NATURAL GAS EXTRACTION: ISSUES AND POLICY OPTIONS

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Table of Contents

Executive Summary ii

1. Natural Gas Extraction Issues 1

1.1. Environmental Issues 1

1.1.1. Water Quality and Quantity Issues 1
1.1.2. Air Quality Issues 2
1.1.3. Waste Management Issues 3
1.1.4. General Environmental Issues 3

1.2. Community Issues 3

1.2.1. Boomtown Impacts 3
1.2.2. Service Impacts 4
1.2.3. Housing 4
1.2.4. Transportation and Utilities 5
1.2.5. Employment and Workforce Availability 5
1.2.6. Locus of Costs and Revenues 5
1.2.7. Social Impacts 5
1.2.8. Landowner Issues 6

2. Policy Options and Framework 6

2.1. Policy Options for Environmental Issues 7

2.1.1. Status Quo 7
2.1.2. Increased Government Involvement 8
2.1.3. Decreased Government Involvement in Natural Gas Extraction 11

2.2. Policy Options for Community Issues 12

2.2.1. Status Quo 12
2.2.2. Increased Government Involvement 13
2.2.3. Decreased Government Involvement 15

2.3. Likely Consequences 15

2.3.1. Consumers 16
2.3.2. Nearby Residents 16
2.3.3. Natural Gas Extraction Companies 17
2.3.4. Other Businesses 19
2.3.5. Landowners 19

3. Conclusions 19

Appendix 1 – Economic and Policy Functions of Property Taxes 21

Executive Summary

Although natural gas extraction using hydraulic fracturing has existed for decades, it has seen tremendous growth in recent years because advances in horizontal drilling now allow oil and gas operators to tap into previously unprofitable reserves of natural gas in rock formations.

Current policies governing natural gas extraction are a mix of voluntary private efforts and collaboration between federal and state agencies. Simultaneously, calls exist for both more and less government intervention. We need more objective, science-based information about both the potential impacts of natural gas extraction and hydraulic fracturing on water, air, and other environmental media, as well as the long-range impacts of natural gas booms on local communities, but basic assumptions and theory can provide a foundation for reasonable discussion of likely impacts.

Maintaining the status quo mix of government policies and free market guidelines will likely continue to limit public cost in the near term, but do little to further respond to concerns about the potential adverse consequences of hydraulic fracturing to the environment and communities. Natural gas supplies will continue to expand, limiting energy price increases or even pushing prices down and potentially generating foreign exchange earnings. If concerns regarding environmental and community impacts prove unfounded, public costs will have been contained and economic development unaffected. However, if these concerns prove well-founded, existing policies will be too little too late, possibly resulting in serious, harm to the environment or bankrupt communities dealing with boom-bust consequences.

Expanding government intervention in environmental issues will likely increase public cost, limit growth in natural gas supply, and possibly increase the price of energy. If environmental concerns prove unfounded, many will consider the expense a waste and be frustrated at the high opportunity cost. There will also be barriers to economic development; for communities with few options, this could be devastating. However, if the concerns are justified over time, the benefits to the environmental assets protected could be well worth the expense. Additional intervention in community issues will also increase public cost and will likely require additional revenue sources. A severance tax on resource extraction activities could provide a revenue source. Such a tax could also aid conservation efforts, but must be set carefully to ensure optimal long-run extraction levels.

Reducing government involvement will save tax dollars and expand natural gas supplies, likely resulting in lower energy prices. Potential drawbacks of reduced government involvement are similar to the status quo option discussed above.

If consensus has been found among any of these issues, it is that we need much more research focused on objectively and scientifically quantifying both the environmental and long-range economic impacts of natural gas development.

1. Natural Gas Extraction Issues

While horizontal drilling and hydraulic fracturing have been used for decades, recent refinements have made the production of natural gas from a number of shale and other geological formations less costly. As a result, exploration and production steadily increased in recent years, with explosive growth in specific regions. Since the 2008-2009 recession, the growth of natural gas production has been regarded by some as a highly positive development as it can increase employment and economic diversification while bringing lower energy prices to consumers. However, many are concerned the production practices used in natural gas extraction pose environmental risks, while others are concerned about the impacts that sudden economic expansion can have on communities.

Decision-makers at every level of government confront a number of policy issues and potential responses. This paper will outline some of these issues, alternatives for responding to those issues, and how the various options can impact a number of stakeholder groups.[1]

1.1. Environmental Issues

Natural gas extraction using horizontal drilling and hydraulic fracturing involves constructing a well pad (often accompanied by an access road) for a drilling rig and its supporting equipment. The drilling rig creates a wellbore to the targeted formation into which a casing will be inserted. In the process, the wellbore may cut through formations that contain potable water; many states require a seal be placed between the casing and such formations. Once the targeted formation is reached, the operator pumps large volumes of a mixture of water and other materials, called "fracturing fluid" (or "frack fluid") into the wellbore at high pressure. The application of the frack fluid creates and maintains small fractures in the surrounding rock, allowing oil and/or natural gas to enter the wellbore. The oil and gas are drawn to the surface where they may be processed and sent to market. Concerns about the potential environmental effects of these operations tend to fall into the following groupings: water quality and quantity, air quality, waste management, and general environmental issues.

1.1.1. Water Quality and Quantity Issues

The potential impacts of natural gas extraction on water supplies have drawn some of the most intense discussions. Five primary questions tend to emerge in these discussions.[2]

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[1] To keep this paper relatively brief, only the basics of each issue and the policy alternatives are discussed here. A companion piece presenting an overview of extraction techniques, Technical Supplement to Natural Gas Extraction: Issues and Policy Options (hereinafter referred to as "Technical Supplement") is available from NARDeP on request.

[2] For information on water issues, see section 3 of the Technical Supplement. The division of these issues into five questions was posed in EPA OFFICE OF RESEARCH AND DEVELOPMENT, PLAN TO STUDY THE POTENTIAL IMPACTS OF HYDRAULIC FRACTURING ON DRINKING WATER RESOURCES," ix (2011), *at* http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/hf_study_plan_110211_final_508.pdf, visited Nov. 19, 2012.

a) *What are the potential impacts of large volume water withdrawals from ground and surface waters on drinking water resources?* Hydraulic fracturing requires millions of gallons of water per well and can impact other water uses and the environment depending on the concentration of fractured wells, the sources from which the water is drawn, the time of year it is drawn, and local climatology.
b) *What are the impacts of surface spills of fracturing chemicals and other materials?* The transport and mixing of fracturing fluid components create the risk of spills that could reach nearby surface waters or percolate into groundwater formations. Some regard this possibility as a more significant risk than the hydraulic fracturing process itself.
c) *What are the possible impacts of the injection and fracturing process on drinking water resources?* Proponents of fracturing note natural geologic barriers separate the gas-containing shale formations from groundwater-containing formations, and that those barriers often comprise thousands of feet of rock. Opponents of fracturing counter by noting it is difficult to know whether pre-existing or man-made pathways in the formations, weaknesses in the wellbore, could allow fracturing fluids and/or hydrocarbons to mix with groundwater. Studies suggest potential links between gas activity and well contamination, though it is clear more research is needed to reach a firm conclusion. Many stakeholders are also asking for more information regarding the composition of fracturing fluid. The industry voluntarily provides this information through its FracFocus website, www.fracfocus.org. At this time, there is not a federal disclosure requirement, though many states require varying levels of disclosure.
d) *What are the possible impacts of surface spills on or near well pads of flowback and produced water on drinking water resources?* Flowback (fracturing fluid and water returned to the surface by backpressure from the target formation) and produced water (water that was already in the target formation brought to the surface) can constitute a large volume of water that must be handled carefully to prevent spills that can contaminate surface or groundwater.
e) *What are the possible impacts of inadequate treatment of hydraulic fracturing wastewaters on drinking water resources?* Flowback and produced water must either be re-injected into the earth through injection wells, or the waters must be treated and discharged. Waste injection raises many of the same concerns as the hydraulic fracturing process. Treatment and discharge of these waters requires either treating with private equipment or sending the water to a publicly owned treatment works (POTW); these POTWs may not be equipped to handle the chemical components of such fluids.

1.1.2. Air Quality Issues

Natural gas production emits air pollutants, primarily from the equipment used to drill the well and to process and transport the oil and gas. Some experts suspect other uncontrolled, non-point source emissions to also be an issue.[3] These emissions can include sulfur dioxide, nitrogen oxides, and volatile organic compounds (VOCs) and methane. The effects of such sources can be concentrated with the intense resource development of a small region. Some stakeholders also worry about gases that can be

[3] For information and references on air issues, see section 3.3 of the Technical Supplement.

vented to the atmosphere from flowback and produced water stored in open structures. Others are concerned that potential releases of methane (the gas that typically makes up 70 to 90% of natural gas) could worsen climate change impacts.

1.1.3. Waste Management Issues

Drilling operations generate material from the wellbore and used drilling mud.[4] They must be disposed of on-site or transported to an approved disposal facility. These materials may also include substances referred to as "normally occurring radioactive materials" (NORM). Some stakeholders worry the materials may be more concentrated in certain areas or in particular wells and may pose an additional safety issue.

1.1.4. General Environmental Issues

Beyond the issues discussed here, a number of other issues are raised by stakeholders. These concerns include the disruption or fragmentation of wildlife habitat by wellsites and roads or the noise and activity associated with drilling and production activities.[5] Some are concerned that hydraulic fracturing may cause earthquakes in sensitive areas.[6]

1.2. Community Issues

The rapid expansion of any industry can be a cause of great excitement for those looking to grow an area's economy. At the same time, a number of "growing pains" can accompany such developments, and the rapid growth of natural gas exploration and production is no exception. While several of the environmental issues presented by natural gas extraction are relatively new, decision-makers have the benefit of experience with natural resource booms, even if that experience may come from other communities with other natural resource endowments. Some have argued that shale gas formations will have extremely fast depletion rates, which would imply a shorter "boom" than typically experienced with other types of natural resource extraction.[7] Nonetheless, prior experiences help predict many of the issues now appearing in communities with high levels of natural gas development. This section will discuss some of these issues.[8]

1.2.1. Boomtown Impacts

History provides a number of examples about opportunities and challenges presented to small communities undergoing rapid economic growth in one sector, particularly a natural resource-based sector like natural gas extraction. The

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[4] For information and references on waste issues, see section 3.4 of the Technical Supplement.

[5] A discussion of habitat impacts can be found in DOE OFFICE OF FOSSIL ENERGY AND NATIONAL ENERGY TECHNOLOGY LABORATORY, MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES: A PRIMER, 48 (2009), *at* http://www.netl.doe.gov/technologies/oil-gas/publications/epreports/shale_gas_primer_2009.pdf (visited Sept. 26, 2012).

[6] The most comprehensive summary of research on the topic of induced seismicity found in the course of researching this paper was found in NATIONAL RESEARCH COUNCIL, INDUCED SEISMICITY POTENTIAL IN ENERGY TECHNOLOGIES (2012, prepublication version), *available at* http://www.nap.edu/catalog.php?record_id=13355 (visited Nov. 19, 2012).

[7] Energy Policy Forum and Post Carbon Institute, "A Reality Check on the Shale Revolution." Downloaded at http://shalebubble.org/wp-content/uploads/2013/02/BSH_fact-sheet.pdf on Feb. 22, 2013.

[8] A discussion of community and landowner issues, including references, can be found at Section 3.5 of the Technical Supplement.

commonalities between these experiences have led to the development of a sociological model called the "Boomtown model."[9] The central concept of the Boomtown model is small communities exposed to rapid, intense economic development in one sector may experience a number of economic benefits, but may also face increased needs for infrastructure, social services, workforce, housing and other community resources. While such development may benefit sectors of the community, others may be worse off as a result of inflationary pressures, unmet needs for services, or other shortfalls. The Boomtown model and other sociological models predict that proactive steps to address these concerns can help grow and diversify the local economy in ways that mitigate the impacts that come when resource extraction activities eventually decline. Conversely, communities that do not address these challenges might actually find themselves worse off as resources are devoted to dealing with the extractive industry and prices for inputs such as labor rise, making other industries less competitive and resulting in a phenomenon sometimes called the "Dutch disease" or the "natural resources curse."[10] The Boomtown model focuses primarily on small, geographically isolated communities; more populous areas or regions may avoid some of these impacts due to larger numbers of available workers and establishments.

1.2.2. Service Impacts

Research examining communities impacted by rapid expansion of natural gas extraction in recent years showed increases in business for restaurants, one-stop gas stations, bars, retail establishments, and similar services.[11] Survey results also suggested some service facilities faced strains from the growth, with respondents noting insufficient capacity in dining facilities and hotels. As demand for these services grow, providers may increase prices, making such services more difficult to afford for those not benefiting from the industry. Increased demand can also crowd out other service consumers, such as tourists and visitors.

1.2.3. Housing

As natural gas exploration and production grows in an isolated area, the local workforce may not meet labor needs, so workers may move to the area for varying lengths of time, and seek hotel accommodations, rental properties, or home purchases.[12] An increase in demand can increase rental and purchase values; while this is good for property owners, it can also make housing less affordable for others, particularly those on fixed incomes. The type of housing provided to meet this demand can impact a number of other community elements. For example, temporary "man camps" may be linked to increases in crime, substance abuse, and a sense of isolation between long-term residents and new residents. In less isolated areas, a commuting workforce may develop, which

[9] The "Boomtown" model is discussed in more detail at Section 3.5.1 in the Technical Supplement.
[10] For a discussion of the Dutch disease / natural resource curse concepts, see E. R. Larsen, *Escaping the Resource Curse and the Dutch Disease? When and Why Norway Caught Up with and Forged Ahead of its Neighbors*, 68:3 AMERICAN J. OF ECONOMICS AND SOCIOLOGY 605-640 (2006) and J. Sachs & A. Warner, *The Curse of Natural Resources*, 45 EUROPEAN ECONOMIC REVIEW 827-838 (2001). *See also* section 3.5.1 of the Technical Supplement.
[11] More information and references on service impacts is in the Technical Supplement, section 3.5.2.
[12] More information and references on housing impacts is in the Technical Supplement, section 3.5.3.

may reduce pressures on housing prices by allowing workers to reside in their own homes or by placing a larger stock of housing within a commuting distance of their worksite.

1.2.4. Transportation and Utilities

The hydraulic fracturing process can involve hundreds or thousands of truck-trips per wellsite to transport the needed equipment and materials.[13] Since these truck-trips usually involve heavy equipment, the increased traffic likely triggers the need for increased repair of roadways and potential reinforcement of bridges or other sensitive road structures, along with increased accident rates. If a commuting workforce begins to develop, needs for public transportation may increase. Other infrastructure investments required by rapidly-growing areas may include water supply and water treatment facilities, electrical systems, telecommunications services and street systems. Depending on the tax structure in effect, these infrastructure costs may outpace the revenues generated for financial support.

1.2.5. Employment and Workforce Availability

Increased employment is often hailed as a key benefit of rapidly-expanding natural gas extraction activities in a region.[14] Such development frequently increases both employment and wages in the mining sector. This effect can spill over into other sectors as well. While this can trigger many positive effects, it can also cause inflationary pressure, raising prices in the region. Employers outside the energy sector may find it difficult to recruit qualified employees, making those employers less competitive.

1.2.6. Locus of Costs and Revenues

Services and infrastructure use by natural gas extraction activities likely will be most intense near the resource deposit; however, this does not mean the majority of tax revenues will be captured there.[15] Depending on the tax structure of the jurisdictions involved, tax revenues may not be received by the jurisdiction bearing the highest costs in providing, maintaining, and expanding infrastructure and services. In some cases, local jurisdictions such as municipalities and counties may not have authorization to enact taxes on resource extraction activities. Similarly, states may lack mechanisms to equitably share revenues with subordinate jurisdictions. Further, the lag between the incidence of costs and the receipt of revenue may strain the cash flow of jurisdictions trying to meet service and infrastructure needs.

1.2.7. Social Impacts

Rapid expansion of industrial activity in an area frequently triggers sudden shifts in population, which, in turn, can trigger spikes in a number of social issues.[16] These issues may be as large, or larger, than environmental issues in the minds of residents.

A frequent concern for residents of the area is an increase in crime, which some studies have shown to increase at rates higher than population-proportionate levels in non-resource extraction areas. Other impacts of concern include increases in substance

[13] Additional discussion of infrastructure impacts is in the Technical Supplement, section 3.5.4.
[14] Background materials on employment issues are in the Technical Supplement, section 3.5.5.
[15] Information regarding the locus of costs and revenues are in the Technical Supplement, section 3.5.6.
[16] More on the social impacts of natural gas development is in the Technical Supplement, section 3.5.7.

abuse, domestic violence, and sexually transmitted diseases. Studies suggest the combination of all of the issues surrounding resource booms increase the likelihood of tensions between new residents and long-time residents in the area, impacting the quality of life for both new- and long-term residents and reducing the sense of community. For some residents, the changes to their community may change their sense of place, leading them to conclude that their town may never "be the same again." However, long term studies of some boomtowns indicate that sound public-private partnerships and intensive mitigation programs can reduce negative community impacts and enable measures of community satisfaction to return to pre-boom levels.

1.2.8. Landowner Issues

Mineral owners receive direct benefits of natural gas extraction in the form of rent or royalties but other landowners may bear burdens without such benefits.[17] Neighbors may feel the activities associated with the natural gas operations are a nuisance due to noise, traffic, or aesthetic issues. When the surface ownership of a property is separate from the mineral ownership, the surface owner may bear much of the burden of mineral development without compensation (except where the law requires compensation). Mineral owners may find themselves with unsatisfactory agreements with mineral developers if there were asymmetries of negotiating power and/or information between the mineral developer and the owner.

2. Policy Options and Framework

Given the issues discussed above, dialogue among stakeholders at the local, state, and federal level is needed to evaluate the potential policy options each level of government could adopt to address these concerns. Such a discussion requires effective public education regarding the issues involved as well as a framework that presents the issues in an unbiased, constructive, and comprehensive matter. Thus, it is suggested the issue, for the purposes of this discussion, be framed as follows:

> **There is public concern about how to extract natural gas resources in a manner that provides additional energy sources while maintaining and enhancing economic development and assuring the protection of natural resources for safe use by humans, flora and fauna. These concerns include how to best manage potential impacts to the environment and communities arising from the development of natural gas resources.**

With this framing in place, the discussion turns to the policy alternatives available for addressing these concerns, along with the likely consequences associated with them. Policy alternatives generally derive from discussions among industry experts and novices, opposition experts and novices, public or university scientists, community and state leaders, and others. As with any policy issue, public policy solutions are a mix of what governments choose to do and *not* do. These policies are the result of interaction between facts, myths and values. Scientists are usually attempting to separate the myths

[17] A deeper discussion of landowner issues is provided at section 3.5.8

of the situation from the facts, but the reality is the values of the affected groups and individuals help shape the consideration of facts in the development of policy.

The identification of policy options is a delicate matter, but the starting point of this process must be the status quo. As "bad" as some consider the status quo, it provides a launching point for public discussion. Status quo policy is almost always a patchwork of rules administered by agencies across all levels of government. The status quo may also include results reached by free-market transactions where specific government involvement is absent.

A starting point for developing alternatives to the status quo is either more or less government involvement in the issue. More government involvement, in the case of hydraulic fracturing, can include a range of programs including increased regulation, additional fees or taxes, oversight, more government-sponsored/conducted research or development, or outright moratoria/bans. Conversely, less government involvement can include reductions in fees, oversight, and government-sponsored research, or elimination of government intervention.

Within this framework, the paper will evaluate alternatives for addressing potential environmental and community impacts from natural gas extraction by examining the general alternatives of the status quo, more government involvement, and less government involvement in natural gas extraction and the likely consequences of each alternative.

2.1. Policy Options for Environmental Issues

A complete review of current local, state, and federal regulations applicable to natural gas extraction would require volumes, but a brief discussion of the current regulatory environment is provided in discussing the status quo below. A general overview of the alternatives for more and less government involvement in environmental issues is then presented. Specific alternatives for increased involvement are included in the policy matrix found in Appendix 1 to this report.

2.1.1. Status Quo

The status quo itself is a topic of significant discussion among natural gas industry advocates and opponents. While some stakeholders feel the current levels of environmental regulation are insufficient to protect the environment, others feel the current regulatory system is oppressive and prevents development of needed energy resources.

Presently, many environmental regulations originate at the federal level. While a number of federal environmental laws would normally encompass hydraulic fracturing, many of those laws also contain exemptions for oil and gas operations in general or specifically for hydraulic fracturing. Exemptions for natural gas production are allowed within the regulations of the Safe Drinking Water Act (SDWA) and its regulatory system for the injection of fluids below ground called the Underground Injection Control (UIC) program, the Clean Water Act (CWA), and the Resource Conservation and Recovery Act (RCRA). Similarly, NORM materials typically do not fall within federal regulatory limits for the disposal of radioactive materials. Until now, emissions from natural gas production typically fell below the thresholds required to trigger federal air regulations under the Clean Air Act (CAA), but recently enacted New Source Performance Standards (NSPS) for gas wells would require operators to use emissions control measures at

natural gas wells; implementation of this rule is currently being stayed pending litigation and a re-evaluation of some of the rule's provisions.[18] Although there are no federal requirements for the disclosure of the contents of hydraulic fracturing fluids, the Bureau of Land Management (BLM) has proposed a regulation requiring the disclosure of such contents for fluids used on lands under its management[19] and at least two bills have been proposed in Congress that would create federal disclosure requirements (the FRAC Act) or delegate authority to impose such requirements to the states (The FRESH Act).

Exemption of these aspects of natural gas extraction from federal regulation opens the door for state regulation. Except where prohibited or preempted by a federal law, states can enact environmental regulations that are "at least as protective of the environment" (to use the federal statutory language) as comparable federal regulations. Some states, regional authorities, counties and municipalities have enacted moratoria on natural gas extraction activities (though the enforceability of the county and municipal moratoria may be in question). Such moratoria are often phrased as temporary and pending the results of specific state studies on the environmental impacts of practices such as hydraulic fracturing. Other states regulate specific elements of the natural gas extraction process.

In addition to federal and state regulations, another layer of complexity arises when jurisdictions overlap or work together. With respect to hydraulic fracturing, federal policy is typically administered by the EPA and BLM (in BLM's management of federal lands). However, EPA may delegate a portion of its authority to requesting states. This is referred to as "collaborative federalism."[20] As Corcoran et al. report, "The states now conduct between 80 and 90 percent of all environmental enforcement actions, while more than 75 percent of the major delegable environmental programs have been delegated to or assumed by the states." While it is an important digression this report will not make, it should be noted this evolution to collaborative federalism is very much at risk as federal and state budgets are being cut. It is unclear what will result if state budgets are cut to a point that would prevent what EPA considers adequate enforcement. It is also unclear what will occur if federal budget cuts prevent EPA from maintaining oversight of state enforcement programs. Sufficient for mention here is to note there will be unintended consequences to otherwise well-intentioned budget cutting at any level.

Finally, we note that counties and municipalities may have some authority in environmental regulatory matters through state statutory authority granted to them to act through health and/or environmental departments or "de facto" environmental authority achieved indirectly through zoning, land use, and construction permitting activities.

2.1.2. Increased Government Involvement

2.1.2.1. Federal Level

At the federal level, the continuum of choices includes, at one end, a federal moratorium on hydraulic fracturing – either outright or at locations where there is an

[18] On January 16, 2013, the EPA filed a motion in the U.S. Court of Appeals for the D.C. Circuit to stay several court challenges to the rule while it reconsidered a number of elements of the rule.
[19] Although the initial rule was withdrawn, BLM is in the process of re-proposing the rule as of this writing.
[20] K. CORCORAN, K. JOSEPH, E. LAPOSTA, E. SCOTT. , SELECTED TOPICS IN STATE AND LOCAL REGULATION OF OIL AND GAS EXPLORATION AND PRODUCTION, UC Hastings College of the Law, Public Law Research Institute. (nd), *available at* http://www.uchastings.edu/public-law/docs/OGEP.pdf (visited Sept.28, 2012).

elevated risk to water contamination. Short of a moratorium, the federal government could enact new regulations to address specific environmental issues surrounding natural gas extraction. A ban on the use of any toxic substances in fracturing fluid could be imposed at the federal level. Congress could enact legislation such as the currently proposed FRAC Act to require disclosure of fracturing fluid components, or it could enact federal standards for hydraulic fracturing operations, such as minimum well construction and operation standards. Another alternative would be to withdraw all or some of the current exceptions for oil and gas production under current environmental laws.[21] The effect of withdrawing these exemptions, in many cases, would be to place a number of elements of oil and gas production within the jurisdiction of the federal EPA (or those states who have received delegated enforcement authority from EPA).

At the other end of this continuum are options whereby the federal government does not take any regulatory actions, but does increase the funding for research by objective, unbiased public scientists. A number of government reports recommend new studies to determine risk to water, develop best management practices, and craft additional environmental protection regulations.[22] These reports also recommend more investigation of complaints, and formal coordination where jurisdiction is shared between the federal and state governments. Such recommendations would increase government spending in this area, with the hope that protection of environmental resources would be enhanced. A result of the studies could also be efficiency gains in the industry.

There is also the possibility of increased regional or interstate regulation of activities. Following the model of river compacts and their federally-authorized collaborative management of a common resource, Congress could authorize compacts among states to manage a given geological formation or region together, enacting environmental regulations that would apply uniformly across the area.

Another federal action that could enhance state-level involvement would be to create menus of regulatory options states could enact at their initiative. Rather than creating standards to be achieved by delegated state programs, the federal government could create either levels of regulatory restrictions (most restrictive to least restrictive) or "pick-and-choose" options (alternatives for fracturing fluid component disclosure, well construction and monitoring, water discharge, etc.) states could adopt under delegation. Alternatively, federal research could develop and analyze such alternatives for adoption by states outside of any delegated programs.

Still another area of environmental regulation potentially benefitting from joint federal-state action would be the problem of operators declaring bankruptcy or dissolving to avoid payment of environmental cleanup costs. While the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) exempts many oil and natural gas production materials through the definition of "hazardous substance" (upon which CERCLA liability largely turns),[23] there remain some releases from natural gas extraction that could trigger liability for costs under CERCLA, other environmental

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[21] For a discussion of these exemptions, see section 2.1.1. above and section 3 of the Technical Supplement.

[22] *See, e.g.,* U.S. DEPARTMENT OF ENERGY, OFFICE OF FOSSIL ENERGY, NATIONAL ENERGY TECHNOLOGY LABORATORY, STATE OIL AND NATURAL GAS REGULATIONS DESIGNED TO PROTECT WATER RESOURCES, funded by US DOE, May 2009. (2009), *available at* http://www.gwpc.org/sites/default/files/state_oil_and_gas_regulations_designed_to_protect_water_resources_0.pdf (visited Sept. 28, 2012).

[23] *See* 42 U.S.C. § 9601(14)(F).

laws, or through tort liability. However, environmental liabilities can be discharged in bankruptcy, or in some cases avoided by the dissolution of the corporate entity incurring the environmental liability. Bankruptcy is largely a function of federal law, and modifications to the Bankruptcy Code must be made at the federal level. Congress could explicitly prohibit the discharge of environmental liability in bankruptcy. Such an action would not be unprecedented; a number of other debts are not dischargeable under the Bankruptcy Code, such as many tax liabilities, student loans, child support, alimony, and a number of tort liabilities.[24] At either the state or federal level, bonding or other financial security requirements could be set to provide funding for cleanup of environmental hazards such as spills or abandoned wells. Many oil and gas producing states already have such programs, but the programs could be enhanced either by increasing bonding amounts or by removing exemptions. Regulation of corporate entities is largely a function of state law and dealing with dissolution issues likely would be done at that level. States could enact legislation prohibiting dissolution of a corporate entity while it holds environmental liabilities, or require assumption of personal liability for such liabilities (allowing such liabilities to "pierce the corporate veil" in the language of corporate law) by either officers of the corporation or the shareholders, though such measures would be unprecedented.

2.1.2.2. State Level

Many states have taken steps to address the environmental issues associated with natural gas extraction. In many cases, states with a long history of petroleum industry activity already had regulations that readily adapted to hydraulic fracturing activities, while in others new regulatory ground has been. These "trailblazing" efforts can serve as useful starting points as other states consider increasing their level of involvement with regulating natural gas extraction activities.

At one end of the continuum of options, as discussed above for the federal government, is an outright moratorium on certain practices across the state or in sensitive regions. New York and New Jersey implemented such moratoria while they examined the issues associated with new extraction technologies. These moratoria provide time to gather additional information and discuss alternatives with stakeholders before taking definitive action. At the same time, moratoria delay the accrual of economic benefits from natural gas extraction activities and can also cause numerous stakeholders who have already placed investment in extraction activities or resources to incur significant costs.

Short of a moratorium, states could follow the lead of other jurisdictions and specifically regulate aspects of the natural gas extraction process. Numerous alternatives exist along these lines, including regulations that have been enacted by one or more states already as included in Appendix 1. Alternatively, states could accept federal delegation of environmental programs under the CWA, CWA, RCRA and/or CERCLA in those cases where they have not already done so. By the same token, the federal government could facilitate state regulation by expanding the scope of delegated authority. In some cases, federal delegation restricts the states' imposition of regulations more stringent than federal regulations.

[24] The list of non-dischargeable debts can be found at 11 U.S.C. § 523.

2.1.2.2. Local Level

Finally, both the federal and state government could authorize increased county and municipal involvement by authorizing legislation. At the moment, most subordinate jurisdictions have limited, if any, authority to enact environmental regulations. Increasing local government involvement would likely require explicit action, almost always at the state level, since in most jurisdictions counties and municipalities expressly granted to them by state authorizing legislation.

Many local governments have enacted moratoria on natural gas extraction, but a number have been overturned on grounds that they exceeded the authority of the local government. Some municipalities and counties (where those counties have zoning or permitting authority) have successfully implemented zoning regulations to restrict natural gas extraction activities by setting minimum distances wells must be located from specified sensitive areas, such as occupied residences, water supplies, schools or other public facilities, and the like. Other counties and municipalities may have the power through either departments of health or environment to enact locally-applicable regulations that could restrict natural gas extraction activities in much the same way as federal or state regulations.

2.1.2.3. Consequences of Increased Government Involvement

Additional government involvement adds cost to exploration and production, thus preventing exploration on some wells, shutting other wells down prematurely, and likely reducing overall production. On the other hand, any of these added measures are likely to reduce safety concerns and fears of water contamination. If hydraulic fracturing were to be banned, some locations where conventional drilling could prove effective would see more wells drilled, which would likely create a different set of issues. The elimination of some fracturing fluid substances could have the effect of eliminating fracturing altogether because of the lack of substitutes, and this would likely increase costs and reduce production until more acceptable alternatives could be developed. Alternatively, elimination of potentially harmful substances could increase the safety to humans, water and the natural environment. There has, however, been some precedent for targeted reductions with a memorandum between EPA and several major companies to eliminate diesel fuel in fracturing because of its high benzene content. More stringent waste handling rules would also add cost to both the industry and public agency management. However, the concerns of landowners, water users, and environmentalists could be alleviated.

2.1.3. Decreased Government Involvement in Natural Gas Extraction

Reduced state and federal involvement regarding exploration and production is another policy option. Easing or eliminating regulations, taxes, and other barriers would be included in this discussion. Ever since the EPA and (to a lesser extent, state environmental agencies) entered the arena of oil and gas regulation, industry preferences have been for less or no government intervention. Congress and/or state legislatures could initiate this withdrawal by repealing existing environmental laws or expanding

existing exemptions. Following the less government option, reduced involvement would allow more freedom for the industry and could allow the sector to grow more quickly.

Within the natural gas industry, the result would likely be cost reduction, a supply increase, and perhaps decreased natural gas prices or increased exports. Alternatively, many current concerns about environmental impacts and hazards could be magnified. If borne out, there could be adverse impacts to water resources, land, humans, and the natural environment. Economic theory suggests the cost of such impacts would shift from industry to government and individuals. Private mechanisms such as litigation would likely see increased use to resolve these cost allocation issues.

2.2. Policy Options for Community Issues

The community issues related to natural gas extraction activities are every bit as complex as the environmental issues. While the community issues may be better understood due to past experiences with other natural resource booms, they may also be less prone to provide direct results, due to the sometimes-unpredictable nature of human activity.

2.2.1. Status Quo

Communities presently deal with the impacts of natural gas extraction activities in a number of ways. Their basic functions as municipal or county governments already include the provision of basic services such as infrastructure construction and maintenance, emergency services (such as police, fire, and ambulance), utilities (including water, sewage, waste disposal, electrical power, and telecommunications), education, public amenities (such as parks, libraries, cultural programs, and other recreation opportunities), and in some cases, housing and support for economic development. With a sharp increase in activity in a particular economic sector, and especially in the case of natural resource extraction activities such as the natural gas industry, many or all of these services must be rapidly expanded to accommodate increased visitors and/or residents in the area. These needs are beyond those incurred by the direct activity of the industry itself. [25]

The mechanisms used to fund community responses to these increased needs vary greatly from jurisdiction to jurisdiction. In some cases local and municipal governments can assess *ad valorem* (a tax based on the value of the property) taxes on natural resources such as mineral holdings (which would include oil and natural gas) in place. Alternatively, these taxes may be assessed when the resource is extracted; such taxes may be *ad valorem* (based on the market price of the resource) or based on a fixed amount tax per unit of the resource extracted. Taxes incurred when a resource is extracted are called a "severance tax." Some states allow local jurisdictions to collect such taxes and use the revenues to address community impacts. Conversely, some states reserve the right to impose such taxes themselves. Among such states, some direct a portion of the revenues from such taxes back to the jurisdictions where the resources were extracted to aid in meeting the needs of that area. Other states retain a majority or all of these funds for appropriation to general state uses.

Another approach employed by some states is to take revenues from severance taxes and place some or all such funds in an endowment. Alaska, Colorado, New

[25] These challenges are discussed in greater detail in section 1 above and in the Technical Supplement.

Mexico, North Dakota, Utah, and Wyoming have established such funds, as have the Navajo nation and the country of Norway. Some states also have regional endowments. Each of these funds have varying purposes, but, in many cases, these funds seek to take revenues generated by non-renewable sources and apply them to meeting the needs of communities impacted by resource extraction and to provide economic development and government revenue stability to counter the boom-bust cycle. One example of such a fund is the Iron Range Trust in Minnesota. Funded by severance taxes, the trust is managed by the Iron Range Resources and Rehabilitation Board (IRRRB) and is charged with administering revenues from the trust to promote economic development, community infrastructure, and develop the regional workforce.[26] Other funds use revenues to support general fund expenditures such as education, remediation of areas impacted by resource extraction, or to support research in the relevant industry.

2.2.2. Increased Government Involvement

Communities have many options to increase their involvement in natural gas extraction issues. At federal, state, and local levels, governments could take a more proactive approach to such issues by providing mechanisms to "get in front of" issues such as infrastructure capacity, common and emergency services, and employment issues. Where a strong possibility of resource development exists, governments can form planning groups with stakeholders from the public and private sectors to anticipate needed responses both in terms of infrastructure and services and to facilitate the implementation of such changes when needed. Governments can also plan how to use revenues generated from increased economic activity to fund projects aimed at diversifying the local economy so as to avoid negative economic impacts when resource extraction activity eventually subsides (this assumes, though, the relevant governmental unit has the capacity to capture revenues from resource extraction activities) to help avoid the Dutch Disease concept discussed above.[27]

At the federal or state level, additional research into the impacts of natural gas extraction could be used to create ready-to-go "toolkits" of policies and regulatory options and could empower local jurisdictions to enact those policies through enabling legislation. Additional research capacity could be made available to provide communities with rapid and individualized assessments of local conditions, opportunities, and needs to facilitate quicker response by local governments.

Though each of the community issues and potential responses are discussed with greater detail in the companion policy matrix publication, it is worth noting that many community impacts, and thus the potential responses to those impacts, are interrelated. A large influx of workers into a small, geographically isolated community will necessarily trigger changes in a number of social elements, including housing, recreation, services, public health, emergency services, and interpersonal relationships; all of these elements, to some extent, depend on each other. Thus, while the potential policy responses are presented as individual action items, the research strongly suggests that the most effective strategies for increased involvement are integrated approaches across multiple dimensions that engage residents, local government, and natural resource developers.

[26] Information about the IRRRB can be found at http://mn.gov/irrrb/.
[27] Refer to the discussion of Dutch Disease in section 1.2.1. above.

Given the present condition of federal, state, and local budgets, finding the funding for increased levels of government involvement will frequently require the expansion of existing funding sources or the creation of new ones. Implicit in every suggestion of increased government involvement is the consequence that it will require the expenditure of additional monies. To that end, the discussion turns to the most common tax used to deal with resource extraction issues–the severance tax.

2.2.2.1. Financing Responses to Community Issues: Severance Taxes

A major policy option for public management of natural resource extraction has been the adoption of severance taxes. This practice is specifically a levy on the removal or severing of the resource, rather than a property tax. It is considered by local or state governments to compensate for permanent loss, environmental damage and economic hardship to individuals and society. Most oil and gas operations face state and or local severance taxes.[28]

The application and use of a severance tax has varied by state. Some apply it instead of a property tax (on minerals in-place rather than as-extracted), while others apply both.[29] Some severance taxes target those with an interest in the end product, some with the producer/operators, and some with the owner of the resource. Various severance tax regimes allow local assessment and state taxes, while others do one or the other. Other taxes may be imposed as well, including fees, excise taxes, conservation taxes and income taxes. Uses of tax revenue vary from conservation and reclamation, education, damage compensation, enhancement of public infrastructure, to trust funds for extending revenue streams beyond the end of extraction. Where competition for revenue use or concerns about increased environmental costs of extraction encourage increase in the severance tax, research suggests caution. Brandly and Barnett claim there is a tipping point where the tax can become so high it is in the operator's short run interest to plug and abandon marginal wells to take them off the tax books.[30] Within a time frame of limited technology and falling prices, this may have a consequence of irreversibly closing the well from future exploitation. Whether that is an intended or unintended consequence is the question for public oversight.

The economics of severance taxes are relatively basic. A review of the economic concept known as a Pigouvian tax (named after economist Arthur Pigou, who first set forth the economic framework justifying such taxes) explains the rationale and likely

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[28] Much of the legal discussion of this section is taken from JJ POWELL, A SURVEY OF STATE SEVERANCE TAXES ON NATURAL GAS: PERSPECTIVE FOR PENNSYLVANIA, (Columbia University School of Law research report, 2011). State severance tax laws are in flux. New York and Virginia have only local authority for the tax. Texas, Arkansas, West Virginia, Kentucky, New Mexico, Colorado, Arizona, California, Illinois, Kansas, Nebraska, Ohio, and Wyoming have authority for both state and local severance taxes. Louisiana, Oklahoma, Montana, South Dakota, Alabama, Mississippi, Alaska, Florida, North Dakota, Pennsylvania, Tennessee, Indiana, Nevada, Oregon and Utah have only state-level authority to impose severance taxes.

[29] There is disagreement about whether severance taxes are better than ad valorem taxes in achieving certain goals, such as capturing more private dollars for public revenue enhancement, and doing so with the stability of the public income stream in mind. Olson and Kleckley, in *Severance Tax Stability*, 42:1 NATIONAL TAX JOURNAL 69-78 (1989), suggest that ad valorem taxes have better long run yield growth. However, the same study indicated greater cyclical yield stability for the severance tax.

[30] M. Brandly, and A.H. Barnett., *The Irreversible Effects of Severance Taxes on Oil*, 27:5 PUBLIC FINANCE REVIEW (1999).

impacts of such taxes.[31] When private production and supply is deemed as greater than what society considers beneficial, a tax on the production side of economic activity increases the cost of doing business. This theory suggests that the severance tax effectively slows extraction, thereby reducing currently marketable supply.[32] Assuming other factors remain unchanged, this action raises the natural gas price. Consumers pay more for less. This results in a form of price-driven conservation.[33] More on the role of severance taxes as moderating resource extraction rates is included in Appendix 1.

Severance taxes play another role in balancing property rights. Problems resulting from the exploitation of natural resources and the potential for environmental impacts are typically examples of what economists refer to as "externalities." These are benefits or costs outside a decision-making unit that are uncompensated by-products of production, processing or distribution. Most of the impacts discussed in this paper are negative externalities because they are uncompensated harms to society as a whole, or some segment of society. Examples include pollution of air and water, degradation of community infrastructure, and boomtown effects. A severance tax can force the "internalization" of these externalities by linking the costs of remedying the externality to the revenues an extractor receives from the extraction activities. The function of severance taxes as a means of linking externalities and internalities by assigning property rights is also discussed in Appendix 1.

One last point must be made on the issue of severance taxes and their use in permanent endowment funds. All such funds are prone to raiding when other sources of revenue diminish or when large expenditures are desired by a government. As a result, if such funds are the vehicle used to receive severance tax funds and to balance the "boom-bust" cycle, then they must be protected by robust institutional controls that prohibit the repurposing of such funds to uses other than those originally intended, or, at the very least, make such diversions extraordinarily difficult.

2.2.3. Decreased Government Involvement

Decreased government involvement in addressing community impacts is somewhat difficult to define in that many local governments are required to maintain certain minimum levels of infrastructure and services. Decreased government involvement in these arenas may simply mean a longer lag period between the incidence of need for infrastructure and services and the provision of a response. Governments could take a less-proactive approach to dealing with anticipated needs, and instead pursue a reactive course. Where allowed by the legal framework, governments could relinquish the provision of certain services to private providers. As with the environmental issues discussed above, private dispute resolution systems, such as litigation, could see increased use in handling conflicts among parties.

2.3. Likely Consequences

Every policy move, whether maintaining the status quo, increasing government involvement, or decreasing government involvement will have some impact on a number

[31] For basic explanation of the Pigouvian tax and its implications see S. C. HACKETT, ENVIRONMENTAL NATURAL RESOURCES ECONOMICS, 4th ed. (M.E. Sharpe, 2006) or other introductory economics texts.
[32] In economic terms, the tax increases marginal cost.
[33] For discussion of how severance taxes can be used to adjust extraction rates, refer to Appendix 1.

of stakeholders. To limit the scope of this discussion, the groups that were identified for this report are A) consumers, B) residents living near natural gas deposits, C) natural gas extraction companies, D) other businesses, and E) landowners. The impacts suggested by scholarship and economic theory on each of these groups is provided below.

2.3.1. Consumers

Based on the discussion above, it seems clear energy consumers will benefit in the near term from maintaining the status quo or less government intervention. Under the status quo, supply will continue to grow and prices remain relatively low. With less government, it is possible supply will expand at an increasing rate for years to come. With that prospect, it is likely prices will fall, and consumers will gain. If this helps the U.S. continue its current trend of energy expansion, the benefit to consumers in foreign markets will also be significant. The traditional market for residential and industrial use will continue. The small, niche market for transportation will expand, relieving pressure on gasoline and diesel consumption, and could cause their prices to trend lower at some point. If there is a great increase in transportation use co-incident with falling prices, this could pose a challenge to renewable fuel production, which would lead to calls for balancing subsidies. In the long term, consumers might experience costs associated with potential environmental issues caused by full development of the gas deposits.

2.3.2. Nearby Residents

Impacts on residents of communities located near natural gas deposits are complex. Categories of impact include: A) environment; B) jobs; C) community development (growth, cost of living, pressure on infrastructure, local taxation, asset appreciation—residences and businesses); and, D) quality of life.

A) *Environmental impact*: Maintaining the status quo can provide a consistent (as opposed to changed) set of rules for residents. In some cases, these will be sufficient to assure environmental protection. However, if some studies are accurate, there will be new cases of water, land and air pollution. The groups most at risk will be the nearby residents. An increase in government intervention to further protect the environment will reduce such risk to nearby residents. Less government intervention could have the opposite effect and further endanger nearby residents. A mix of policies and voluntary efforts based on further scientific studies could support more environmental protection, while lessening adverse impacts in economic areas, as suggested below.

B) *Jobs*: States experiencing expansion of natural gas exploration and production are among the fastest growing job markets in the country, and residents of nearby fields are likely to benefit from additional employment opportunities. Not only are there additional gas field jobs, but also the multiplier effect expands jobs in town, especially in the services sector. These communities were among the first to recover from the 2008 economic recession. Maintaining the status quo will likely continue this boom into the near future. More government intervention to regulate the natural gas industry would likely inhibit job growth. Less government intervention could further expand job growth, although some communities have already reached their limit of accommodating such growth. There is an ironic tradeoff in states with competing industries, such as coal. Cheaper natural gas could reduce coal consumption and extraction, thus reducing jobs in coal country. This could cause a net increase in jobs from natural gas to be less in such states (Ohio, for example). These are empirical questions to be further evaluated.

C) *Community development*: In some cases, the status quo brings growth to nearby communities, an increased cost of living, added pressure on infrastructure, and often increased local taxation and asset appreciation – especially residences and businesses. There is a vexing issue of ability of neighboring communities to absorb the rapid growth, sometimes referred to as the "boomtown effect," with these impacts. Communities with excess capacity and leadership in both the private and public sectors willing to promote adjustment and expansion do see short- to intermediate-term benefits. Pressure on public infrastructure often requires tax increases to expand schools, improve roads and bridges, and expand access to utilities. Less government regulation of hydraulic fracturing would likely accentuate this phenomenon. More government intervention to regulate and protect the environment would slow or even reduce this form of economic development. Such a change could leave communities with the downside of the boomtown effect: economic recession, fewer people to support the increased tax base, excess capacity in public infrastructure, and fewer people to pay for it. Alternatively, communities in less isolated regions may mitigate many of these impacts as they are spread over more communities and population.

D) *Quality of life*: There are typically various members of the community who are happiest with their current living conditions and seek to minimize disruptions to them. These citizens live in a rural community because they like the slower pace, intergenerational social ties, and less congestion. The status quo or less government options is significantly upsetting to this demographic. Likewise, those who are concerned about environmental contamination typically see their quality of life diminished with the existing level of activity or the expanded levels that could come from less government involvement. Only more government regulation to the point of restricting hydraulic fracturing or banning it altogether would have a chance of returning such communities to this group's desired quality of life. However, given the problems noted above with an enlarged bill for expanded infrastructure, the damage may be irreparable. Of course, there are also residents who want to see their communities and economies grow. They want their property to appreciate in value. They want jobs to enable their children to stay or return for gainful employment. These citizens want improvements in schools and other types of infrastructure. In their communities, they want the diversity of retail shops, restaurants, health care, and other services that only growth will support. This demographic will prefer the status quo or less government, even if there is some risk of environmental problems, provided these problems can be managed without acute impacts.

2.3.3. Natural Gas Extraction Companies

The status quo would likely allow continued resource exploitation and profit opportunities for the affected companies in the industry. This would result in an expanded supply of natural gas. More government regulation would result in increased cost to the exploration and production companies, likely resulting in loss of competitiveness for the industry. It is possible there could be investment in safer extraction methods over time. In any event, there would likely be a slowdown or reduction in supply. As noted in the appendix, the uncertainty of the industry's elasticity makes statements about revenue change difficult to predict. Less government involvement would likely lead to expanded extraction rates, increased profit margins, and expanded supply of natural gas.

Summary Matrix of Options and Consequences

Key Agents		Do Nothing (Status Quo)	Increased state/federal intervention in extraction	Reduced state/federal intervention in extraction
Group A: US energy consumers	Energy Consumers	Continued relatively low natural gas price; stable/rising reliance on natural gas.	Increased cost of NG; possible instability in supply.	Low/lower prices; increased supply.
	Water users	Continued uncertainty about impacts to water quality.	Reduced threat to water quality from real/perceived extraction practices; possible increase in research of interaction between practices and quality.	Increased concerns about adverse impacts to water quality; opportunity for private-driven research to assure public that extraction methods are safe.
	Future generations	Creates question as to whether the energy base be available at affordable rates to maintain/ enhance quality of life.	Lower long-term environmental risk, but higher cost for energy; severance taxes do not seem to slow extraction with rapid growth in extraction technology outpacing tax rate; severance tax offers opportunity to improve optimal extraction rate.	Long-term risk to environment increased, but relatively lower cost for energy likely; if energy use picks up, could face earlier peak in supply availability, resulting in higher prices.
	Non-industry taxpayers	To extent local/state revenues gain from NG extraction, taxpayers could gain; to extent public budgets cover affected roads/bridges, environmental damages & regulatory oversight, pressure for more tax funds.	More regulations/oversight causes increase in taxes or offsets; severance fund could reduce tax rates for those outside the natural gas industry.	Less government involvement results in lower taxes or offsets.
Group B: Residents of Local communities		Continued/ enhanced economic development with job opportunities.	Threat to growth of extraction & benefits therefrom, or pace and scale of development; severance funds available for compensation/mitigation.	Possibly increased economic development opportunities; reduced severance funds could worsen post-extraction impacts.
Group C: Natural gas industry		Continued resource exploitation & profit opportunities; expanded supply of natural gas.	Increased cost; loss of competitiveness; possible investment in safer extraction methods; reduced supply; severance tax impact depends on who is target, but could slow extraction rate and reduce industry capture of rents.	Expanded extraction rate; increased profit margins; expanded supply of natural gas.
Group D: Other businesses		Agriculture & existing businesses could gain in short term, but lose in a bust time if adverse environmental impacts occur later.	Businesses that rely on quality environmental flows will benefit from more government intervention.	Businesses that rely on expanded economic development will benefit from less government intervention.
Group E: Landowners		Continued opportunities for profit from leases and wealth gains; continued concerns about adverse impacts to land, related natural resources, flora/ fauna, land values.	Reduced opportunities for profit; reduced concerns about adverse impacts; severance tax increase could lead to early plugging of marginal wells.	Increased opportunities for economic gain; increased concern for adverse impacts.

2.3.4. Other Businesses

The likely impacts on other businesses are as diverse as the businesses themselves. Industry-related businesses could be impacted similarly to the industry. Non-industry businesses, however, are more complex. Businesses that rely on quality environmental flows will benefit from more government intervention. Businesses that rely on expanded economic development will benefit from less government intervention. Agriculture may be a special case. While needing high quality natural resources, agricultural landowners may reap significant gains from leasing to the exploration and production companies if they also own mineral interests, although they may also face increased prices for inputs (such as labor) along with other businesses. Existing local businesses, such as restaurants and retail shops, could see initial gains in business, then increased competition from new businesses, then increased payroll to competitively pay workers, an increased tax burden to support rapidly expanding public infrastructure/maintenance, then the tax burden of paying for over-built infrastructure if/when the bust occurs. Businesses with the flexibility to expand and contract could do very well and capture gains when the opportunities are there, regardless of policy changes.

2.3.5. Landowners

For landowners, the status quo will provide continued opportunities for profit from leases and wealth gains. For some, there will be continued concerns about adverse impacts to land, related natural resources, flora/fauna, and possible reduction in land values. More government involvement would likely lead to reduced profit opportunities. However, there would be fewer concerns about adverse impacts to the environment. With less government, there could be increased opportunities for economic gain, but increased concern for adverse impacts to some landowners.

3. Conclusions

Federal, state, and local governments face a myriad of choices in addressing both the environmental and economic impacts that can result from natural gas extraction activities. See our companion policy matrix document for more specifics in terms of choices.

In addressing environmental impacts, the federal government has a number of options ranging from a nationwide moratorium on hydraulic fracturing practices, to removing current exemptions in federal environmental laws for oil and gas operations, or simply funding additional research into environmental issues. Since jurisdiction for many environmental programs is shared between the federal government and states, the federal government could also pre-select menus of regulatory options that could be exercised by states or could increase the delegated authority to such states. These states, on the other hand, could enact protections beyond those provided at the federal level, so long as such protections were not preempted or prohibited by conflicting federal law. Alternatively, states could also reduce their level of regulatory involvement by either relinquishing delegated federal authority or by not seeking it. States could also empower local jurisdictions to engage in environmental regulation.

To address community impacts, federal and state governments could make funding available to help communities anticipate improvements in infrastructure and services for mitigation of the rapid economic expansion impacts in a natural resource extraction industry. State governments can also help fund responses through a severance tax or similar mechanisms, or could authorize lower levels of government to collect such taxes. Several states have designated at least a portion of severance tax revenues to endowment or trust funds meant to be a permanent source of funding to help level the long-term returns from the extraction of non-renewable resources. While such funds can provide important benefits, they also must be carefully protected to avoid the redirection of funds to purposes unrelated to resource extraction impacts.

Any change in a government's level of involvement with natural gas extraction will likely have impacts to a variety of stakeholders. Increased governmental involvement may lead to enhanced environmental protection and improved local infrastructure and services, but may also increase energy prices and slow economic growth or recovery. Decreased governmental involvement may lead to decreased energy prices and more vigorous economic expansion of resource-endowed areas, but also risks some irreparable, environmental harm and a sharp, negative economic impact as the resource is depleted.

Appendix 1 – Economic and Policy Functions of Property Taxes

Regulating Resource Extraction Rates and the Net Present Value of a Resource

Beyond the scope of this paper is a more detailed discussion of the optimal rate of extraction. What is a future stream of net benefits worth? Are there legitimate and measurable reasons the answer to this question would be different for the private extractors and the public? A thorough discussion for this concept involves benefit-cost analysis, discounting, private versus social discount rates and values, project length, market and nonmarket goods and their values, "knowns and unknowns" related to future generations, and a discussion of the ethical dimensions of attempting to quantify the value of some things such as life, cultural history and natural amenities and ecosystems that may be damaged by extraction. The private market will attempt to maximize the net present value of the depletable stock—natural gas in this case. If the value to society is greater than the value to the private sector, then the value to the private sector would result in an extraction rate that is too fast to realize those additional social values.

The extraction question can be divided into two sub-questions. First, does the price of the resources cover all of the marginal costs, both private and non-private? If the answer is yes, then the question is when to extract and how much to extract each year. The best answer is to determine the rate of extraction that maximizes the net present value of private and public benefits. The solution involves equating user cost plus marginal extraction cost to price. The marginal extraction cost is the sum of the private owner's cost plus costs not paid by the private owner or company. These include but are not limited to damages to roads and bridges, possible subsidence, and water pollution. For example, in the case of lead mining in northeastern Oklahoma and southeastern Kansas these damages continue long after the mining has ceased. User cost is the discounted value of future benefits lost because of current extraction. If the future supply of the resource will be limited so its discounted future benefit is greater than current benefits, then current extraction should be reduced or delayed.[1]

If the rate of extraction occurs to the point where only private marginal cost is equal to price then extraction occurs too rapidly and/or too soon. The part of the problem due to non-private extraction costs being ignored can be addressed either through changes in private property laws or taxes. In principle, air and water rights can be assigned but this is a slow process that may produce unintended consequences. The method chosen may depend on the particular cost or resource. As an example, damage from acid mine drainage has been addressed by a change in laws whereby the private owner is responsible for closure after mining has ceased. Assignment of liability for groundwater pollution or subsidence where multiple companies are involved is more difficult. In the case of petroleum production in regions where the geology is sufficiently understood, regulations on well casings for extraction and or injection wells have been effective. However, with damages to roads and bridges or where underground water pollution or

[1] For a richer discussion of the optimal rate of extraction, see J.L. SWEENEY, ECONOMIC THEORY OF DEPLETABLE RESOURCES: AN INTRODUCTION (1992), *available at* http://www.stanford.edu/~jsweeney/paper/SWEENEY%20Handbook%20Chapter.pdf or A.V. KNEESE AND J.L. SWEENEY (eds.), HANDBOOK OF NATURAL RESOURCE AND ENERGY ECONOMICS, Volume 3 (2012), *available at* http://www.sciencedirect.com/science/handbooks/15734439.

subsidence are involved it is difficult to assign liability to specific producers. Taxes on production or the companies involved may be the most cost effective measure.

Solutions to the problem of ignoring user cost or myopic extraction (and thereby obtaining less than the maximum net present value from the resources) might be addressed through education. Central regulation by a state agency (such as the Texas Railroad Commission's regulation of oil and gas activities in that state) has been used to limit individual extraction and would increase producer benefits. Economists such as Ciriacy-Wantrup and Hotelling have shown that production taxes can also be used to increase net social benefits from the resource

Additional important issues to be addressed are the length of time for analysis of the project, whether and how to measure benefits and costs for nonmarket goods/services (loss of ecosystems, loss of endangered species, increased incidence in social disharmony (divorce, drug/alcohol abuse, changing "character" of the neighboring communities—such as "man camps"), risk to healthy life, opportunity cost of foregone economic development and jobs, and uncertainty about the future on a variety of levels. The private company and the government may both have reasons to maximize extraction in the short run. The company wants profits now. The government wants economic development and jobs right away. There may be an export market to be satisfied in the short run. However, those rationales may be counter-productive over time. Rapid extraction could drive the price down, allow export market to pay relatively lower prices, leaving domestic energy consumers facing future energy shortages, higher prices, and being placed at the mercy of foreign markets in later years. Governments could reap a short-term windfall in public funds and economic activity, thus rapidly expanding public services. Assuming a rapid resource extraction program, who pays to maintain the expanded infrastructure of public services (such as roads, schools, utilities, etc.) when the extractors leave and plug the gas wells? There are further technical complications because of the geologic characteristics that affect the economic extraction, such as the pressure and concentrations required to push the gas up to the surface. Government is looking at the proverbial bottle of fine wine, wondering the best time to pop the cork. Net present value based on thorough benefit-cost analysis can help determine the optimal time path of extraction when all costs and benefits to society and the private sector are included.

Where these differences can be evaluated, governments can use the severance tax to slow the extraction rate and increase net social benefits. However, advances in technology such as hydraulic fracturing may increase the level of potential stock. Changing such assumptions alters the optimal rate of extraction. There is both a general and technical understanding of physical stocks of nonrenewable resources such as natural gas: known reserves ranges from demonstrated to inferred, suggesting extraction is relatively technologically feasible and economic; and, unknown reserves, which range from hypothetical and speculative to undiscoverable and irretrievable, suggesting extraction is not yet technologically feasible nor economic.[2]

[2] For a chart and explanation showing the distinction between known and unknown reserves, see T. TIETENBERG AND L. LEWIS, ENVIRONMENTAL ECONOMICS & POLICY, 6th ed. (2009) or U.S. BUREAU OF MINES AND THE U.S. GEOLOGICAL SURVEY, PRINCIPLES OF THE MINERAL RESOURCE CLASSIFICATION SYSTEM OF THE U.S. BUREAU OF MINES AND THE U.S. GEOLOGICAL SURVEY, (USGS Geological Survey Bulletin 1450-A, 1976).

As technology and economic opportunity improve, reserves move from the unknown to the known category. So long as the known reserve growth rate is greater than the consumption rate, the currently marketable stock will increase, driving down price. At some point, lower prices due to expansion will slow both the extraction rate and the exploration rate. In turn, if demand is increased, price may stay stable and eventually increase when and if scarcity comes into play. Rising prices create a positive feedback loop where more exploration is possible and extraction is financially feasible at higher costs. While this exposition gets complicated and the modeling analysis is complex, the point is relatively straightforward. Where total net present social value is greater than net present private value for the resource (natural gas), leaving the private sector to its own devices will result in more rapid depletion of the stock and greater capture of the rent by the private sector.

If the severance tax is set at a level to sufficiently increase price, the extraction rate may slow and the resource will last longer. Slowing the extraction rate may reduce environmental harm and smooth out the boom-bust cycle. However, such results are by no means guaranteed.

Using Severance Taxes to Allocated Property Rights

Problems resulting from the exploitation of natural resources and potential for environmental impacts are typically examples of what economists refer to as "externalities". These are benefits or costs outside the decision-making unit that are uncompensated by-products of production, processing or distribution. Most of the impacts discussed in this paper are negative externalities because they are uncompensated harms to society as a whole, or some segment of society. Examples include pollution of air and water, degradation of community infrastructure, and boomtown effects. Common pool and open-access resources such as airsheds and water aquifers are especially problematic because of difficulty with assignment of property rights.3

Property rights are an important factor in this discussion. While the natural gas or exploration company may purchase the rights to the natural gas, the air and water quality rights may be unassigned. When governments get involved in regulating such matters, they are, in effect, taking possession of the rights. When government allows access to air and water and allow waste disposal at some level, it is assigning the property rights of those natural resource aspects to the extractors. In return, the government typically requires some rate of compensation or potential for compensation. What this does is internalize the externality into the decision-making unit of the extractor. If the government prohibits any pollution, or use of the common resource, it is appropriating the property rights to the public it represents and excluding specific rights to the extractor. In effect, this will force reduced extraction, or prevent it altogether, depending on the specific situation. Usually the government allows for optimal pollution where marginal damage costs equals marginal abatement costs.. Thus, it internalizes the social costs, reducing the negative externality.

Government entities may not think in terms of "assigning property rights". The key to understand improved efficiency in the natural gas extraction, however, is how to internalize any identified externalities into the decision making process of the extractor.

[3] Review and editorial comments of Art Stoecker and Tracy Boyer, both of Oklahoma State University, are greatly appreciated for this segment.

So, when governments consider such actions as road fees for use of public roads to move gas, or fees for disposal of wastewater, or penalties for pollution of the air, or severance taxes for extraction, they are forcing the extractor to internalize and compensate for what would otherwise be uncompensated impacts to some segments of society.

Other Regulatory Functions of Taxes

Government, as noted earlier, has a variety of "carrot or stick" choices in attempting to gain more social value: regulations, taxes, fines, subsidies, tax credits, education, research, etc. The threat of use or actual use of any of these choices is likely to bring about rent-seeking by various segments of the private and public arenas. Those claiming harm from extraction lobby government for a share of receipts as compensation. Representatives of the public may also lobby to channel the receipts into general or selected public uses to limit their taxation or enhance benefits in the near and long terms.

Severance taxes have come to be known as "ecotaxes" for very specific reasons; they are considered to protect or enhance the environment and, as necessary, compensate for environmental damages. When coupled with regulatory actions, the government can begin to balance equities in managing the power of large corporations who may be perceived to be abusing the environment in the extraction process. When levied against smaller producers, it may be a heavy burden for the company to manage and for the government agency to enforce. States may provide partial or complete exemptions for such smaller companies. However, this could have the unintended consequence of strategic behavior of oil and gas companies to contract out the taxed behavior to smaller companies qualifying for exemption.

As noted earlier, production technology advances and expanding supply may swamp hopeful conserving effects of a severance tax. In other words, revenue funds will grow, but have little impact on the protection aspects. Thus, there is no doubt an enforced severance tax creates public revenue that can be put to use for the public good. Whether it has much value as a protection from ecological harm, however, is questionable.[4] If harm does occur, the revenue may be available for allocation to compensate, mitigate, or clean up to the extent such actions are politically, economically and technically feasible. Here, the pairing of the tax with regulatory regimes can be useful. The damage to the environment may be irreversible, but, where compensation and mitigation are feasible, government can require post-extraction mechanisms such as extension of legal liability, bonding, expert-citizen resource councils with authority, refunds and bonus programs for good stewardship, and management of funds with long term sustainability in mind.

[4] Ujjayant Chakravorty, Shelby Kerking, and Andrew Leach, *State Tax Policy and Oil Production: The Role of the Severance Tax and Credits for Drilling Expenses*, in U.S. ENERGY TAX POLICY (G. E. Metcalf, ed., 2011). In this chapter, the authors review the oil industry over the past 50 years and conclude that the severance tax has little effect on production levels and serves mainly to redirect rents earned in the oil industry to the public sector. This discussion begs the question of whether higher tax rates could achieve the goal of environmental protection.