A NATURAL GAS EXTRACTION POLICY ALTERNATIVES MATRIX

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Volumes could be written about the potential policy responses available to address the issues presented in this paper. However, the authors have worked to provide a sample of both the issues presented by natural gas extraction activities and the policy alternatives that have been or could be used to address those issues. It should be noted that while examples of implementation of these alternatives have been provided in many cases, the authors do not wish to convey those examples as *exemplary*. In many regions of the U.S., the natural gas extraction industry, in its modern form with a high reliance upon hydraulic fracturing and horizontal drilling, is relatively new. As a result, the objective and peer-reviewed body of scientific literature regarding the efficacy of such measures in reaching their stated goals is small, but growing. The matrix can be used by policy makers to zero in on options to explore for their relevance to the concerns at hand in their jurisdiction.

To save space, the following abbreviations are used in the matrix:
CERCLA: Comprehensive Environmental Response, Compensation and Liability Act
EPA: U.S. Environmental Protection Agency
HF: hydraulic fracturing
NG(E): natural gas (extraction)
NORM: Naturally Occurring Radioactive Material
NRDC: Natural Resources Defense Council
RCRA: Resource Conservation and Recovery Act
SGEIS: Supplement Generic Environmental Impact Statement
VOC: Volatile Organic Compound

Cover Photo: Deep Well Natural Gas Rig, Casper, Wyoming
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http://www.blm.gov/wo/st/en/bpd.html

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General Environmental Issues

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
General concerns regarding hydraulic fracturing issues / insufficient information for regulation	Moratorium on hydraulic fracturing (HF) operations pending investigation/research	□ "Freezes" development allowing time to gather additional information and stakeholder input. □ Postpones economic benefits □ Issue of counties' and municipalities' authority to enact	□ State: New Jersey (1 year moratorium by Gov. Christie in conditional veto of S-2576 on 9/15/2012)[1] □ State: New York (Exec. Order 41 blocks permitting of HF wells pending completion of SGEIS)[2] □ Buffalo, New York municipal ban[3] □ Municipality: Morgantown, WV (moratorium judicially overturned)[4]
Habitat fragmentation	Require / incentivize production of larger area from one well site through increased size of well spacing units and/or increased utilization of multiple-well drilling by horizontal drilling	□ Reduces overall land use and fragmentation by producing larger area from one well site □ Increases spatial impact on surface estate where larger well site is located □ Increased unit size may be contested by mineral owners as decreasing their proportion of unit ownership □ Increased use of horizontal drilling may exacerbate other concerns	□ Oklahoma Corporation Commission spacing rules[5]

Water Quality and Quantity

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
Quantity of water used for natural gas extraction (NGE)	Measurement and monitoring of water used for NGE / cap on maximum use / encouragement of recycled water use	□ Enables collection of data re: NGE water use □ Question of who pays for monitoring / enforcement of cap □ Question of how limits are set □ Cap may restrict NGE activities and economic benefits □ Water recycling technology developing quickly, but may not be widely available	□ Colorado Department of Natural Resources Groundwater Diversion Regulations[6] □ API Water Management Associated with Hydraulic Fracturing – guidelines for water management, recycling & disposal[7]
	Restrictions on time / amount of water withdrawals for NGE	□ Can time-shift withdrawals to avoid acute impacts to other uses (aquatic habitat, agriculture, power, etc.) □ Requires understanding of region's hydrologic cycle; dependent on rainfall and other variables □ Seasonality can make NGE development more expensive; delays may be costly	□ State of Michigan Department of Natural Resources Report (discussion of impacts based on seasonality)[8]
	Differential water pricing based on use (premium for water used for NGE)	□ Can increase revenues for water supplier (if pricing does not discourage use) □ Can link revenues and costs of expanding water supply □ High probability of contest by NG developers if rates are different from other industrial users	□ Proposed by City of Carlsbad, NM 1/8/2013[9]
Surface spills of fracturing fluid components / blowback / produced water	Require secondary containment around all storage areas and/or enhanced requirements for storage vessels and pits	□ Reduces probability that spills reach surface/groundwater sources □ Requires development of standards □ Question of who pays for inspection/enforcement □ Restricting use of earthen pits may mean use of portable storage units, which can increase truck traffic and risk of accident/roadside spills	□ Proposed requirement for closed storage systems in New York SGEIS[10] □ Oklahoma Corporation Commission specifications for drilling fluid storage/disposal pits[11]
Impacts from injection of fracturing fluids	Specify requirements for well construction, casing/seal requirements, pressure testing	□ Can prevent formation of artificial pathways connecting hydrocarbon formations and groundwater formations □ Requires extensive technical knowledge to develop and implement □ Only effective to extent requirements can be monitored, enforced and evaluated; question of who pays	□ Texas Railroad Commission specifications for casing, cementing, drilling, and completion requirements[12]
	Regulation of HF through Underground Injection Control program of Safe Drinking Water Act	□ Requires federal legislative action □ Would increase federal authority to regulate HF activities (increases state authority under delegated programs) □ Would represent significant change in federal policy/cost of enforcement	□ FRAC Act[13]
	Establish baseline testing requirements for water resources near HF wells	□ Can aid understanding of impacts (if any) of HF operations on local water quality □ Must be used in concert with other scientific investigations □ Costly to implement and maintain □ May be "too late" if HF operations already commenced	□ Colorado Oil &and Gas Conservation Comm'n Groundwater Protection Rule[14] □ Pennsylvania Act 13[15]
Use of toxic substances	Ban use of toxics in fracturing fluids	□ Eliminates concern of introduction of toxics to environment through HF activity □ May block HF operations in some areas if non-toxic substitute not available	□ Research unable to find any bans currently in place
Disclosure of fluid components	Enact requirements for disclosure of fracturing fluid components, amounts and concentrations	□ Significant voluntary efforts already in place □ Facilitates public dialogue re: potential impacts of fluid use and development of regulatory systems □ Disclosure of information deemed "trade secret" may result in legal challenges	□ Voluntary disclosure program through www.fracfocus.org □ Pennsylvania state disclosure requirement[16]
Inadequate treatment of wastewaters	Increase requirements for pretreatment of waters sent to POTWs for final treatment and discharge / prohibit discharge of wastewaters to POTWs	□ Shifts portion of treatment efforts and costs from POTWs to NG developers □ May significantly increase costs of NGE □ Requirement for NG developers to treat waters on-site likely requires additional equipment, increasing wellpad size, risk of on-site spills, and truck traffic	□ Proposed federal requirement for increased pretreatment of wastes[17] □ New York proposed prohibition of discharge of NGE waters to POTWs[18] □ New Jersey general ban on treatment of HF waste[19]

Air Quality

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
Emissions from wellbore	Require increased controls at all stages of drilling and production under "green completion" system	□ Can reduce emissions by requiring capture or combustion of gas emissions that might otherwise escape during well completion process □ Must develop technical specifications for capture or control mechanisms □ Increases cost of NG well development	□ Federal requirement enacted but implementation currently in abeyance pending review by EPA[20]
Emissions from supporting equipment	Specify requirements for operation of engines and generators (limiting hours, requiring emissions controls, etc.)	□ Address point-sources of air pollutants; potentially least-cost and most easily implemented pollution control □ Hour restrictions can make NGE activities difficult; may have effect of "trading" chronic emissions for acute emissions	□ Federal requirements stationary compression ignition internal combustion engines[21]
Emissions from storage of flowback and produced water	Require flowback and produced water to be kept in closed vessels; require emissions controls for venting of gases from storage	□ Reduces overall emissions □ Transforms fugitive emissions into more manageable point-source emissions. □ Emissions from these sources not yet fully understood; need to adapt emission control requirements from other programs to fit emissions from closed storage of flowback and produced water □ Management through closed vessels can be difficult if high volumes of flowback and produced water are encountered	□ Regulation of VOC emissions from storage tanks.[22]

Solid Waste Disposal Issues

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
Disposal of drill cuttings and used drilling mud	Establish standards for disposal of wastes	□ Significant experience in developing such regulations from states with history of petroleum development facilitates rule development □ Reduced risk of environmental exposure to pollutants from waste streams □ Requirements that call for off-site disposal can increase truck traffic; on-site disposal may increase size of well site	□ Proposed requirement for disposal of drill cuttings in approved solid waste disposal facility in New York proposed SGEIS[23]
	Regulation of exploration and production waste through RCRA / CERCLA systems	□ Requires federal legislative action □ Would increase federal authority to regulate disposal of wastes (increased state authority under delegated programs) □ Would represent significant change in federal policy □ Increased costs of enforcement	□ NRDC proposed rulemaking proposal to amend Subtitle C of RCRA[24]
Handling of wastes with high NORM content	Regulation of NORM disposal if materials exhibit elevated levels of radioactivity or have high concentrations of NORM	□ Potentially reduces risks associated with exposure to sources of radioactivity □ Likely applies to relatively small portion of NGE wastes □ Potentially expensive compliance □ Disposal of materials with high levels of NORM could take already-scarce space at approved disposal facilities	□ New York state requirements for handling of NORM found in New York proposed SGEIS.[25]

Liability Issues

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
Avoidance of environmental liability through bankruptcy / dissolution of company	Prohibit discharge of environmental liability in bankruptcy / prohibit dissolution of company while it holds environmental liabilities	□ Provides additional enforcement strength for payment of environmental costs □ Requires federal legislative action (bankruptcy code) or state legislative action (corporate dissolution) □ May not provide any additional benefit if company does not have financial ability to fund cleanup efforts	□ Research did not reveal any such prohibitions currently in place

Financing Government Responses to NGE Issues

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
Generating revenue to finance governmental functions necessitated by NGE activity	*Ad valorem* (value-based) severance tax or fee on NG production	□ Provides revenue source to fund needed government serves, particularly where need for services derives from NGE activities □ Severance tax may allow for internalization of externalities and help set extraction rates closer to societal "optimal" rates □ Allows flexibility to NG developers since cost of tax increases with increased NG prices, but decreases with decreased prices □ Flexibility of tax results in flexibility of revenue generated, which may provide "windfall" to government if prices are high, but may result in deficiencies if prices are low	□ Texas severance tax (value-based severance tax[26] □ Pennsylvania Unconventional Natural Gas Well Fee (limited-flex per-well fee adjusted on schedule based on annual natural gas average price; not a "severance" tax in that it is not dependent on volume of NG produced).[27]
	Fixed (per-unit) severance tax on NG	□ Provides revenue source to fund needed government serves, particularly where need for services derives from NGE activities □ Severance tax may allow for internalization of externalities and help set extraction rates closer to societal "optimal" rates □ May increase revenue stability for government since tax is volume-based, and historically, production volumes have been less volatile than prices □ Reduced flexibility to NG developers since cost of tax remains constant even if NG prices fall	□ Louisiana severance tax[28]
	Establish trust fund to save collections and provide long-term revenue source	□ Provides revenue source that may be sustained after depletion of exhaustible resource □ Revenues generated from fund can be used to diversify local/regional economy to reduce negative effects of decrease in NGE activity □ Fund requires careful management and commitment of all stakeholders to long-term vision for fund □ Fund may be target of "raiding" in times of reduced budgets	□ Iron Range Trust / Iron Range Resources and Rehabilitation Board[29]
	Creation of mitigation fund by voluntary payments from resource developers	□ Creates highly-flexible revenue source that can be used to address broad range of community needs □ Voluntary nature of payments and participation in decisions regarding fund usage engages resource developers in community matters □ Developers may be unwilling to make voluntary payments if already required to pay number of other taxes □ If large number of developers are involved, development of consensus and "enforcement" of contributions may become difficult □ Small independent developers may be unwilling or unable to contribute at same level as larger developers.	□ IPP mitigation fund for community of Delta, Utah[30]
Allocation of collected revenues to jurisdictions bearing costs of NGE activity	Revenue-sharing requirement for collecting government unit to allocate revenues to other jurisdictions in proportion to measure of NGE impacts	□ Links revenues generated by NGE activities to costs incurred as result of those activities, and links benefits and burdens of development □ Implementation of revenue sharing among jurisdictions adds complexity to administration of revenue mechanism □ Crafting "proportionate" allocation method complex and difficult test requiring balancing number of interests	□ Pennsylvania Unconventional Natural Gas Well Fee allocation system; portions of funding allocated based on number of unconventional wells, population, miles of state highway and other proportional measures[31]

Planning for Community Needs

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
Need to engage community stakeholders to plan responses to increased needs for services and infrastructure in community	Education efforts to familiarize local leaders and stakeholders with likely "boomtown" impacts and examples of how impacts can be successfully managed.	□ Allows leaders to learn from experiences of other communities, facilitating their ability to predict potential challenges and plan responses □ Question of who to include in training and how to select training materials & experiences □ May unintentionally exacerbate "anticipatory" negative impacts of development by learning of challenges faced in other communities	□ Delta, Utah leaders' "boomtown" tour of communities that had faced similar development issues (construction of large power plant).[32]
	Create environment for community engagement to receive stakeholder input regarding identified needs and concerns via surveys, focus groups, and facilitated public forums	□ Public deliberation method allows stakeholders to constructively reshape the problem and to identify themes common among multiple groups □ Deliberation process itself may increase community engagement by allowing diverse stakeholder to "let their voice be heard" □ Success of efforts require buy-in from broad cross-section of community and from NG developers □ Process must be diligently moderated to avoid assertion of control by any one group or devolution of discussion process into "venting"	□ Kettering Model[33]

Housing

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
Availability of housing for workforce	Community-built and operated housing facilities (may be mix of permanent, semi-permanent, RV parks, manufactured / modular housing)	□ Providing locally-available housing encourages works to spend locally, increasing ability of community to capture benefits of NGE activities □ Public-private partnerships to develop housing could simultaneously address multiple housing needs (family housing, community facilities, "dry" housing to address alcohol and substance abuse issues) □ Housing that allows workers' families to join them can avoid numerous other negative impacts (reduction in crime) □ Community must have human and financial capital to build, operate, supervise and maintain facilities □ Question of sustainability if housing cannot be successfully reused or repurposed post-boom	□ Sublette County, Wyoming oilfield housing and regulations[34]
	Developer-led construction of temporary and semi-permanent housing that is removed or turned over to local ownership upon project completion	□ Provision of housing by developers links benefits and burdens of NGE activities □ Flexibility in type of housing (modular, manufactured, and semi-permanent) can avoid overwhelming market in start of "boom" cycle and removing housing can stabilize property values after it ends □ Housing that allows workers' families to join them can avoid numerous other negative impacts (reduction in crime) □ May require adaptation or modification of local land use restrictions □ Requires commitment by developers to maintain properties and honor obligations for closure when units are no longer needed □ Question of sustainability if housing cannot be successfully reused or repurposed post-boom	□ IPP housing program in Delta, Utah[35]
	Educate local construction companies, realtors, lenders, and permitting agencies about likely housing needs	□ Can expedite development of housing stock by building both human capital and overall capacity of local housing sector □ Lenders and permitting agencies may also need information regarding projected needs to position their institutions for rapid response □ Depends upon availability of land, willing and able developers, and availability of workforce (which may be strained due to NGE needs)	□ Extension of community engagement models, ex. Kettering model
	Increase capacity of local planning/permitting departments by "lending" planning staff from other jurisdictions with excess capacity	□ Decreases time needed to secure permits to build/develop housing □ Makes use of existing human capital that may be underutilized; can extend benefits of NGE activities to employees involved □ May require authorizing legislation or cooperative agreements to be negotiated among participating communities □ Moving staff to community may worsen problem it is meant to solve (may be alleviated or eliminated by allowing participants to telecommute)	□ Concept of development capacity-building outlined in "Marcellus Natural Gas Developments Effect on Housing in Pennsylvania" report[36]
Accessibility of housing for fixed or low-income residents	Use of voucher or subsidy programs for low- or fixed-income residents	□ Provides means of combating inflation in housing prices targeted at residents in most need of assistance □ Presumes availability of suitable housing stock; if not initiated early enough in "boom" cycle, may not have access to sufficient quality and quantity of stock □ Defining and auditing qualification criteria may be difficult □ Section 8 (housing choice vouchers) are limited to lowest income consumers; oilfield workers will likely not qualify	□ Federal program: Department of Housing and Urban Development Section 8 vouchers program[37]

Sociological Impacts

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
Increased crime / fear of crime	Increase level of connection between workers and community through directed community engagement programs	□ Research indicates increasing police strength alone may not significantly impact crime rates, may be expensive or take too long for smaller communities □ Addresses number of other "boom" stressors deriving from isolation factors □ May have limited effectiveness where workers are engaged in long, irregular work periods in isolated areas or where workers are commuters rather than residents	□ "Civic community" concept in Lee and Thomas (2010), social factors facilitating crime in Carrington, McIntosh and Scott (2010), and community development initiatives in Cheshire (2010)[38]
Substance abuse issues	Intensive, on-site services such as counseling and harm reduction services, provision of "dry" camps and/or family housing	□ Irregular work schedules and geographic isolation that can contribute to substance abuse issues may also frustrate traditional support program delivery; on-site delivery of programs can counteract these elements □ Availability of dry camps or family housing could reduce negative influences / increase positive influences for workers □ Requires development of partnership with NG developers to provide on-site facilities	□ Intervention programs outlined in Goldenberg, et al (2010)[39]
Increased incidence of sexually transmitted diseases, esp. among young NGE workers	Public-private partnerships with NG developers and local health authorities; place-based awareness, testing, and prophylactic distribution programs	□ Work conditions of many NG industry employees makes access to testing and preventative services difficult; culture may stigmatize seeking of assistance □ Public and private partnerships may enable more specific and effective targeting of programs □ Delivery of programs on work sites may encourage use of services □ Requires willingness of all parties to participate and culture supporting assistance □ Local groups may object to involvement with this aspect of public health	□ Program outlined in work of Goldenberg, et al.[40]
Individual / family stressors manifested in individual mental health issues, increased rates of divorce / domestic violence	Coordinated community programs providing group support/therapy for domestic violence issues	□ Group support/therapy programs shown to reduce incidence of family stress issues such as divorce, violence □ Tailoring of programs to specific needs (age, ethnic/cultural groups, chemical dependency) may be needed to increase efficacy of program □ Maximum effectiveness may also require legal consequences for offenders who do not complete program □ Research shows impact of programs may be small compared to cost	□ Duluth Domestic Abuse Intervention Project model[41]
Increased youth behavioral problems / crime	Community engagement programs to create youth-supportive local environments	□ Community-based approach can focus on preventive measures to avoid unhealthy behaviors in youth □ Programs can also increase engagement among long-term residents and new residents if both are involved in program □ Question of who will be involved and what roles they will play □ May take years for effects of program to become apparent	□ Communities that Care program[42]
Increased isolation / disengagement / community cohesion and identity concerns	"Welcome wagon" to facilitate integration of new and long-term residents and facilitate interactions with current residents; community social activities creating opportunities for development of new acquaintances	□ Lack of community connectedness and decreased density of acquaintance often cited as factors contributing to decreased quality of life in boomtown communities □ Can affect perceptions of both long-term and new residents relative to each other □ May increase community ties and encourage new residents to become long-term residents □ Requires number of local "champions" to engage long-term residents who may be reluctant to participate □ Irregular work schedules and geographic isolation may limit ability of NGE workers to participate	□ "Community Cohesion" policy in UK[43] □ Mining community development programs in Australia[44]

Education

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
Increased need for schooling for families that move to the area	Use of temporary facilities to accommodate increases in student enrollment; "shift" classes	□ Temporary structures or repurposed facilities (ex. converted retail or commercial space) may be able to provide space for additional classes □ Requires additional qualified teachers, which may be difficult if housing is not available and/or inflationary pressures make cost of living high □ Separation of classes from main campuses may make administration, integration of student populations difficult □ If additional classroom space is not available, students may attend some classes in "shifts" □ Research suggests students in such environments may not perform at same level of students in more traditional learning environments	□ Educational impacts discussed in Jacquet (2009)[45]
	Facilitate homeschooling / alternative schooling arrangements	□ Homeschooling or other arrangements (such as combined-grade / "one room" schools) may make educational opportunities available where traditional modes would be difficult to implement, esp. in isolated areas and family housing developments □ May reduce strain on existing school systems □ Can address number of impacts cited as influences in "boomtown" schools □ May be difficult to implement with highly mobile population □ May increase community isolation factors	□ National Home Education Research Institute materials[46]

Workforce Availability

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
Insufficient local skilled labor to fill available NGE jobs	Accelerated training programs	□ Can improve local employment and local capture of economic benefits □ Most effective if conducted in partnership with NG developers □ Only effective if nearby population is large enough to meet industry needs □ Requires available education facilities, staff, and curricula	□ Odessa College oilfield training program[47] □ High Plains Technology Center wind energy training program[48]

Transportation Infrastructure

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
Paying for repairs / improvements due to increased traffic from NGE activities	Posting and enforcement of vehicle weight limits	□ Established weight limits for defined roads; vehicles over weight limit must have permit (with fee) or must post bond for potential road damage □ Requires police or transportation enforcement of limits and permits □ Reducing amount of weight that can be carried by single vehicle may increase overall volume of traffic	□ Pennsylvania municipality and township regulations (certain jurisdictions only)[49]
	Well permit fees	□ Links public costs of NGE impacts to revenue and specifically allocates portion of fee to road repair / improvement □ May not be proportionate in effect (wells using less truck-trips charged same amount as wells using more truck-trips)	□ Pennsylvania Act 13 allocation of unconventional natural gas wells to transportation funds (based on highway mileage)[50]
	Road maintenance agreements	□ Public-private agreements for payment of funds (sometimes called "in lieu of" funds) to government units for road maintenance needs caused by NGE activity □ May be easier to implement if small number of NG developers operating in area; more difficult if large number of operators in area	□ Ohio Road Use Maintenance Agreement provisions under Senate Bill 325[51]

Landowner Issues

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
Visual impacts and light pollution / aesthetic concerns	Tree belts / fencing or other visual barriers around sites, directional lighting requirements, operational hour restrictions	□ Visual impacts often cited as source of aesthetic concerns and nuisance issues; addresses this issue, at least in part □ Restriction of operational hours may cause production delays or problems for NG developers	□ City of Arlington lighting restrictions, requirement for site maintenance to avoid "unsightly" condition[52] □ City of Fort Worth aesthetic restrictions[53]
Noise impacts	Specification of maximum noise levels, requirement for noise mitigation measures such as mufflers, sounds blankets, and sound walls, operational hour restrictions	□ Auditory impacts also often cited as source of aesthetic concerns and nuisance issues; also form basis of some health concerns □ Restriction of operational hours may cause production delays or problems for NG developers	□ City of Arlington noise restrictions (decibel limits for operations, measurement procedures, and sound mitigation technologies specified)[54] □ City of Fort Worth noise restrictions (similar)[55]
Property value impacts	Prohibit NGE activities within residential areas	□ Residential areas pose highest concentration of potential property value impacts as well as other impacts (visual, auditory, traffic, etc.) □ Ban may also reduce environmental concerns of residents □ Blocks development of some resource deposits □ Potential challenges from mineral owners in residential areas □ Potential jurisdictional/authority issues	□ City of South Fayette, Pennsylvania Ordinance No. 5 of 2012 (currently under judicial review)[56]
	Establish setback requirements for NG wells relative to sensitive property items (homes, water wells, etc).	□ Setbacks may reduce impacts to most sensitive receptors from NGE activities □ Larger setback distances may functionally ban NG wells in areas with high density of setback points	□ Colorado Oil and Gas Conservation Commission setback rules (proposed).[57]
	Mitigation of specific real or perceived impacts by NG developers provision of alternative sources (ex.: groundwater well impacts avoided by municipal water supply extension)	□ In some cases, one specific factor (ex. real or perceived groundwater impacts) may have significant impact to property values; addressing specific factor may have important marginal impacts on property values □ Determining specific factors may require intensive analysis of factors unique to area □ NG developers may be unwilling to participate in voluntary mitigation program, esp. if recipients of mitigation benefits already receiving mineral payments	□ Property value impacts outlined in Muehlenbachs, Spiller, and Timmins (2012)[58]
Benefit/burden sharing between surface and mineral owners	Require compensation to surface owners and tenants for NG exploration and extraction activities impacting surface (surface damage payments)	□ Provides compensation to surface estate, which has to bear burden of NGE activities without other economic benefits. □ Reduces litigation and facilitates NG development by reducing need for surface owners to sue developers for damages to receive compensation. □ May represent significant change to property law. □ Requires state legislative action	□ North Dakota statutes governing oil and gas production damage compensation and seismic exploration damages[59]
	Allow surface owner to claim "abandoned" mineral interests, reuniting surface and mineral estates	□ Creates opportunity to unify surface and mineral estates, thus aligning interests bearing burdens and benefits of NGE □ Requires vigilance on part of mineral owners to retain interest □ Requires state legislative action	□ North Dakota statutes governing termination of mineral interest[60]
	Prohibit severance of mineral estate if not already severed	□ Avoids additional fragmentation of mineral estates, which can provide benefits to surface owners and NG developers □ Reduces opportunities for economic exchange of mineral resources □ Requires state legislative action	□ Oklahoma Airspace Severance Restriction Act (analogous provision for wind rights)[61]

Landowner Negotiation of Resource Development Agreements

Issue	Policy Alternatives	Potential Consequences	Examples (if available)
Asymmetries of information / negotiating power in resource lease agreements	Educational programs providing information on lease negotiation to landowners	□ Increases landowner awareness of issues to be examined in evaluating resource leases □ Provides landowners with improved ability to negotiate balanced lease agreements □ Improved information may facilitate accrual of economic benefits to local residents □ Requires funding and acquisition of knowledgeable staff to develop, implement, update, and present materials	□ Penn State Extension Natural Gas Program[62]
	Provide information "clearinghouse" and landlord forum with lease examples and updated information on compensation values	□ Increases landowner access to information on sample lease provisions to protect rights and "going rates" on compensation items such as royalties and damage payments □ Provides landowners with improved ability to negotiate balanced lease agreements □ Improved information may facilitate accrual of economic benefits to local residents □ Requires funding to acquire information, deploy information sharing tools, and to curate information / forums □ Information may be difficult to obtain as NG developers may be reluctant to share information □ Information obtained by landowner surveys may require verification	□ Privately-organized and curated Natural Gas Forums[63]

Notes

[1] http://www.state.nj.us/governor/news/news/552011/approved/20110825c.html.
[2] http://www.governor.ny.gov/archive/paterson/executiveorders/EO41.html.
[3] http://www.alternet.org/fracking/after-federal-and-state-governments-fail-regulate-fracking-communities-fight-back.
[4] http://www.breakinglawsuitnews.com/morgantown-wv-fracking-ban-overturned/.
[5] 165 OKLA. ADMIN. CODE Ch. 10, Subch. 1, Part 5 (2011).
[6] 2 COLO. CODE REGS. §§ 402-16.5 and 402-16.8 (2012).
[7] http://www.shalegas.energy.gov/resources/HF2_e1.pdf.
[8] http://www.michigandnr.com/PUBLICATIONS/PDFS/ifr/ifrlibra/Research/reports/2089/RR2089.pdf.
[9] http://www.circleofblue.org/waternews/2013/world/amid-roaring-demand-a-u-s-city-plans-to-triple-water-rates-for-oil-and-gas-customers/ .
[10] New York SGEIS (proposed) section 7.1.7.4. (2011).
[11] 165 OKLA. ADMIN. CODE §10-7-6 (2012).
[12] 16 TEXAS ADMIN CODE §3.13.
[13] H.R. 1084, S. 587.
[14] Colorado Oil & Gas Conservation Commission Rule 609 (enacted January 7, 2013), *at* http://cogcc.state.co.us/RR_HF2012/Groundwater/FinalRules/FinalRule609-01092013.pdf.
[15] 58 PENN. CONS. STAT. §3218 (2012).
[16] 58 PENN. CONS. STAT. §3222.1 (2012).
[17] 76 FED. REG. 66286-66304 (October 26, 2011).
[18] New York Bill S6893 (2012).
[19] New Jersey Assembly Bill 575 (2012).
[20] 40 C.F.R. Part 60, Supbart OOOO (Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution) (2013).
[21] 40 C.F.R. Part 60, Subpart IIII (Standards of Performance for Stationary Compression Ignition Internal Combustion Engines) (2013).
[22] 30 TEX. ADMIN. CODE Ch. 115, Subch. B, Div. 1 (2012).
[23] New York SGEIS (proposed) section 7.1.3.2. (2011).
[24] http://docs.nrdc.org/energy/files/ene_10091301a.pdf.
[25] New York SGEIS (proposed) section 7.7.2. (2011).

[26] TEX. TAX CODE §§201.001 – 204.010 (2012).
[27] 58 PENN. CONS. STAT. §2302 (2012).
[28] LA. ADMIN. CODE §§ 61:1.2901 – 61:1.2903 (2012).
[29] http://mn.gov/irrrb/.
[30] Ralph B. Brown et al, *Local Flexibility in Spending Mitigation Monies: A Case Study of Successful Social Impact Mitigation of the Intermountain Power Project in Delta, Utah*, 21:3 IMPACT ASSESSMENT AND PROJECT APPRAISAL 205-213 (2012).
[31] 58 PENN. CONS. STAT. §2314 (2012).
[32] Ralph B. Brown et al, *Local Flexibility in Spending Mitigation Monies: A Case Study of Successful Social Impact Mitigation of the Intermountain Power Project in Delta, Utah*, 21:3 IMPACT ASSESSMENT AND PROJECT APPRAISAL 205-213 (2012).
[33] www.kettering.org.
[34] A. Best, *Bad Gas or Natural Gas*, 75:9 PLANNING 30-34 (2009).
[35] Ralph B. Brown et al, *Local Flexibility in Spending Mitigation Monies: A Case Study of Successful Social Impact Mitigation of the Intermountain Power Project in Delta, Utah*, 21:3 IMPACT ASSESSMENT AND PROJECT APPRAISAL 205-213 (2012).
[36] Jonathan Williamson and Bonita Kolb, MARCELLUS NATURAL GAS DEVELOPMENT'S EFFECT ON HOUSING IN PENNSYLVANIA, Center for the Study of Community and the Economy, 2011, *available at* http://www.marcellus.psu.edu/resources/PDFs/housingreport.pdf.
[37] http://portal.hud.gov/hudportal/HUD?src=/topics/housing_choice_voucher_program_section_8.
[38] M. R. Lee and S. A. Thomas, *Civic Community, Population Change, and Violent Crime in Rural Communities*, 47 JOURNAL OF RESEARCH IN CRIME AND DELINQUINCY 118-147 (online at http://jrc.sagepub.com/content/47/1/118) (2009); K. Carrington, A. McIntosh and J. Scott, *Globalization, Frontier Masculinities and Violence: Booze, Blokes and Brawls*, 50 BRITISH JOURNAL OF CRIMINOLOGY 393-413 (2010); L. Cheshire, *A Corporate Responsibility: The Constitution of Fly-in, Fly-out Mining Companies as Governance Partners in Remote, Mine-affected Localities*, 26:1 JOURNAL OF RURAL STUDIES 12-20 (2010).
[39] S.M. Goldbenberg, J.A. Shoveller, M. Koehoorn and A. Ostry, *And They Call This Progress? Consequences for Young People of Living and Working in Resource-Extraction Communities*, 20:2 CRITICAL PUBLIC HEALTH 157-168 (2010).
[40] S. Goldenberg, J. Shoveller, A. Ostry, and M. Koehoorn, *Sexually transmitted infection (STI) testing among young oil/gas workers: the need for innovative, place-based approaches to STI control*. 99:4 CANADIAN J. OF PUBLIC HEALTH 350–354 (2008); S. Goldenberg, J. Shoveller, A. Ostry, and M. Koehoorn, *Youth sexual behavior in a 'Boomtown': implications for the control of sexually transmitted infections*. 84 Sexually Transmitted Infections 220–223 (2008).
[41] The Duluth model is discussed at http://www.theduluthmodel.org/training/index.html. Research regarding the impacts of this and similar intervention programs can be found in Julia Babcock and Ramalina Steiner, *The Relationship Between Treatment, Incarceration, and Recidivism of Battering: A Program Evaluation of Seattle's Coordinated Community Response to Domestic Violence*, 13:1 JOURNAL OF FAMILY PSYCHOLOGY 46-59 (1999), and J. Babcock, C. Green, and C. Robie, *Does Batterer's Treatment Work? A Meta-analytic Review of Domestic Violence Treatment*, 23 CLINICAL PSYCHOLOGY REVIEW 1023-1053 (2004).
[42] *See* Substance Abuse and Mental Health Services Administration, Center for Substance Abuse Prevention, http://www.samhsa.gov/about/csap.aspx
[43] D. Robinson, *The Search for Community Cohesion: Key Themes and Dominant Concepts of the Public Policy Agenda*, 42:8 URBAN STUDIES 1411-1427(2005).
[44] L. Cheshire, *A Corporate Responsibility: The Constitution of Fly-in, Fly-out Mining Companies as Governance Partners in Remote, Mine-affected Localities*, 26:1 JOURNAL OF RURAL STUDIES 12-20 (2010).
[45] J. Jacquet, ENERGY BOOMTOWNS AND NATURAL GAS: IMPLICATIONS FOR MARCELLUS SHALE LOCAL GOVERNMENTS AND RURAL COMMUNITIES, NERCRD Rural Development Paper No. 43 (2009).
[46] http://www.nheri.org/
[47] http://www.texastrustees.org/news-clips/boomtown-schools-prepare-students-oil-industry .
[48] http://www.hptc.net/bis/energytraining/windtechtraining.asp.
[49] K. J. Braiser, M. R. Filteau, D. K. McLaughlin, J. Jacquet, R. Stedman, T. W. Kelsey, and S. J. Goetz, *Residents Perceptions of Community and Environmental Impacts from Development of Natural Gas in the Marcellus Shale: A Comparison of Pennsylvania and New York Cases*, 26:1 JOURNAL OF RURAL SOCIAL SCIENCES 32-61 (2011).
[50] 58 PENN. CONS. STAT. §2314 (2012).
[51] http://ohiodnr.com/tabid/23947/Default.aspx.
[52] City of Arlington, Texas Code, Gas Drilling and Production, § 7.01(A).
[53] City of Fort Worth (Texas) Code of Ordinances, Chapter 15, § 15-36(C)(10).
[54] City of Arlington (Texas) Code, Gas Drilling and Production, § 7.01(G)(2012).
[55] City of Fort Worth (Texas) Code of Ordinances, Chapter 15, § 15-42(B)(2)(2012).
[56] Ordinance on file with authors and available upon request.
[57] http://cogcc.state.co.us/RR_HF2012/Setbacks/COGCC_APPROVES_SWEEPING_NEW_SETBACK_RULES.pdf, rules docket posted at http://cogcc.state.co.us/RR_HF2012/setbacks/setbacks.htm .
[58] L. Muehlenbachs, E. Spiller, and C. Timmins, SHALE GAS DEVELOPMENT AND PROPERTY VALUES: DIFFERENCES ACROSS DRINKING WATER SOURCES (2012) National Bureau of Economic Research Working Paper 18390.
[59] N.D. CENT. CODE Ch. 38-11.1 and 38-11.2 (2012).
[60] N.D. CENT. CODE Ch. 38-18.1 (2012).
[61] 60 OKLA. STAT. § 820.1 (2012).
[62] http://extension.psu.edu/naturalgas.
[63] www.naturalgasforums.com.