



Research and strategy for the land community.

September 9, 2016

Kimberly Bose, Secretary
Nathaniel J. Davis, Sr., Deputy Secretary
Federal Energy Regulatory Commission
888 First Street NE, Room 1A
Washington, DC 20426

REFERENCE: OEP/DG2E/Gas 2
PennEast Pipeline Company, LLC
FERC Docket No. CP15-558-000
FERC/EIS-0271D

Dear Ms. Bose and Mr. Davis:

Thank you for this opportunity to comment on the Draft Environmental Impact Statement (DEIS) regarding the PennEast pipeline project as proposed by PennEast Pipeline Company, LLC. I am an economist specializing in research on the relationships between natural resource stewardship and environmental quality on human well-being. Key-Log Economics has been retained by Delaware Riverkeeper Network to conduct an independent analysis of key effects of the proposed pipeline, including changes in property value, lost natural benefits (also known as ecosystem services), health care costs and others. Based on what we have found in the course of that ongoing research, and on behalf of Delaware Riverkeeper Network, we offer the comments below regarding FERC's own as reflected in the DEIS.

I also teach microeconomics, natural resource economics, and natural resource policy at the undergraduate and graduate level. In that vein, I am including the following brief discussion of economic effects, prices, and value to frame my specific comments regarding the PennEast pipeline and FERC's analysis of its environmental effects.

As it pertains to the proposed PennEast pipeline and FERC's subsequent analysis as reported in the DEIS and supporting documents, these relationships result in two distinct, but overlapping types of effects on human well-being. They are:

- Effects on human welfare that are at least partially reflected in observed prices of goods and services and/or expenditures on those goods and services. These would include both positive and negative economic impacts, such as income earned in jobs allocated to operating a pipeline, or expenditures to repair roads and replace water supplies damaged or disrupted by pipeline construction.
- Effects on human well-being that are not reflected in observable market prices that we can observe. These are commonly known as non-market benefits (of environmental quality or improvements, for example) and non-market costs (such as those from environmental degradation). Non-market benefits include the value to people (willingness to pay) over and above what they actually have to pay for an environmental good (such as clean water to drink) or

c/o Studio IX, 969 2nd St., SE, Charlottesville, Virginia 22902
main: 202.556.1269 mobile: 802.272.9849 | team@keylogeconomics.com

over and above what they actually have to pay to remediate environmental damage. Non-market benefits and costs also include changes in human welfare from environmental effects for which there is no out-of-pocket payment at all. Enjoying the aesthetic quality of a view may cost nothing to experience, but it still is valued by the observer.

Closely related to these effects are “external costs.” External costs are effects on human welfare that are not considered as part of a given market transaction because they are borne by or imposed on people other than the parties to the transaction. They are outside -- that is, external to -- the transaction, but they are every bit as much of an economic effect as private (internal) costs are. When external costs are present, market prices can be said to be too low. Consequently, the level of provision of the market good in question--for example natural gas or the pipelines to transport it--will be too high, resulting in an inefficient allocation of resources and what economists call a “deadweight loss” to society.

Because “the market” fails to count external costs on its own, additional analyses and decision making processes are required. FERC’s policy on the Certification of New Interstate Natural Gas Pipeline Facilities (88 FERC, para. 61,227, or Hoecker et al., 1999) is one example of an attempt to ensure consideration of at least some external costs. The policy requires that adverse effects of new pipelines on “economic interests of landowners and communities affected by the route of the new pipeline” be weighed against “evidence of public benefits to be achieved [by the pipeline]” (Hoecker et al., 1999, pp. 18–19). Further, “...construction projects that would have residual adverse effects would be approved only where the public benefits to be achieved from the project can be found to outweigh the adverse effects” (p. 23).

In principle, this policy is in line with the argument, on economic efficiency grounds, that the benefits of a project or decision should be at least equal to its cost, including external costs. However, the policy’s guidance regarding what adverse effects must be considered and how they are measured is deeply flawed. The policy states, for example, “if project sponsors...are able to acquire all or substantially all, of the necessary right-of-way by negotiation prior to filing the application...it would not adversely affect any of the three interests,” with the three interests being pipeline customers, competing pipelines, and “landowners and communities affected by the route of the new pipeline” (Hoecker et al., 1999, pp. 18, 26). The Commission’s policy therefore contends that the only adverse effects that matter are those affecting owners of properties in the right-of-way. Even for a policy adopted in 1999, this contention is completely out of step with long-established understanding that development that alters the natural environment has negative economic effects.

The policy’s confusion over what counts as an environmental effect (again, most of which will have economic effects) is further expressed by the following statement:

Traditionally, the interests of the landowners and the surrounding community have been considered synonymous with the environmental impacts of a project; however, these interests can be distinct. Landowner property rights issues are different in character from other environmental issues considered under the National Environmental Policy Act of 1969 (NEPA) (Hoecker et al., 1999, p. 24)

By the Commission’s reasoning, environmental effects are a matter of the Commission’s “traditions”, not science, and environmental effects are deemed to be both synonymous with, and distinct from, interests of landowners and the surrounding community. This statement seems to contradict the statement one page earlier (p. 23) that “There are other interests [besides those of customers,

competitors, and landowners and surrounding communities] that may need to be separately considered in a certificate proceeding, such as environmental interests.” While we agree that separate/additional consideration of environmental “interests” must indeed be part of the Commission’s review¹, the policy embodies such a muddle of contradictions on the question of what impacts to examine and why (tradition versus science), that it seems unlikely that any pipeline certification granted under the policy would be scientifically or economically sound. In the case of the proposed PennEast pipeline we find the DEIS to be greatly lacking both in the scope of economically relevant environmental effects considered and in the quality of the analysis of those few effects considered.

A further weakness of the FERC policy is that it relies on applicants to provide information about benefits and costs. The policy’s stated objective “is for the applicant to develop whatever record is necessary, and for the Commission to impose whatever conditions are necessary, for the Commission to be able to find that the benefits to the public from the project outweigh the adverse impact on the relevant interests” (Hoecker et al., 1999, p. 26). The applicant therefore has an incentive to be generous in counting benefits and parsimonious in counting the costs of its proposal. And as reflected in the DEIS at hand, FERC has made no effort itself to ensure a full accounting of economic costs to landowners or the broader community despite the wealth of comments placed on the docket that could support such an assessment. Under these circumstances, it seems unlikely that the Commission’s policy will prevent the construction of pipelines for which the full costs are greater than the public benefits they would actually provide.

Compliance with the the National Environmental Policy Act (NEPA) adds, or should add, breadth to the assessment of economics costs of proposed pipelines. NEPA requires an evaluation of all relevant effects. Of particular interest here, such relevant effects include direct, indirect, and cumulative economics effects--changes in human welfare that might or might not be reflected in the market economy. As the NEPA regulations state,

Effects include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial (emphasis added, 36 CFR 1508.b).

It is important to note that NEPA does not require that federal actions—which in this case would be approving or denying the PennEast certification—necessarily balance or even compare benefits and costs. NEPA is not a decision-making law, but rather a law requiring decisions be supported by as full as possible accounting of the reasonably foreseeable effects of federal actions on the natural and human environment. It also requires that citizens have opportunities to engage in the process of analyzing and weighing those effects.

Relative to these requirements of NEPA, the PennEast DEIS falls short. The DEIS ignores several important external costs and discounts others. It also relies too heavily on inadequate and misleading information provided by the applicant and the natural gas industry. While predictable, given the

¹ Note that environmental effects overlap, but are not limited to, the interests of landowners and surrounding communities. The effects of air emissions, loss of productive or aesthetically pleasing land uses, lost recreational opportunities, impacts on climate, and others will affect many people, some much farther from the pipeline itself than “surrounding communities” would connote.

inherent bias and weakness in FERC's certification policy noted above, the outcome leaves FERC and the public without a full picture of the relevant economic effects of the proposed PennEast pipeline.

Details on economics-related shortcomings of the DEIS are provided in the remainder of this comment, beginning with the overarching issue of the DEIS missing several opportunities for meeting energy service needs in a least-cost / lowest impact manner.

The DEIS fails to define and analyze a reasonable range of alternatives.

As required by CEQ regulations mentioned in the above section, FERC considered in the DEIS a No Action alternative, system alternatives, pipeline route alternatives, pipeline route variations, and aboveground facilities alternatives. The selection criteria for alternatives include whether they 1) Are technically and economically feasible, reasonable, and practical 2) Offer a significant environmental advantage over the proposed action 3) Have the ability to meet the objectives of the project (Federal Energy Regulatory Commission, 2016).

FERC's failure to consider alternatives aimed at the bigger picture question of energy efficiency and renewables has important implications for the economics of the proposed pipeline. Namely, unless further alternatives for meeting actual regional needs for energy services (which is not the same as the applicant's stated "need" to transport natural gas) are considered, it will remain impossible to know whether one of the alternatives considered is actually best. If energy services could be delivered to people and industry at a lower cost (including all external costs) by focusing on energy efficiency or power generation from renewable fuels, then considering ONLY gas transmission options will guarantee an inefficient, wasteful outcome.

FERC states that renewable energy generation or gains realized from increased energy efficiency are not considered because they are not transportation alternatives. But NEPA requires a broader view. Under NEPA, federal actions must consider the cumulative impact, defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR §1508.7). Changes in energy markets due to energy efficiency gains and/or further market penetration by renewable alternatives to fossil fuels are reasonably foreseeable. For example, renewable energy accounted for 40% of new domestic power capacity installed (American Council On Renewable Energy, 2014), and the relative cost of producing power from renewable sources, which is already competitive, is falling (Randall, 2016; U.S. Energy Information Administration, 2016). Moreover, and as shown in Lander (2016), "there are 49.9% more resources available to meet peak day demand from local gas distribution companies in the region than is needed (p. 9)." In light of these facts and related factors, FERC must consider alternatives that reflect the likely future reality in which the gas the PennEast pipeline would transport is not needed and/or is not a cost-effective choice for consumers or electric power generators. To do otherwise--that is, to focus narrowly on only transportation options--could lead to a federal action that imposes significant environmental effects and associated economic costs for no reason.

DEIS Overestimates Positive Economic Effects

Based on a study of potential economic impacts sponsored by the applicant (Econsult Solutions & Drexel University School of Economics, 2015), the Commission concludes that construction and

operation of the PennEast pipeline would have “minor” and “minor to moderate” positive effects² in the form of jobs, payroll taxes, workers’ expenditures, and local governments’ tax revenues (DEIS, ES-12). Unfortunately, and due to flaws in the methods and execution of the Econsult study, even these minor benefits are overblown³. In short, the study

- Overestimates short term impacts due to inherent issues with the models used and the choice of the size of the study region.
- Overestimates long-term job “creation” and other impacts due to use of a model empirically proven to have no value as a predictor of economic activity occurring more than a year into the future.

Overestimation of short-term impacts due to pipeline construction.

The Econsult study’s estimates of economic impacts resulting from spending on the construction of the pipeline suffer from inherent problems with input-output analysis, for which Econsult used the IMPLAN data and modeling software. Input-output models are so-named because they purport to translate an exogenous change in the economy—that is, the “input,” which in this case is spending required to construct the proposed PennEast pipeline—into “outputs,” which are spending by firms that PennEast LLC would hire to build the pipeline, spending by firms that those firms would hire, and so on, plus spending by the households whose labor the various firms would hire. The spending by PennEast LLC in this case would be a “direct” effect. Spending by the other firms would be the “indirect effects.” Spending by those households would be the “induced effects.” The ratio of the sum of all three effects to the direct effect is called the “multiplier.”

While intuitively satisfying, empirical input-output models like IMPLAN are built on a very restrictive set of assumptions about how those spending/hiring decisions are made. Namely, the models assume that decisions are made the way they have always been made. Even though firms and people in the real world will adjust and innovate when faced with a new situation, firms and people in the input-output model will simply do what they have always done. And since innovation tends toward cost minimization, using input-output models as a proxy for real-world decision-making tends to overestimate a firms’ spending and results in overestimates of “multiplier effects” (Hoffmann and Fortmann, 1996). What that means in this case is that construction of the PennEast will not involve as much indirect and induced spending, or create as many indirect and induced jobs, in the real world as the output from Econsult’s run of the IMPLAN model suggests.

Another caution—and another reason the estimates of construction impacts are likely inflated—is that Econsult chose to use the entire states of Pennsylvania and New Jersey as regions for analysis in addition to analyzing impacts for the six-county region where the pipeline would be built. Regional economic impact depends on the degree to which direct, indirect and induced spending can occur

² Note that the authors of the Econsult study characterize these effects as “significant.” While “minor” and “significant” are subjective and relative terms, it cannot be the case that the estimated positive economic impacts of the pipeline are both minor and significant.

³ Econsult also asserts, without reference to any data or analysis, a primary long-term benefit due to lower natural gas and electricity prices for consumers. The authors fail to consider the possibility that end users could experience higher costs due to the burden of supporting more transmission infrastructure than is needed (Lander, 2016), the effect of natural gas price increases and/or volatility as Marcellus Shale supplies wane in the long run, or the potential availability of lower-cost energy alternatives.

within the study region. The bigger the region one selects for analysis, the more likely it is that one can find a firm in that selected region from which to buy materials or services, and the more likely it becomes that one could hire labor from someone living inside the region. In other words, the larger the selected region, the larger the multiplier effect. The Econsult studies do not present a rationale for the choice of entire states as the study regions.

Overestimate long-term impacts due to pipeline operation and maintenance.

Econsult (2015) also uses input-output modeling and IMPLAN to project long-term or ongoing impacts from the operation and maintenance (O&M) of the pipeline. Input-output modeling, however, is not suited for long-term economic impact assessment, and it has been empirically shown to be unreliable for that purpose. As Haynes et al. (1997) note:

Where the economic base approach gets into trouble is when it is used inappropriately as a tool for planning or predicting impacts of greater than one year in duration; a snapshot of current conditions tells little about the form a region's future economy may take.

The reason for this caution is that economic base theory and empirical input-output models grounded in that theory (e.g., the IMPLAN model used in the Econsult report) assume a static economy. In such an economy, there are no changes in relative prices, no input substitution or technological change in the production processes, no labor mobility, no change in products or consumers' tastes and preferences, no regional migration, and no changes in state and local tax laws—to name a few. The constant technology assumption, for example, prevents firms from using cost-savings innovations, forcing them to be inefficient, and the result is higher multiplier effects than are actually experienced (Hoffmann and Fortmann, 1996).

Due to these restrictive assumptions, economic base models have a dismal track record when it comes to predicting economic growth in the real world and in the long run. (The “long run” is more than a year into the future, when a firm can change technology, prices can adjust, and people can change what they want to buy.) In a review of 23 studies, Krikelas (1991) compared predictions of the economic base model against the actual experience of the subject regions and found only 4 studies where the models correctly predicted longer run economic growth. Similarly, Robertson (2003) tested predictions from input-output models against actual experience in 15 communities in Southeast Alaska (a region in which many of the restrictive assumptions of economic base theory might actually apply). He found that initial economic stimulus does not “cause changes in economic activity serving local demand for the average community.... The implications of these results [are that] secondary economic impacts [i.e., “multiplier effects”] cannot be taken as a foregone conclusion in policy analysis” (p. iii).

While Econsult does reference some of the shortcomings of its modeling approach in an appendix to its report, the report shrugs off the limitations, stating “Regardless, I-O models still serve as the standard in the estimation of local and regional impacts.” Despite the shortcomings, and under the cloak of its “everyone else does it” defense, Econsult plugs the 24 direct jobs required to operate and maintain the pipeline (PennEast Pipeline Company, LLC, 2015) into the IMPLAN model and projects that there would be 74 additional jobs supported by PennEast. Those 74 jobs are due to the multiplier effect and include “indirect” employment, or jobs in companies providing materials and services needed for operation and maintenance of the PennEast pipeline, and “induced” jobs, which are jobs supported when the people with the direct and indirect jobs spend their pay at grocery stores, at the doctor, or for other local goods and services. (For comparison, employment in the six-county study region stood at

1.06 million in 2014, making even the the inflated total employment impact less than one one-hundredth of one percent (0.009%) (Headwaters Economics, 2015.)

Regardless of the size of the estimate, to ascribe these indirect and induced jobs to the PennEast pipeline as the cause of that employment in the long-term is to assume that the workers in those indirect and induced jobs would otherwise be idle. Such an assumption is not realistic: idle workers in the real world typically re-train or relocate to take already open jobs, or they create new employment opportunities for themselves where they live. Those 74 jobs, in other words, will most likely exist **somewhere** (in another sector in the study region or in another region) with or without the direct PennEast jobs. Operation of the pipeline, in other words, does not create those indirect and induced jobs any more than the pipeline can create methane to pump through it.

In short, we do not doubt that the construction and operation of the PennEast pipeline will spur economic activity in the form of jobs and income associated with construction and operation of the proposed pipeline. And we agree with FERC that the level of that activity is minimal. Because the estimated level of activity presented by the applicant through the Econsult study is grossly overstated, we would amplify FERC's assessment and conclude that the employment and income effects are not minimal, but practically nonexistent.

DEIS Misses or Discounts Important Economic Effects

Public Health

Compressor stations have been implicated in a variety of illnesses among nearby residents. (Subra, 2009, 2015). The stations can also be noisy, with low-frequency noise cited as a constant nuisance. ("Proximity of Compressor Station Devalues Homes by as much as 50%," 2015). These issues have led some homeowners to pull-up stakes and move away and to reduced property value assessments for others (Cohen, 2015; "Proximity of Compressor Station Devalues Homes by as much as 50%," 2015).

One way the PennEast pipeline impacts air quality is by converting forests, which remove normal levels of impurities from the air, to other land uses. There is also concern for impacts that would occur due to the dumping of excess impurities into the air in the first place. The 47,700 horsepower (hp) compressor station proposed for Kidder Township, Carbon County, Pennsylvania, for example, will emit noise as well as gas and other substances (lubricants, etc.) as a normal part of operations. The negative effects of the compressor station would include noise and air pollution from everyday operations plus periodic "blowdowns," or venting of gas in the system to reduce pressure. As a recent study by the New York Department of Environmental Conservation indicates, pollution around compressor stations is common and severe. The five-state study found that "more than 40% of the air samples from compressor stations exceeded federal regulations for certain chemicals like methane, benzene, and hydrogen sulfide" (Lucas, 2015). The study also found high rates of illnesses such as nosebleeds and respiratory difficulties among people living near the stations.

While more definitive epidemiological studies are needed to determine the extent to which natural gas compressor stations add to background rates of various illnesses, these stations are implicated as contributing to a long list of maladies. According to Subra (2015), individuals living within 2 miles of compressor stations and metering stations experience respiratory impacts (71% of residents), sinus problems (58%), throat irritation (55%), eye irritation (52%), nasal irritation (48%), breathing difficulties (42%), vision impairment (42%), sleep disturbances (39%), and severe headaches (39%). In

addition, some 90% of individuals living within 2 miles of these facilities also reported experiencing odor events (Southwest Pennsylvania Environmental Health Project, 2015). Odors associated with compressor stations include sulfur smell, odorized natural gas, ozone, and burnt butter. (Subra, 2009). Finally, compressors emit constant low-frequency noise, which can cause negative physical and mental health effects (Lockett, Buppert, & Margolis, 2015).

In Carbon County, 560 people live within 2 miles of the proposed compressor station (US Census Bureau, 2015). This would mean 504 people experiencing odor events, 398 people experiencing respiratory impacts, 325 people experiencing sinus problems, and 218 people experiencing sleep disturbances and/or severe headaches. In addition to the health impacts discussed above, this pollution can cause damage to agriculture and infrastructure. One study found that shale gas air pollution damages in Pennsylvania already amount to between \$7.2 and \$30 million, with compressor stations responsible for 60-75% of this total (Walker & Koplinka-Loehr, 2014). Using the low estimate of 60%, that is between \$4.32 and \$18 million in damages associated with compressor stations.

Social Cost of Carbon: PennEast pipeline would abet the emission of 20.1 metric tons of CO₂ equivalent a year, adding \$252.4 million annually to the cost of the pipeline.

The social cost of carbon (SCC) is a comprehensive estimate of the economic cost of harm associated with the emission of carbon. The SCC is important for regulation because it helps agencies more accurately weigh the costs and benefits of a new rule or regulation. In April 2016, a federal court upheld the legitimacy of using the social cost of carbon as a viable statistic in climate change regulations (Brooks, 2016). In August 2016, The Council on Environmental Quality (CEQ) issued its final guidance for federal agencies to consider climate change when evaluating proposed Federal actions (Council on Environmental Quality, 2016). The CEQ states “agencies should consider applying this guidance to projects in the EIS or EA preparation stage if this would inform the consideration of differences between alternatives or address comments raised through the public comment process with sufficient scientific basis that suggest the environmental analysis would be incomplete without application of the guidance, and the additional time and resources needed would be proportionate to the value of the information included” (Council on Environmental Quality, 2016).

PennEast, LLC estimates the pipeline would transport 401,500,000 dekatherms annually, contributing to an equivalent of 20.1 metric tons of CO₂ emitted per year (U.S. EPA, 2016). Using the most conservative estimate of the cost per metric ton of carbon (U.S. EPA, 2016), the additional emission of CO₂ would cost \$252.4 million annually. FERC must count this significant cost among the effects of the proposed pipeline.

Ecosystem Services: FERC ignores the potential loss of human benefit due to pipeline-induced land conversion.

The idea that people receive benefits from nature is not at all new, but “ecosystem services” as a term describing the phenomenon is more recent, emerging in the 1960s (Millennium Ecosystem Assessment, 2005). According to a White Memorandum titled “Incorporating Ecosystem Services into Federal Decision Making” (Donovan, Goldfuss, & Holdren, 2015), ecosystem services are “benefits that flow from nature to people.” They include tangible physical quantities, such as food, timber, and clean drinking water, life support functions like assimilating waste that ends up in air and water or on the

land, as well as aesthetics, recreational opportunities, and other benefits of a more cultural, social, or spiritual nature.

If ecosystem services are the products of nature, then ecosystems themselves--the land--are the factories where those products and values are produced. Just as with different man made factories, different types of ecosystems (forest, wetland, cropland, urban areas) produce different arrays of ecosystem services, and/or produce similar services to greater or lesser degrees. This is true for the simple reason that some ecosystems or land uses produce a higher flow of benefits than others.

By similar reasoning, a changes in ecosystems or more fundamentally, changes in land use, will change the type, amount, and value of the ecosystem services produced in the affected area. In the case of natural gas transmission pipelines, there is the conversion in the short run of all land in the construction zone from forests, cropland, urban open space, and other productive uses to barren land with very little, if any ecosystem service value.

In the longer run, a portion of the construction zone will revert to its pre-disturbance land cover, though the effects of soil compaction, introduction of invasive species, etc. may make even reverted land formerly in the construction zone less productive. In the right-of-way however, land that had been forested before construction, will revert to the (less productive) land cover of grassland, or perhaps shrub scrub, depending on the frequency of mowing to keep the right-of-way free of trees.

Cropland in the ROW could revert to cropland, but if there are restrictions on the weight of vehicles that can be operated on top of the buried pipeline, it may turn out to be the case that cropland reverts, at best, to pastureland. Moreover, there could be long-standing harm to agricultural productivity due to soil compaction, soil temperature changes, and alteration of drainage patterns due to pipeline construction. As agronomist Richard Fitzgerald (2015) concludes in the context of another proposed pipeline, "it is my professional opinion that the productivity for row crops and alfalfa will never be regenerated to its existing present 'healthy' and productive condition [after installation of the pipeline]." In the path of the PennEast pipeline, grower Ron Fulper of West Amwell, New Jersey has seen "very low [corn] yields" in the portion of his fields crossed by an existing natural gas pipeline (Colaneri, 2015).

By applying per-acre ecosystem service productivity estimates (denominated in dollars per acre per year) to the various arrays of ecosystem service types, one can estimate ecosystem service value produced per year in the periods before, during, and after construction. The difference between annual ecosystem service value during construction and before construction is the annual loss in ecosystem service value of construction. The difference between the annual ecosystem service value during ongoing operations (i.e., the value produced in the ROW) and the before-construction baseline (no pipeline) is the annual ecosystem service cost that will be experienced indefinitely.

Using methods established in Phillips and McGee (2016) and applied to pipelines in Phillips, Wang and Bottorff (2016), we estimate that the PennEast pipeline would cause an initial loss of \$7.3 million in ecosystem services during a one-year construction period. For each year the pipeline is in operation, the pipeline would induce an additional loss of \$2.4 in ecosystem services due to conversion of land in the ROW. Land converted for use as permanent pipeline-related infrastructure would mean an additional loss of \$218,200 each year.

These are preliminary estimates, and we recommend that FERC undertake its own assessment of the ecosystem services impacts of the proposed action. Such a review would be consistent with current

executive branch direction and coming implementation guidance (Donovan, Goldfuss, & Holdren, 2015). FERC should follow the lead of other agencies and use existing resources, such as Federal Resource Management and Ecosystem Services (National Ecosystem Services Partnership, n.d.) and Best Practices for Integrating Ecosystem Services into Federal Decision Making (Olander et al., 2015) in its review. Such a review would help ensure that these important environmental effects (and their economic consequences) are no longer ignored in FERC's decision making.

The failure to include in the DEIS an analysis of ecosystem services lost due to the construction and operation is a glaring example of inadequacy of FERC's "traditional" conflation of the interests of landowners and surrounding communities with environmental impacts described above. The exclusion of ecosystem service losses means that many of the economic consequences of environmental effects, not to mention many environmental effects, have not been considered at all. This renders the DEIS inadequate for informing decision making about the PennEast pipeline.

Property Value: Claims that pipelines do not harm property value are invalid.

The DEIS (Federal Energy Regulatory Commission, 2016) and PennEast, LLC cite studies purporting to show that natural gas pipelines (and in one case a liquid petroleum pipeline) have at most an ambiguous and non-permanent effect on property values (Allen, Williford & Seale Inc., 2001; Fruits, 2008; Palmer, 2008; Diskin et al. 2011). While the studies differ in methods, they are similar in that each fails to take into account two factors potentially voiding their conclusions entirely. First, the studies do not consider that the property price data employed in the studies do not reflect buyers' true willingness to pay for properties closer to or farther from natural gas pipelines. For prices to reflect willingness to pay (and therefore true economic value), buyers would have to have full information about the subject properties, including whether the properties are near a pipeline.

Second, and for the most part, the studies that find no difference in prices for properties closer to or farther away from pipelines are not actually comparing prices for properties that are "nearer" or "farther" by any meaningful measure. The studies compare similar properties and, not surprisingly, find that they have similar prices. Their conclusions are neither interesting nor relevant to the important question of how large an economic effect the proposed pipeline would have.

When the pre-conditions for a functioning market are not met, observed property prices do not (and cannot) indicate property value.

Economic theory holds that for an observed market price to be considered an accurate gauge of the economic value of a good, all parties to the transaction must have full information about the good. If, on the other hand, buyers lack important information about a good, in this case whether a property is near a potential hazard, they cannot bring their health and safety concerns to bear on their decision about how much to offer for the property. As a result, buyers' offering prices will be higher than both what they would offer if they had full information and, most importantly, the true economic value of the property to the buyer.

As Albright (2011) notes in response to the article by Diskin, Friedman, Peppas, & Peppas (2011):

"The use of the paired-sales analysis makes the assumption of a knowing purchaser, but I believe this analysis is not meaningful unless it can be determined that the purchaser had true, accurate and appropriate information concerning the nature and impact of the gas pipeline on,

near or across their property. ... I believe that the authors' failure to confirm that the purchasers in any of the paired sales transactions had full and complete knowledge of the details concerning the gas transmission line totally undercut the authors' work product and the conclusions set forth in the article. (p.5)"

Of the remaining studies, only Palmer (2008) gives any indication that any buyers were aware of the presence of a pipeline on or near the subject properties. For Palmer's conclusion that the pipeline has no effect on property value to be valid, however, it must be true that **all** buyers had full information, which was not the case in the study.

In some cases, however, the location and hazards of petroleum pipelines become starkly and tragically known. For example, a 1999 liquid petroleum pipeline exploded in Bellingham, Washington, killing three, injuring eight and causing damage to property and the environment. In that case and as Hansen, Benson, and Hagen (2006) found, property values fell after the explosion, which is to say, once would-be buyers became aware of the pipeline in the neighborhood. The authors also found that the negative effect on prices diminished over time. This makes perfect sense if, as is likely, information about the explosion dissipated once the explosion and its aftermath left the evening news and the physical damage from the explosion had been repaired.

Today's market is quite different. In contrast to Bellingham homebuyers in the months and years after the 1999 explosion, today's homebuyers can query Zillow to see the history of land prices near the pipeline and explore online maps to see what locally undesirable land uses exist near homes they might consider buying. They also have YouTube and repeated opportunities to find and view news reports, citizens' videos, and other media describing and depicting such explosions and their aftermath. Whether the pre-explosion prices reflected the presence of the pipeline or not, it is hard to imagine that a more recent event and the evident dangers of living near a fossil fuel pipeline would be forgotten so quickly by today's would-be homebuyers.

In Resource Report 5, PennEast, LLC claims that "it has never been commonplace for consumers to identify the presence of natural gas pipelines as part of their real estate transaction diligence and therefore, it can be argued the presence of natural gas pipelines is not a significant determinant to the value for real estate transactions" (2015). This is grossly misleading and plainly illogical. One cannot conclude a lack of a negative effect from the fact that home sellers do not typically, and counter to their own self-interest, disclose information that could induce a drop in the sale price. There are many attributes of homes offered for sale that are not typically included in the information displayed on real estate marketing sites. Drafty windows or unpleasant neighbors are but two examples of things home sellers do not typically include in their description of a home one is trying to sell. They are nevertheless two attributes of a home that would diminish the value to prospective buyers and, once known by those buyers, would also diminish the price offered.

PennEast LLC would instead have FERC believe that all persons selling real estate always disclose any and all features of their property that could possibly reduce the offers they may receive. If that were true, there would be no need for the laws that require homeowners to disclose, for example, whether the basement is damp or if the property is included in a homeowners association. Either PennEast LLC does not understand rational buyer/seller behaviour, or they expect that FERC and the public do not.

What Zillow.com or other sites do accomplish is lowering the effort required for homebuyers to visualize the location of properties relative to other land uses, including pipeline rights of way.

Combined with other information, such as maps of pipeline routes and other searchable online information, real estate marketing tools do make it more likely that prospective buyers will gain information about the hazard they could be buying into.

With more vocal/visible opposition to large, high-pressure natural gas pipelines, it also seems likely that prospective home buyers will not have to wait for an incident involving the PennEast pipeline to learn of it and, therefore, for the PennEast pipeline to affect their willingness to pay (and actual offer prices) for properties nearby. A drive down the street and a quick online search for information about a community one is considering a move to is likely to reveal “no pipeline” signs, municipal ordinances opposing the pipeline, and facebook groups created by local community members formed to raise awareness about the pipeline. Anyone with an eye toward buying property near the proposed PennEast corridor could quickly learn that the property is in fact near the corridor, that there is a danger the property could be adversely affected by the still-pending project approval, and that fossil fuel pipelines and related infrastructure have an alarming history of negative health, safety, and environmental effects.

When people have more complete information about a property, they are able to express their willingness to pay when it comes time to make an offer. Accordingly, the prices buyers offer for homes near the PennEast pipeline will be lower than the prices offered for other homes farther away or in another community or region.

Studies concluding that proximity to pipelines does not result in different property values do not actually compare prices for properties that are different.

While the studies cited in Resource Report 5 and the DEIS purport to compare the price of properties near a pipeline to properties not near a pipeline, many or in some cases all, of the properties counted as “not near” the pipelines are, in fact, near enough to have health and safety concerns that could influence prices. In both studies written by the Interstate Natural Gas Association of America (INGAA) the authors compare prices for properties directly on a pipeline right-of-way to prices of properties off the right-of-way. However, in almost all cases the geographic scope of the analysis was small enough where most or all of the properties not on the right-of-way were still within the pipelines’ respective evacuation zones (Allen, Williford & Seale Inc., 2001; Integra Realty Resources, 2016).⁴

In the 2016 INGAA study, the specific distance from pipeline was reported for eight case studies. In those cases, an average of 72.5% of the “off” properties were actually within the evacuation zone and, like the “on” properties, are therefore likely to suffer a loss in property value relative to properties farther away. (We estimated the evacuation zone based on available information about the pipeline diameter and operating pressure.) For the other two cases, the study reported a simple “yes” or “no” to indicate whether the property abutted the pipeline in question. For these cases, we assume the author’s methods, while flawed, are at least consistent from one case study to the next meaning it is likely at least 50% or more of the comparison properties (the “off” properties) are in fact within the evacuation zone.

To adequately compare the price of properties with and without a particular feature, there needs to be certainty that properties either have or do not have the feature. It is a case where comparing apples and oranges is not only reasonable, but also essential. In the case of these studies, there is little to no

⁴ Proximity of properties to pipelines is based on best estimate of the location of the pipelines derived from descriptions of the pipelines’ locations provided in the studies and an approximation of the evacuation zone based on pipeline diameter and operating pressure (Pipeline Association for Public Awareness, 2007).

variation in the feature of interest (i.e., the majority of properties are within the evacuation zone). The studies are looking at and comparing the “apples.” In this case, the feature of interest is the presence of a nearby risk to health and safety. With no variation in that feature, a systematic variation in the price of the properties is not expected. By comparing apples to apples when it should be comparing apples to oranges, the INGAA studies reach the obvious and not very interesting conclusion that properties that are similar in size, condition, and other features including their location within the evacuation zone of a natural gas pipeline, have similar prices.

To varying degrees, the other studies cited by FERC PennEast LLC suffer from the same problem. Fruits (2008), who analyzes properties within one mile of a pipeline that has a 0.8-mile-wide-evacuation zone (0.4 miles on either side), offers the best chance that a sizable portion of subject properties are in fact “not near” the pipeline from a health and safety standpoint. He finds that distance from the pipeline does not exert a statistically significant influence on the property values, but he does not examine the question of whether properties within the evacuation zone differ in price from comparable properties outside that zone. A slightly different version of Fruits’ model, in other words, could possibly have detected such a threshold effect. (It should go without saying that such an effect would show up only if the buyers of the properties included in the study had been aware of their new property’s proximity to the pipeline.)

In short, the conclusion that pipelines do not negatively affect property values cannot be drawn from these flawed studies. To evaluate the effects of the proposed PennEast pipeline on property value, FERC and others must look to studies (including those summarized in the next section) in which buyers’ willingness to pay is fully informed about the presence of nearby pipelines and in which the properties examined are truly different in terms of their exposure to pipeline-related risks.

Better information about the effect of pipelines on property values is available.

To say the impacts and potential impacts of the PennEast pipeline on private property value are important to people along its proposed route would be an extreme understatement. Along with Delaware Riverkeeper Network, we are reviewing all comments regarding the PennEast proposal. While that review is still underway, we can report that of the random sample of comments reviewed so far 35% mention concerns about the effect on property value. Of this group, 99.6% believe the effect on property value will be negative.

While it is impossible to know precisely how large an effect the specter of the PennEast pipeline has already had on land prices, there is strong evidence from other regions that the effect would be negative. In a systematic review, Kielisch (2015) presents evidence from surveys of Realtors, home buyers, and appraisers demonstrating natural gas pipelines negatively affect property values for a number of reasons. Among his key findings relevant to PennEast:

- 68% of Realtors believe the presence of a pipeline would decrease residential property value.⁵
- Of these Realtors, 56% believe the decrease in value would be between 5% and 10%. (Kielisch does not report the magnitude of the price decrease expected by the other 44%.)

⁵ This result demonstrates that Realtors’ knowledge of their own market is not defined by or limited to what is advertised on realtor.com.

- 70% of Realtors believe a pipeline would cause an increase in the time it takes to sell a home. This is not merely an inconvenience, but a true economic and financial cost to the seller.
- More than three quarters of the Realtors view pipelines as a safety risk.
- In a survey of buyers presented with the prospect of buying an otherwise desirable home with a 36-inch diameter gas transmission line on the property, 62.2% stated that they would no longer buy the property at any price. Of the remainder, half (18.9%) stated that they would still buy the property, but only at a price 21%, on average, below what would otherwise be the market price. The other 18.9% said the pipeline would have no effect on the price they would offer.

Not incidentally, the survey participants were informed that the risks of “accidental explosions, terrorist threats, tampering, and the inability to detect leaks” were “extremely rare” (Kielisch, 2015, p. 7). Considering only those buyers who are still willing to purchase the property, the expected loss in market value would be 10.5%.⁶ This loss in value provides the mid-level impact in our estimates. A much greater loss (and higher estimates) would occur if one were to consider the fact that 62% of buyers are effectively reducing their offer prices by 100%, making the average reduction in offer price for all potential buyers 66.2%.⁷ In our estimates (see below), however, we have used the smaller effect (-10.5%) based on the assumption that sellers will eventually find one of the buyers still willing to buy the pipeline-easement-encumbered property.

- Based on five “impact studies” in which appraisals of smaller properties with and without pipelines were compared, “the average impact [on value] due to the presence of a gas transmission pipeline is -11.6%” (Kielisch, 2015, p. 11). The average rises to a range of -12% to -14% if larger parcels are considered, possibly due to the loss of subdivision capability.

Kielisch’s findings demonstrate that properties on natural gas pipeline rights-of-way suffer a loss in property value. Boxall, Chan, and McMillan (2005), show that pipelines also decrease the value of properties lying at greater distances. In their study of property values near oil and gas wells, pipelines, and related infrastructure, the authors found that properties within the “emergency plan response zone” of sour gas⁸ wells and natural gas pipelines faced an average loss in value of 3.8%, other things being equal.

The risks posed by PennEast would be different—it would not be carrying sour gas, for example—but there are similarities with the PennEast scenario that make Boxall et al.’s finding particularly relevant. Namely, the emergency plan response zones (EPZs) are defined by the health and safety risks posed by the gas operations and infrastructure. Also, and in contrast to the FERC- and PennEast-cited studies showing no price effects (see “Property Value: Claims that pipelines do not harm property value are invalid,” above), the Boxall study examines prices of properties for which landowners must inform prospective buyers when one or more EPZs intersect the property.

In addition to the emerging body of evidence that there is a negative relationship between natural gas infrastructure and property value, there have been many analyses demonstrating the opposite analog.

⁶ Half of the buyers would offer 21% less, and the other half would offer 0% less; therefore the expected loss is $0.5(-21\%) + 0.5(0\%) = -10.5\%$.

⁷ This is the expected value calculated as $0.622*(-100\%)+0.189*(-21\%)+0.189*(0\%)$.

⁸ “Sour” gas contains high concentrations of hydrogen sulfide and poses an acute risk to human health.

Namely, it is well-established that amenities such as scenic vistas, access to recreational resources, proximity to protected areas, cleaner water, and others convey positive value to real property.⁹ There are also studies demonstrating a negative impact on land value of various other types of nuisance that impose noise, light, air, and water pollution, life safety risks, and lesser human health risks on nearby residents (Bixuan Sun, 2013; Bolton & Sick, 1999; Boxall et al., 2005). The bottom line is that people derive greater value from, and are willing to pay more for, properties that are closer to positive amenities and farther from negative influences, including health and safety risks.

Using the results established by Kielisch (2015) and Boxall, Chan, McMillan (2005), and applied to pipelines in Phillips, Wang and Bottorff (2016), we estimate that construction of the the PennEast pipeline would result in a loss of \$158.3 to \$176.0 million in property value in the right-of-way and evacuation zone.

Further property value impacts near the Kidder compressor station.

In addition to the direct effects on nearby residents' health and quality-of-life noted above, compressor stations have caused some homes to lose value and some homeowners to move away rather than endure the noise, smells, and illnesses they have experienced. In one case from Minisink, New York, a family of six moved to escape the effects of a 12,600 hp compressor station operated by Millennium Pipeline LLC. After two years of headaches, eye irritation, and lethargy among the children and even lost vigor in their fruit trees, the couple, unable to find a buyer for their home, moved away, leaving their \$250,000 investment in the property on the table with their bank holding the balance of the mortgage (Cohen, 2015).

In Hancock, another New York town with a much smaller (15,000 hp) compressor station, three homeowners have had their property assessments reduced, two by 25% and one by 50%, due to the impact of truck traffic, noise, odors, and poor air quality associated with the compressor station ("Proximity of Compressor Station Devalues Homes by as Much as 50%", 2015). The larger of these reductions was for a home very close to the station and reflected physical damage that led to an increase in radon concentrations above safe levels. The two properties devalued by 25% were approximately one half mile away (Ferguson, 2015).

As of this writing, there have not been statistical studies of the relationship between a property's value and its proximity to a compressor station. The mounting anecdotal information does suggest that there is a negative relationship, however, and depending on the particular circumstances, the effect can be large—up to the 100% loss sustained by the family in Minisink (less whatever the bank can recover at auction). FERC must therefore count the potential loss of property value associated with the compressor station proposed for location in Kidder Township.

For our estimates, we follow the example of the Hancock, New York case and assume that properties within one half mile of the Kidder Township compressor station would lose 25% of their value if the station is built. We believe this assumption provides a conservative estimate in part because the Kidder compressor station would be more than three times the horsepower of the Hancock station. It is therefore likely that its noise, odor events, and other physical effects would be experienced at a greater distance and/or with greater intensity than in the New York case. The resulting loss of value would affect Carbon County landowners over a wider area and, possibly, the percentage reduction would be

⁹ Phillips (2004) is one such study that includes an extensive review of the literature on the topic.

greater at any given distance. Under these conservative assumptions, the Kidder compressor station would reduce the value of 40 properties by a total of \$1.4 million dollars.

Beyond health and safety concerns, compressor stations might also affect property values due to a “stigma of industrialization” similar to that found for high-voltage lines, according to real estate expert Kurt Kielisch of the Forensic Appraisal Group (Personal Communication 1/6/2016).

Conclusion

Based on our own and others’ research regarding the potential economic effects of natural gas transmission pipelines, we find the following critical weaknesses in FERC’s Draft Environmental Impact Statement regarding the proposed PennEast pipeline.

1. The DEIS reflects FERC’s policy on pipeline certification, which embodies confused and economically incorrect guidance regarding the scope or extent of the area within which economic costs the pipeline would be experienced. Namely, the policy looks only at impacts on owners of pipeline rights of way and an undefined “surrounding community,” rather than the full geographic area over which impacts could be felt. In addition, the policy ignores even the surrounding community if a significant proportion of landowners have agreed to sell easements to their property.
2. The range of alternatives is inadequate, resulting in the potential that the DEIS has missed opportunities to meet the same energy services need at a lower environmental and economic cost.
3. The DEIS, while noting that economic benefits would be slight, still relies on over-estimates of those benefits.
4. The DEIS ignores important economic costs, including public health and the value of ecosystem services lost due to land conversion in the pipeline construction corridor and right-of-way.
5. The DEIS accepts and repeats the conclusions of studies purporting to show that pipelines have no affect on property value and ignores research showing that pipelines do harm property value.

Taken together, these flaws render the DEIS unsuitable as a guide to evaluating the economic effects of the proposed PennEast pipeline. We look forward to submitting to the record our own evaluation of economic costs that FERC has ignored in the DEIS. We strongly recommend that FERC undertake its own rigorous examination of the full economic effects.

Sincerely,



Spencer Phillips, Ph.D.
Principal

Works Cited

- Albright, H. K. (2011). A Question of Disclosure. *Right of Way*, (March/April), 5.
- Allen, Williford & Seale Inc. (2001). *Natural Gas Pipeline Impact Study* (No. F-2001-02) (p. 236). Interstate Natural Gas Association of America (INGAA) Foundation, Inc.
- American Council on Renewable Energy. (2014). *The Outlook for Renewable Energy in America*. Retrieved from http://acore.org/files/pdfs/ACORE_Outlook_for_RE_2014.pdf
- Bixuan Sun. (2013). *Land use conflict in an iron range community: an econometric analysis of the effect of mining on local real estate values and real estate tax collections* (written). University of Minnesota-Morris.
- Bolton, D. R., & Sick, K. A. (1999). Power Lines and Property Values: The Good, the Bad and the Ugly. *The Urban Lawyer*, 31(2). Retrieved from <https://altered-states.net/barry/newsletter143/lawyer.htm>
- Boxall, P. C., Chan, W. H., & McMillan, M. L. (2005). The impact of oil and natural gas facilities on rural residential property values: a spatial hedonic analysis. *Resource and Energy Economics*, 27(3), 248–269. <http://doi.org/10.1016/j.reseneeco.2004.11.003>
- Brooks, S. (2016, August 29). In Win for Environment, Court Recognizes Social Cost of Carbon. Retrieved August 30, 2016, from <http://blogs.edf.org/energyexchange/2016/08/29/in-win-for-environment-court-recognizes-social-cost-of-carbon/>
- Cohen, J. (2015, Winter). Home Sick from Toxic Emissions. Retrieved December 31, 2015, from <http://www.utne.com/environment/home-sick-from-toxic-emissions-zmOz15wzdeh.aspx>
- Colaneri, K. (2015, April 15). In New Jersey, open space sacrificed for cheaper natural gas. Retrieved from <https://stateimpact.npr.org/pennsylvania/2015/04/15/in-new-jersey-open-space-sacrificed-for-cheaper-natural-gas/>
- Council on Environmental Quality. (1978). *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act*. Washington, DC: Executive Office of the President.
- Diskin, B. A., Friedman, J. P., Peppas, S. C., & Peppas, S. R. (2011). The Effect of Natural Gas Pipelines on Residential Value. *Right of Way*, (January/February), 24–27.
- Donovan, S., Goldfuss, C., & Holdren, J. (2015). *Incorporating Natural Infrastructure and Ecosystem Services in Federal Decision-Making* (No. M-16-01) (p. 5). Executive Office of the President, OMB & CEQ. Retrieved from <https://www.whitehouse.gov/blog/2015/10/07/incorporating-natural-infrastructure-and-ecosystem-services-federal-decision-making>

- Econsult Solutions, & Drexel University School of Economics. (2015, February 9). PennEast Pipeline Project Economic Impact Analysis. Retrieved from <http://www.econsultsolutions.com/experience/reports/>
- Federal Energy Regulatory Commission. (2016). *PennEast Pipeline Project Draft Environmental Impact Statement Docket No. CP15-558-000*. Retrieved from http://elibrary.ferc.gov/idmws/file_list.asp?accession_num=20160722-4001
- Ferguson, B. (2015, December 31). Personal Communication, Bruce Ferguson, Catskill Citizens for Safe Energy.
- Fitzgerald, R. L. (2015, February 28). Letter regarding effect of pipelines on crop productivity.
- Fruits, E. (2008). *Natural Gas Pipelines and Residential Property Values: Evidence from Clackamas and Washington Counties*. Retrieved from <http://pstrust.org/docs/NGPipesPropertyValues.pdf>
- Hansen, J. L., Benson, E. D., & Hagen, D. A. (2006). Environmental hazards and residential property values: Evidence from a major pipeline event. *Land Economics*, 82(4), 529–541.
- Haynes, R. W., Adams, D. M., Alig, R. J., Ince, P. J., Mills, J. R., & Zhou, X. (2007). *The 2005 RPA timber assessment update*. (General Technical Report No. PNW-GTR-699) (p. 212). Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.
- Headwaters Economics. (2015). *Economic Profile System*. Retrieved from <http://headwaterseconomics.org/tools/eps-hdt>
- Hoecker, J. J., Breathitt, L. K., & He'bert Jr., C. L. Certification of New Interstate Natural Gas Pipeline Facilities, 88 FERC, para. 61,227 (1999).
- Hoffman, S. A., & Fortmann, L. (1996). Poverty in forested counties: an analysis based on aid to families with dependent children. In *Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, Assessments and scientific basis for management options*. Davis, CA: University of California, Centers for Water and Wildland Resources.
- Integra Realty Resources. (2016). *Pipeline Impact to Property Value and Property Insurability* (No. 2016.01) (p. 144). Interstate Natural Gas Association of America (INGAA) Foundation, Inc. Retrieved from <http://www.ingaa.org/PropertyValues.aspx>
- Kielisch, K. (2015). *Study on the Impact of Natural Gas Transmission Pipelines* (p. 28). Forensic Appraisal Group, Ltd.
- Krikelas, A.C. (1992). "Why Regions Grow: A Review of Research on the Economic Base Model." *Economic Review* 77 (4).
- Lander, G. (2016, March 9). Analysis of Public Benefit Regarding PennEast Pipeline. Retrieved June 27, 2016, from <http://njconservation.org/docs/PennEastNotNeeded.pdf>
- Lucas, D. (2015, July 6). Officials To NYS: Take A Second Look At Pipelines. Retrieved July 14, 2015, from <http://wamc.org/post/officials-nys-take-second-look-pipelines>

- Luckett, B., Buppert, G., & Margolis, J. M. (2015, April 28). SELC ACP Comment, FERC DOCKET NO.: PF15-6-000,20150428-5504(30537222). Southern Environmental Law Center; Appalachian Mountain Advocates; Center for Biological Diversity.
- Millennium Ecosystem, & Assessment Panel. (2005). Ecosystems and Human Well-Being. Retrieved August 21, 2016, from <http://www.millenniumassessment.org/documents/document.356.aspx.pdf>
- National Ecosystem Services Partnership. (n.d.). Federal Resource Management and Ecosystem Services Guidebook. Retrieved February 10, 2015, from <https://nespguidebook.com/>
- Olander, L., Johnston, R. J., Tallis, H., Kagan, J., Maguire, L., Polasky, S., ... Palmer, M. (2015). *Best Practices for Integrating Ecosystem Services into Federal Decision Making*. Durham, North Carolina: National Ecosystem Services partnership, Duke University.
- Palmer, D. R. (2008, February 21). The impact of natural gas pipelines on property values: Market analysis prepared for Palomar Gas Transmission LLC. PGP Valuation, Inc.
- PennEast Pipeline Company, LLC. (2015, September). PennEast Pipeline Project Resource Report 1. Retrieved April 26, 2016, from <http://www.roanokecountyva.gov/DocumentCenter/View/6136>
- Phillips, S., & McGee, B. (2016). Ecosystem Service Benefits of a Cleaner Chesapeake Bay. *Coastal Management*, 241–258. <http://doi.org/10.1080/08920753.2016.1160205>
- Phillips, S., Wang, S., & Bottorff, C. (2016). *Economic Costs of the Mountain Valley Pipeline: Effects on Property Value, Ecosystem Services, and Economic Development in Virginia and West Virginia* (p. 51). Key-Log Economics LLC. Retrieved from http://keylogeconomics.com/wp1/wp-content/uploads/2016/05/EconomicCostsOfTheMVP_TechnicalReport_FINAL_20160516.pdf
- Proximity of Compressor Station Devalues Homes by as much as 50%. (2015, July 7). Catskill Citizens for Safe Energy. Retrieved from <http://catskillcitizens.org/learnmore/DEVALUE.pdf>
- Randall, T. (2016, April 6). Wind and Solar Are Crushing Fossil Fuels. Retrieved September 1, 2016, from <http://www.bloomberg.com/news/articles/2016-04-06/wind-and-solar-are-crushing-fossil-fuels>
- Richardson, H. W. (1985). Input-Output and Economic Base Multipliers: Looking backward and forward. *Journal of Regional Science*, 25(4).
- Robertson, G. (2003). *A Test of the Economic Base Hypothesis in the Small Forest Communities of Southeast Alaska* (General Technical Report No. PNW-GTR-592) (p. 101). USDA Forest Service, Pacific Northwest Research Station. Retrieved from http://www.fs.fed.us/pnw/pubs/pnw_gtr592.pdf
- Southwest Pennsylvania Environmental Health Project. (2015, February 24). Summary on Compressor Stations and Health Impacts. Southwest Pennsylvania Environmental Health Project. Retrieved from <http://www.environmentalhealthproject.org/wp-content/uploads/2012/03/Compressor-station-emissions-and-health-impacts-02.24.2015.pdf>

- Subra, W. (2009, December). Health Survey Results of Current and Former DISH/Clark Texas Residents. Earthworks. Retrieved from http://www.earthworksaction.org/files/publications/DishTXHealthSurvey_FINAL_hi.pdf
- Subra, W. (2015, October 3). Toxic Exposure Associated with Shale Development. Subra Company and Earthworks Board.
- U.S. Energy Information Administration. (2016). *Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2016*. Washington, DC: U.S. Department of Energy. Retrieved from http://www.eia.gov/forecasts/aeo/pdf/electricity_generation.pdf
- U.S. EPA, C. C. D. (2016, June 12). Social Cost of Carbon [Overviews & Factsheets,]. Retrieved June 12, 2016, from <https://www3.epa.gov/climatechange/EPAactivities/economics/scc.html>
- U.S. EPA. (2016, May). Greenhouse Gas Equivalencies Calculator [Data & Tools]. Retrieved August 21, 2016, from https://www.epa.gov/sites/production/files/widgets/ghg_calc/calculator.html#results
- Walker, M., & Koplinka-Loehr, S. (2014, July 9). Air Quality and Health Impacts of Milford Compressor Station Expansion. Clean Air Council. Retrieved from http://www.cleanair.org/program/outdoor_air_pollution/shale_gas_infrastructure/milford_compressor_station_air_impacts_commun