov't* 199 So. 3d at 8.

including a provision that, with respect to "local and municipal matters," local ordinances supersede any conflicting state law (Colo. Const. art. XX, § 6).

The Colorado Supreme Court explained that oil and gas drilling is a matter of mixed local and state concern, implicating both local zoning and land use powers but also "the state's interest in the efficient and fair development of oil and gas resources in the state."[12] Accordingly, the city's ban on fracturing and waste storage "materially impedes" the state law and was invalid.[13] In *City of Fort Collins v. Colorado Oil & Gas Association*, No. 15SC668 (Colo. May 2, 2016), the city did not ban drilling, but issued a temporary moratorium on hydraulic fracturing and the storage of fracturing waste (five years), which was similarly held invalid under a state law preemption analysis.

An important factor impacting any effort to use local land use ordinances to regulate oil and gas drilling -- even simply to designate *where* within a local jurisdiction oil and gas drilling can occur -- is the unique nature of oil and gas reserves. In invalidating local land use ordinances in Colorado, the Supreme Court of Colorado has explained that

> oil and gas are found in subterranean pools, the boundaries of which do not conform to any jurisdictional pattern. . . . [C]ertain drilling methods are necessary for the productive recovery of these resources [and] it is often necessary to drill wells in a pattern dictated by the pressure characteristics of the pool; . . . an irregular drilling pattern would result in less than optimal recovery and a corresponding waste of oil and gas, and it could adversely impact the correlative rights of the owners of oil and gas interests in a common source or pool by exaggerating production in one area and depressing it in another. [A] city's total ban on drilling within the city limits could result in uneven and potentially wasteful production of oil and gas from pools that underlie the city but that extend beyond the city limits. Accordingly, [even the] location and spacing of individual wells [are matters] of state concern.[14]

[12] *City of Longmont* 369 P.23d at 580.
[13] *Id.* at 585.
[14] *City of Longmont,* 369 P.3d at 580.

Similarly, total bans within a town's limits are particularly suspect from a state perspective because such efforts "may create a 'ripple effect' across the state by encouraging other municipalities to enact their own fracking bans, which could ultimately result in a de facto statewide ban."[15]

In New Mexico, a county ordinance stated that "[i]t shall be unlawful for any corporation to engage in the extraction of oil, natural gas, or other hydrocarbons within Mora County."[16] The United States District Court for the District of New Mexico invalidated the county ordinance under a conflict preemption analysis, where the county ordinance "prohibit[ed] activities that state law permits: the production and extraction of oil and gas."[17] The court did not find in the state law any express intent to preempt local regulation nor any evidence of field preemption. Because of these findings, the court noted that if the locality had endeavored to regulate, as opposed to entirely ban, the activity that the state law allowed, the outcome may have been different under a conflict pre-emption analysis.[18]

Counties in both West Virginia and Colorado that have enacted local land use ordinances which do not expressly ban oil and gas drilling, but impose burdensome restrictions by zoning certain activities necessary for drilling out of the county or township, also have seen those ordinances invalidated under a state-law preemption analysis.[19] In *EQT Production Co. v. Wender*, 191 F. Supp.3d 583 (S.D. W. Va. 2016), Fayette County's ordinance prohibited the storage of wastewater from oil and gas operations in the county. In striking down the ordinance on the basis of field preemption, the court rejected the county's argument that it has "sovereign

[15] *Id.* at 581.
[16] *Swepi, LP v. Mora Cty*., N.M., 81 F. Supp. 3d 1075, 1093 (D.N.M. 2015).
[17] *Swepi, LP v. Mora Cty., N.M.*, 81 F. Supp. 3d 1075, 1198 (D.N.M. 2015).
[18] *Id*. at 1200.
[19] *EQT Production Co. v. Wender*, No. 16-00290 (S.D. W. Va. June 10, 2016).

powers" to make "legislative judgments" to which the court must give deference. Rather, the court noted that

> County commissions, like municipalities, are artificial entities created by state statute. . . . As such, they possess only the powers expressly granted to them by the state constitution or legislature, or necessarily implied from those expressly given. . . . In other words, towns and cities, as well as counties, are without power to adopt ordinances which might, in any way, interfere with legislate enactment . . . passed in carrying out a particular policy of the [state] legislature.[20]

Because, pursuant to the West Virginia Oil and Gas Act, "the state has comprehensively regulated this area, including storage activity at drilling sites," the law left "no room for local control" and the county ordinance was preempted and permanently enjoined.[21]

Some courts, however, have deferred to efforts by home-rule local governments to regulate oil and gas development within their borders through land use and zoning. For example, in *Wallach v. Town of Dryden,*[22] the New York state oil and gas law expressly stated that it "shall supersede all local laws or ordinances relating to the regulation of oil, gas, and solution mining industries,"[23] yet New York's highest court held this language was not intended to preempt the town's zoning laws.[24] Illinois courts also have upheld a non-home rule city's authority to prohibit oil and gas drilling within residential districts despite issuance of a state permit to drill, finding that the state law did not preempt the city ordinance because the state law expressly provided that local governments must provide "official consent" before a state drilling permit could issue.[25]

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[20] *Id.* at 594 (internal citations and quotations omitted).
[21] *Id.* at 598-99.
[22] 23 N.Y.3d 728, 739 (2014).
[23] *Id.* at 744.
[24] Interestingly, the New York statute expressly retained the right of local governments to manage local roads, a specific exclusion from a preemption provision that is not often seen in other state oil and gas laws.
[25] *Tri-Power Res., Inc. v. City of Carlyle,* 967 N.E.2d 811, 813 (Il. App. 2012).

Finally, rapid shale gas development in Pennsylvania has both benefited and burdened local governments, giving rise to a number of cases addressing the extent of local versus state control over oil and gas operations. The Pennsylvania Supreme Court in 2009 had ruled that express preemption language in the state law did not extend to local zoning and land use decisions, but that local governments could not regulate activities already covered by the state oil and gas law; accordingly, local government could use their zoning powers to determine the proper location of wells.[26] In response, the state legislature enacted a law prohibiting local governments from enforcing existing zoning ordinances or adopting new ones that would conflict with the state's chosen policy of "rapid exploitation" of oil and gas, mandating that local governments allow drilling as a permitted use in "all zoning districts" (58 Pa. C.S. § 3304(b)(5)-(6)). Townships immediately brought constitutional and other challenges to this elimination of local land use power.

The Pennsylvania Supreme Court found that abrogating local zoning and land use authority violated the Environmental Rights Amendment of the Pennsylvania Constitution. The court determined that "as an exercise of police power, [these sections of the Act related to local zoning] are incompatible with the Commonwealth's duty as trustee of Pennsylvania's public natural resources."[27] Because the *Robinson Twp*. decision relies on a unique state constitutional provision and not the common law public trust doctrine, it may be of limited impact in other states. However, even in Pennsylvania, local townships are still limited with respect to the impact they may have on oil and gas development, and local efforts to regulate which are tied to

[26] *Huntley & Huntley v. Borough of Oakmont*, 964 A.2d 855, 855-56 (Pa. 2009).
[27] *Robinson Twp., Washington Cty. v. Com.*, 83 A.3d 901, 985 (Pa. 2013).

the traditional purposes served by land use and zoning authority are likely to be most successful.[28]

The above cases provide just a few illustrations of the challenges that can arise when local activities such as oil and gas development raise both local and state concerns and local governments attempt to use land use or zoning powers to regulate the activity. Decisions allowing local governments to partially or totally ban oil or gas drilling appear to be outliers, and do not represent a likely outcome where local drilling regulations are challenged, especially in states where oil and gas development is an important economic driver. If oil and gas operators view a local regulation as unduly burdensome or an exceedance of local authority, they are more likely to bring legal challenges. The cost to the local government of defending these legal actions (which more often than not have been unsuccessful for the locality) can put a significant financial burden on local taxpayers.

If a locality elects to impose zoning restrictions on oil and gas operations, the more narrowly tailored the zoning regulation is to address a specific local problem, the more likely it is to survive preemption scrutiny (Duffy, 2014). More limited attempts to zone the activity in certain approved areas consistent with the local government's existing approach to zoning are likely to be more successful.[29] In her dissent from the Ohio Supreme Court's opinion invalidating local zoning efforts, Justice Lanzinger found that

> The ordinances reflect traditional zoning concerns, while the state statutes control technical aspects of the drilling of an oil and gas well. Local zoning exists to address such concerns as traffic control, traffic volume, property values, enhancement of municipal revenue, costs of municipal

[28] *Pennsylvania Gen. Energy Co., LLC v. Grant Twp*., 139 F. Supp. 3d 706, 718 (W.D. Pa. 2015) (Pennsylvania township ordinance restricting deposition of fracing waste within township was invalid as exceeding grant of legislative authority from the state).

[29] *Tri-Power Res., Inc. v. City of Carlyle*, 967 N.E.2d 811, 812 (Il. App. 2012).

> improvement, land use, nuisance abatement, and the general welfare and development of the community as a whole. Municipalities are more familiar with local conditions and are in the best position to determine which zoning regulations will best promote the health, safety, and general welfare of their communities. This is why a "strong presumption" exists in favor of the validity of the ordinances, a fact that the lead opinion does not mention.[30]

Localities are more likely to be able to impose restrictions on "where" drilling is conducted than on "how" the drilling is conducted.[31] Zoning goes to the heart of a locality's ability to separate, for example, the location of schools and houses from heavy industrial activity, within a community. Where local impacts need to be addressed, local planners should carefully develop effective and legally supportable responses. From a transportation perspective for example, if a particular district of a town or county has numerous old bridges that cannot support the increased heavy truck traffic, a land use regulation limited to that area and for that purpose, as opposed to banning drilling in the entire county or town, may be more likely to be upheld. Transportation is also unique in that both industry and local governments share a common interest in passable, high quality roads. Using local land use power to limit routes or otherwise minimize impacts to infrastructure likely falls within the authority of local governments and is less likely to be challenged by oil and gas operators than outright bans or burdensome regulatory restrictions. For this reason, working cooperatively with industry towards the common goal of maintaining high quality transportation infrastructure can be significantly more effective than engaging in policy debates about the value of hydraulic fracturing or oil and gas development in general.

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[30] *State ex rel. Morrison v. Beck Energy Corp.*, 37 N.E.3d 128, 143 (dissent, J. Lanzinger) (internal citations omitted).

[31] *See Huntley & Huntley*, 964 A.2d at 865 (noting that zoning laws serve a different purpose than laws aimed at regulating how oil and gas is produced or the use of natural resources, and finding that a local zoning ordinance which prohibited drilling in a residential district was not preempted by state law).

Taxes and Exactions: Fees, Bonds, and Permits

Most states impose state-wide taxes, fees, or permit requirements on the hydrocarbon extraction industry. In 2010, thirty-one states had oil and gas specific severance taxes, which generated more than $11 billion that year (Pless, 2012). However, local governments have not always been allocated a sufficient percentage of these funds to support local roads, even though the economic activity that generates the funds is taking place at the local level and is burdening the local roads more than state roads. As one study noted, while some costs of high volume hydraulic fracturing are born by society at large, "roadway consumptive costs accrue directly to the state and local departments of transportation" (Abramzon, 2014).

Currently, most counties with significant oil and gas development fund their roads primarily out of the *ad valorem* (property) tax paid by the industry in their county. Because the *ad valorem* tax rate varies widely by state and county and because the tax proceeds may not be entirely funneled back to the local government (Brown, 2013), in many areas these taxes have not been sufficient to maintain roads supportive of modern oil and gas development. Some states may authorize local governments to include additional fees or taxes in order to address a local impact. If the burden of development falls disproportionately on local communities while the benefits inure to the states, local governments should be provided a larger share of the state-imposed tax, or be authorized to impose an additional impact fee to address local needs directly related to the development.[32] As Spence has noted, "attempts by local governments to veto [or

[32] Although this Chapter discusses these issues primarily where there are only two competing interests, the state government and a single local government, many states may have additional levels of governmental authority, each with its own jurisdictional interest in regulating oil and gas development. For example, if the hydraulic fracturing operations occur in a township, but the trucks must pass over town, county, and state roads, there should be a mechanism for sharing fees to account for these extraterritorial impacts. The principle of subsidiarity -- that the smallest level of local government that will bear the costs is the one that should have the regulatory authority -- provides one example of an approach that could be applied when impacts are experienced across a range of jurisdictions. These

regulate] local development are essentially fights over the distribution of the costs and benefits of development" (Spence, 2014).

Although in the transportation context, locally imposed taxes, fees, permits, and bond requirements are all variations of local police power efforts to offset the damage done to roads by the extraction industry, there are key differences in these approaches. For example, a local government may be authorized to impose a fee, but not a tax, depending on the state. Generally, taxes raise revenue for general government spending and may require voter approval, whereas a fee raises money to pay for a specific program with a proper regulatory purpose and is typically paid to obtain a service or benefit (such as a fee to obtain a permit).[33] With respect to road degradation, the ability to impose a local tax or fee can be a key revenue raising approach for localities that do not have sufficient funds to maintain public roads, but it must be implemented within the bounds of state law.

There also can be substantial overlap in these approaches. A fee may be required to obtain a county permit to drill, and the permit might require its holder to make repairs to roads, to provide gravel to the county, to undertake a road analysis, or to limit truck traffic to particular routes. A county might require a permit that contains some of these requirements, but also require heavy truck users to post a bond to assure repairs to roads are made. Importantly, weight limits and bonding may not always be the answer. For example, in some locations the majority

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principles are established in the Treaty on European Union (TEU) with the stated goal that "powers are exercised as close to the citizen as possible" (European Parliament, 2017).

One example of these more complex jurisdictional issues can be seen in Greene County, Pennsylvania, where fracing occurred both in Green County, but also in Cumberland Township within Greene County. The state received most of the fiscal benefit from oil and gas impact fees, and the township and county the least (Herzenberg, et *al.*, 2014). Approximately 60% of the per-well impact fee was to be split between the county and the township; but this raises additional issues of which governmental entity should have the power to regulate, and how best to regulate, when impacts generated in one jurisdiction are felt across another.

[33] *See e.g., USA Cash #1, Inc. v. City of Saginaw,* 776 N.W.2d 346, 359 (Mich. App. 2009).

of the truck loads impacting local county roads were under the legal weight limits; it was the significant increase in the number of trucks over concentrated time periods that led to road degradation (MacAdam, 2014).

In *State ex rel. Morrison v. Beck Energy Corp.*, an Ohio community used a land use regulation to impose permitting requirements, fees, and bonding requirements on oil and gas operations in addition to those imposed by state law, only to have the local ordinances invalidated by the court.[34] The *Morrison* decision is interesting because the Ohio Supreme Court distinguished between a local government's exercise of the police power, which is more circumscribed by state law preemption analysis, and "local self-government," which is entitled to more deference under Ohio's Home Rule provisions. The Ohio court noted that anytime a local government requires a license or permit to act, that is an exercise of the police power and, despite Ohio's broad grant of Home Rule authority in the Ohio constitution, the Home Rule provision did not authorize local governments to exercise the police power in a way that conflicts with the state's general laws.[35]

However, other types of permits or fees may be more likely to go unchallenged or upheld, especially the more they are directly related to addressing a local problem (road degradation) rather than inhibiting or regulating technical aspects of state approved economic activity (hydraulic fracturing).[36] Arlington, Texas has a local ordinance that provides a good example of a permit scheme which addresses local road impacts. Arlington's ordinance requires

[34] *State ex rel. Morrison v. Beck Energy Corp*., 37 N.E.3d 128, 134 (Ohio 2015).
[35] *Id.* at 133.
[36] It should be noted that while most local-state conflicts arise in the context of local governments imposing limits or banning oil and gas operations where the state has expressly authorized energy extraction, one state with oil and gas resources has banned hydraulic fracturing. In New York, even if a local government wanted to authorize the activity, any effort to do so would be preempted by the state decision to prohibit it.

a city-issued Gas Well Permit before well construction can begin. To obtain the permit, an application must be submitted which shows the "proposed transportation routes and roads for equipment, supplies, chemicals or waste products used or produced by the gas operation" and the location of public roads used for ingress and egress and areas to be used for truck staging or storage.[37] This allows the city to assess current road conditions and potential damage, and the ordinance additionally authorizes the city to impose a road damage fee (Arlington, Texas Ordinance 11-068, § 5.01(i)). The ordinance provides that the fee shall be calculated based on the access lane miles for the appropriate road type, the assessment per lane mile, and the number of lane miles included in each gas well permit application. Replacement costs for asphalt and/or concrete road segments shall be determined from current cost per square yard of road surface material, including installation and labor.

Industry brought legal challenges to the Arlington ordinance and the city eventually withdrew the more contentious provisions, but the road damage fee and permitting requirements remain.

Voluntary Agreements / Road Use and Maintenance Agreements

As the oil and gas boom was well underway, Colorado Governor John Hickenlooper recognized the substantial resources that were being spent on litigating challenges to local efforts to regulate hydraulic fracturing, and created a task force to make recommendations for better state and local coordination (Hickenlooper, 2012). One of the recommendations of the task force was for local governments to enter into Memoranda of Understandings with oil and gas operators and state agencies tasked with oil and gas regulation, rather than increase local ordinances or regulations (Colorado Department of Natural Resources, 2012). The research undertaken for the

[37] Arlington, Texas Ordinance 11-068, § 5.02(C)(3)(a), available at http://www.arlington-tx.gov/cityattorney/wp-content/uploads/sites/15/2014/05/GasDrilling-Chapter.pdf.

projects discussed in Chapters Two and Three revealed that some of the most successful approaches to road and bridge degradation in local communities were voluntary agreements between local governments and oil and gas operators. These ranged from informal oral understandings to formal binding contracts (known as Road Use Agreements (RUAs), Road Use and Maintenance Agreements (RUMAs), or Excess Use Agreements (EUA)). Indeed, van de Biezenbos has argued for the use of private agreements as a means to stave off litigation and enhance local governments' ability to address impacts (van de Biezenbos, 2017). Because the local oil and gas operators have a role in the development and terms of the agreement, legal challenges are significantly less likely to occur then where local ordinances are imposed on operators.

Oil and gas operators pay state and local taxes, and like individuals, expect the government to deliver passable roads without being singled out to pay extra for them. However, my interviews with operators and state department of transportation officials revealed that in most cases, operators were willing to pay for extra-ordinary damage they cause, but sought a fair process by which to do so. Many did not feel that imposition of local ordinances -- which often lacked flexibility -- accomplished the fairness they sought. In some states, local operators believed they were being asked to pay for damage their trucks did not cause, or on roads that were already damaged before the oil and gas industry arrived. This was especially the case where the agreements tended to be less formal or did not allow for a base line road assessment, or meaningful methods by which to distinguish between operators whose trucks may be using the same roads. In these localities, the relationship between local governments and operators was not as positive and approaches to road maintenance or repair tended to be less effective than in

localities where there was a more collaborative relationship between industry and local regulators (Dundon, 2017).[38]

Ohio perhaps represents one of the most effective approaches to road impacts, as indicated by road maintenance/quality and effective collaboration between local governments and operators. In Ohio, the state Department of Transportation (ODOT) facilitated discussions between industry and local planners, having learned from less effective approaches taken in other states. The majority of impacted roads in Ohio were county roads not under state jurisdiction, however, one of Ohio's successes was having a dedicated ODOT employee who facilitated mutual and better understandings regarding industry, ODOT, and local practices and procedures. ODOT took responsibility for the state roads that were designed for heavy truck use, but did not have jurisdiction on local or county roads. However, ODOT personnel facilitated conversations between local planners and industry to develop the Ohio Road Use and Maintenance Agreement, a legally binding agreement that each operator executes with each affected local government entity. The RUMA's allow for standardization across the various oil and gas producing counties and with industry and local government support, the RUMA was incorporated into state law in 2012. In this respect, Ohio is something of a hybrid between voluntary and mandatory approaches: Ohio law requires operators to file a signed RUMA (or the oil and gas operator must demonstrate a good faith effort to enter into a RUMA) as a requirement to obtain a drilling permit, but the RUMA document was not codified, so counties, towns, and operators can develop terms that fit local needs or circumstances, and the agreements are mutually agreed to. The type

[38] By way of some examples, Pennsylvania's Department of Transportation (PennDOT), which has jurisdiction over most of the roads in the state including county roads, required oil and gas operators to enter into Excess Maintenance Agreements (EMA) in order to obtain an "Authorization to Exceed Posted Highway Weight Restriction" permit. The details of the EMA are agreed to between each operator and PennDOT, and typically include pavement analysis and planned routes, but only extends to "excess maintenance and restoration" not normal maintenance that is required of PennDOT.

of work that is incorporated in the RUMA can include agreement to widen roads, full depth pavement rehabilitations, drainage improvements, and more. Local governments report that the RUMA approach has largely been successful.

In addition to the RUMA, involving the state DOT to help facilitate discussions between local governments and industry as issues arise has also been an important factor in Ohio's success. In this regard, ODOT personnel, while they have no jurisdiction over local county roads, have become an important information source in Ohio, standardizing discussions, sharing approaches that have worked or met with challenges in other counties, and being able to identify to counties companies that have enjoyed reputations elsewhere as responsible actors and those that may pose challenges to local regulators.

Ohio also created a careful record of the development of the RUMA, that could be followed in other states. County attorneys in Ohio requested a formal opinion from the Ohio Attorney General as to the legality of road use agreements, especially because the RUMAs not only required private companies to pay for county road repair, but often to arrange for or undertake the work themselves. Another unique feature of the county RUMAs was that RUMAs were required only of the oil and gas and wind industries. The Ohio Attorney General ultimately issued a 20+ page opinion concluding that although the RUMA's raised novel questions of law, the RUMAs were supportable under state laws (Ohio Attorney General, 2012). The fact that the AG's interpretation of this novel approach has not been challenged may suggest that the approach is working well for both the regulated community and the regulators.

Challenges

Preemption by state law is the most likely successful challenge to local efforts to regulate oil and gas, and is therefore discussed above in the context of zoning. However, as local

governments consider what approaches would best advance the goals of road maintenance and responsible development of hydrocarbon resources, close collaboration with town, city, or county counsel and an understanding of other potential challenges can be useful. As noted, the best approach to maintaining transportation infrastructure will vary from jurisdiction to jurisdiction, as will the risk of challenges. Whether a challenge to a local regulation is successful or not, avoiding the costs of litigation may be a better use of resources. However, this framework provides a starting point by which townships can begin to examine potential options.

Exactions and Unconstitutional Conditions

Permit conditions and impact fees are known as exactions, that is, conditions or costs that governments impose on a developer in exchange for allowing certain land uses that the government could otherwise prohibit (Been, 2010). Exactions imposed by local governments are permissible if they do not violate what is known as the "unconstitutional conditions" doctrine; that is, the condition being sought by the government (whether money, road repair, an easement, or otherwise) must bear an "essential nexus" to a legitimate public interest and be "roughly proportional" to the projected impact of the property use.[39] The unconstitutional conditions doctrine has its roots in the notion that the government should not be able to use its permitting or other regulatory powers to coerce individuals (or companies) into giving up constitutional protections.[40] The U.S. Supreme Court has recognized the doctrine in a number of circumstances, from prohibiting the government from burdening the constitutional right to travel by conditioning health care benefits on local residency requirements, to "pressuring a property

[39] *Nollan v California Coastal Commission*, 483 US 825, 837 (1987); *Dolan v City of Tigard*, 512 U.S. 374, 391 (1994) ("'[R]ough proportionality' best encapsulates what we hold to be the requirement of the Fifth Amendment . . . the city must make some sort of individualized determination that the required dedication is related both in nature and extent to the impact of the proposed development.").
[40] *Koontz v. St. Johns River Water Management District*, 133 S. Ct. 2586 (2013).

owner into voluntarily giving up property for which the Fifth Amendment would otherwise require just compensation."[41]

Importantly, road and traffic impacts generated by development have traditionally been well within the realm of permissible impacts local governments can address by imposing an exaction (Been, 1991).[42] However, the ability of local governments to quantify the impacts to local roads stemming from oil and gas development is especially important in defending against claims of unconstitutional conditions. The local government would need to establish that any condition it imposes on the oil and gas operator (e.g., road repair and maintenance requirements, direct financial contribution to city road management, truck volume limits, etc.) are roughly proportional to the impact of the intended use of the property (the drilling of the well and use of the public roads to transport oil and gas). Accordingly, the specific impact that oil and gas development has on local roads (including the use of well technologies that necessitate higher truck volumes) will be directly related to the types of conditions that the local government can constitutionally impose on operators. This is why the work discussed in Chapter Three is vital to a locality's ability to address the impacts through local control measures.

Moreover, a local government cannot seek to remedy the impact of a number of operators or an entire industry in an area by burdening just one or a few companies. The condition the government imposes on an oil and gas operator must be roughly proportional only to that operator's proposed property use. This can be challenging with respect to local road maintenance in counties or townships where multiple oil and gas companies operate, because it is often difficult to determine which operator's trucks and how many of them are operating on

[41] *Id.* at 2594.
[42] *B.A.M. Dev., L.L.C. v. Salt Lake Cty*., 282 P.3d 41, 47 (Utah 2012) (upholding exaction to offset traffic and road impacts).

any particular road. Accordingly, methods by which local governments can quantify road impacts using a per-well fee, road use permits, or other methods that accurately link potential impacts to individual operators are most useful to establish the required "rough proportionality" between the operator's property use and the condition imposed on that operator by the locality.

State constitutions and laws may impose additional limitations on the types of exactions local governments may impose, but challenges based on unconstitutional conditions may be likely if an operator believes the local government has violated these constitutional requirements. For example, in Arlington, Texas, the oil and gas association raised the unconstitutional exaction argument in its challenge to city permitting and fee requirements, although the case was ultimately settled after the city amended its ordinance.[43]

Two debates in the literature regarding exactions are important to note. First, the question of who ultimately pays the price of exactions imposed on development by local or state governments (Been, 2005) is critical to understanding which stakeholders such fees may ultimately benefit or burden. There is an argument that impact fees ultimately are passed on to the consumer (Huffman, et al., 2007). In the context of oil and gas development, if the payment goes from an oil and gas operator to the local government for road maintenance, but the cost of that payment is ultimately reflected in the price of gas or oil to a national consumer, then consumers may be bearing more of the true cost of the resource extraction. If the revenue of impact fees or benefits of other exactions are directed at the level of government where the impacts are most felt, with revenue sharing consideration given to neighboring jurisdictions

[43] *City of Arlington v. Texas Oil and Gas Association*, No. 02-13-00138-CV (Ct. App. 2nd Dist. Texas, 2013). The primary challenge by industry was to a fee being charged to well developers for the training and equipping of City firemen on how to fight gas well fires, a charge that was never imposed on other industries and, in their view, amounted to an unlawful occupation tax under Texas Law. The city ultimately amended the ordinance and withdrew that fee, and the case settled. The road use permitting fees are still in force.

which also bear associated costs, this may result in a more equitable allocation and assure that more of the revenue from any impact fee will actually be used to address impacts (Pennsylvania Public Utility Commission, 2016).

Second, it is not entirely settled whether the exaction framework laid out in Nollan and Dolan applies to legislatively imposed exactions (in this context, the local government exercising the power of the legislature by enacting ordinances) (Kent, 2010). The argument is that because these types of actions apply more widely, rather than a more targeted administrative decision that seeks a fee from a single company, legislative actions are less subject to improper government behavior. However, the majority view rejects exempting these types of legislative actions from the exactions framework (Goodin, 2005).

In contrast to legislatively imposed fees or costs, payments or costs imposed in an ad-hoc way fall squarely within the constitutional exactions framework.[44] Figure 19, set forth and discussed later in this Chapter, classifies ad-hoc decisions as subject to these types of challenges, but reflects a view that they are less likely to be challenged because of the voluntary nature by which they arise in the oil and gas context. Regardless, it is an issue that local governments should be aware of as they determine which approaches will be most effective for a particular locality.

Takings

Private property is not absolute, and has traditionally been described as a "bundle of rights" that one might have with respect to some thing or interest (e.g., money, land, or an intellectual idea). For example, the bundle of rights might include the right to exclude others, the right to possess the property, the right to control its use and enjoyment, or the right to sell it.

[44] *San Remo Hotel L.P. v. City & County of S.F.*, 41 P.3d 87, 104-06 (Cal. 2002) (applying Nollan/Dolan to ad-hoc fees).

State law typically defines what "property" is[45], but once something is property, federal constitutional protections attach.

The U.S. Constitution allows the federal or state government to take private property for a public use if just compensation is paid to the property owner. U.S. Const. Amend. V and XIV. Like other state powers, the eminent domain authority belongs to the state but the state can, and does, delegate that power to state agencies or to local governments.[46]

The government, in the lawful exercise of its police power, also can enact regulations that burden or even extinguish one or more of the various "rights" in the bundle without having to pay the property owner compensation. If the case were otherwise, and the government had to pay compensation every time it burdened private property by enacting regulations to support the public welfare, it effectively would not have any real police power to exercise.[47] However, where a legitimate government regulation of property requiring no compensation to be paid ends, and a taking requiring just compensation begins, is a question that often ends up in the courts to be decided on the specific facts of each case.

In the context of oil and gas development, the most common kind of takings challenges are regulatory takings challenges. In these cases, rather than seizing physical property, the government uses its police power to adopt regulations or laws that burden property rights that a mineral rights owner may have with respect to their ability to extract and sell the oil or gas. The property in these cases is typically the right to the value of an existing oil or gas lease, a

[45] *Stop the Beach Renourishment, Inc. v. Fla. Dep't of Envtl. Prot.*, 560 U.S. 702, 707 (2010) ("Generally speaking, state law defines property interests....").
[46] *See e.g., Borough of Essex Fells v. Kessler Inst. for Rehab., Inc*., 673 A.2d 856, 860 (N.J. Super 1995) (power of eminent domain belongs to the state legislature, which it can delegate to political subdivisions).
[47] *Pennsylvania Coal Co. v. Mahon*, 260 U.S. 393, 413 (1922) ("Government hardly could go on if to some extent values incident to property could not be diminished without paying for every such change in the general law. As long recognized some values are enjoyed under an implied limitation and must yield to the police power.").

recognized property interest. For example, regulations that mandate how drilling should be conducted, safeguards that must be put in place, the allowable locations for drilling, or a requirement that a permit be obtained all may burden the right of the leaseholder to extract and sell the oil or gas, but these are more likely valid exercises of the police power of the state to protect the public and the environment.

A more difficult case may arise if a locality or a state bans hydraulic fracturing, or all oil and gas drilling, entirely. In that case an operator may argue that its mineral lease (in which it may have invested heavily in reasonable reliance on its expectation of being able to extract and sell the minerals) is now worthless, and that the government has taken its property by virtue of the regulation, requiring compensation (ultimately to be paid by local taxpayers). The Supreme Court has established that if a regulation wipes out all (100%) of the economically viable use of the property then a taking requiring compensation has likely occurred.[48] However, if anything less than 100% of the value remains (whether it's 1% or 99%) a fact specific balancing test is applied to determine if a compensable taking has occurred, looking at (1) the character of the regulation, (2) the extent of the diminution in value of the property caused by the regulation, and (3) the impact of the regulation on the reasonable investment-backed expectations of the property owner.[49]

A number of considerations can impact the outcome; for example, is the "property" only the single mineral lease in a township, or if the operator holds multiple leases should they all be considered together (thereby diluting any economic impact of a drilling ban that may not impact

[48] *Lucas v. South Carolina Coastal Council*, 505 U.S. 1003 (1992). The Court explained that these type of regulations "carry with them a heightened risk that private property is being pressed into some form of public service under the guise of mitigating serious public harm." *Id.* at 1018.
[49] *Penn Cent. Transp. Co. v. New York City*, 438 U.S. 104, 124 (1978).

all the leases)?[50] Should the operators have anticipated the possibility of a drilling ban or other limits when it made investments in expectation of being able to drill? Finally, the character of the regulation as a safety or other protection measure often weighs against finding a taking, as opposed to other types of property invasions, such as physical occupation of property (Lynch, 2016).[51]

Court opinions applying takings law to hydraulic fracturing regulations are rare because courts will avoid deciding matters on constitutional grounds when other bases exist; most local fracing bans have been struck down on the basis of state law preemption, not a takings analysis. However, operators are likely to continue to raise takings claims when local governments enact regulatory measures that impact the value of their mineral leases. For example, in *Swepi, LP v. Mora County*, 81 F. Supp.3d 1075 (D.N.M. 2015), a county ordinance prohibited all oil and gas extraction within the county, and the oil and gas company alleged, among other things, a takings claim. In finding that Swepi had standing to bring the claim, the court went further to discuss the merits of the takings claim, concluding that the effect of the ordinance was to wipe out all economically viable use of the property, the oil and gas lease. "[W]hat makes the right to drill for oil valuable—*i.e.* an oil-and-gas lease valuable—is the ability to act on it by drilling for oil. Without that right, an oil-and-gas lease is worthless."[52]

[50] For purposes of a Takings claim, defining the boundaries of the property is critical to whether such a claim is successful. If the "property" is a single oil and gas lease, a local action banning fracing would arguably wipe out 100% of the economic value of the property, and a takings claim may be more plausible. However, if the "property" is the value of all the oil and gas leases held by the operator affected, then a single town's actions may have less impact on the total value of the "property." Similarly, if the "property" included both surface and mineral rights, even extinguishing all the mineral rights would still leave the property owner with some value at the surface, again making a Takings challenge more difficult. This is known as the "denominator problem" referring to the comparison between the value that is taken and the value of the property that remains (Eagle, 2014).

[51] *Id.*

[52] *Swepi*, 81 F. Supp.3d at 1151.

> As long as SWEPI, LP has an interest in the leases—*i.e.* a legally protectable, concrete interest—then it has standing if the Ordinance infringes on this interest, which it does. This taking and destruction of SWEPI, LP's property constitutes an injury in fact. Its leases provide it with a particularized, concrete interest in property that state law protects. The reduction in the leases' value and the destruction of all economic use is an actual injury, rather than one that is conjectural or hypothetical. Accordingly, SWEPI, LP has suffered a sufficient injury in fact to support its takings claim.[53]

Local governments considering regulation of hydraulic fracturing should also be cognizant of the relevance of current norms within their area to the analysis of whether a particular ordinance or regulation takes private property. For example, it is understood that hydraulic fracturing is a necessary component of oil and gas drilling in most formations; without the technology a well could not be economically drilled at all.[54] Also, if oil and gas drilling is prevalent in the area, operators may be more likely to succeed on claims that their investment backed expectations in mineral leases in the area are reasonable.[55]

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[53] *Swepi*, 81 F. Supp at 1153. Additional cases continue to address takings claims in the mineral lease context. For example, although the court determined that the city in *Tri-Power Resources, Inc. v. City of Carlyle*, 967 N.E.2d 811 (Il. App. Ct. 5th Dist. 2012) could ban drilling within residential districts, it expressly reserved judgment as to whether the company was entitled to compensation from the city because the ban would amount to a taking of private property. *Id.* at 817; *Norse Energy Corp. USA v Town of Dryden, No. 2013-00245, 2014 WL 3386936 (April 18, 2014 N.Y. App.),* Amici Brief for Joint Landowners Coalition of New York (arguing that town-wide bans of hydraulic fracturing deprives landowners' of their rights to subsurface minerals and constitutions a compensable regulatory taking*); see also Arsenal Minerals and Royalty et al. v. Denton, Texas,* No. 4:14-cv-00639 (E.D. Tex. 2015) (raising takings claims, but ultimately dismissing the case because the city's regulations did not apply to the plaintiffs' mineral leases); (Lynch, 2016; Smith, 2015).

[54] *City of Longmont v. Colorado Oil & Gas Ass'n*, 369 P.3d 573, 580 (Co. 2016) ("the record before us demonstrates that many operators have determined that fracking is necessary to ensure the productive recovery of oil and gas. For these operators, banning fracking would result in less than optimal recovery and a corresponding waste of oil and gas."); *id* at 593 (virtually all oil and gas wells in Colorado are fracked).

[55] *See e.g., City of Fort Collins v. Colorado Oil*, 369 P.3d 586, 594 (Colo. 2016) (rejecting the city's reliance on regulatory takings cases to argue that temporary moratoriums are aimed at preserving the status quo because oil and gas drilling was prevalent across the state and the city's ordinance "substantially disrupts" the status quo of extensive oil and gas development).

With respect to roads and other transportation infrastructure, local governments may have strong arguments that imposing fees or taking other measures sufficient to offset non-customary damages to infrastructure would be a legitimate use of the police power which does not constitute a taking, but the details of any potential regulation or ordinance should be carefully evaluated with both preemption and takings jurisprudence in mind to avoid costly litigation that may not be successful for the local government.

Dormant Commerce Clause Challenges

The regulation of interstate commerce is a power expressly given to the federal government by the Commerce Clause of the U.S. Constitution (U.S. Const. art.I, § 8, cl.3). Although states have some latitude to regulate interstate commerce, a state (and its political subdivisions operating under delegated authority), "may not exercise that police power where the necessary effect would be to place a substantial burden on interstate commerce."[56] The interstate sale and transmission of oil and gas is within the scope of the commerce clause, and waste is also an item of commerce.[57] If a local regulation imposes sufficient burdens on the management or movement of oil or gas production or hydraulic fracturing waste, it may violate the "dormant Commerce Clause," a description given to impermissible burdens on interstate commerce, even where Congress has not acted affirmatively.

The "fundamental objective" of the dormant commerce clause is to "preserve a national market for competition. . . . [T]here can be no local preference, whether by express discrimination against interstate commerce or undue burden upon it . . . ."[58] Local regulations

[56] *Line Corp. v. Hackensack Meadowlands Development Commission*, 464 F.2d 1358 (3d Cir. 1972).
[57] *C & A Carbone, Inc. v. Town of Clarkstown*, 511 U.S. 383, 391 (1994) (invalidating local ordinance that required waste processed in town to be processed at the town's transfer station as violating the Commerce Clause).
[58] *General Motors Corp. v. Tracy*, 519 U.S. 278, 299 (1997).

that burden interstate commerce must "effectuate a legitimate local public interest" and cannot be "excessive in relation to the putative local benefit."[59]

Accordingly, mineral rights owners have argued that local bans on hydraulic fracturing violate the dormant commerce by placing undue burden on commerce. Local regulations on transportation of oil and gas, including those that "curtail transportation" have also been singled out as excessive burdens on commerce, but these arguments have not yet been resolved by courts.[60] In *Grafe-Kieklak v. Town of Sidney,* local landowners sued the local town arguing that the local law banning hydraulic fracturing within town limits violated the dormant commerce clause.[61] The court invalidated the ban on other grounds, but some expect that dormant commerce clause claims will become more prevalent as local government attempts to exercise more control over oil and gas development, and the U.S. Supreme Court may need to "step in to remind us all once again that we do not exist in isolation" (Wegener, 2013).

Discrimination / Equal Protection

Imposing a tax, fee, or bonding requirements on one industry but not another may be seen as discriminatory, especially in relation to road impacts which are arguably a function of weight and truck volume, not truck contents, and could violate the state or federal constitution's equal protection clause. Corporations are "persons" within the meaning of the Constitution's Equal Protection clause and are entitled to its protections.[62] Any time a law or regulation treats certain classes or groups differently than others similarly situated, equal protection may be implicated; however, unless the class or group allegedly discriminated against is recognized as a protected

[59] *Pike v. Bruce Church, Inc.*, 397 U.S. 137, 142 (2013).
[60] *See Norse Energy Corp. USA v Town of Dryden*, No. 2013-00245, 2014 WL 3386936 (April 18, 2014 N.Y. App.), Amici Brief for Joint Landowners Coalition of New York at *24.
[61] *Matter of Grafe-Kieklak v. Town of Sidney*, Index No. 2013-602 (N.Y. Sup. Ct. Delaware Co.) filed June 12, 2013.
[62] *Metro Life Ins. Co. v. Ward* 470 U.S. 869, 881 n.9 (1985).

class (e.g., race or national origin) or the law burdens a 'fundamental right,' (e.g., freedom of speech), equal protection challenges are often very difficult to win. In these ordinary cases, to prevail the government need only establish that the classification is reasonably related to some rational government purpose, a low bar to meet.

Although oil and gas operators are not a suspect class, companies are raising equal protection challenges where local governments attempt to curtail oil and gas development. The oil and gas operators made such an argument in *City of Arlington v. Texas Oil and Gas Association*[63], reasoning that a city fee that singled out natural gas operators from other similar industries and imposed a disproportionate permit fee violated well operators equal protection rights. The town charged a $2400 per well fee to natural gas operators, but only a $55 annual fee to other similarly situated business with similar risks and impacts. The court ruled that an industry association had standing to bring the equal protection claim on behalf of its members and while the case ultimately settled, local governments should be aware of these potential challenges.

Swepi, LP v. Mora County, provides a good example of how difficult it can be to prevail on equal protection claims in the oil and gas context.[64] In *Swepi*, the town banned hydrocarbon extraction by corporations, but not by individuals. The oil and gas operators argued that this violated the equal protection clause by discriminating against corporations. Although the court found that the companies had standing to bring the equal protection claim and that it was ripe, the court ruled that the county's distinction between corporations and individuals was not arbitrary (corporations conduct virtually all of the oil and gas drilling, not individuals) and the

[63] No. 02-13-00138-CV (Ct. App. 2d. Dist. Texas, Sept. 18, 2013).
[64] *Swepi L.P. v. Mora County*, 81 F. Supp.3d 1075 (D.N.M 2015).

purpose of the ordinance as stated by the county was legitimate (protecting its water supplies).[65] The court invalidated the ordinance on other grounds, but rejected the equal protection claim.

Nevertheless, courts have found these claims legally sufficient and have required local governments to establish that its classification meets the rational basis test.[66] Before the recent fracing boom, a zoning ordinance in the Town of Westfield, New York required commercial drillers to post a bond, but did not require a bond from landowners drilling gas wells on their own property for their or their tenants' use. Industry argued this discrimination violated their equal protection rights and the court remanded on the equal protection claim, requiring that the town "demonstrate that there is a rational basis for the classification which is fairly related to the objectives of the Ordinance."[67] Especially with respect to road damage, local governments would likely have strong arguments that protecting roads is a legitimate government purpose and courts would be deferential to local government's approaches to do so; but, local planners should assure that proposed ordinances (and any classification scheme) are tailored so that they are "rationally related" to achieving these legitimate government purposes.

Ohio's approach to energy development impacts on roads is interesting in this regard because it expressly only applies to private companies that conduct oil and gas drilling or operate wind farms, thereby regulating on the basis of the class of company, not on the basis of weight or

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[65] Swepi, 81 F.Supp.3d at 1180.

[66] When the constitutionality of a statute or ordinance is challenged, courts utilize one of three different levels of review to determine whether the law or ordinance may stand. The most lenient review is called "rational basis" review, where the court will uphold the law if it is merely *rationally related* to a *legitimate government interest*. Where a law impacts certain "suspect classes" of people (e.g., race or religion) or rights that have been found by courts to be "fundamental" (e.g., the right to certain forms of free speech), a much higher level of justification for the law is required, known as "strict scrutiny." The government must show that the law was *narrowly tailored* to further a *compelling governmental interest,* or the law will be invalidated. Finally, intermediate review requires that the law be *substantially* related to an *important government interest* and is often applied to equal protection challenges to certain gender classification cases.

[67] *Envirogas, Inc. v. Town of Westfield*, 82 A.D.2d 117, 442 N.Y.S.2d 290 (4th Dep't 1981).

the number of trucks. Local counties sought a formal opinion from the Ohio Attorney General as to the legality of this law which authorized Ohio counties to compel only these two categories of private companies to "improve and repair public roads." The Ohio Attorney General issued a formal opinion concluding such an approach is permissible,[68] and I am not aware of any challenge to the Ohio law on equal protection grounds or otherwise.

Substantive Due Process

The Fourteenth Amendment's Due Process Clause provides that "no State shall ... deprive any person of life, liberty, or property without due process of law." U.S. Const. amend. XIV, § 1. This clause has both a procedural component (what process must the government go through before it can lawfully deprive a person of life, liberty, or property) and a substantive component, meaning that regardless of the adequacy of the process, the state cannot deprive a person of life, liberty, or property for an arbitrary reason.[69] When local ordinances burden, diminish or entirely wipe out the value of a company's oil and gas lease -- which is property protected by the constitution -- companies have argued that the ordinances violate their substantive due process rights.[70] Property (land or mineral interests) is not a fundament right, so an ordinance burdening property generally must only bear a rational relationship to a legitimate government interest to satisfy due process.[71]

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[68] Ohio Attorney General Opinion No. 2012-029, September 19, 2012.
[69] *Daniels v. Williams*, 474 U.S. 327, 331 (1986); *Hyde Park Co. v. Santa Fe City Council*, 226 F.3d 1207, 1210 (10th Cir. 2000).
[70] *See Creatures of Circumstance: Conflicts Over Local Government Regulation of Oil and Gas*, 60 RMMLF-INST § 11.03((2)(c)(i), (2014) at 11-42.
[71] *Dias v. City & Cnty of Denver*, 567 F.3d 1169, 1181 (10th Cir. 2009); *see also Nectow v. City of Cambridge*, 277 U.S. 183 (1928) ("The governmental power to interfere by zoning regulations with the general rights of the land owner by restricting the character of his use, is not unlimited, and, other questions aside, such restriction cannot be imposed if it does not bear a substantial relation to the public health, safety, morals, or general welfare.").

It is important to note that the framework for addressing substantive due process claims is not always consistent and has lent itself to some confusion in the courts. Federal courts are not all in agreement regarding the standard to apply to different property interests, and state courts similarly take varying views. In addition, *executive* action is reviewed under a different standard than *legislative* actions and must generally be "abusive," "shock the conscience" or sufficiently egregious to violate constitutional norms (Chesney, 2000). Because local government (county, city, or town) ordinances and regulations are legislative in nature, this section of the dissertation focuses on the due process requirements for legislative acts and potential outcomes local governments should be aware of when making efforts to regulate oil and gas development.

The Due Process clause of the U.S. Constitution provides minimum mandatory protections applicable to all, but similar clauses found in state constitutions may be interpreted as providing even greater limits on government intrusion. States have taken a variety of approaches to analyzing substantive due process challenges brought under both the federal Due Process clause and state counterparts. Some states look carefully (but still with deference to the local government's conclusions) at the benefits a local regulation creates in relation to its lawful purpose as compared to the burdens and costs on the aggrieved party's rights. For example, a Texas court applying a state counterpart to the federal Due Process clause looked at the costs and benefits of legislation to determine whether the "actual, real-world effect" of the law on the aggrieved party "could not arguably be rationally related to, or is so burdensome as to be oppressive in light of, the governmental interest."[72]

In *Patel v. Texas Dep't of Licensing & Regulation*, a state licensing scheme required eyebrow threaders to obtain a cosmetology license which required 750 hours of training that, the

[72] *Patel v. Texas Dep't of Licensing & Regulation*, 469 S.W.3d 69, 87 (Tex. 2015).

threaders argued, "had no rational connection to reasonable safety and sanitation requirements, which the State says are the interests underlying its licensing of threaders."[73] The Texas Supreme Court agreed, stating that

> [T]he admittedly unrelated 320 required training hours, combined with the fact that threader trainees have to pay for the training and at the same time lose the opportunity to make money actively practicing their trade, leads us to conclude that the Threaders have met their high burden of proving that, as applied to them, the requirement of 750 hours of training to become licensed is not just unreasonable or harsh, but it is so oppressive that it violates [the due process clause of the state constitution].[74]

Although occurring in the context of burdensome licensing requirements, the *Patel* decision illustrates that local government regulations that burden oil and gas operators with "oppressive" requirements may not survive review, depending on the governmental interest at stake. Banning hydraulic fracturing entirely may serve the ends of protecting road infrastructure, but the resulting infringement on oil and gas owner's property rights may violate the dormant commerce clause. Less burdensome restrictions are more likely to be considered rationally related to the government's legitimate need to maintain transportation infrastructure.

With respect to zoning ordinances, Illinois courts have applied an eight factor test that includes a review of the gain to the public in relation to the burden to the property owner within the context of existing property uses nearby.[75] Other states take a more deferential view of local government control over property rights (Serkin, *et al.*, 2013).[76]

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[73] *Id*. at 88.
[74] *Id.* at 90.
[75] *Twigg v. County of Will*, 627 N.E.2d 742 (Ill Ap Ct. 1994) (finding unconstitutional a local zoning ordinance that prohibited a landowner from building two residences on a 5-acre parcel).
[76] *Cormier v. County of San Luis Obispo*, 207 Cal. Rptr. 880 (Ct. Ap. 1984); *Bonner v. City of Brighton*, 848 N.W.2d 380, 393 (Mich. 2014) (rejecting due process challenge to local ordinance that allowed destruction of unsafe structures without providing property owner the opportunity to repair).

Oil and gas companies have raised substantive due process challenges to local regulations, but most of these claims have settled or been resolved on other grounds. However, in *Swepi, LP v. Mora Cty*.,[77] the court found that the oil and gas association had standing to bring a substantive due process claim challenging a local ordinance banning drilling by corporations because the "the claim centers around deprivation of its property – its [oil and gas] leases – for an arbitrary reason – because it is a corporation."[78] The court nevertheless found no substantive due process violation because property is not a fundamental right, and the county had a rational basis for banning corporations, but not individuals, from hydrocarbon extraction; that is, only corporations typically engage in drilling.

For purposes of substantive due process challenges, evidence regarding the burden to the oil and gas driller or property owner in relation to existing local land use approaches and the benefits to be gained by the ordinance are likely to be relevant. Local planners attempting to enact ordinances to manage the impacts of oil and gas to local roads (a legitimate government purpose) arguably have a myriad of approaches available to them that would survive any substantive due process challenge. However, planners should give consideration so that the means by which a local ordinance accomplishes a legitimate government purpose is reasonable in relation to the burdens it imposes on property owners or other recognized rights of citizens or companies.

Supremacy Clause

The oil and gas operators in *Swepi* succeeded on their claim that the local county ordinance violated the Supremacy Clause of the U.S. Constitution by declaring that corporations would not have federal constitutional rights. The court ruled that these sections of the ordinance

[77] *Swep*i LP v. Mora Cty, 81 F. Supp. 3d 1075 (D.N.M. 2015).
[78] Swepi, 81 F. Supp.3d at 1153.

were invalid as conflicting with the established decisions of the U.S. Supreme Court interpreting the U.S. Constitution, noting that a local ordinance cannot strip corporations of their federal constitutional rights.

42 U.S.C. § 1983

The vehicle through which oil and gas operators are likely to assert a cause of action for local government violations of constitutional rights and federal law is 42 U.S.C. § 1983 (Ritchie, 2014). Section 1983 provides that any person whose federal or constitutional rights (such as the right not to be deprived of property without due process) are violated by persons acting "under color of [law]" is liable to the injured party. Section 1983 applies to local legislative bodies such as town councils and zoning boards, and local governments are not immune from suit (Ritchie, 2014). Local ordinances can be invalidated and local governments may be required to pay attorney's fees.

A Policy Toolkit for Local Planners

Krane, *et al* has called the "degree and types of discretionary authority possessed by local governments [the] 'toolkit' with which local officials may act to satisfy local needs" (Krane, *et al*., 2001). The approaches discussed in this Chapter are broad; the specifics must be determined by local planners addressing local needs which will vary across communities. For example, while impacts may be addressed through the requirement that an operator obtain a drilling permit, the precise terms of that permit will vary. The permit may prescribe certain routes that must be avoided or taken, may impose an impact fee that will be delegated to road repair, may require a pre-well construction road analysis, an in-kind grant of road construction materials to the locality, or any number of requirements. Moreover, the approaches discussed here are targeted to addressing impacts to transportation infrastructure, other types of impacts may best be

served by the utilization of other tools at a local government's disposal (e.g., noise or dust mitigation, ecosystem protections, etc.).

Figure 19 sets forth the survey of regulatory approaches, along with potential challenges depending on the approach selected, that local governments could use to quickly assess potential options to addressing impacts to transportation infrastructure. The box at the top of the Figure indicates that the local government must first have been delegated power by the state legislature in order to act. Although determining the extent of this power is a critical first step, most local governments have been delegated some form of power by the state, so the next step shown on the Figure concerns whether the local government will exercise its zoning power or its police powers.[79] As illustrated, the use of the zoning power entails local land use controls that a local government can implement, such as to prohibit oil and gas development next to a school or residential district.

The other pathway available to local governments is the exercise of the police power. This can take the form of mandatory and legally binding ordinances that would be imposed on operators, or voluntary agreements that the operators would enter into with the local government. Approaches colored in orange are more likely to be vulnerable to the potential legal challenges correspondingly indicated in orange to the right under the heading "Potential Challenges." The "agreements" pathway is colored green because voluntary agreements are less likely to be the subject of legal challenges than mandatory ordinances. However, the specific examples of agreements are shown half in orange because while they are less likely to be challenged given the input the oil and gas operator has into the process, they are not immune from the selected

[79] Zoning power and police powers, as noted above, can be interlinked, but for purposes of Figure 19 they are considered separately because zoning has traditionally been one of the fundamental powers of a local government and would be limited primarily to land use decisions.

potential challenges; local governments should therefore assure even voluntary agreements are legally defensible. This is especially true where the local government may *require* the execution of a 'voluntary' agreement in order to obtain a drilling or other essential permit. The framework represented by Figure 19 is intended to assist localities in developing defensible strategies that support the maintenance of transportation infrastructure and the efficient allocation of scarce resources.

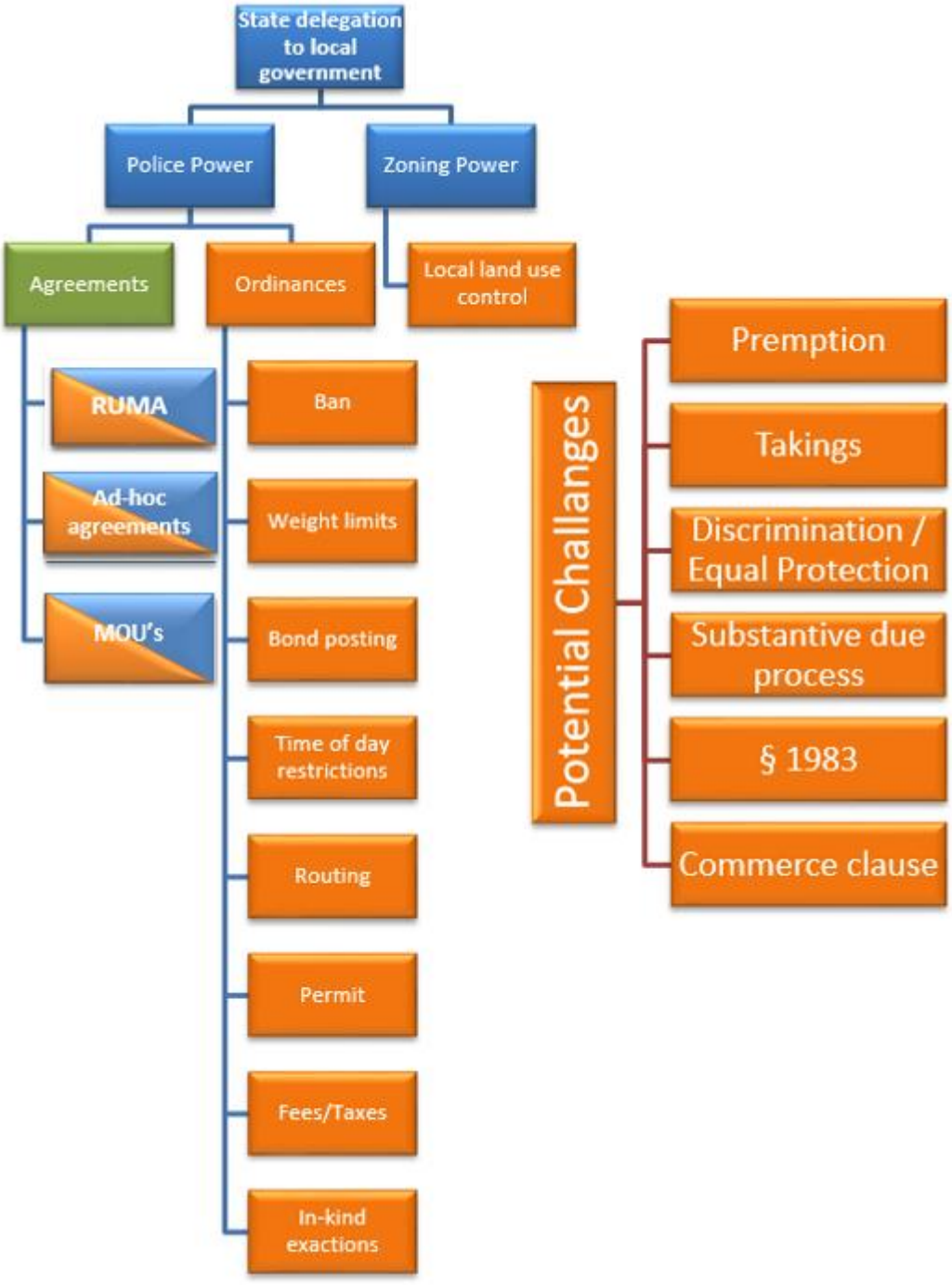

Figure 19. Regulatory methods and potential legal challenges to addressing energy sector impacts to local transportation infrastructure. Orange in left diagram indicates vulnerability or potential vulnerability to the legal challenges indicated on the right in orange.

Conclusion

As many studies have now made apparent, whether and how much road degradation occurs in a community from an influx of hydraulic fracturing is based on many factors. These include the number, weight, and types of trucks, but also the road design, road age, other road uses, local maintenance approaches, season, weather, and geographic location (roads subject to a freeze-thaw cycle can experience significantly more damage than roads in more temperate climates). Accordingly, there is no single approach (regulatory, market driven, voluntary, or otherwise) that will adequately address all the problems experienced across the country. Rather, a number of potential approaches to draw from is needed, one that is flexible and from which local planners can adapt to suit unique local circumstances. In the transportation context, oil and gas operators and local planners have the same goal: transportation infrastructure that performs with adequate safety. Some of the approaches outlined in this Chapter can be instrumental in supporting improved local decision making and assisting local governments better understand which approaches may most benefit their communities. Understanding the legal authority for local government action, and the potential legal challenges to selected regulatory approaches, can better position local planners to promote and defend the responsible development of oil and gas resources.

CHAPTER V

CONCLUSION

Perhaps more than any other environmental issue in the last twenty years, none has been more controversial than the recent increases in the number of oil and gas wells being drilled, thanks to technological advances in hydraulic fracturing and horizontal drilling. It is likely that no one could have predicted that in just a few years the U.S. would become the world's largest producer of both oil and gas, surpassing Russia and Saudia Arabia and remain at the top for so long, even with historically low oil prices. Areas of the country that do not have a history and long experience with a robust oil and gas industry suddenly found themselves impacted by both the positive and negative aspects of what could be considered a modern gold rush, this time for oil and gas. Citizens suddenly living in close proximity to oil and gas wells, without knowledge of the process or technology, understandably became afraid of the unknown. Local planners were tasked with assuaging a sometimes fearful public, promoting oil and gas development because of the economic prosperity it can being to an area, and managing transportation and other infrastructure impacts from this new industry with which many may have had little experience. This dissertation work endeavored to provide insight and methodologies to assist with all of these issues.

Chapter Two of this work addressed one of the first emerging concerns regarding hydraulic fracturing: public stakeholder engagement in and knowledge of the constituents being used in the hydraulic fracturing process. To respond to public fear, a group of oil and gas regulators, and a group of ground water protection regulators, came together to develop a tool, FracFocus.Org, by which members of the public could search for hydraulic fracturing information on a well-by-well basis. Almost immediately, a paper out of Harvard Law School,

that was never peer reviewed, claimed that FracFocus.Org was a "failure" and not useful to state regulators.

Recognizing the lack of data and analysis to support this conclusion, and the importance to the national debate of a better understanding of hydraulic fracturing impacts, the work discussed in Chapter Two set forth to undertake a national survey of state regulators with experience using FracFocus. The work sought to determine whether the claims made in the Harvard Report were supported by the regulator's experiences, and whether there were important practices and knowledge that could be better shared among the states to address stakeholder concerns.

The work outlined in Chapter Two concluded that States overall have a very positive view of FracFocus and are using it in their regulatory programs in robust and even novel ways. Importantly, it appears that FracFocus has provided an extra measure of accountability for operators, in that several states are using the site to double check submissions that are made to the state against submissions made to FracFocus, and are promptly following up with operators when compliance issues come to light in this way. By highlighting the various ways states are using FracFocus in an accessible format, states are now better able to share and learn from each other's practices.

Next, I sought to leverage the information and data gained through the analysis of FracFocus to develop methods by which local planners, especially in rural, underfunded communities, could utilize to better address local impacts to transportation infrastructure. Adequate transportation infrastructure is a critical component of a successful oil and gas industry. Operators must be able to get equipment, supplies, and ultimately the product, to or from the wells. One significant finding from the work conducted for Chapter Two was that

FracFocus collects well-by-well data on water volume usage, which is one of the most salient factors for a local community to determine damage to roads and bridges. Many local planners were not aware this information existed or how to access it, yet managing water flows to and from wells can dramatically reduce the impacts to local roads.

As a result, in Chapter Three, I present a method by which local planners, in particular those with few resources, can use to determine where well development is likely to occur, where it already has aging or sub-standard roads and bridges, and options for minimizing impacts. The method discussed relies in part on using FracFocus to obtain data on water use information in a local community. By understanding water use, and identifying and mapping a local community's most vulnerable transportation infrastructure in relation to potential wells, local planners can quickly understand what measures may be most effective at mitigating damage.

Finally, local planners have a range of options available to them to address impacts to the community and infrastructure from oil and gas development. What was lacking in the literature was a comprehensive framework for assisting planners in identifying defensible strategies and the likely challenges to selected strategies. Chapter Four sets forth a legal and policy framework local planners can utilize when weighing costs and benefits of different responses to particular impacts. This framework can aid planners in identifying efficient and effective responses that are most likely to withstand scrutiny.

Although, for environmental reasons, the world needs to move away from burning fossil fuels, fossil fuels are responsible for the development of the modern world and many of the conveniences we enjoy and depend on. The human ingenuity, science, and technology that allows us to reach vast reserves of oil and gas trapped deep below the earth's surface and refine it to provide electricity and power our cars, generators, homes and offices, airplanes and more,

deserves some measure of admiration. The energy poverty in which a lot of the world's population lives, and which directly accounts for a tremendous amount of human suffering, disease, and early death, also cannot be forgotten. In this regard, hydraulic fracturing brings with it both benefits and burdens. While we are still reliant on oil and gas, this dissertation hopefully provides a small step towards more effective management of those impacts, especially in more rural communities in the U.S., and greater responsiveness to the variety of stakeholders involved.

Further research could build on the work presented here that would assist local planners. For example, FracFocus is a relatively new tool and further research should explore additional ways to leverage the data being collected to support the responsible development of oil and gas resources. More research is also needed to find methods and approaches by which under-funded local governments can more easily gain access to, and awareness of, the best practices and knowledge being developed across the country. Local planners are some of the most important stakeholders in this conversation, yet are too often overlooked, especially in rural communities. The development of additional proof of concept case studies could also be undertaken to test the processes developed in this dissertation work. Local planners also could benefit from easily accessible and free or low-cost computer based tools that could model, with minimal inputs from local planners regarding current road conditions and materials, degradation and expenses associated with an increase in high volume truck traffic. These types of computer based tools could provide tremendously useful, especially those that can reasonably estimate per-well impact fees the locality is likely to experience.

The work discussed here regarding bridges could also be expanded to include ratings for the current load carrying capacity of local bridges. If local governments had access to a better understanding of the current load capacity of their bridges, this could support better decisions

regarding routing or needed repair work. Some local officials informed us that moving a drilling rig alone can take up to 150 trucks, and often half of those may be over size or over weight. Because it only takes one truck over a bridge's load limit to cause the bridge to fail, knowledge regarding the current load carrying capacity of the bridges is very important.

Finally, this work has only begun to explore the link between operator perspectives and successful management of transportation infrastructure by local planners. There is a need for a greater understanding of the impacts that the relationships between state legislature, local planners, and oil and gas operators have on the quality of transportation infrastructure and the ability to maintain it.

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APPENDIX A

FracFocus Survey Questions for Chapter II

Survey of state regulators

Question #	Question	Response options
1	Does your state require reporting to FracFocus.org? You should answer yes if there are any circumstances described by your regulations that would require an operator or service provider to report to FracFocus.org, even if there are some cases where reporting to FracFocus.org would not be required.	Yes No Other [with text box for comments]
2	Is reporting to FracFocus.org an optional method of meeting certain disclosure or reporting requirements that is available in your state?	Yes No Other [with text box for comments]
3	If you answered Yes to either Question 1 or 2, please describe the process by which you are notified when a company makes a submission to FracFocus.org. For example, please explain if the company notifies you directly, provides copies of the submission to you, or if you learn of a company's submission directly from FracFocus.	Text Response
4	In your view, is FracFocus.org timely in notifying state regulators when a company makes a submission to FracFocus in your states (whether or not the company's submission is mandated by state regulations or made voluntarily)?	Very Timey (we are typically notified within a few days or less of the submission) Fairly Timely (we are typically notified within a week or 10 days of the submission) Not so Timely (it can take weeks before we are notified) Extremely Poor (the delay can be very long or we may not be notified at all) Other (with text box for comments)
5.	Has your agency ever used the FracFocus.org website to download data directly into your state computer systems or do you have any plans to do so?	Yes No

6.	Does your state use FracFocus.org to gather information on chemicals used in the hydraulic fracturing process in your state? (You should answer yes if FracFocus.org is at least one method you use to obtain the information, even if there are other methods).	Yes No Don't know or not sure
7.	Does your state use FracFocus.org to gather information on water volumes being used in the hydraulic fracturing process in your state? (You should answer yes if FracFocus.org is at least one method you use, even if there are other methods).	Yes No Don't know or not sure
8.	Please describe how your agency has used FracFocus.org to support your regulatory programs. Provide as much detail as you would like.	Text response
9.	Protection of trade secrets information has been part of the national discussion regarding hydraulic fracturing chemical disclosure requirements. How satisfied are you with FracFocus.org's approach to identifying when claims of trade secret have been made on a submission to FracFocus.org?	Very Satisfied Satisfied Neutral Dissatisfied Very Dissatisfied
10.	Overall, how satisfied are you with FracFocus.org	Very Satisfied Satisfied Neutral Dissatisfied Very Dissatisfied
11.	Please use this space to let us know anything you would like to about how regulators view FracFocus.org.	Text response

APPENDIX B

Study Synthesis for Chapter III

Synthesis of Studies Addressing Transportation Impacts Associated with U.S. Oil and Gas Development

Formation and/or State	Study Name and Authors	Summary of study goals and methods	Important findings
Bakken (oil) (Montana)	*Impacts of Bakken Region Oil Development on Montana's Transportation and Economy, Montana Department of Transportation* Brown, N., Fossam, H., Hecht, A., Dorrington, C., McBroom, D. January 31, 2013	Examine impact of total traffic from population increases stemming from energy development to determine if there are road capacity issues in Eastern Montana; ran four oil-production scenarios correlated with two population increase scenarios (total traffic correlated with population increases). Most of the oil boom was in Western North Dakota, growth was expected in Eastern Montana but the extent and level of that growth was uncertain, prompting the need for this study of potential transportation impacts. This study used REMI, an input-output model that allows users to input specific changes to an industry and region and it will provide year by year forecast outputs for a range of economic and demographic characteristics. The authors were able to customize inputs/outputs for horizontal wells in Montana, which differ from conventional vertical wells. Model inputs were construction of new wells, operation of new wells, ND effects that spill into MT, royalties from MT production, taxes from MT production, truck transportation associated with construction and operation of wells. From this the model provides population growth and economic impacts over time, all of which translates into traffic growth, which was the primary aim of the study.	Under higher population scenario AADT grows from 4000 in 2007 to 16,000 in 2030, but this does not present a road capacity problem. Developed a production equation that relates the production to the number of new wells drilled and the total number of wells producing using least squares relationship of new wells to barrel production and average relationship of new wells to cumulative producing wells for northeast MT for 1990-2012. Was very close to actuals until 2010 (explained because movement to ND occurred). *Assumes permits are a leading indicator of future new oil wells*.
Bakken (ND)	*Additional Road Investments Needed to Support Oil and Gas Production and Distribution in North Dakota*. Upper Great Plains Transportation Institute (UGPTI). December 9, 2010.	Purpose of the study is to forecast road investment needs in oil and gas producing counties to meet expected growth in ND over the next 20 years. Effort was made to quantify the needed investments to maintain roads to acceptable service levels for oil and passenger use. Focus was on roads owned or maintained by counties and townships. Study methods used: forecast projected oil production, forecast well inbound and outbound trips, conduct a traffic analysis deploying counters in 100	Total truck trips per well = 2,024 (half loaded) Estimated investment needs (cost of oil-related traffic) for unpaved roads over next 20 years is $567 million; for paved roads it is $340 million. Average reduction in service life with oil traffic is 5 years on paved county roads. Certain roads recommended for structural overlays or reconstruction.

Formation and/or State	Study Name and Authors	Summary of study goals and methods	Important findings
		locations, identify and rank the structure of paved county roads, identify roadway widths, using design equations and ESAL factors; service life of each impacted road is then projected with and without oil traffic. Provided detailed information on paved and unpaved roads analysis and by county.	
Bakken (ND)	*Infrastructure Needs: North Dakota's County, Township and Tribal Roads and Bridges: 2015-2034.* Final Report to the North Dakota Legislative Assembly. Upper Great Plains Transportation Institute, November 24, 2014	Detailed GIS model developed for the entire state using proprietary software. It includes the origins of key inputs (water, sand, pipe, chemicals, etc.), the destinations for the oil and water coming out of the well, and the capacities or each source or destination (rail, pipeline, or other transfer facilities). Capacities of transfer sites are expressed in throughput volumes per day. GIS model routes the products, and can then sum the individual movements over each road segment to yield total truck trips per year. Trips are converted to equivalent axle loads and trips per day. Combining this with road type and condition data yields estimates of improvements and maintenance needed for both paved and unpaved roads.	$5.5 billion needed statewide over next 20 years, with 54% of this stemming from the 17 oil and gas producing counties.
Barnett (Texas)	*Road Damage Fee Assessment Study: City of Keller, TX* Belcheff and Associates (2010) for the City of Keller	The authors of this study estimated the total costs to roads associated with gas extraction activities in the City of Keller, Texas. By estimating the number of heavy truck vehicle trips associated with constructing and operating a single well over the lifetime of the well (assumed to be 20 years) under different conditions (such as water trucked or piped), the authors estimated the total ESALs available on each of eight types of city roads, then estimated loss of road life because of oil or gas activities. These findings enabled them to derive a fee per lane-mile that would offset damages.	Fees ranging from $53 to $19,977 per lane mile to offset the expected damages are needed, depending on the transportation methods and type of roads.
Barnett (gas) and Permian Basin (oil) (Texas)	*Impacts of energy developments on the Texas transportation system infrastructure* Prozzi, J. P., Prozzi, J. A., Grebenschikov, S., & Banerjee, A., (2011). No. FHWA/TX-11/0-6513-1A. Center for Transportation Research, University of Texas at Austin.	Comprehensive study to quantify the effect of energy related traffic on Texas' transportation system.	High axel weights and volume over a very short time period can significantly shorten roadway life. State highways and interstates were not as impacted. For natural gas wells, well construction and facing activities had the most impact on roads.
Colorado	*Road & Bridge Department Impact Fee Support Study*, Rio	This study assessed existing road damage, projected future growth, and developed a fee assessment per ESAL, then translated	Cost estimates of approximately $18,000 per well (2010 dollars) to account for damage to roads.

Formation and/or State	Study Name and Authors	Summary of study goals and methods	Important findings
	Blanco County, Colorado. RPI Consulting. (2008).	that to a fee per well based on the expected ESALs needed over the lifetime of the well.	(Rio Blanco, CO currently imposes a well impact fee for wells deeper than 5,500' of $17,981 per well and $10,581 for wells less than 5500' deep. Wells with on-site produced water disposal pay $10,881 per well).
Texas	*Energy developments and the transportation infrastructure in Texas: Impacts and strategies.* Quiroga, C., Fernando, E., and Oh, J. (2012). Texas Transportation Institute, San Antonio, TX. Report No. FHWA/TX-12/0-6498-1	This study used traffic and pavement condition data and field inspections to assess impacts and remaining pavement life, as well as estimated truck loads and developed a methodology for impacts. Impact assessment focused on pavement impacts, roadside impacts, operational and safety impacts, and economic impacts. The authors used MODULUS 6 and Overweight Ruck Route Analysis software programs to analyze road remaining life using many data inputs.	Major impacts to roads from drilling/fracturing operations, and developed recommendations for road maintenance approaches, funding, and more.
Barnett Shale (Texas)	*Evaluating the Effect of Natural Gas Developments on Highways: Texas Case Study* Banerjee, A., Prozzi, J., Prozzi, J., Transportation Research Record: Journal of the Transportation Research Board. DOI: http://dx.doi.org/10.3141/2282-06	Goal was to quantify the effect of truck traffic on Texas state highways. The study looked at the OS/OW database from the state DOT, interviewed Texas DOT personnel regarding truck traffic during the different phases of well development, and the study looked at specific highway road damage along certain routes.	Damage from increased truck traffic from well development was quantified as a reduced service life of 5.6% associated with rig movement (the rig is the heaviest equipment at the well), 29% associated with well construction, and 16% with disposing of flowback and produced water from the well.
Marcellus (PA) (gas)	*Economic Impact of the Value Chain of a Marcellus Shale Well* Hefley, W., et al, August 2011. University of Pittsburgh Pitt Business Working Papers	This study evaluated one "average" well in the Marcellus (shale gas) and quantified the costs associated with every step in the process, considering all inputs and outputs (from mineral leasing and permitting through putting the well into production, but excluding site exploration and further maintenance once well is producing).	Total estimated cost for one Marcellus Shale well = $7,651,825
Marcellus (NY) (gas)	*Hammer Down: A guide to Protecting Local Roads Impacted by Shale Gas Drilling* Randall, C., 2010 Working Paper Series: A comprehensive economic impact analysis of natural gas extraction in the Marcellus Shale, Cornell University.	This study was a review of impact literature and a recommendation of best practices for use by New York planners in addressing the potential for fracing impacts to roads.	Recommended "best practices" from other states include 1. Conduct traffic impact study with engineering firm to understand ability of roads to withstand volume of traffic anticipated; 2. Document baseline road conditions and calculate value of remaining road life; 3. Sign a Road Use Agreement with operators that requires the operator offset the predicted loss of useful life at current reconstruction costs; 4. Develop and implement a system for haul route management, and post signs on roads; 5. Enforce load zoning, from routine patrol to "high intensity multi agency enforcement sweeps." (Pavement Management Software is available from

Formation and/or State	Study Name and Authors	Summary of study goals and methods	Important findings
			Cornell for $25). 5. Towns without traffic ordinances are harder hit when drilling commences and developing a comprehensive plan in advance can cost less than major repairs. Pool resources with multiple towns to hire engineers to defray costs of road studies.
Marcellus (NY)	*Impacts on Community Character of Horizontal Drilling and High Volume Hydraulic Fracturing in Marcellus Shale and Other Low-Permeability Gas Reservoirs* NTC Consultants, 2011. Prepared for the New York State Energy Research and Development Authority, NYSERDA Contract #: 11170 & 1955.	This report was prepared to assist the Department of Environment and Conservation develop a draft environmental impact statement. Accordingly, it conducted an evaluation of a range of impacts from hydraulic fracturing. Much of the data in this report is found in the final draft EIS prepared by New York State.	Estimated 3,399 truck trips. (Unclear but likely these are round trips). Recommended the use of Road Use Agreements between municipalities and operators.
Niobrara (WY)	*Draft Data Collection and Analysis Strategies to Mitigate the Impacts of Oil and Gas Activities on Wyoming County Roads* (***Phase 1)*** Ksaibati, K., 2011. Wyoming T²/ LTAP, Report prepared for the Wyoming Department of Transportation	This was Phase I of a planned 3 part study funded by the Wyoming Legislature. The main study objective was to "outline a methodology which will help counties in developing strategies so that their roads can effectively serve the needs of the driving public as well as the oil and gas industry." The study's approach was to identify current conditions and needed investment, rank needed improvements within each county, and provide a method for allocating resources. Phase 1 included a major data collection and analysis and developed the methodology for evaluating the impact of oil and gas on local roads, based on guidelines of WY T²/ LTAP (Univ. of Wy Center that assists on technical transportation issues). The Wyoming legislature allocated $610,000 for study	Recommend that local agencies focus on measuring actual impact of drilling rather than on forecasting and planning tools. Do this using a pavement management system. Enables planners to document network conditions, identify needs, and evaluate the effectiveness of their maintenance and rehab programs (and keep track of actual maintenance and rehab activities). Enables more cost effective decisions. WY T²/ LTAP developed a gravel roads management methodology. Counties with significant gravel roads may find this useful
Nioabrara (WY)	Huntington, G., Pearce, A., Stroud, N., Jones, J., & Ksaibati, K. (2013). Mitigating impacts of oil and gas traffic on southeastern Wyoming county roads. *Cheyenne: Wyoming Department of Transportation* (**Phase 2).**	This study implements the methodology developed in the Phase I study within four selected counties in Wyoming. Phase II conducted traffic counts, evaluated oil and gas trip generation, paved and unpaved county roads, cattle guards, bridges, safety, permitting, and county resources. The study collected data on county road networks – specifically maintenance costs and surface conditions -- to quantify oil and gas impacts to county roads, which included an analysis of conditions before and after drilling activities. Service strategies and prioritization rankings were performed to assist lawmakers allocate	This study found that given the current conditions of the county roads and serviceability of those roads, "it is evident that increased oil and gas activity will quickly deteriorate local pavements" because of a multitude of factors. The study developed priority rankings and rehabilitation strategies to determine where funding should be directed. It recommend a one-time fee per well until counties can adopt permits or road use agreements.

Formation and/or State	Study Name and Authors	Summary of study goals and methods	Important findings
		resources. Also analyzed each of 4 counties' ability to fund needed measures to handle the impacts of increased oil and gas traffic	
Texas	Mason, J. M., Jr. (1983). *Effect of oil field trucks on light pavements.* J. Transp. Eng., 10.1061/(ASCE)0733-947X(1983)109:3(425), 425–439.	Estimated pavement life reduction on low volume rural roads due to oil and gas activities. Identified types of traffic needed to service oil fields through continuous photographic monitoring and estimated reduction in pavement life due to drilling activities.	Over approximately 70-day time period 10,353 vehicles were recorded entering or leaving the well site, with an average of 150 vehicles per day. The "rigging up" and "rigging down" period saw peak traffic volumes of 325 vehicles per day. Up to 200 vehicles per day occurred during the actual drilling process.
Texas	*The Effects of Oil Field Development on Rural Highways* Mason, J., et. al, Interim Report 299-1, Phase I—Identification of Traffic Characteristics, Pavement Serviceability and Annual Cost Comparison, Texas Transportation Institute, TTI-2-10-81-299-1, February 1982. Study sponsored by the Texas State Department of Highways and Public Transportation	Goals were to identify the phases of oil development and associated vehicles, and estimate annual cost associated with reduced pavement life. One of the first studies aimed at examining road rehabilitation needs and assessing site specific impacts created by specialized industries (such as oil and gas).	Increased annual costs of $12,500 per mile for low volume (250 ADT), light duty (.5" bituminous surface treatment on a 6" foundation base course) pavement section. "This cost considered only a capital investment for a surface treated pavement and the cost to resurface the pavement for the intended use condition. The initial pavement placement cost was estimated at $61,000/mile."
Marcellus (NY)	*Final Supplemental Generic Environmental Impact Statement (EIS) On the Oil, Gas, and Solution Mining Regulatory Program*. New York State Department of Environmental Conservation, June 2015, available at http://www.dec.ny.gov/energy/75370.html.	Comprehensive environmental impact assessment on impact of permitting high volume hydraulic fracturing in New York. This assessment looked at transportation impacts, as well as many other types of potential impacts. No traffic assessments were conducted because location of wells was hypothetical, instead, the assessment assumed impact based on estimated truck trips. Mitigation measures were suggested.	Fracturing transportation impacts are temporary, but cumulative impact can adversely affect local and state roads. The mitigation measures recommended including requiring a drilling permit applicant to develop a Transportation Plan that sets forth proposed routes, surveys existing road conditions (done at operator expense where local governments do not have funding to do so), and identifies whether a road use agreement is in place to address impacts. The assessment also found that water volume used and its source can significantly alter the number of trucks used. Estimates for the number of heavy and light duty trucks needed per well for

Formation and/or State	Study Name and Authors	Summary of study goals and methods	Important findings
			both horizontal and vertical drilling were developed. Authors found that a horizontal well has two to three times more truck traffic than a vertical well. The assessment concluded that trucking during the long term production phase of a well is "insignificant" compared to initial construction/fracturing/production.
8 states	*Energy Development Impacts on State Roadways: A Review of DOT Policies, Programs and Practices Across Eight States*. David Bierling, et al. 2014., Texas A&M Transportation Institute	This study looked in depth at how eight DOT's have assessed and addressed impacts to state roadways from oil and gas activities. The study included those states with recent and intensive increase in oil or gas development. The states studied were Colorado, Kansas, North Dakota, Oklahoma, Pennsylvania, Utah, West Virginia, and Wyoming.	*When a boom occurs damage can happen rapidly – years of damage can occur in a matter of weeks. *Similar transportation impacts occur in states with rapid development regardless of geography or location *challenging to enforce rogue trucks without OS/OW permits *rural roads and bridges get the worst impacts first (cases of roads being pulverized in a matter of days). *Local roads can be impacted even more than state-maintained roads. *major successful approached include posted weight limits, bonding and maintenance agreements, active industry engagement, capital improvement programs (increase in funding) *accurate truck counts are important to long term planning
Marcellus (PA)	*Estimating the consumptive use costs of shale natural gas extraction on Pennsylvania Roadways.* Journal of Infrastructure Systems, 20(3), 06014001. Abramson, S., Samaras, C., Curtright, A., Litovitz., & Burger, N. (2014)	Goal of study was to estimate costs to state-maintained roads of additional heavy truck-traffic stemming from shale gas development in Pennsylvania, with a particular focus on state routes where agreements with operators to repair roads were not in place. Authors employed methods to estimate the number of truck trips per well and road life and maintenance/ construction. Then, these estimates (truck travel and road costs) were combined to estimate consumptive roadway use costs associated with energy development.	Estimating truck trips is difficult because it depends on many factors, especially whether water is piped in or trucked in, how many wells per pad and what type of equipment is used. Authors relied on truck estimates from the New York State Environmental Impact Statement. In 2011 estimate of costs to roads were approximately $13,000 - $23,000 per well for all state roadway types, or $5,000 -10,000 per well if low-volume state roads are excluded. Study identified three primary types of policy responses to address costs: 1. cost recovery through taxes or fees on drillers; 2. policies/regulations designed to decrease damage to roadways such as weight limits/use pipelines/require heavy trucks to have more axels to distribute the weight; 3. altering infrastructure to make it more resilient to higher intensity traffic. Authors concluded that the best policy would be to combine all three approaches.
Eagle Ford (TX)	*Transportation Impacts of Fracing in the Eagle Ford Shale Development in*	Using the Eagle Ford Shale in Texas as a case study, the authors looked a literature review regarding estimating impacts from	County officials perceived a much greater impact to transportation issues than city officials. Ninety-four percent of county

Formation and/or State	Study Name and Authors	Summary of study goals and methods	Important findings
	Rural South Texas: Perceptions of Local Government Officials. Dianne Rahm, Billy Fields, and Jayce L. Farmer, (2015), The Journal of Rural and Community Development, 10(2), 78-99 (p.96).	energy development, reviewed crash statistics, and interviewed local city and county government officials to understand local government perceptions on the impacts of hydraulic fracturing.	survey respondents perceived a great amount of increased road maintenance costs compared with 27 percent of city officials. The boom and bust cycles makes transportation impact planning difficult. Funding is not adequate for counties. Texas approach has been to rely on increased state funding, other approaches are less successful in Texas where operators have more power and have "socialized the cost of transportation."
Marcellus (PA)	*Shale Gas Development linked to traffic accidents in Pennsylvania*. Muehlenbachs, L., & Krupuick, A.J. (2013). Resources for the Future.	Goal was to provide a statistical estimate of the effects of heavy energy-related trucks on accidents, fatalities, and property damage.	Counties with gas development saw an increase in total crashes involving heavy trucks. Adding 1 well a month = 2% increase in crashes involving heavy trucks (there are an average of 9 crashes per county per month.)
Marcellus (PA)	*Transport of hydraulic fracturing water and wastes in the Susquehanna river basin*. Gilmore, K., Hupp, R. L., & Glathar, J. (2014). Journal of Environmental Engineering, 140 (5), 1-2.	Used GIS to quantify truck travel distances associated with water and hydraulic fracturing in Marcellus	Authors concluded that trucks travel longer than necessary because of inefficient routing. Travel distances could be reduced 40-80% if routing improvements were implemented.
Canada	*Assessment of impact of energy development projects on local roads* Wilke, P., and Harrell, M., paper prepared for presentation at the sessions: Challenges Facing Low-Volume Roads for the 2011 Annual Conference for the Transportation Association of Canada, Edmonton, Alberta.	This paper summarized impact of energy development on local, low-volume roads and presented several methods to estimate impacts from trucks on pavement and quantify those costs.	
50 state review	*Impacts of Energy Development on U.S. Roads and Bridges*, National Cooperative Highway Research Program, Synthesis 469, 2015	Documents impact of heavy trucks from energy development on roads and bridges, and best practice strategies transportation agencies are using to prevent damage and fund repairs. The synthesis conducted a comprehensive survey of state DOT's and follow up interviews. Fifty states received the survey, 41 state DOT's responded, and five states were selected for more in depth, post-survey interviews.	Hundreds of millions of dollars are spent annually on road repairs "necessitated by energy development." Most common impact assessment method was a determination of pavement remaining service life, and the study documented three primary approaches to determining service life.

APPENDIX C

Survey of Oil and Gas Operators for Chapter III

Survey Questions and Responses

No.	Survey question	Response
1	When significant drilling occurred in the TMS, were local and county road conditions an issue (either positively or negatively) in the counties in which you operate in Mississippi? If yes, please explain in any detail you would like.	**Respondent #1:** Yes, road access is an important issue for our operations. State highways were not a problem as far as current condition and maintenance but permitting new driveway entrances to the well sites was problematic in many cases. The problem was the limit on the number of driveways on a particular tract of land and their distance apart. So if a home owner had a drive and the oil company wanted to build a separate drive onto the property that may not be allowed. A second problem with permitting is the required line of sight from hills and curves in relationship to the proposed drive. County roads were a big problem for operators. The vast majority of county roads were not designed or built to a very high standard. It seems they were just improved a little bit at a time over the years. The narrow width, lack of a shoulder, low weight bridges, base and top material is all substandard. Heavy truck traffic would damage the roads. The counties would then demand the oil companies, not the timber or other companies, repair the roads or pay for repairs to a much higher level than existed before. Counties have very limited budgets for road maintenance. It was reported to me that the taxes paid from the drilling and production did not fairly come down from the state level to the individual county supervisor.
		Respondent #2: The local and county roads have potholes and minor issues, but they are adequate for drilling TMS activity.
2	Are you satisfied with the approach county governments have taken with respect to road repair and maintenance and are there any different approaches you would recommend?	**Respondent #**1: Mostly unsatisfied. We understand the road systems were not good before the activity. We also understand budgets don't allow significant improvement or repair. For the most part County officials have tried to accommodate road access needs of the operators. But as soon as there is a problem the county demands substantial repair or payment and threatens to pull the permit. The road use ordinance and agreement required to receive a heavy load permit from Amite and Wilkinson County is poorly written. Requires the operator to make repairs to public roads, we do not want to assume that liability.

		Even distribution of tax income dollars from a well to those roads used for the well. Example: county road budget is divided equally between all districts. Districts with little or no drilling activity receive the same portion as a district with heavy activity. Support from the State in the form of economic development and distribution of existing tax dollars to upgrade specific county roads. Many county roads were improved over the years by adding a thin layer of asphalt to a gravel road. The local citizens liked this and it handled light duty traffic. This thin layer quickly fell apart under heavy traffic. Even though the local citizens will complain, the asphalt should be removed and these roads converted back to gravel roads which are easily maintained and repaired. In most cases the operators can make due with poor road conditions, even though not ideal we can get in and out. The county government and local citizens will not accept same.
		Respondent #2: No, we are not satisfied with the regulation from the county governments. The Chancery Clerk sent demand letters requiring payment for road damages on county roads on route to drilling locations. The damage estimate included repairing every pothole on the road – regardless of whether it existed prior to our activity. The county used the 'excavate and replace' method to calculate damages; but when the repairs were made, they just filled the potholes which is a much less expensive process and not as long-lasting. On county roads with multiple operator's locations, the demand letters required each company to pay the full cost to repair the road. We attempted to negotiate, but the Chancery Clerk threatened to revoke our right to use county roads if the demands were not paid. On any new jobs, we will require a pre-job survey of all county roads needed to access that job. We will use that survey to contest any future demands from the Chancery Clerk, and to estimate the cost to repair using the counties' excavate and replace method. The estimate to repair all pre-existing damages will be included when evaluating a new well's economics. Hence, the costs for road repairs that are beyond what is fair and reasonable will affect the activity level to the extent that they affect the well economics. We will gladly pay for any damages we caused to county roads, but we are not interested in paying for decades of damages caused by logging and under-investment by the county. There needs to be recourse for the oil company to contest the damage estimate.
3	Would your answers to the previous	**Respondent #1:** Yes, it would become much worse.

	questions change if there were a substantial "boom" in drilling in the TMS?	If operators are going to be required to pay for county roads used, that will negatively affect the economics of each well drilled. Would the operator have to add an additional million dollars to the cost of a well to pay for a county road to be upgraded and maintained, and how long would that take?
		Respondent #2: No.

APPENDIX D

Home Rule Statutes and Rules for Chapter IV

***State Delegations of Power to Municipalities**

Ala. Code § 11-45-1 (1975)
Alaska Const. art. X, § 11
Ariz. Const. art. XIII, § 2
Ark. Code Ann. § 14-55-102 (1987)
Cal. Const. ART XI, § 7
Colo. Const. art. XX, § 6
Conn. Gen. Swat. Ann. § 7-148 (West 2001)
Del. Code. Ann. tit. 22, § 802 (2000)
Fla. Const. art. VIII, § 2
Ga. Code Ann. 36-34-1
Haw. Const. art.VIII, § 2
Idaho Const. art. XII, § 2
65 Ill. Comp. Stat. Ann. 5/11-1-1 (West 2001)
Ind. Code § 36-1-3-2 (1997)
Iowa Const. art. III, § 38A
Kan. Const. art. 12, §5
Ky. Rev. Stat. Ann. § 82.082 (Banks-Baldwin 2001)
La. Const. art. 6, § 5
Me. Const. art. VIII, Part 2, § 1
Md. Const. art. XI-E, § 3
Mass. Const. art., II § 6
Mich. Const. art.VII, § 21
Minn. Stat. § 410.04 (2000)
Minn. Stat. § 410.19 (2000)
Miss. Code Ann. § 21-17-5 (2001)
Mo. Const. art. 6, § 19
Mont. Const. art. XI, § 6
Neb. Const. art. XI, §§ 2-4
Nev. Rev. Stat. Ann. 266.010 (2001)
N.H. Rev. Stat. Ann. § 31.39
N.J. Stat. Ann. § 40:69A-30 (2001)
N.M. Const. art. X,§ 6
*2aaa N.Y.Const. art. IX, § 2
N.C.Const. art. VII, §1
N.D. Const. art.7, § 1
Ohio Const. art.XVIII, § 3
Okla. Const. art.XVIII, § 3A
Or. Const. artXI, § 2
Pa. Const. art. 9, § 2
R.I. Const. art.XIII, § 2

S.C. Const. art.VIII,§ 17
S.D. Const. art.IX,§ 2
Tenn. Const. art.XI, § 9
Tex. Const. art.XI,§ 5
Utah Const. art.XI, § 5
Vt. Stat. Ann. Tit. 24, § 2291 (1999)
Va. Code Ann. § 15.2-1102 (1997)
Wash. Const. art.XI,§ 11
W. Va. Const. art.VI, § 39
Wisc. Const. art.XI, § 3
Wyo. Const. art. 13 § 1

*Adapted from Petitioner's Brief, Appendix C, in *City of Columbus v. Ours Garage and Wrecker Service, Inc.*, No. 01-419, 2002 WL 264636, (6th Cir. Feb 19, 2002).