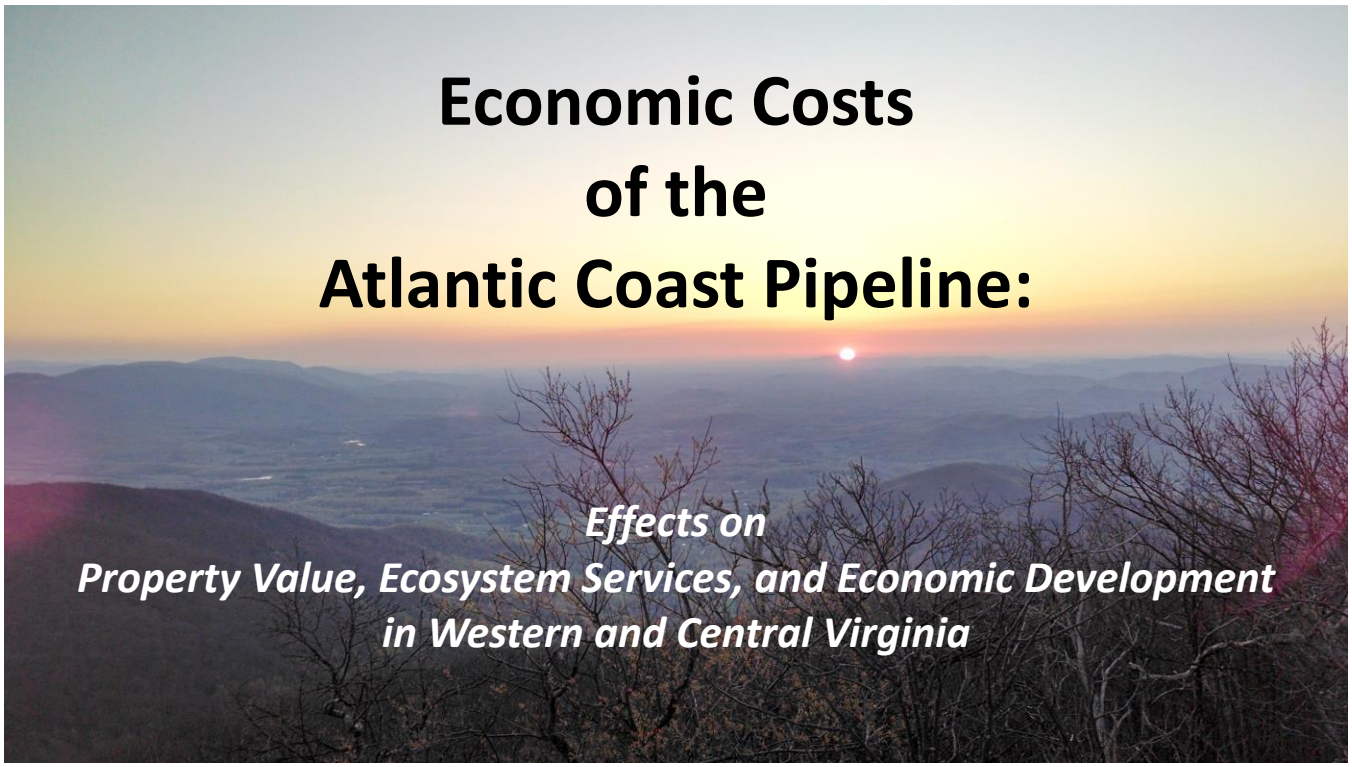

Economic Costs of the Atlantic Coast Pipeline:

Effects on Property Value, Ecosystem Services, and Economic Development in Western and Central Virginia

FEBRUARY 2016

Highlanders for Responsible Development

Augusta County Alliance

Friends of Nelson County

Friends of Buckingham, Virginia

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EXECUTIVE SUMMARY

The Atlantic Coast Pipeline (ACP) is proposed to carry natural gas from the Marcellus Shale through a 564-mile-long swath of West Virginia, Virginia, and North Carolina to markets in Virginia and North Carolina and, potentially, overseas. It has been represented as both environmentally safe and economically beneficial, providing economic opportunity for local communities along the proposed route.

Promised economic benefits, however, are only part of the impact the Federal Energy Regulatory Commission (FERC) must review before deciding whether to approve the construction and operation of the pipeline. Under the National Environmental Policy Act, FERC's review must consider the full range of environmental effects of the proposed pipeline. These include the various ways in which environmental effects would result in changes in human well-being—that is, in economic benefits and costs. While estimates of positive economic effects including construction jobs and local tax payments have been developed and promoted as reasons to move forward with the pipeline, no systematic consideration of the potential negative economic effects—economic costs—of the ACP has been completed.

To help fill the gap in current information, five community groups from a four-county region in central and western Virginia commissioned this independent research into key economic costs of the ACP. This region, comprised of Highland, Augusta, Nelson, and Buckingham Counties, would experience three types of economic costs due to the construction, operation, and presence of the ACP. First, the pipeline would impact property values along the 126 miles of pipeline proposed for the region. Affected properties are those touched by the 75-foot-wide right-of-way, within the 1.4-mile-wide evacuation zone, in proximity to the compressor station proposed for Buckingham County, and throughout the viewshed of the proposed pipeline. Second, construction and the ongoing operation of the pipeline would alter land use/land cover in ways that diminish ecosystem service values, such as aesthetics, water supply, and timber and food production. Third, and in part due to a loss of scenic and quality-of-life amenities, there would be decreases in visitation, in-migration, and small business development and a loss of jobs and personal income those activities would otherwise support.

Considering this four-county region alone, estimated one-time costs range from $72.7 to $141.2 million. These one-time costs comprise lost property value and the value of ecosystem services lost during construction. Annual costs following the construction period include lower ecosystem service productivity in the ACP's right-of-way, lower property tax revenue due to the initial losses in property value, and dampened economic development. These total between $96.0 and $109.1 million per year, and would persist forever. (See "At a Glance," below for details.) Putting the stream of costs into present value terms [1] and adding the one-time costs, the total estimated cost of the ACP in Highland, Augusta, Nelson, and Buckingham Counties is between $6.9 to $7.9 billion. For reasons explained in the body of this report, these are conservative estimates.

The costs represented by the estimates presented here are what economists call "externalities," or "external costs," because they would be imposed on parties other than (external to) the company proposing to build the pipeline. Unlike the private (or internal) costs of the pipeline, external costs borne by the public do not affect the company's bottom-line. From an economic perspective, the presence of externalities is what demands public involvement in decsions about the ACP. Without consideration of all of the costs of the project, too much pipeline (which may mean any pipeline at all) is the inevitable result. FERC must therefore consider the true bottom line and ensure that the full costs of the pipeline, especially those external costs imposed on the public, are rigorously examined and brought to bear on its decision about whether or not to permit the ACP project to proceed.

[1] The present value of a perpetual stream cost is the one-year cost divided by the 1.4% real discount rate recommended by the Office of Management and Budget for cost-benefit and cost-effectiveness analysis of public projects and decisions (http://federalaccounting.org/2015/01/omb-updates-cost-benefit-analysis-discount-rates/).

At a Glance:

The Atlantic Coast Pipeline in Western and Central Virginia
~ Highland, Augusta, Nelson, & Buckingham Counties ~

- Miles of Pipeline: 125.5
- Acres in the construction corridor and permanent right-of-way (ROW): 1,901 and 1,140
- Most impacted land cover types (ROW only): forest (795 acres) and pasture (247 acres)
- Parcels touched by ROW: 521
- Parcels in the 1.4-mile-wide evacuation zone: 6,148
- Parcels within one half mile of the compressor station: 87
- Residents and housing units in the evacuation zone: 15,128 people and 8,762 homes
- Parcels from which the pipeline would be visible: 31,117, or 29% of all parcels in the four-county study region
- Baseline property value at risk (and expected one-time cost due to the ACP):
    - In the ROW: $277.1 million ($11.6 to $36.0 million)
    - In the evacuation zone: $1.13 billion ($43.0 million)
    - Near the compressor station: $4.9 million ($1.2 million)
    - In the viewshed: $7.44 billion (to avoid double counting with lost aesthetic value under ecosystem services, this impact is not separately estimated)
- Total property value lost: $55.8 to $80.2 million
- Resulting loss in property tax revenue (annual): $281,300 to $408,400
- Lost ecosystem service value, such as for water and air purification, recreational benefits, and others:
    - Over the two-year construction period: between $16.9 and $61.0 million (a one-time cost)
    - Annually for the life of the ACP: between $4.9 and $17.8 million
- Lost economic development opportunities due to the erosion of these Counties' comparative advantages as attractive places to visit, reside, and do business. Under the scenarios described below, these could include:
    - Annual loss of recreation tourism expenditures of $41.3 million that supports 387 jobs and $7.4 million in payroll and generates $1.8 million in state and $1.3 million in local taxes
    - Annual loss of personal income of $6.6 million due to slower growth in the number of retirees
    - Annual loss of personal income of $1.6 million due to slower growth in sole proprietorships
- One-time costs (property value and ecosystem services during construction) would total between $72.7 and $141.2 million
- Annual costs (all other costs above) would range from $96.1 to $109.1 million

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ABBREVIATIONS AND TERMS

ACP: Atlantic Coast Pipeline. For this report, this generally refers to the pipeline corridor itself as well as the compressor station proposed for Buckingham County.

ACP LLC: Atlantic Coast Pipeline, LLC, an entity formed by Dominion Resources, Inc., Duke Energy Corporation, Piedmont Natural Gas Co., Inc., and AGL Resources, Inc. to develop, own, and operate the proposed Atlantic Coast Pipeline (ACP)

BTM: Benefit Transfer Method, a method for estimating the value of ecosystem services in a study region based on values estimated for similar resources in other places

DTI: Dominion Transmission, Inc., the entity that would build and operate the proposed ACP under contract to ACP LLC

EIS: Environmental Impact Statement, a document prepared under the National Environmental Policy Act analyzing the full range of environmental effects, including on the economy, of proposed federal actions, which in this case would be the approval of the Atlantic Coast Pipeline

FERC: Federal Energy Regulatory Commission, the agency responsible for preparing the EIS and deciding whether to grant a certificate of public convenience and necessity (i.e., whether to permit the pipeline)

NEPA: National Environmental Policy Act of 1970, which requires the environmental review of proposed federal actions, preparation of an EIS, and, for actions taken, appropriate mitigation measures

AUTHORS' NOTE:

We are grateful for the assistance the sponsoring organizations (Highlanders for Responsible Development, Augusta County Alliance, Friends of Nelson County, Yogaville Environmental Solutions, and Friends of Buckingham Virginia) have provided in identifying local information sources and making contacts in the study region. Key-Log Economics however, remains solely responsible for the content of this report, the underlying research methods, and the conclusions we draw from them.

BACKGROUND

The proposed Atlantic Coast Pipeline (ACP) is a high-volume transmission pipeline intended, as described in filings with the Federal Energy Regulatory Commission (FERC), to transport 1.5 billion cubic feet (bcf) per day of natural gas from the Marcellus Shale region in West Virginia to power generation facilities, natural gas distributors, and commercial and industrial end users in Virginia and North Carolina (Natural Resource Group, 2015c).[2] Atlantic Coast Pipeline, LLC, would control the pipeline, while permit applications, construction, and operations would be managed by Dominion Transmission, Inc. (DTI).

The majority of the pipeline, and all of it in the four-county region considered in this study (Figure 1), would consist of 42-inch diameter pipe and would be operated at a pressure of 1,440 pounds per square inch gauge (PSIG). This pressure would be maintained by three compressor stations, including one proposed for Buckingham County, Virginia, which is part of the study region (Natural Resource Group, 2015c).

Along the way, the ACP would cross portions of the Monongahela and George Washington National Forests, Blue Ridge Parkway, the Appalachian Trail, and other public conservation, scenic, and natural areas. Its permanent right-of-way and temporary construction corridor—75 and 125 feet wide, respectively—would also cross thousands of private properties. Pipeline leaks and explosions could cause substantial physical damage and require evacuation of even wider swaths, affecting perhaps tens of thousands of homes, farms, and businesses. Still wider, but more difficult to gauge and estimate, are the zones within which the construction, operation, and presence of the pipeline would affect human well-being by changing the availability of ecosystem services such as clean air, water supply, and recreational opportunities. This would occur as the pipeline creates an unnatural linear feature on a landscape that otherwise remains largely natural or pastoral and dampens the attractiveness of the affected region as a place to live, visit, retire, or do business.

To date, such negative effects and estimates of their attendant economic costs have not received much attention in the otherwise vigorous public debate surrounding the ACP proposal. This report, commissioned jointly by five community groups[3] located in central and western Virginia is both an attempt to understand the nature and potential magnitude of the economic costs of the ACP in a particular four-county area, as well as to provide an example for FERC as it proceeds with its process of analyzing and weighing the full effects of the proposed ACP along its entire length and, by extension, throughout the region in which its effects will occur.

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[2] While pipeline backers maintain that the gas transported via the ACP would not be for export, the pipeline would add to overall national gas transmission capacity and thus would serve to free up more gas for export at Dominion Cove Point LNG LP's newly approved liquefied natural gas export facility in Calvert County, Maryland.

[3] These are, from west to east, Highlanders for Responsible Development, Augusta County Alliance, Friends of Nelson County, Yogaville Environmental Solutions, and Friends of Buckingham Virginia.

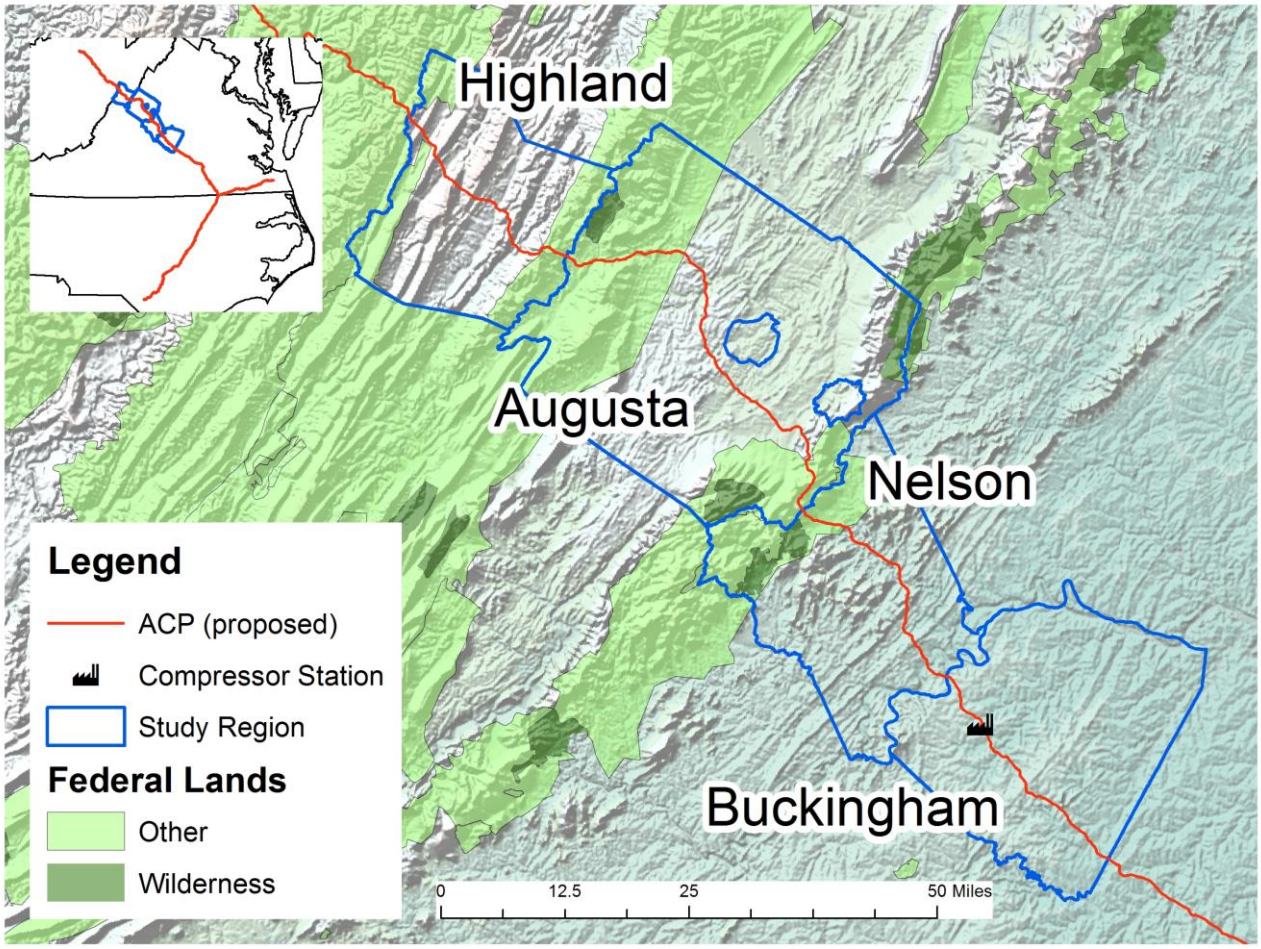

Figure 1: Four-County Study Region.

Note: Augusta County includes the independent cities of Staunton and Waynesboro

Sources: ACP route and compressor digitized from interactive map, Dominion Resources Inc. http://dom.maps.arcgis.com/, and Resource Report 1: Appendix A, Topographic Route Maps (Natural Resource Group 2015); Study Region (counties); federal lands, and hill shade from USGS and http://nationalmap.gov/small_scale/

Policy Context

Before construction can begin, the ACP must be approved by FERC. That approval, while historically granted to pipeline projects, depends on FERC's judgment that the pipeline would meet a public "purpose and need." Because the approval would be a federal action, FERC must also comply with the procedural and analytical requirements of the National Environmental Policy Act (NEPA). These include requirements for public participation, conducting environmental impact analysis, and writing an Environmental Impact Statement (EIS) that evaluates all of the relevant effects. Of particular interest here, such relevant effects include direct, indirect, and cumulative effects on or mediated through the 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 NEPA does not require that federal actions – which in this case would be approval or not of the ACP – necessarily balance or even compare benefits and costs. NEPA is not a decision-making law, but rather a law that requires decisions be supported by as full as possible an 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.

In addition to the requirements of NEPA, FERC's own policy regarding the certification of new interstate pipeline facilities (Docket No. PL99-3-000) 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, Breathitt, & He'bert Jr., 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 principal, 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 total cost, including external costs. The policy's guidance regarding what adverse effects must be considered and how they are measured is deeply flawed, however. The policy states, for example, that "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," the third of which include communities through which the proposed pipeline would pass (Hoecker et al., 1999, p. 26). In effect, the Commission's policy contends that the only adverse effects that matter are those that affect owners of properties in the right-of-way. Even for a policy adopted in 1999, this contention is completely out of step with then current understanding of the economic effects of development that alters the natural environment.

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[4] and parsimonious in counting the costs of its proposal. Under these circumstances, it seems unlikely that the Commission's policy will prevent the construction of pipelines

[4] Dominion Resources and Dominion Transmission Inc. have published estimates of economic benefits in the form of employment and income stemming from the construction and operation of the ACP. As has been well documented elsewhere, both studies suffer from errors in the choice and application of methods and in assumptions made regarding the long-run economic stimulus represented by the ACP. Most significantly, the studies make no mention of likely economic costs, and their projections of long-term benefits extend far beyond the time period (of a year or so) within which economic impact analysis is either useful or appropriate. See Phillips (2015b) and Stanton et al. (2015) for details on these shortcomings.

for which the full costs are greater than the public benefits they would actually provide. Indeed, FERC has never rejected a pipeline proposal (van Rossum, 2016).

With ACP LLC having failed to acquire a sufficient portion of the right-of-way and with the need for other federal agencies, including the US Forest Service, to evaluate how the ACP would affect resources under its stewardship, the Commission issued a Notice of Intent to prepare an EIS in February of 2015 (Federal Energy Regulatory Commission, 2015). The process began with a series of scoping meetings at which members of the public could express their thoughts on the pipeline in general as well as what effects should fall under the scope of the EIS. Interested parties also had the opportunity to submit comments online and through the mail. FERC received more than 1,600 individual comment letters, another 1,239 form letters, and several petitions bearing multiple signatures each.[5]

Much of what FERC heard from citizens echoed and expanded upon the list of potential environmental effects listed in its Notice of Intent. Of those, several are particularly important as the sort of environmental effects that resonate in the lives of people. These effects can take the form of external economic costs that would be borne by individuals, businesses, and communities throughout the landscape the ACP would traverse. Table 1 lists these key issues along with the number of scoping letters from residents of Highland, Augusta, Nelson, and Buckingham County who mentioned the issue.

FERC also received input about both the legal and economic importance of considering the economic consequences of these environmental effects along with recommendations of the type and scope of economic analysis that should be undertaken to quantify, to the extent possible, the magnitude of the economic costs (see Phillips, 2015, for example). DTI responded to this input in a letter to FERC arguing against such analysis, stating "because there is no commonly accepted methodology to weigh the economic benefits of the ACP against possible environmental, health, and safety risks using all possible positive and negative externalities, the economic impact assessment can only address tangible economic benefits of the ACP using known variables and economic modeling" (Woolard & Natural Resource Group, 2015, p. 58).

Contrary to DTI's claim, experts in the fields of natural resource, agricultural, environmental, and ecological economics have been developing, testing, and improving such methods since the 1960s (and the underlying economic models have been established for even longer). Textbooks such as *The Benefits of Environmental Improvement: Theory and Practice* (Freeman III, 1979) or *Valuing Natural Assets: The Economics of Natural Resource Damage Assessment* (Kopp & Smith, 1993) plus many thousands of peer-reviewed papers and other resources provide ample documentation of the methods

[5] While the NEPA's scoping phase is intended to generate guidance for the lead agency (FERC) on how to conduct the EIS and is not intended as a referendum, FERC nevertheless has heard opinions in support of the pipeline, and, as it turns out, many more opinions in opposition to the pipeline. Pipeline opponents cite a variety of concerns, including those that are the subject of this report. Key-Log Economics is preparing a full analysis of content of the scoping comments. Using crowd-sourcing, Key-Log Economics has reviewed and coded the content of all 2,875 individual letters, form letters, and petitions submitted to FERC through, and somewhat beyond, its announced formal scoping period. A report summarizing that content as a measure of citizens' level of interest in the issues they have raised and, therefore, those they should most expect FERC to cover in the EIS process, will be released in early 2016.

by which one may estimate the negative externalities and other economic consequences of changes in environmental quality that projects like the proposed ACP would cause.

TABLE 1: Environmental Concerns Raised During FERC Scoping Process

Environmental Issue / Resource Value[a]	Mentions among 1,299 scoping comment letters[b,c]
Impacts on property values, tourism, and recreational resources	521 (property value) 630 (tourism) 381 (recreation)
Safety issues, such as construction and operation of the planned facilities near existing residences, schools, businesses, and military training facilities, and in karst and steep slope terrain	528 (risk of accidents) 467 (general safety) 420 (erosion)
Impacts on forested areas and other vegetation	739 (forested areas, vegetation, habitat, etc.)
Impacts on surface water resources including rivers springs, seeps, and wetlands	812 (waterways) 604 (water quality) 370 (water supply)
Impacts on groundwater resources and wells	370 (water supply)
Impacts on protected species and habitat	404 (wildlife)
Impacts on cultural resources including battlefields, cemeteries, and historic properties	489 (rural character) 240 (culture)
Concerns regarding construction and operational noise, especially related to compressor stations	334 (health) 517 (quality of life) 40 (compressor station)

Notes:

a. This is a partial list of "Currently Identified Environmental Issues" from FERC's Notice of Intent to prepare an Environmental Impact Statement regarding the ACP (Federal Energy Regulatory Commission, 2015, p. 12165).
b. The categories in parentheses are related to the "currently identified environmental issues" listed in the FERC Notice of Intent (Federal Energy Regulatory Commission, 2015, p. 12165).
c. These "mentions" are the number of comment letters written by or on behalf of residents of the study region (Highland, Augusta, Nelson, and Buckingham Counties) that noted or mentioned the listed issue. While detailed analysis of the full set of comments is ongoing, the vast majority of commenters from the the study region expressed a belief that the ACP would have a negative impact on the resource/value listed in the first column.

Moreover, precedent from the Tellico Dam, to the Exxon Valdez settlement, to the national forest planning rule and recent guidance from the Council on Environmental Quality (with their emphases on ecosystem services) show that such methods do exist and are useful both for determining the costs of environmental damage and for guiding cost-effective environmental decision-making (Carson et al., 2003; Donovan, Goldfuss, & Holdren, 2015; Randall, 1987; USDA Forest Service, 2012).

The applicant's professed ignorance of established methods for estimating the economic costs of environmental damage perhaps serves "to develop whatever record is necessary" (Hoecker et al.,

1999), for FERC to permit the pipeline, but it does nothing to develop a proper assessment of costs and or to serve the public interest. To ensure an economically efficient use of public and private resources and to meet its obligations under NEPA, FERC must obtain credible estimates of public benefit (which has so far not been demonstrated), develop rigorous estimates of the full suite of costs, and bring both sets of information to bear on its decisions regarding the Atlantic Coast Pipeline.

Study Objectives

Given the policy setting and what may be profound effects of the ACP as proposed on the people and communities of central and western Virginia, we have undertaken this study to provide information of two types:

1. An example of the scope and type of analyses that FERC could, and should, undertake as part of its assessment of the environmental (including economic) effects of the ACP.
2. An estimate of the potential magnitude of economic effects in this four-county subset of the landscape where the ACP's environmental and economic effects will be felt.

We do not claim the estimates below represent the total of all of the potential costs that would attend the construction, operation, and presence of the pipeline. Specifically, we have not estimated costs in two categories: "passive-use value,"[6] including the value of preserving the landscape, without a pipeline, for future direct use; and increases in the cost of community services like road maintenance and emergency response that may increase due to the construction and operation of the pipeline.[7]

Therefore, our figures should be understood to be conservative, lower-bound estimates of the true total cost of the ACP in that sub-region and, of course, they do not include costs for the remainder of the region proposed for the ACP. We do urge that the FERC augment the results of this study with its own similar analysis for the entire region and with additional research to determine the costs of community services and other relevant classes of costs not counted here.

Current Economic Conditions in the Study Region

[6] Passive-use values include *option* value, or the value of preserving a resource unimpaired for one's potential future use; *bequest* value, which is the value to oneself of preserving the resource for the use of others, particularly future generations; and *existence* value, which is the value to individuals of simply knowing that the resource exists, absent any expectation of future use by oneself or anyone else. In the case of the ACP, people who have not yet, but who may intend, to travel the Blue Ridge Parkway or attend the Highland Maple festival are better off knowing that the setting for activities is a beautiful aesthetically pleasing landscape. What such visitors would be willing to pay to maintain that possibility would be part of the "option value" of an ACP-free landscape.

[7] As in communities impacted by the shale gas boom itself, communities along the pipeline can expect spikes in crime as transient workers come and go, more damage to roads under the strain of heavy equipment, increases in physical and mental illnesses including asthma, depression, anxiety, and others triggered by exposure to airborne pollutants, to noise, and to emotional, economic, and other stress. See, for example, Ferrar et al. (2013), Healy (2013), Fuller (2007), Campoy (2012), and Mufson (2012).

Our geographic focus is a four-county region comprising Highland, Augusta,[8] Nelson, and Buckingham Counties in Virginia. This 2,480 square-mile region supports diverse land uses, from some of Virginia's wildest forests, the iconic Shenandoah Valley, the heart of Virginia's Blue Ridge traversed by both the Appalachian Trail and Blue Ridge Parkway, thriving cities, international retreat centers, historically and culturally significant human settlements, working farms, and extensive commercial timberland. These natural, cultural, and economic assets are among the reasons more than 150,000 people call this region home and an even larger number visit each year for skiing, sightseeing, music and maple festivals, spiritual retreats, weddings, wine tastings, brewery tours, and other pursuits.

Statistics from the Center for the Study of Rural America, part of the Federal Reserve Bank of Kansas City, further reveal the extent to which the region has the right conditions for resilience and economic success in the long run (Low 2004). These data show that the study region has a higher human amenity index (based on scenic amenities, recreational resources, and access to health care), more financial wealth in the form of investment income per capita, and stronger entrepreneurship than most Virginia counties (Figure 2).[9]

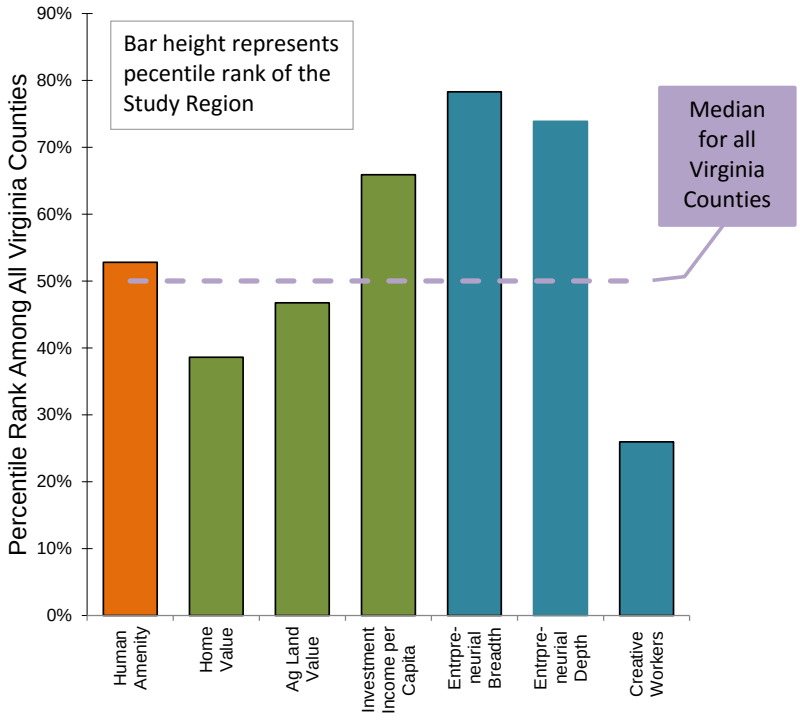

FIGURE 2: Regional Asset Indicators for the Study Region, Relative to All Virginia Counties (Source: Federal Reserve Bank of Kansas City)

More traditional measures of economic performance suggest the region is strong and resilient. From 2000 through 2014, for example:

- Population in the study region grew by 8.5%, compared to a 0.2% loss of population for non-metro Virginia[10]

[8] Two independent cities, Staunton and Waynesboro, lie within the geographic borders of Augusta County. In this report, subject to some limitations where noted, statistics, estimates, and other information labeled as "Augusta County" reflect totals for the County plus the two independent cities.

[9] Note that the Fed's statistics have not been updated since 2004-2006, and conditions in and outside the study region have undoubtedly changed. Some of these relative rankings may no longer hold.

[10] "Non-metro Virginia" comprises those counties that are not a part of a federally defined metropolitan statistical area (MSA). While Augusta is part of the Staunton-Waynesboro-Augusta MSA and Nelson and Buckingham are part of the Charlottesville MSA, each of the study region counties are predominantly rural in landscape and character and are much more like other non-metro counties than they are like Northern Virginia or Tidewater. Therefore, we believe that averages

- Employment grew by 6.3%, compared to a drop of 6.7% for non-metro Virginia
- Personal income grew by 23.8%, compared to 13.1% for non-metro Virginia
- Earnings per job are higher, by about $2,400/year, than the average for non-metro Virginia
- Per capita income is higher, by $4,000/year, than the average for non-metro Virginia
- Unemployment grew by less and ended the period two points lower than the average for non-metro Virginia.[11]

These and other trends indicate not only that the region has been doing quite well, but also that it is doing well with, and perhaps because of, a relative absence of industrial development like the ACP. The region has what regional economists McGranahan and Wojan have called the "Rural Growth Trifecta" of outdoor amenities, a creative class of workers, and a strong "entrepreneurial context" (innovation-friendliness) (2010). Individual workers, retirees, and visitors are attracted to the natural beauty of the region while entrepreneurs are attracted by the quality of the environment, by the quality of the workforce, and by existing support from local government. Workers, for their part, are retained and nurtured by dynamic businesses that fit with the landscape and lifestyle that attracted them in the first place.

As four further indicators of this dynamic, consider since 2000:

- The region's population growth has been primarily due to in-migration
- The proportion of the population 65 years and older has increased from 15.0% to 17.6%
- Proprietors' employment is up by 28.1%
- Non-labor income (primarily investment returns and age-related transfer payments like Social Security) is up by 45.8%.[11]

These trends suggest that entrepreneurs and retirees are moving to (or staying in) this region. They bring their income, their expertise, and their job-creating energy with them.

Temporary residents – tourists and recreationists – are also an important part of the region's economy. Tourists spent more than $413 million in the study region in 2014. The companies that directly served those tourists employed 3,866 people, or 4.9% of all full- and part-time workers (Headwaters Economics, 2015; Virginia Tourism Corporation, 2015).

It is in this context the potential economic impacts of the ACP must be weighed and the apprehension of the region's residents understood. The region has been doing quite well on the strength of its amenities and quality of life. Many believe the construction and operation of the pipeline will kill or at least dampen the productivity of the proverbial goose that lays its golden eggs in the region. This could result in a slower rate of growth, which would mean worse economic outcomes than would be expected with a continued absence of a pipeline. For example, if the pipeline is built, business groups

for non-metro Virginia provide a more appropriate point of comparison than statistics that include the Commonwealth's more urban areas.

[11] These data are from Headwaters Economics (2015), US Bureau of Economic Analysis (2015), and US Bureau of the Census (2014, 2015).

Friends of Wintergreen and Nelson 151 identified $75 million in foregone investments and between 200 and 300 new employees who will not be hired (Theiss, 2015). These businesses, which depend on the scenic and other amenities noted above, would simply not have enough business in the form of visitors, diners, skiers, golfers, and others to justify their now-on-hold expansions and new developments.

More dire is the prospect that such businesses will not be able to maintain their current levels of employment. Just as retirees and many business can choose where to locate, visitors and potential visitors have practically unlimited choices for places to spend their vacation time and expendable income. If the study region loses its amenity edge, other things being equal, people will go elsewhere, and this region could contract.

> ***"Whether they are seeking a retirement home or a weekend retreat, people choose Highland county BECAUSE it doesn't have what people have in other places—over-development, noise, traffic or pollution. They want to get away from all that and be where they can enjoy the peace and beauty of the natural landscape. For my clients, the viewshed, along with the previously mentioned attributes, was a critical driving factor in where they would purchase."***
>
> *– Fran Davenport, retired Realtor*
> *Monterey, Virginia*

Instead of a "virtuous circle" with amenities and quality of life attracting/retaining residents and visitors, who improve the quality of life, which then attracts more residents and visitors, the ACP could tip the region into a downward spiral. In that scenario, loss of amenity and risk to physical safety would translate into a diminution or outright loss of the use and enjoyment of homes, farms, and recreational and cultural experiences. Potential in-migrants would choose other locations and some long-time residents would move away, draining the region of some of its most productive members. Homeowners would lose equity as housing prices follow a stagnating economy. With fewer people to create economic opportunity, fewer jobs and less income will be generated. Communities could become hollowed out, triggering a second wave of amenity loss, out-migration, and further economic stagnation.

ENVIRONMENTAL-ECONOMIC EFFECTS AND WHERE THEY WOULD OCCUR

In the remainder of this report, we follow this potential cycle and estimate three distinct types of economic consequences.

First, corresponding to the direct biophysical impacts of the proposed pipeline, are effects on ecosystem services – the benefits nature provides to people for free, like purified water or recreational opportunities, that will become less available and/or less valuable due to the ACP's construction and operation. Second are effects on property value as owners and would-be owners choose properties farther from the pipeline's right-of-way, evacuation zone, viewshed, or, in the case of the compressor station, noise. Third and finally are more general economic effects caused by a dampening of future growth prospects or even a reversal of fortune for some industries.

We begin with an exploration of the geographic area over which these various effects will most likely be felt.

Impact Zones within the Study Region

Construction of the pipeline corridor itself would require clearing an area 125 feet (38.1 m) wide in most areas and 75 feet (22.9 m) wide in wetlands. After construction, the permanent right-of-way (ROW) would be 75 feet wide along the entire length of the pipeline. It is from within this construction zone and right-of-way that the greatest disruption of ecosystem processes will occur, so it is from these zones that reductions in ecosystem service value (ESV) will emanate. Since we are estimating ecosystem service values at their point of origin, we will focus on this zone in that analysis below. The value of land crossed by the ROW and the somewhat larger number of parcels crossed by the construction zone will be acutely affected.

Operated at its intended pressure and due to the inherent risk of leaks and explosions, the pipeline would present the possibility of having significant human and ecological consequences within a large "High Consequence Area" and an even larger evacuation zone. A High Consequence Area (HCA) is "the area within which both the extent of property damage and the chance of serious or fatal injury would be expected to be significant in the event of a rupture failure (Stephens, 2000, p. 3)." Using Stephens' formula, the HCA for this pipeline would have a radius of 1,092 feet (332.8 m). The evacuation zone is defined by the distance beyond which an unprotected human could escape burn injury in the event of the ignition or explosion of leaking gas (Pipeline Association for Public Awareness, 2007, p. 29). There would be a potential evacuation zone with a radius of 3,583 feet (1092.1 m).[12] An explosion would definitely affect ecosystem processes within the HCA, but given the probability of an explosion at any given point along the pipeline at a given time is small, we do not include effects *on ecosystem service value* in this zone in our cost estimates.

Effects on land value are another matter, and it is reasonable to consider land value impacts through both the high consequence area and the evacuation zone. As Kielisch (2015) stresses, the value of land is determined by human perception, and property owners and would-be owners have ample reason to perceive risk to property near high-pressure natural gas transmission pipelines. Traditional news reports, YouTube, and other media reports attest to the occurrence and consequences of pipeline leaks and explosions, which are even more prevalent for newer pipelines than for those installed decades ago (S. Smith, 2015). Information about pipeline risks translates instantly into buyers' perceptions and, therefore, into the chances of selling a property exposed to those risks, into prices offered for those properties, and, for people who already own such properties, into diminished enjoyment of them.

Along similar lines, 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

[12] See the map (Figure 3) which includes a close-up of these zones near the Augusta-Nelson County line.

much as 50%," 2015). For the estimates of property value effects below, we consider just those properties within one half mile of the proposed compressor station in Buckingham County. Because this zone overlaps the ROW and the evacuation zone, and because we assume that the more acute and ever present effect of proximity to the compressor station would dominate all other effects, we ignore the ROW and evacuation zone effects for these properties.

In addition, loss of view quality would be expected for properties both near to and far from the pipeline corridor. Unlike leaks and explosions, view quality impacts will occur with certainty. If the pipeline is built, people will see the corridor as a break in a once completely forested hillside, and their

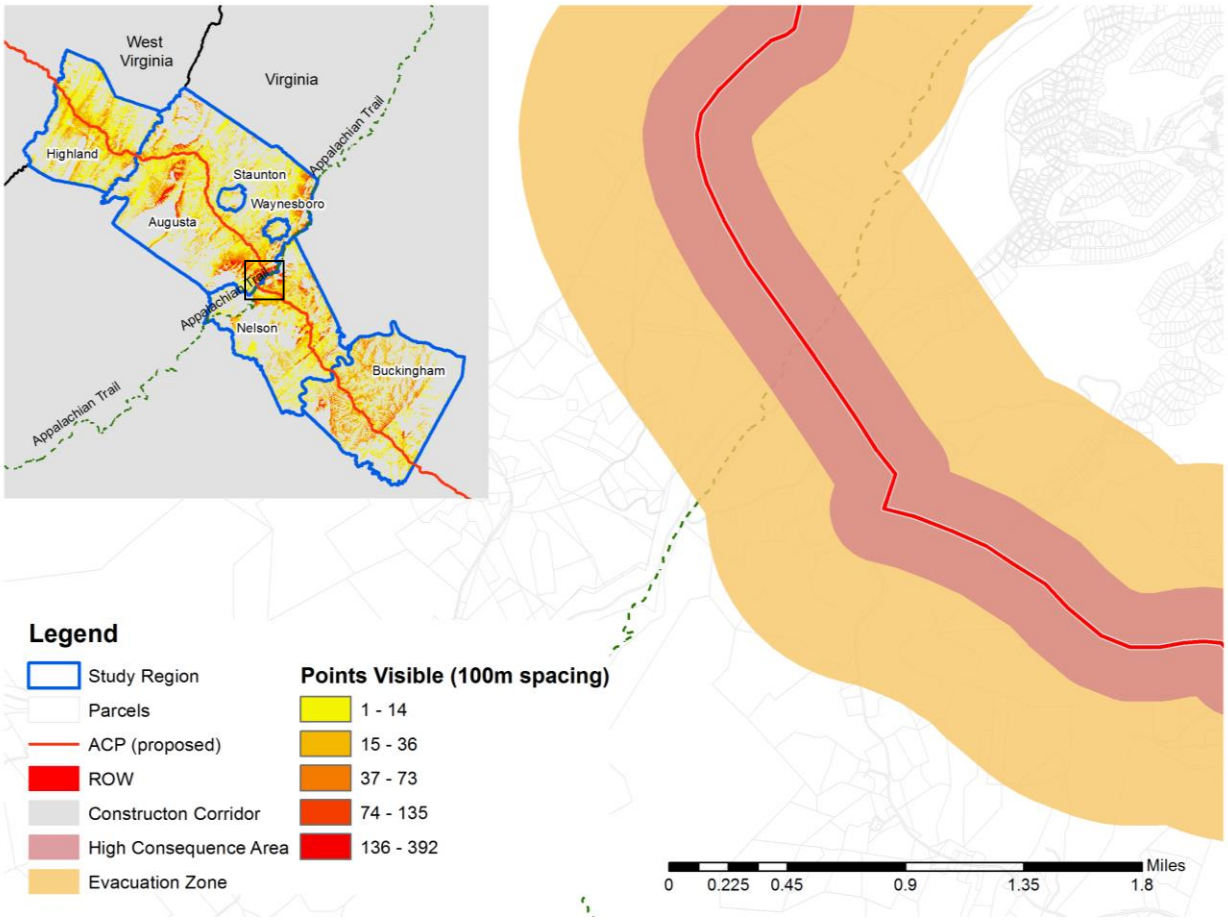

FIGURE 3: Study Region Showing Affected Viewsheds (Inset) and Parcels in Right-of-Way, Construction, High Consequence, and Evacuation Areas.

Sources: ACP route digitized from interactive map, Dominion Resources Inc. (http://dom.maps.arcgis.com/); National Map Study Region (counties) from USGS (http://nationalmap.gov/small_scale/), and Appalachian Trail from the Appalachian Trail Conservancy (http://www.appalachiantrail.org/).

"million-dollar" view will be diminished. Therefore, for our analysis of land value below, we consider any place where there is considerable potential to see the pipeline corridor to be within its direct impact zone.

Beyond the loss of ecosystem services stemming from the conversion of land in the ROW and the loss of property value resulting from the chance of biophysical impacts or the certainty of impacts on

aesthetics, the proposed ACP would also diminish physical ecosystem services, scenic amenity, and passive-use value that are realized or enjoyed beyond the evacuation zone and out of sight of the pipeline corridor. The people affected include residents, businesses, and landowners throughout the study region, as well as past, current, and future visitors to the region. The impacts on human well-being would be reflected in economic decisions such as whether to stay in or migrate to the study region, whether to choose the region as a place to do business, and whether to spend one's scarce vacation time and dollars near the ACP instead of in some other place.

To the extent the ACP causes such decisions to favor other regions, less spending and slower economic growth in the study region would be the result. One would expect a secondary effect of that slower growth on land values, but in this study we consider the primary effects in terms of slower population, employment, and income growth in key sectors. Table 2 summarizes the types of economic values considered in this study and the zones in which they are estimated.

One would also expect economic development effects to spill beyond the county boundaries that define our study region. For example, the Satchidananda Ashram - Yogaville attracts thousands of visitors to the region each year (5,642 in 2014; 3,687 through early August, 2015) from around the world. Based on its own survey of past visitors, leaders there anticipate visits will decrease drastically, perhaps catastrophically if the ACP is built near its campus in Buckingham County. Most of its students, instructors, and other visitors come from out of state, so fewer visits to Yogaville will mean, for example, fewer flights into Charlottesville-Albemarle airport, fewer car rentals, and perhaps fewer side excursions to Monticello or extended stays in the wider region. Such negative economic effects of the pipeline would be felt in Charlottesville and Albemarle County and would be in addition to the direct effects felt by Yogaville and/or within the immediate study region.

The same dynamic would play out if, as business leaders fear, people from outside the study region make fewer trips to Wintergreen for skiing, attend fewer wine tastings or concerts in the Rockfish Valley, skip a stay in the Shenandoah Valley, or make fewer return visits to the Highland Maple festival.

We do not include those outside-the-region effects in the current study. This is a matter of study scoping and budget only, and should not be construed as a suggestion that these and other impacts cease at the Buckingham-Albemarle County line or any other study region boundary. The effects we do include are enumerated and estimated in more detail in the following sections. To recap before proceeding, Table 2 summarizes the geographic extent of the values and analyses included as well as those that should be considered as part of FERC's research agenda to gain an even more complete picture of the proposed ACP's economic effects.

TABLE 2: Geographic Scope of Effects.
A check mark Indicates those zones/effects for which estimates are Included in this study. The "X's" indicate areas for future study.

Values / Effects	Right-of-Way and Construction Zone	High Consequence Area	Evacuation Zone	Com-pressor Station Zone	Pipeline Viewshed	Entire Study Region	The World Beyond the Study Region
Ecosystem Services	✓	a	a		a	✗[a,b]	✗
Land / Property Value	✓[c]	✓[d]	✓[d]	✓	✓[e]	✗	n/a
Economic Develop-ment Effects	f	f	f	f	f	✓	n/a

Notes:

a. Changes in ecosystem services that are felt beyond the ROW and Construction zone may be key drivers of "Economic Development Effects," but they are not separately estimated to avoid double counting.
b. With the exception of the impact on visual quality, we do not estimate the spillover effects of alteration of the ecosystem within the ROW on the productivity of adjacent areas. The ROW, for example provides a travel corridor to invasive species that could reduce the integrity and ecosystem productivity of areas that, without the ACP would remain core ecological areas, interior forest habitat, etc.
c. We estimate land value effects for the ROW but not for the construction zone.
d. Properties in the HCA are treated as though there is no additional impact on property value relative to the impact of being in the evacuation zone. Also, we exclude properties in the compressor station zone from estimates of impacts related to the ROW and the evacuation zone. The reason is that while the compressor station's effects on land value may be similar (that is, they are driven by health and safety concerns and possible loss of use), they are both more acute and more certain. (Noise and air emissions from the compressor stations will be routine, while leaks from the pipeline should be rare.) We assume that the ongoing effects of the compressor station on use and enjoyment of properties nearby would overshadow or dominate the possibility of a high-consequence event or the need to evacuate.
e. To avoid double-counting, changes in property value due to an altered view from the property are considered to be part of lost aesthetic value under the heading of ecosystem services.
f. Economic development effects related to these subsets of the study region are included in estimates for the study region.

EFFECTS ON ECOSYSTEM SERVICE VALUE

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, 2003). "Benefits people obtain from ecosystems" is perhaps the simplest and most commonly heard definition of ecosystem services (Reid et al., 2005). Other definitions abound, including the following from Gary Johnson of the University of Vermont. It is helpful both because it emphasizes that services are not necessarily things–tangible bits of nature–but rather, they are the effects on people of the functions of bits of nature:

> Ecosystem services are the effects on human well-being of the flow of benefits from an ecosystem endpoint to a human endpoint at a given extent of space and time (2010).

This definition also makes clear that ecosystem services happen or are produced and enjoyed in particular places and at particular times.

No matter the definition, different types of ecosystems (forest, wetland, cropland, urban areas) produce different arrays of ecosystem services, and/or they produce similar services to greater or lesser degrees. Certain ecosystems or land uses simply produce a higher flow of benefits than others.

"Ecosystem services" is sometimes lengthened to "ecosystem goods and services" to make it explicit that some are tangible, like physical quantities of food, water for drinking, and raw materials, while others are truly services, like cleaning the air and providing a place with a set of attributes that are conducive to recreational experiences or aesthetic enjoyment. We use the simpler "ecosystem services" here. Table 3, lists the provisioning, regulating, and cultural ecosystem services included in this study.

At a conceptual level, we estimate the potential effects of the ACP on ecosystem service value by identifying the extent to which the construction and longer-term existence of the pipeline would change land cover or land use, which in turn results in a change in ecosystem productivity. Construction would essentially strip bear the 125-foot-wide construction corridor. Once construction is complete and after some period of recovery, the 75-foot-wide right-of-way will be

Ecosystem Service Impacts 1: Water Supply

Currently the Cowpasture River Valley in Highland County enjoys naturally clean water thanks to environmental filtration. However, if the ACP is built any contamination that it causes through erosion, sedimentation, or spills would carry high costs.

For a domestic well, a landowner would face an estimated out-of-pocket expense of $35,000 or more to drill into a potable aquifer. For a livestock operation, which needs more water, a contaminated aquifer would be even worse. Dairies and ranches in the Cowpasture River Valley that need to replace their water supply would face an estimated cost of $50,000, and they would need an emergency supply of 20,000 gallons daily. If a city or town must replace a municipal water supply that becomes contaminated, the costs are even higher; it would take an estimated out-of-pocket cost of $2.5 million to complete geophysical, hydrological, and engineering studies, purchase land, drill a well, and build the necessary surrounding infrastructure.

-Nelson Hoy, Cowpasture River Preservation Association

TABLE 3: Ecosystem Services Included in Valuation

Provisioning Services[a]
Food Production: The harvest of agricultural produce, including crops, livestock, and livestock by-products; the food value of hunting, fishing, etc.; and the value of wild-caught and aquaculture-produced fish. **Associated land uses**[b]**:** Cropland, Pasture/Forage, Forest
Raw Materials: Fuel, fiber, fertilizer, minerals, and energy. **Associated land uses**[b]**:** Forest
Water Supply: Filtering, retention, storage, and delivery of fresh water—both quality and quantity—for drinking, irrigation, industrial processes, hydroelectric generation, and other uses. **Associated land uses**[b]**:** Forest, Water, Wetland
Regulating Services[a]
Air Quality: Removing impurities from the air to provide healthy, breathable air for people. **Associated land uses**[b]**:** Shrub/Scrub, Forest, Urban Open Space
Biological Control: Inter- and intra-specific interactions resulting in reduced abundance of species that are pests, vectors of disease, or invasive in a particular ecosystem. **Associated land uses**[b]**:** Cropland, Pasture, Grassland, Forest
Climate Regulation: Storing atmospheric carbon in biomass and soil as an aid to the mitigation of climate change, and/or keeping regional/local climate (temperature, humidity, rainfall, etc.) within comfortable ranges. **Associated land uses**[b]**:** Pasture/Forage, Grassland, Shrub/Scrub, Forest, Wetland, Urban Open Space, Urban Other
Erosion Control: Retaining arable land, stabilizing slopes, shorelines, riverbanks, etc. **Associated land uses**[b]**:** Cropland, Pasture/Forage, Grassland, Shrub/Scrub, Forest
Pollination: Contribution of insects, birds, bats, and other organisms to pollen transport resulting in the production of fruit and seeds. May also include seed and fruit dispersal. **Associated land uses**[b]**:** Cropland, Pasture/Forage, Grassland, Forest
Protection from Extreme Events: Preventing and mitigating impacts on human life, health, and property by attenuating the force of winds, extreme weather events, floods, etc. **Associated land uses**[b]**:** Forests, Urban Open Space, Wetland
Soil Fertility: Creation of soil, inducing changes in depth, structure, and fertility, including through nutrient cycling. **Associated land uses**[b]**:** Cropland, Pasture/Forage, Grassland, Forest
Waste Treatment: Improving soil and water quality through the breakdown and/or immobilization of pollution. **Associated land uses**[b]**:** Cropland, Pasture/Forage, Grassland, Shrub/Scrub, Forest, Water, Wetland
Water Flows: Regulation by land cover of the timing of runoff and river discharge, resulting in less severe drought, flooding, and other consequences of too much or too little water available at the wrong time or place. **Associated land uses**[b]**:** Forests, Urban Open Space, Urban Other
Cultural Services[a]
Aesthetic Value: The role that beautiful, healthy natural areas play in attracting people to live, work, and recreate in a region. **Associated land uses**[b]**:** Forest, Pasture/Forage, Urban Open Space, Wetland
Recreation: The availability of a variety of safe and pleasant landscapes—such as clean water and healthy shorelines—that encourage ecotourism, outdoor sports, fishing, wildlife watching, etc. **Associated land uses**[b]**:** Cropland, Forest, Water, Wetland, Urban Open Space, Urban Other

Notes:

a. Descriptions follow Balmford (2010, 2013), Costanza et al. (1997), Reid et al. (2005), and Van der Ploeg, et al. (2010).

b. "Associated Land Uses" are limited to those for which per-unit-area values are available in this study.

occupied by a different set of ecosystem (land cover) types than were present before construction. By applying per-acre ecosystem service productivity estimates (denominated in dollars) to the various arrays of ecosystem service types, we can estimate ecosystem service value before, during, and after construction. The difference between ecosystem service value during construction and before construction is the cost during construction. The difference between the ecosystem service value during ongoing operations (i.e., the value produced in the ROW) and the before-construction baseline is the annual ecosystem service cost that will be experienced indefinitely.

This overall process is illustrated in Figure 4 and the details of our methods, assumptions, and calculations are described in the following two sub sections.

Ecosystem Service Estimation Methods

Economists have developed widely used methods to estimate the dollar value of ecosystem services and/or natural capital. The most widely known example was a study by Costanza et al. (1997) that valued the natural capital of the entire world. That paper and many others since employ the "benefit transfer method" or "BTM" to establish a value for the ecosystem services produced or harbored from a particular place.[13] According to the Organization for Economic Cooperation and Development, BTM is "the bedrock of practical policy analysis," particularly in cases such as this when collecting new primary data is not feasible (OECD, 2006).

As the name implies, BTM takes a rate of ecosystem benefit delivery calculated for one or more "source areas" and applies that rate to conditions in the "study area." As Batker et al. (2010) state, the method is very much like a real estate appraiser using comparable properties to estimate the market value of the subject property. It is also very much like using an existing or established market or regulated price, such as the price of a gallon of water, to estimate the value of some number of gallons of water supplied in some period of time. The key is to select "comps" (data from source areas) that match the circumstances of the study area as closely as possible.

Typically, values are drawn from previous studies that estimate the value of various ecosystem services from similar land cover or ecosystem types. Also, it is benefit (in dollars) per-unit-area-per-year in the source area that is transferred and applied to the number of hectares or acres in the same land cover/biome in the study area. So, for example, if data for the source area includes the value of forest land for recreation, one would apply per-acre values from the source area's forest to the number of acres of forestland in the study area. Furthermore, it is important to use source studies that are from regions with underlying economic, social, and other conditions similar to the study area.

Following these principles as well as techniques developed by Esposito et al. (2011), Esposito (2009), and Phillips and McGee (2014, 2016), and as illustrated in Figure 4, we employ a four-step process to evaluate the short-term and long-term effects of the ACP on ecosystem service value in our study region. The steps are described in greater detail below, but in summary, they are:

[13] See also Esposito et al. (2011), Flores et al. (2013), and Phillips and McGee (2014) for more recent examples.

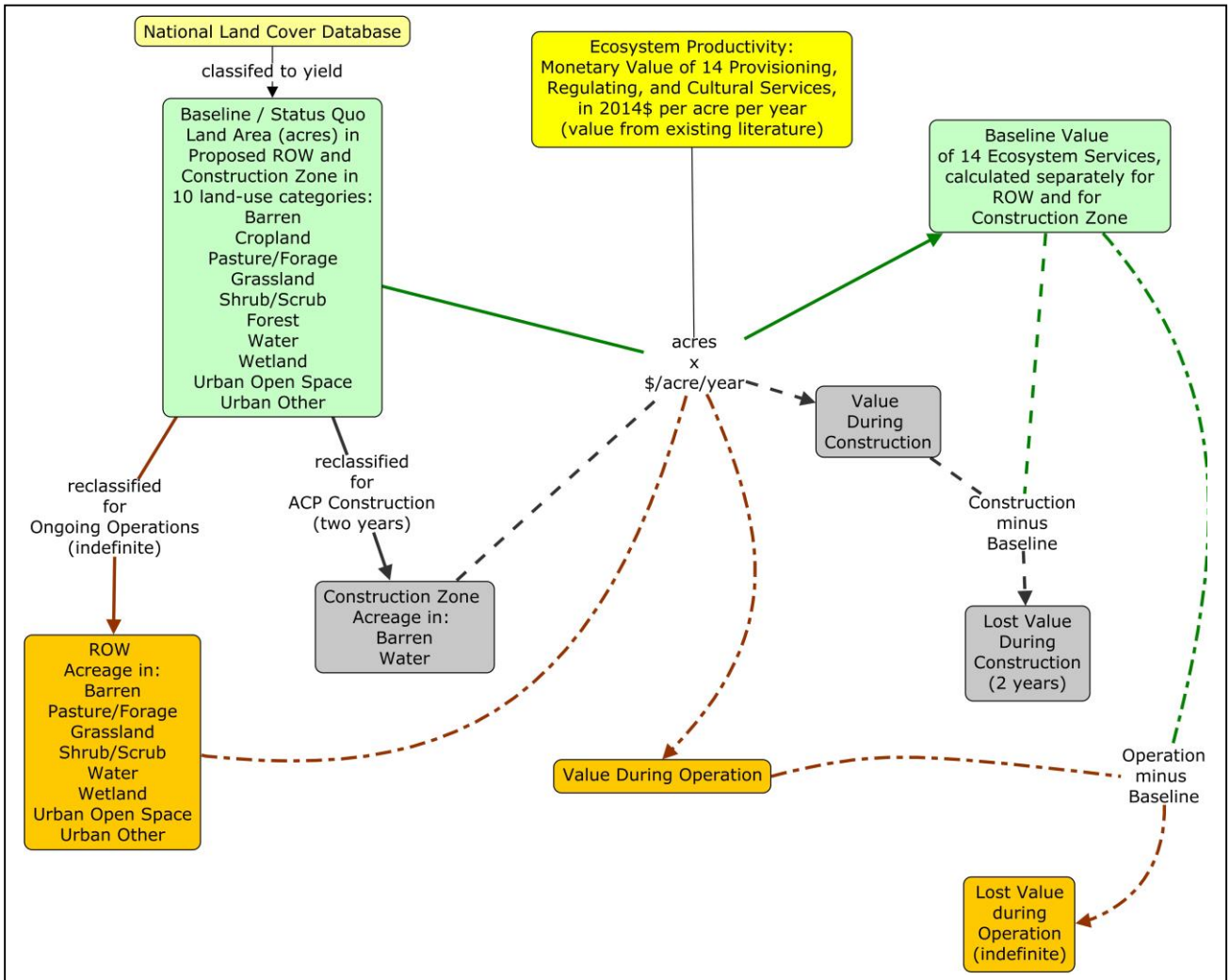

FIGURE 4: Ecosystem Service Valuation Concept Map
Follow the green lines to baseline (without ACP) ecosystem service value. Grey dashed lines show the path to ecosystem service value during construction. Brown dashed lines lead to values during ongoing operation. Differences between construction and operations value and the baseline yield estimates of the cost of the ACP in terms of ecosystem services forgone.

1. Assign land and water in the study to one of 10 land uses based on remotely sensed (satellite) data in the National Land Cover Dataset (NLCD) (Fry et al., 2011). This provides the array of land uses for estimating baseline or "without ACP" ecosystem service value.

2. RE-assign or re-classify land and water to what the land cover would most likely be during construction and during ongoing operation.

3. Multiply acreage by per-acre ecosystem service productivity (the "comps") to obtain estimates of aggregate ecosystem service value under the baseline/no ACP scenario, for the construction corridor (and period), and for the ROW during ongoing operation.

   For simplicity and given the two-year construction period, we assume that the construction

corridor will remain barren for a full two-year period. We recognize that revegetation will begin to occur soon after the trench is closed and fill and soil are returned, but it will still be some time until something like a functioning ecosystem has actually been restored.

4. Subtract baseline ESV from ESV for the construction period (and in the construction corridor) and from ESV during ongoing operations (in the ROW) to obtain estimates of the ecosystem service costs imposed annually during the construction and operations period, respectively.

Step 1: Assign Land to Ecosystem Types or Land Uses

The first step in the process is to determine the area in the 10 land use groups in the study region. This determination is made using remotely sensed data from the National Land Cover Database (NLCD) (Fry et al., 2011). Satellite data provides an image of land in one of up to 21 land cover types at the 30-meter level of resolution;[14] 15 of these land cover types are present in the study region (Table 4).

Looking forward to the final step, we will use land use categories to match per-acre ecosystem value estimates from source areas to the four-county study region. Unfortunately, there are not value estimates for all of the detailed land use categories present in the region. We therefore simplify the NLCD classification by combining a number of classifications into larger categories for which per-acre values are more available. Specifically, low-, medium-, and high-intensity development are grouped as "urban other," and deciduous, evergreen, and mixed forest are grouped as "forest."

In addition, we add land in the NLCD category of "woody wetlands" to the "forest" category for two reasons. The first is that, left to their devices, such wetlands would normally become forest in the study region. Second, wetlands have some of the highest per-acre values for several ecosystem services. So, to avoid over-estimating the ecosystem services contribution of "woody wetlands," we count them as "forest" instead of "wetland".

In the end, at least for baseline conditions, we have land in 10 land uses. The total area that would be disturbed in the construction corridor through the study region is 1,900 acres,[15] and 1,140 acres would be occupied by the permanent right-of-way. Tables 5 and 6 show acreage in the land cover types across the four counties in the study region.

[14] Because 30 meters is wider than the right-of-way and not much narrower than the 125-foot construction corridor, we resample the NLCD data to 10m pixels, which breaks each 30m-by-30m pixel into 9 10m-by-10m pixels. This allows for a closer approximation of the type and area of land cover in the proposed ROW and construction corridor.

[15] Note that these are minimum estimates of the land that would be taken during construction and for ongoing operations. Not counted in these totals are staging areas, temporary or permanent access roads, and the footprint of any infrastructure, such as the compressor station proposed to be sited in Buckingham County. Consequently (and in addition to other minimizing factors) the estimates of ecosystem service cost of the ACP will likely be much smaller than what would be experienced if the ACP were to be built and operated.

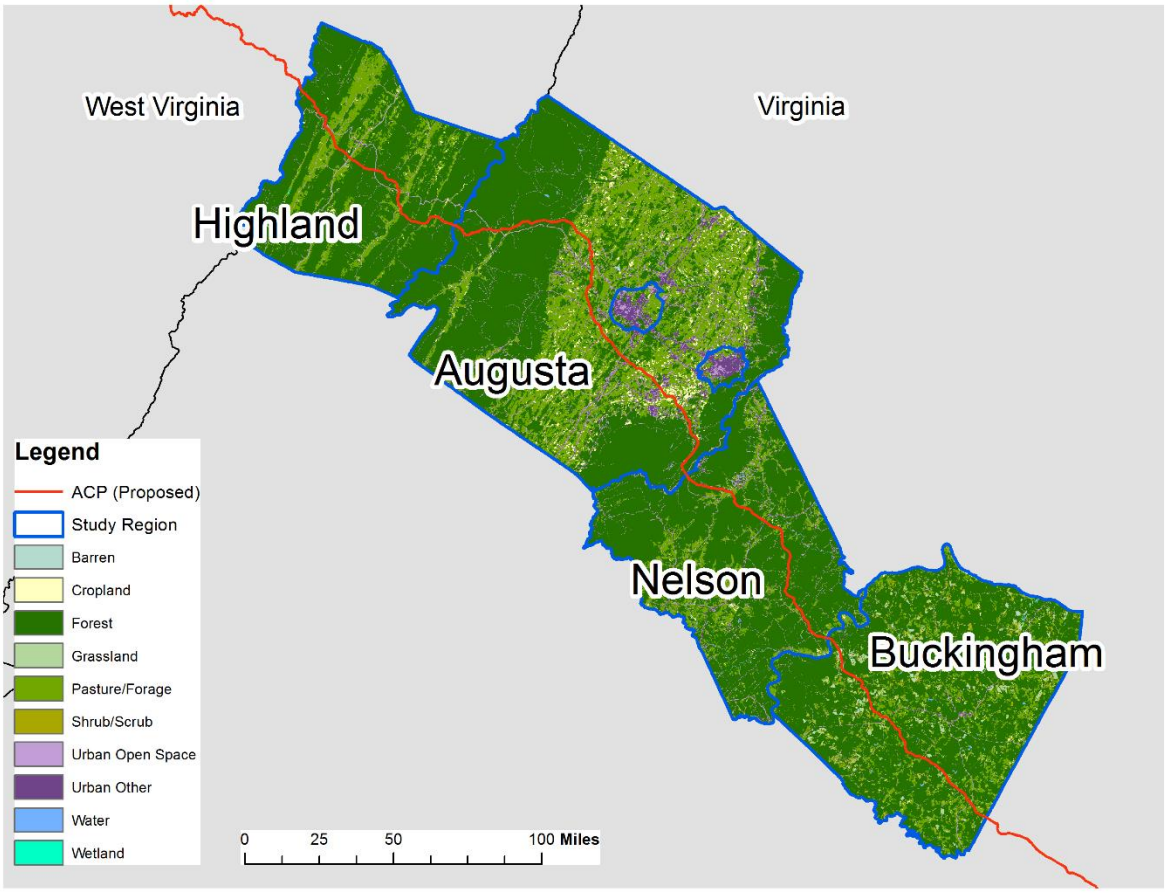

FIGURE 5: Land Use in the Study Region, Classified for Ecosystem Service Valuation
Land cover for the entire study region is shown to display the overall range and pattern of land use. The ecosystem service valuation itself covers only those portions of the study region that would be occupied by the ACP right-of-way and construction corridor.
Source: National Land Cover Database (Fry, et al. 2011).

Step 2: Re-assign Acreage to New Land Cover Types for the Construction and Operation Periods

Table 4 lists the reassignment assumptions in detail, but in general, we assume that all land in the construction corridor will be "barren" or at least possess the same ecosystem service productivity profile as naturally-occurring barren land for the duration of the construction period. Water will remain water during construction.

TABLE 4: Land Cover Reclassification

NLCD Category	Reclassification for Baseline	Reclassification for Construction	Reclassification for Ongoing Operation
Barren Land	Barren	Barren	Barren
Cultivated Crops	Cropland	Barren	Pasture/Forage
Pasture/Hay	Pasture/Forage	Barren	Pasture/Forage
Grassland/Herbaceous	Grassland	Barren	Grassland
Shrub/Scrub	Shrub/Scrub	Barren	Shrub/Scrub
Deciduous Forest	Forest	Barren	Shrub/Scrub
Evergreen Forest	Forest	Barren	Shrub/Scrub
Mixed Forest	Forest	Barren	Shrub/Scrub
Woody Wetlands	Forest	Barren	Shrub/Scrub
Open Water	Water	Water	Water
Emergent Herbaceous Wetlands	Wetland	Barren	Wetland
Developed, Open Space	Urban Open Space	Barren	Urban Open Space
Developed, Low Intensity	Urban Other	Barren	Urban Other
Developed, Medium Intensity	Urban Other	Barren	Urban Other
Developed, High Intensity	Urban Other	Barren	Urban Other

For the indefinite period following construction—during ongoing operations—we assume that pre-ACP forestland will become shrub/scrub, and cropland will become pasture/forage. We recognize that some pre-ACP cropland may be used for crops after construction has been completed, but as expressed in comments to FERC and elsewhere and as we discovered through personal interviews with agricultural producers in the region, it seems likely that the ability to manage acreage for row crops will be greatly curtailed, if not eliminated entirely by the physical limits imposed by the ACP and by restrictions in easements to be held by ACP LLC. These include limits on the weight of equipment that could cross the corridor at any given point and difficulty using best soil conservation practices, such as tilling along a contour, which may be perpendicular to the pipeline corridor. (This would require extra time and fuel use that could render some fields too expensive to till, plant, or harvest.) Reclassifying cropland as pasture/forage (which is generally less productive of ecosystem services) recognizes these effects while also recognizing that some sort of future agricultural production in the ROW (grazing and possibly haying) could be possible.

An additional effect not captured in our methods is 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, “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]." Thus the true loss in food and other ecosystem service value from pasture/forage acreage would be larger than our estimates reflect.

TABLE 5: Acreage in Proposed Construction Corridor, by Land Cover and County, Baseline and in "With ACP" Scenario

Land Cover Classification	Highland		Augusta		Nelson		Buckingham	
	Baseline	*w/ ACP*	*Baseline*	*w/ ACP*	*Baseline*	*w/ ACP*	*Baseline*	*w/ ACP*
Barren	0.0	386.0	0.3	708.1	-	395.9	12.6	409.0
Cropland	3.5	-	37.9	-	2.1	-	0.3	-
Pasture/Forage	76.4	-	249.0	-	35.2	-	52.4	-
Grassland	-	-	-	-	-	-	26.5	-
Shrub/Scrub	-	-	-	-	-	-	13.2	-
Forest	293.5	-	386.6	-	345.7	-	297.1	-
Water	0.2	0.2	-	-	0.8	0.8	0.4	0.4
Wetland	-	-	-	-	0.3	-	-	-
Urban Open Space	12.6	-	31.7	-	11.6	-	6.6	-
Urban Other	-	-	2.6	-	1.1	-	0.2	-
Total	**386.2**	**386.2**	**708.1**	**708.1**	**396.7**	**396.7**	**409.4**	**409.4**

TABLE 5: Continued

Land Cover Classification	Study Region	
	Baseline	*w/ ACP*
Barren	12.9	1,899.0
Cropland	43.8	-
Pasture/Forage	413.0	-
Grassland	26.5	-
Shrub/Scrub	13.2	-
Forest	1,322.9	-
Water	1.3	1.3
Wetland	0.3	-
Urban Open Space	62.5	-
Urban Other	3.8	-
Total	**1,900.3**	**1,900.3**

TABLE 6: Acreage in Proposed Right-of-Way, by Land Cover and County, Baseline and in "with ACP" Scenario

Land Cover Classification	Highland		Augusta		Nelson		Buckingham	
	Baseline	*w/ ACP*	*Baseline*	*w/ ACP*	*Baseline*	*w/ ACP*	*Baseline*	*w/ ACP*
Barren	-	-	0.0	0.0	-	-	7.5	7.5
Cropland	2.0	-	23.2	-	1.2	-	0.2	-
Pasture/Forage	46.1	48.1	148.8	172.1	20.8	22.0	31.2	31.4
Grassland	-	-	-	-	-	-	16.3	16.3
Shrub/Scrub	-	176.4	-	233.0	-	207.6	7.7	185.9
Forest	176.4	-	233.0	-	207.6	-	178.2	-
Water	0.1	0.1	-	-	0.5	0.5	0.2	0.2
Wetland	-	-	-	-	0.2	0.2	-	-
Urban Open Space	7.7	7.7	18.4	18.4	6.8	6.8	4.1	4.1
Urban Other	-	-	1.5	1.5	0.6	0.6	0.1	0.1
Total	**232.3**	**232.3**	**425.0**	**425.0**	**237.8**	**237.8**	**245.5**	**245.5**

TABLE 6: Continued

Land Cover Classification	Study Region	
	Baseline	*w/ ACP*
Barren	7.6	7.6
Cropland	26.7	-
Pasture/Forage	246.9	273.6
Grassland	16.3	16.3
Shrub/Scrub	7.7	802.9
Forest	795.2	-
Water	0.8	0.8
Wetland	0.2	0.2
Urban Open Space	37.0	37.0
Urban Other	2.2	2.2
Total	**1,140.5**	**1,140.5**

Step 3: Multiply Acreage by Per-Acre Value to Obtain ESV

After obtaining acreage by land use in the construction corridor and the ROW, we are ready to multiply those acres times per-acre-per-year ecosystem service productivity to obtain total ecosystem service value in each area and for with- and without-pipeline scenarios. Per-acre ecosystem service values are obtained primarily from a database of more than 1,300 estimates compiled as part of a global study known as "The Economics of Ecosystems and Biodiversity" or "the TEEB" (Van der Ploeg et al., 2010).[16]

[16] Led by former Deutsche Bank economist, Pavan Sukhdev, the TEEB is designed to "[make] nature's values visible" in order to "mainstream the values of biodiversity and ecosystem services into decision-making at all levels" ("TEEB - The Initiative," n.d.). It is also an excellent example of the application of the benefit transfer method.

The TEEB database allows the user to select the most relevant per-unit-area values, based on the land use/land cover profile of the study region, comparison of general economic conditions in the source and study areas, and the general "fit" or appropriateness of the source study for use in the study area at hand. After eliminating estimates from lower-income countries and estimates from the U.S. that came from circumstances vastly different from central and western Virginia, we identified 91 per-acre estimates in the TEEB that adequately provide approximations of ecosystem service value in our study region.[17]

After selecting the best candidate studies and estimates in the TEEB database, we still had some key land use/ecosystem services values (such as food from cropland) without value estimates. To fill some of the most critical gaps, we turned to other studies that had examined ecosystem service value in this general region (Phillips, 2015a; Phillips & McGee, 2016) and to specific data on cropland and pasture/hayland value from Virginia Cooperative Extension and the National Agricultural Statistics Service (Lex & Groover, 2015).

For several land cover-ecosystem service combinations, either multiple source studies were available or the authors of those studies reported a range of dollar-per-acre ecosystem service values. We

Ecosystem Service Effects 2: Food and Farmland

Cros-B-Crest Farm in Staunton was established in 1894 and is now recognized by the Commonwealth of Virginia as a "Century Farm." Harry Crosby is the fourth generation to farm this land and has seen the damage that a utility corridor (last time it was a power line) can do to property values and quality of life. This time, Crosby says, the impacts would be even more profound.

The proposed ACP would affect the farm operations and the farm in several ways. First, the pipeline would run more or less directly down the natural slope of one of Cros-B-Crest's best fields, while Mr. Crosby, to conserve soil and otherwise exercise good stewardship, farms the field along the natural contour. Interrupting the contour with the pipeline would lead to increased erosion. Due to restrictions on crossing the pipeline with larger farm equipment, the ACP would effectively take the entire field (30-40 acres in total) out of production.

Even if the field could still be used, Crosby expects that it would not return to its current high level of productivity any time soon. Digging up, trenching, filling, and attempting to put back the soil will, however carefully done, disrupt the soil profile, increase compaction and otherwise depress fertility that has taken nature and the Crosby family generations to build. (Crosby, 2015a, 2015b).

Beyond the impact on farm operations themselves, Crosby says, the ACP will reduce the enjoyment the family receives from owning and living on the property (Crosby, 2015b). The family might not realize the financial loss unless or until it sells the farm, but it will experience the loss of well-being every day.

[17] Among those U.S. studies included in the TEEB database that we deemed inappropriate for use here were a study from Cambridge Massachusetts that reported extraordinarily high values for aesthetic and recreational value and the lead author's own research on the Tongass and Chugach National Forests in Alaska. (The latter was excluded due to the vast differences in land use, land tenure, climate, and other factors between the source area and the current study region.)

are therefore able to report both a low and a high estimate based on the bottom and top end of the range of available estimates.

In the end, we have 162 separate estimates from 60 unique source studies covering 57 combinations of land uses and ecosystem services. (See Appendix A to this report for a full list of the values and sources that yielded these estimates.) This is still fairly sparse coverage, given that there are 140 possible combinations of the 10 land uses and 14 services. We therefore know that our aggregate estimates will be lower than they would be if dollar-per-acre values for all 14 services were available to transfer to each of the 10 land use categories in the study region. One can either live with that known underestimation, or one can assign per-acre values from a study of one land-use-and-service combination to other combinations. Doing so would introduce unknown over- or perhaps under-estimation of aggregate values. We prefer to take the first course, knowing that our estimates are low/conservative and urge readers to bear this in mind when interpreting this information for use in weighing the costs of the proposed ACP.

With acreage and per-acre ecosystem service values in hand, we can now calculate ecosystem service value for each of the four area/scenario combinations. To repeat, these are:

- Baseline ecosystem service value in the proposed construction corridor
- Ecosystem service value in the construction corridor during construction
- Baseline ecosystem service value in the proposed right-of-way
- Ecosystem service value in the right-of-way during the (indefinite) period of ongoing operations.[18]

Value calculations are accomplished according to this formula

$$\text{ESV} = \sum_{i,j}[(Acres_j) \times (\$/acre/year)_{i,j}]$$

Where:

$Acres_j$	is the number of acres in land use (j)
$(\$/acre/year)_{i,j}$	is the dollar value of each ecosystem service (i) provided from each land use (j) each year. These values are drawn from the TEEB database and other sources listed in Appendix A.

Step 4: Subtract Baseline ESV from ESV in "with ACP" Scenario

With the steps above complete, we can now estimate the cost in ecosystem service value of moving from the baseline or status quo to a scenario in which the ACP is built and operating.

The cost of construction is the ESV from the construction corridor during construction, minus baseline ESV for the construction corridor, times two. The multiplication by two is due to the conservative

[18] Note that while the ROW and construction corridors overlap in space, they do not overlap in time, at least not from an ecosystem services production standpoint. During construction, the land cover that would eventually characterize the ROW will not exist in the construction corridor. Thus, there is no double counting of ecosystem service values or of costs from their diminution as a result of either construction or ongoing operations.

assumption that revegetation and restoration to a land use that is functionally different from barren land will take at least two years.

The ecosystem service cost of ongoing operations is ESV from the ROW in the "with ACP" scenario minus the baseline ESV for the ROW. This will be an annual cost borne every year in perpetuity.

Ecosystem Service Value Estimates

In the baseline or "no pipeline" scenario, the construction corridor produces between $8.5 million and $30.5 million per year in ecosystem service value (ESV). The largest contributors to this total (at the high end) are aesthetic value, water supply, and protection from extreme events. Under a "with ACP" scenario, and not surprisingly given the temporary conversion to bare/barren land, these figures drop to near zero, or between $239 and $1,882 per year for each of the two years. Taking the difference as described above, estimated per-year ecosystem service cost of the ACP's construction would be between $8.5 and $30.5 million, or between $17 and $61 million over two years in the four-county study region.

Loss of aesthetic value and impacts on water (both supply and regulation of flow) represent the largest losses during the construction phase (Table 7).

TABLE 7: Ecosystem Service Value Lost in Construction Corridor in Each of Two Years, Relative to Baseline, by Ecosystem Service (2014$)

	Study Region			
Ecosystem Service	*Baseline (low)*	*Loss (low)*	*Baseline (high)*	*Loss (high)*
Aesthetic Value	5,982,745	-5,982,745	24,137,935	-24,137,935
Air quality	495,418	-495,418	505,421	-505,421
Biological Control	10,671	-10,671	27,452	-27,452
Climate Regulation	149,445	-149,445	163,468	-163,468
Erosion Control	13,270	-13,270	115,341	-115,341
Protection from Extreme Events	1,074,981	-1,074,981	1,094,775	-1,094,775
Food Production	10,598	-10,598	10,598	-10,598
Pollination	275,968	-275,968	362,646	-362,646
Raw materials	32,462	-32,462	220,696	-220,696
Recreation	12,302	-12,107	680,247	-679,050
Soil formation	9,930	-9,930	33,025	-33,025
Waste Treatment	19,858	-19,844	394,699	-394,685
Water Supply	62,726	-62,695	1,710,877	-1,710,205
Water flows	307,049	-307,049	1,069,378	-1,069,378
Total	**$8,457,424**	**-$8,457,185**	**$30,526,558**	**-$30,524,675**

The ecosystem service costs for the ROW are predictably smaller on a per-year basis, but because they will persist indefinitely the cumulative effect will be much higher. Under the "with ACP" scenario, and using minimum values, annual ecosystem service value from the ROW falls from $5.1 million to about $212,000 for an annual loss of over $4.8 million. At the high end, the ecosystem service value of the ROW would fall from $18.3 million to about $554,000 for an annual loss of $17.8 million.

Most of this loss is due to the conversion of forestland to shrub/scrub. Shrub/scrub naturally increases its share of overall ecosystem service value in the "with pipeline" scenario. Those gains are dwarfed, however, by the loss of much more productive forests. Similarly, the value of cropland falls due to its assumed transition to pasture/forage. While there is some gain in the pasture/forage category, there is a net loss of ecosystem service value from the two agricultural land uses of between $2,500 and $63,000 per year (Table 8).[19]

TABLE 8: Ecosystem Service Value Lost Each Year Post Construction in Right-Of-Way, Relative to Baseline, by Ecosystem Service (2014$)

	Study Region			
Ecosystem Service	*Baseline (low)*	*Loss (low)*	*Baseline (high)*	*Loss (high)*
Aesthetic Value	3,595,366	-3,528,488	14,507,758	-14,425,064
Air quality	297,755	-266,627	303,670	-266,627
Biological Control	6,405	-1,994	16,557	-12,146
Climate Regulation	89,097	-39,359	97,529	-47,760
Erosion Control	7,964	15,371	69,285	-31,221
Protection from Extreme Events	645,951	-634,265	657,820	-634,265
Food Production	6,376	-982	6,376	-982
Pollination	165,865	-160,026	218,643	-208,234
Raw materials	19,513	-19,503	132,655	-132,645
Recreation	7,191	2,055	408,782	-398,095
Soil formation	5,968	-4,939	19,887	-18,858
Waste Treatment	11,977	-10,179	237,364	43,876
Water Supply	37,704	-37,681	1,028,422	-1,027,528
Water flows	184,624	-182,824	642,740	-634,198
Total	**$5,081,755**	**-$4,869,443**	**$18,347,488**	**-$17,793,748**

It bears repeating that the benefit transfer method applied here is useful for producing first-approximation estimates of ecosystem service impacts. For several reasons, we believe that this approximation of the effect of the ACP's construction and operation on ecosystem service values is too low rather than too high. These reasons include:

- The estimates include only the loss of value that would otherwise emanate from the ROW and construction corridors themselves. Additional losses would occur due to the conversion of forest and other areas to barren or urban land (both of which have relatively low ecosystem service productivity) that would serve as access roads and other pipeline-related infrastructure.

[19] Note that due to differences in the range of dollars-per-acre estimates available for the various combinations of land use and ecosystem service, there are some instances where an apparent gain at the low end turns into a loss at the high end. For example, and based on the estimates available from the literature, the minimum value for erosion control from shrub/scrub acres is higher than the minimum for forests. Because we assume that forests return to shrub/scrub after the pipeline is in operation, this translates into a net increase in erosion regulation. At the high end, however, available estimates show a higher erosion control value for forests than for shrub/scrub. Thus the high estimate shows a net loss of erosion control benefits. It is important, therefore, to keep in mind that these estimates are sensitive to the availability of underlying per-acre estimates.

The compressor station proposed for a site in Buckingham County is among that pipeline-related infrastructure. Its construction would convert land from more- to less-productive uses. In addition, its operation would mean ongoing noise and air emissions that could adversely affect nearby residents and tax the capacity of surrounding natural areas to absorb and process waste in the form of those emissions. (See box beginning on the next page.)

- The estimates do not account for the extent to which the construction and long-term presence of the ACP could damage the ecosystem service productivity of adjacent land. During construction, the construction corridor itself could be a source of air and water pollution that may compromise the ability of surrounding or downstream areas to deliver ecosystem service value of their own. For example, if sediment from the construction zone in Nelson County were to reach the Rockfish River or its tributaries, those surface waters will lose some of their ability to provide clean water, food (fish), recreation, and other services. This reduced productivity may persist well after construction is complete. [20]

  Over the long term, the right-of-way would serve as a pathway by which invasive species or wildfire could more quickly penetrate areas of interior forest habitat, thereby reducing the natural productivity of those areas.

- Finally, these estimates reflect only those changes in natural benefits that occur due to changes in conditions on the surface of the land. Particularly because the proposed pipeline would traverse areas of karst topography there is well-founded concern that subsurface hydrology could be affected during construction and throughout the lifetime of the pipeline (Jones, 2015; Pyles, 2015). Blasting and other activities during construction could alter existing underground waterways and disrupt water supply. There is also a risk that sediment and other contaminants could reach groundwater supplies if sinkholes form near the pipeline during construction or afterwards. For example, in Nelson County, where steep slopes with shallow soils over bedrock is common (Nelson County Planning Commission, 2002), there is concern that erosion and landslides during and after pipeline construction will harm water quality. These scenarios would entail further loss of ecosystem service value and, for the homeowners or municipalities affected, major expenditures. Officials in Augusta County estimate it would cost at least $2.1 million to establish a new municipal well, for example (Hoover, 2015).

[20] This is not a small risk. As noted by the Dominion Pipeline Monitoring Coalition "pipeline construction over steep Appalachian mountains creates significant runoff and slope-failure problems" (Webb, 2015b). In one example, multiple problems during and after construction of a relatively small pipeline on Peters Mountain in Giles County caused extensive erosion and damage to waterways (Webb, 2015a). The coalition points out that "the potential for water resource problems will be greatly multiplied for the proposed larger projects [like the ACP], both in terms of severity and geographic extent."

Buckingham County Compressor Station

One way the ACP 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. While there is some chance of leaks occurring at any place along the proposed route, leaks and major releases of gas and other substances (lubricants, etc.) at the 40,645 horsepower (hp) compressor station proposed for the Union Hill section of Buckingham County would certainly occur.

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, "Officials To NYS: Take A Second Look At Pipelines."). 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 (Luckett, Buppert, & Margolis, 2015).

In Buckingham, 471 people live within 2 miles of the proposed compressor station (US Census Bureau, 2015). This would mean 424 people experiencing odor events, 334 people experiencing respiratory impacts, 273 people experiencing sinus problems, and 184 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.

Yogaville, an ashram, teaching, and retreat center located approximately 5 miles from the proposed compressor station, is especially concerned about these impacts on its 10,000 annual visitors and on the peace, tranquility, and air quality available at its iconic Mount Kailash and Lotus Shrine. Officials there worry that the air and noise pollution may entirely destroy the Shrine's ability to serve as a place of silent prayer, meditation, and healing (Yogaville, 2015).

The selection of Union Hill for the compressor station also raises environmental justice questions that FERC and others must consider as part of their review (Luckett, Buppert, & Margolis, 2015; Executive Order 12898).

Buckingham County Compressor Station, Continued.

In addition to the direct effects on nearby residents' health and quality-of-life, 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 slightly larger (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, Bruce, Personal Communication, 12/31/2015).

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 that 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). With the caveat that the effect on property value of the compressor station in Buckingham County may be different in scope and intensity, we do include such effects among the total estimated cost of the pipeline in the study region.

For our estimates, we follow the example of the Hancock New York case and assume that properties within one half mile of the Buckingham 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 Buckingham compressor station would be nearly three times the size. 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 Buckingham landowners over a wider area and, possibly, the percentage reduction would be greater at any given distance.

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). It is reasonable to assume that such an effect would occur if a portion of Buckingham County's landscape of working forests, farms, and small villages were turned into a compressor station.

EFFECTS ON PROPERTY VALUE

Land Price Effects

To say that the impacts and potential impacts of the ACP on private property value is important to people along its proposed route would be an extreme understatement. Some 521 comment letters submitted by study region residents to FERC during the scoping period mentioned property value (Docket (PF15-6)). Of these, 517, or 99.2%, expressed a belief that the pipeline would have a negative effect on that value. Those reductions are not merely hypothetical. Landowners and Realtors along the proposed route of the Atlantic Coast Pipeline report that buyers have backed out of contracts and that other buyers are simply less interested in potentially affected properties (Davenport, 2015; Hotz, 2015; R. Smith, 2015a).[21] In the words of one Realtor, "every single one of my buyer clients who are looking to buy property in Augusta County have told me that they do not want to even look at properties that are located ON or NEAR the proposed locations of the ACP" (Adler, 2015). While it is impossible to know how large an effect the specter of the ACP, including the compressor station in Buckingham County, has already had on land prices, there is strong evidence from other regions that the effect would be negative.

> ***"Buyers are concerned about safety, views, and resale values. The permanent easement that it will create will devalue every property in its path."***
>
> *– Daniel Hotz, Realtor*
> *McDowell, Virginia*

In a systematic review, Kielisch (2015) presents evidence from surveys of Realtors, home buyers, and appraisers demonstrating that natural gas pipelines negatively affect property values for a number of reasons. Among his key findings relevant to the ACP:

- 68% of Realtors believe the presence of a pipeline would decrease residential property value.
- 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%.)
- 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.

[21] FERC's docket for the pre-filing phase of the Atlantic Coast Pipeline (PF15-6) is rife with testimony from landowners concerned that their property will be or already has been negatively affected by the mere possibility of the pipeline's construction.

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" (2015, p. 7).

If one considers just those buyers who are still willing to purchase the property, the expected loss in market value would be 10.5%.[22] This loss in value provides the mid-level impact in our estimates. A much greater loss (and higher estimates) would occur if one takes into account 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%.[23] In our estimates, 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.

These findings are consistent with economic theory about the behavior of generally risk-averse people. While would-be landowners who are informed about pipeline risks and nevertheless decide to buy property near the proposed ACP corridor could be said to be "coming to the nuisance," one would expect them to offer less for such a property than they would offer for a property with no known risks.

Kielisch's findings demonstrate that properties on natural gas pipeline rights of way suffer a loss in property value. Boxall, Chan, and McMillan (2005), meanwhile, 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 other infrastructure, the authors found that

Diminished Property Value, Lost Revenue, Higher Costs: Mt. Rush Farm

Mt. Rush Farm located in Buckingham County is a 1,000-acre family farm that has been operated by the Leech family for over 100 years. About half the farm is in managed forests, with the remainder in Angus cattle and crop production. It is one of the largest remaining active farms in the county. The farm typically employs 3 full-time workers, and 4 families live on the property.

The pipeline will bisect the property mainly through the un-wooded portion, which is in daily use. The pipeline will be directly in the way of bringing the cattle in from pasture, a monthly activity. To simply feed their cattle the Leech family would need to cross the pipeline twice daily with heavy equipment. With restrictions on where they could cross the pipeline, these trips would be more time consuming and costly, creating a serious burden on the farm.

"We do not make a lot of money; margins are tight. The pipeline could make it so that we cannot continue farming." If farming is no longer viable, the family worries that the pipeline will also hurt its value for other uses such as housing.

-Irene Ellis Leech, Owner of Mt Rush Farm

[22] 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%.

[23] This is the expected value calculated as 0.622*(-100%)+0.189*(-21%)+0.189*(0%).

properties within the "emergency plan response zone" of sour gas[24] wells and natural gas pipelines faced an average loss in value of 3.8%, other things being equal.

The risks posed by the ACP would be different – it would not be carrying sour gas, for example—but there are similarities between the ACP scenario and the situation in the study that makes their 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, in contrast to ACP-cited studies showing no price effects (see below), the Boxall study examines prices of properties for which landowners must inform prospective buyers when one or more EPZs intersect the property.

The ACP has both a high consequence area (HCA) and an evacuation zone radiating from both sides of the pipeline that are defined by health and safety risks. Whether disclosed or not by sellers, prospective buyers are likely to become informed regarding location of the property relative to the ACP's HCA and evacuation zones or, at a minimum, regarding the presence of the ACP in the study region.

As described in the box above, the compressor station proposed for the Union Hill section of Buckingham County would likely cause its own more severe reduction in the value of nearby properties. We apply the percentage reduction awarded in the Hancock, New York case (25%) to properties that are (as the properties were in that case) within one half mile of the proposed compressor station.

While there remains a paucity of statistical analysis on the effects of high-pressure natural gas transmission lines on property value, there have been many analyses demonstrating the opposite analog–namely, that amenities such as scenic vistas, access to recreational resources, proximity to protected areas, cleaner water, and others convey positive value to real property.[25] 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.

Claims that Pipelines have no effect on property value may be invalid.

Both FERC and ACP LLC have cited several 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. In its Final EIS regarding the Constitution Pipeline, for example, FERC cited two articles concluding, in brief, that effects on property value from the presence of a pipeline can be either positive or negative 3values due to a pipeline explosion diminishes over time (Hansen, Benson, & Hagen, 2006). In its filing, ACP LLC cites additional studies drawing similar conclusions based on comparison of market and/or assessed prices paid for properties "on" or "near" a pipeline versus those farther away (Allen, Williford & Seale Inc., 2001; Fruits, 2008; Natural Resource Group, 2015b; Palmer, 2008).

[24] "Sour" gas contains high concentrations of hydrogen sulfide and poses an acute risk to human health.
[25] Phillips (2004) is one such study that includes an extensive review of the literature on the topic.

While the studies differ in methods, they are similar in that each fails to take into account two factors that may void their conclusions entirely. The first is that the studies do not consider that the property value data used do not represent prices arising from transactions in which all buyers have full information about the subject properties. The second is that, for the most part, the definition of nearness to the pipelines may be inappropriate or inadequate for discerning actual effects on property value of that nearness.

Economic theory holds that for an observed market price to be considered an accurate gauge of the 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—their risk aversion—to bear on their decision about how much to offer for the property. As a result, buyers' offer prices will be higher than they would be if they had full information.

As Albright (2011) notes in response to the article by Disken, 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 have full information, and this was not the case.

The study by Hansen, Benson, and Hagen (2006) actually reinforces the conclusion that when buyers know about a nearby pipeline, market prices drop. The authors found that property values fell after a deadly 1999 liquid petroleum pipeline explosion in Bellingham, Washington. They 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.

We do not think it is appropriate to conclude from this study (as FERC did in the case of the Constitution Pipeline) that natural gas transmission pipelines would have no effect on land prices in today's market. 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 stories, citizens' videos, news reports, 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 home buyers.

Online based tools have changed the ways people shop for homes, and we are now in a real world much closer to the competitive economic model that assumes all buyers have full information about the homes they might purchase. Anyone with an eye toward buying property near the proposed ACP corridor would quickly learn that the property is in fact near the corridor, that there is a danger that the property could be adversely affected by still-pending project approval, and that fossil fuel pipelines and related infrastructure have an alarming history of negative health and environmental effects. Accordingly, the price that buyers would offer for a home near the ACP will be lower than the price offered for one farther away or in another community or region entirely.

The second problem with the studies is that while they 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 the subject pipelines that health and safety concerns could influence prices. In the study for the Interstate Natural Gas Association of America (INGAA), for example, the authors compare prices for properties directly on pipeline rights-of-way to prices of properties off the right-of-way. But in almost all cases the geographic scope of the analysis was small enough that most or all of the properties not on the right-of-way are still within the pipelines' respective evacuation zones (Allen, Williford & Seale Inc., 2001).[26]

If one wants to compare the price of properties with and without a particular feature, one must be sure that some properties have the feature and others do not. It is a case where one actually does need to compare apples to oranges. But if there is no variation in the feature of interest, which in this case would be the presence of a nearby risk to health and safety, then one would expect to find no systematic variation in the price of the properties. By comparing apples to apples when it should be comparing apples to oranges, the INGAA study reaches the forgone 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 and in ACP LLC's filing 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 detect such a threshold effect. Such an effect would show up, of course, only if the buyers of the properties included in the study had been aware of their new property's proximity to the pipeline.

[26] This is based on a best estimate of the location of the pipelines derived from descriptions of the pipeline's location provided in the study (only sometimes shown on the neighborhood maps) and an approximation of the evacuation zone based on pipeline diameter and operating pressure (Pipeline Association for Public Awareness, 2007).

In short, one cannot conclude from these flawed studies' failure to identify a negative effect of pipelines on property value that no such effect exists. To evaluate the effects of the proposed ACP on property value, FERC and others must therefore look to studies (including those summarized in the previous section) in which buyers' willingness to pay is fully informed about the presence of nearby pipelines and in which the properties bought are truly different in terms of their exposure to pipeline-related risks.

Visual Effects and Viewshed Analysis

Information about how the visual effects of natural gas transmission pipelines are reflected in property value is scarcer than information related to health and safety effects. On one hand, we know better views increase property value. Conversely, utility corridors from which power lines can be seen decrease property values (by 6.3% in one study) (Bolton & Sick, 1999). This suggests a pipeline corridor reduces property value either by impairing a good view or, if like power lines, by simply being unattractive. It is reasonable to conclude that the proposed ACP would have effects on property value that are mediated through visual effects, but the literature to date does not offer clear guidance on how large or strong the effect may be. We therefore have not included separate estimates of the impact of the ACP on property value in the viewshed. Moreover, we do not wish to double-count a portion of the impact of the ACP on "Aesthetics," which is already included among the ecosystem service value effects.

We do want to know, however, how many properties might suffer a portion of that lost aesthetic value. To keep the estimate conservative, we count only those properties with a higher-than-average likelihood the ACP corridor could be seen from them. To determine this for each parcel, a GIS-based visibility analysis provides an estimate of how many points along the pipeline could potentially be seen from each 30m-by-30m spot in the study region. To keep the computing needs manageable, we analyzed a sample of points placed at 100m intervals along the proposed ACP route.

Because weather, smog, and other conditions limit the distance at which one can see anything in the mountains and valleys of Virginia, we restricted the scope of analysis for any given point on the pipeline to spots in the study region that lie within a 25-mile radius. As a practical matter, this meant that we analyzed a section of the ACP beginning 25 miles west of the western boundary of Highland County, Virginia and extending to a point 25 miles east of the eastern boundary of Buckingham County.

By tallying the number of points on the pipeline corridor that could be seen from each spot in the study region and then connecting those spots to parcel boundaries, we obtain an estimate of how much of the pipeline could be seen from some spot within a given parcel. In Figure 6, yellow spots on the maps are those where one could see between 1 and 14 points on the pipeline, whereas red spots have a view of up to as many as 392 points along the pipeline. Since each point represents 100 meters of pipeline, there are places in the study region where 39.2 km, or 24.4 miles, of pipeline corridor could be visible.

Taking into account those spots on nearly every parcel from which one could not see the ACP corridor, the average of the maximum number of points visible from a parcel is 12. This serves as our threshold for identifying parcels from which the pipeline would be "visible." Parcels containing no spot (again

each spot is a 30m-by-30m square) from which one could see more than 12 pipeline points is considered to have no view of the pipeline. By this rule, and out of 106,717 parcels in the study region, some 31,117 parcels, or just under one-third, would have a potential view of the pipeline. The total value of these properties is currently $7.44 billion.

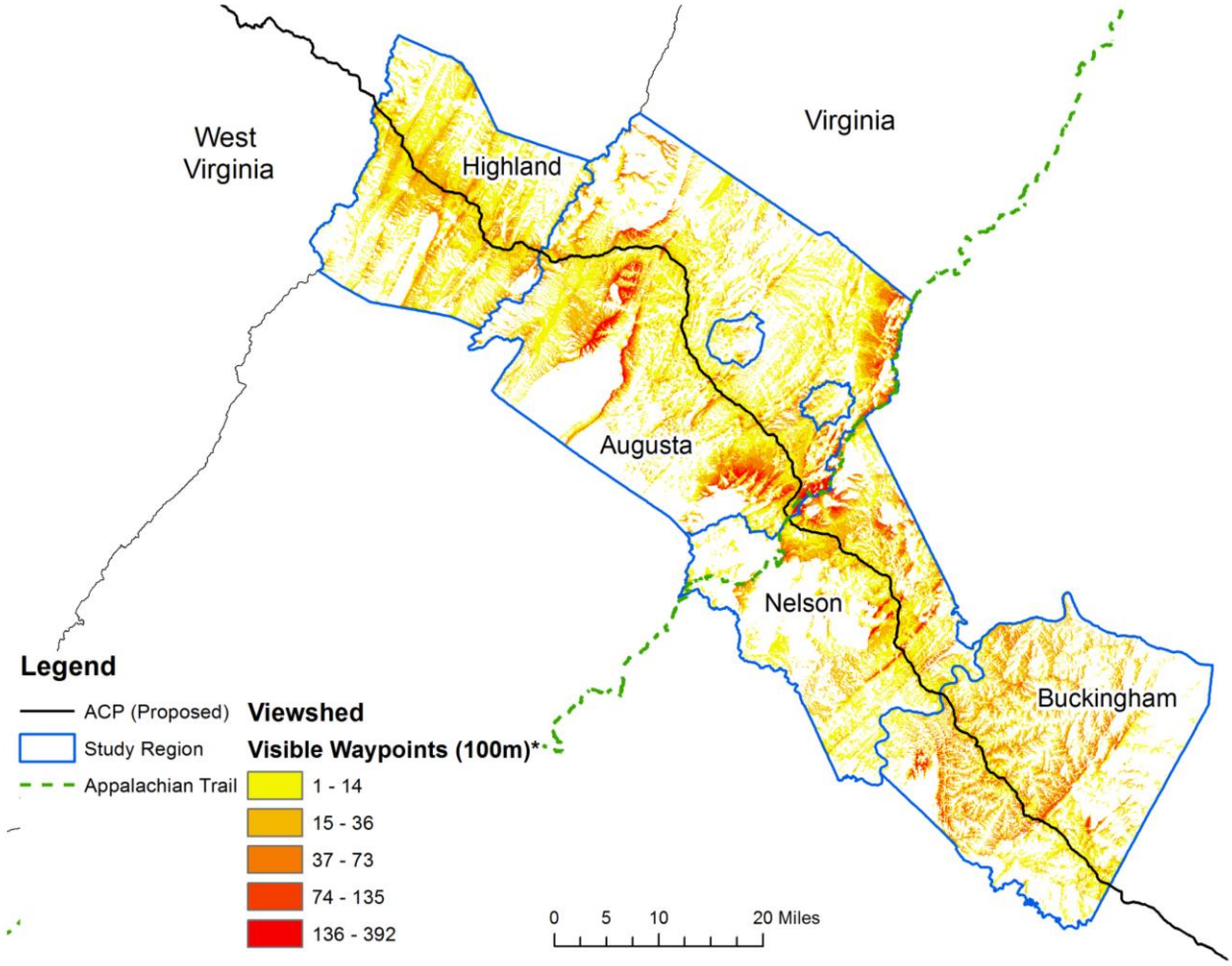

FIGURE 6: Visibility Analysis Results

*The color indicates the number of waypoints, spaced 100m apart along the proposed route that would be visible from the colored grid cell. Only waypoints within 25 miles are considered. Does not account for obstructions like buildings or trees.

We call this a potential view of the pipeline because we have not taken other visual obstructions, such as trees or buildings into account. In particular, smaller parcels in the more densely developed areas could be at elevations relative to the pipeline that could afford a view of it, but the house next door could block that view. The restriction of our analysis to those parcels that have comparatively many spots from which to potentially see the pipeline mitigates this limitation of our GIS analysis. The reason is simply that smaller urban lots have very few 30-meter-square spots to begin with. A parcel has to be at least 13 spots in size (2.9 acres), with the pipeline visible from every spot, to cross the 12-spot threshold.

Parcel Values

With the exceptions of the City of Staunton and Highland County, parcel value is obtained from the jurisdictions' public records. We obtained Staunton's parcel boundaries (the GIS file) from the city, but it is not possible to download or create a file with the assessed value that corresponds to each parcel. For Highland County, we obtained the parcel boundaries from the Commonwealth of Virginia's web-based map service, but those parcels lack any identifying information, such as an address or key code by which parcels could be connected to property value obtained separately from the County.

For both Staunton and Highland County, we adopted a second-best approach to enable some spatial analysis of property value impacts. We extracted the median house value for block groups in those two jurisdictions from the American Community Survey (ACS) (2014). After adjusting the ACS's figures for inflation, we attached those values to each parcel, according to which block group the parcel occupies.[27]

Each of the remaining jurisdictions have some parcels with missing value data or parcels where a match in the jurisdictions' separate assessment records could not be found. This will lead to some underestimation of any land value effects, since the value of these parcels is set to zero.

Two other features of the parcel data required adjustments prior to performing any land value impact calculations. First, the Buckingham County data had instances in which two or more individual tracts in different parts of the County are listed on a single tax record with a single property value. The consequence is that the value of all of the land connected to such multi-tract tax records would be swept up with the value of just those tracts actually crossed by the proposed ROW, in the evacuation zone, or near the compressor station. To avoid overstating impacts, we split the multi-tract parcels into separate tax records and assigned each tract its own value based on its size and the per-acre value of the original multi-tract parcel.

The second remaining issue deals with public land that is unlikely to be sold and therefore does not possess any market value. To ensure these properties would not inflate overall property value effects, we used the "Protected Areas Database" from the National Gap Analysis Program to identify fee-owned conservation properties, such as portions of the George Washington National Forest and state, county, and municipal parks (Conservation Biology Institute, 2012). Once identified, we set the value of all such properties equal to zero.

With all of these adjustments made, there remains the comparatively straightforward matter of identifying parcels of six types for which one could expect some effect of the ACP on the value. In order of increasing distance from the pipeline itself, these are:

1. Parcels crossed by the right-of-way
   (521 parcels, with total value (before ACP) of $277.5 million)
2. Parcels crossed by the construction corridor
   (553 parcels, with total value (before ACP) of $281.8 million)

[27] Because many parcels overlap block group boundaries, each parcel is assigned to a block according to whether its centroid, or geometric center, lies within the block group.

3. Parcels at least partially within the High Consequence Area (HCA)
   (1,799 parcels, with total value (before ACP) of $539.7 million)
4. Parcels at least partially within the Evacuation Zone
   (6,148 parcels, with total value (before ACP) of $1.41 billion)
5. Parcels with their geographic center (centroid) within one half mile of the compressor station
   (87 parcels, with total value (before ACP) of $4.9 million)
6. Parcels from which the pipeline would be visible (as defined above)
   (31,117 parcels, with total value (before ACP) of $7.44 billion)

Note that there is overlap among these zones. All ROW parcels are within the construction, HCA, and evacuation zones, and 13 are near the compressor station, for example. To avoid double counting we apply only one land value effect to any given parcel. We assume that the health and safety concerns associated with the compressor station dominate the effects of the ROW and of the evacuation zone, and so we exclude the compressor zone parcels from estimates of the impact of those zones and estimate a separate effect of the compressor station. Similarly, ROW parcels are assumed to suffer no further reduction in value due to their location within the evacuation zone.

We ignore the construction corridor for this analysis. Even though the additional 32 parcels and $4.3 million in value (relative to parcels in the ROW) are not trivial, we do not have a basis for estimating a change in value that is separate from or in addition to the change due to the parcels' proximity to the ROW or their location within the evacuation zone.

Furthermore, we treat parcels in the HCA and in the evacuation zone the same way and apply a single land value change to all parcels in the evacuation zone. Arguably, there should be a larger effect on parcels in the HCA than those only in the evacuation zone. Living with the possibility that one would need to evacuate one's home at any time day or night would, one would expect, have a smaller effect on property value than living with the possibility that one would not survive a "high consequence" event and, therefore, not have the chance to evacuate at all. We do not have data or previous study results that allow us to draw such a distinction, so instead we apply the lower evacuation zone effect to all HCA and evacuation zone parcels.

To summarize, Table 9 repeats a portion of Table 2, but with the property value effects discussed above in place of check marks.

TABLE 9: Summary of Marginal Property Value Effects

Values / Effects	Right-of-Way (Low, Medium, & High effects)	High Consequence Area	Evacuation Zone	Compressor Station Zone	Pipeline Viewshed
Land / Property Value	-4.2%[a] -10.5%[b] -13.0%[c]	-3.8%[d]		-25%[e]	Impact included with Ecosystem Services

Notes:

a. Kielisch, Realtor survey in which 56% of respondents expected an effect of between -5% and -10% (0.56*-7.5% = -4.2%).

b. Kielisch, buyer survey in which half of buyers still in the market would reduce their offer on a property with a pipeline by 21% (0.50*-0.21 = -10.5%).

c. Kielisch, appraisal/impact studies showing an average loss of between -12% and -14% (-13% is the midpoint)

d. Boxall, study in which overlap with an emergency planning zone drives, on average, a 3.8% reduction in price. We apply this reduction ONLY to those parcels in the evacuation zone that are not also in the ROW or within one half mile of the compressor station.

e. Based on examples from the town of Hancock, New York.

Estimated Land Value Effects

Following the procedures outlined in the previous section, our conservative estimate for costs of the proposed ACP would include between $55.8 million and $80.2 million in diminished property value. Some of the most intense effects will be felt by the owners of 508 parcels in the path of the right-of-way, who collectively would lose between $11.7 million and $36.1 million in property value. There are 87 parcels in the compressor station zone, and their owners would together experience a drop of $1.2 million in property value. Some 5,553 additional parcels lie outside the ROW and compressor station zones but are within or touching the evacuation zone. These parcels' owners would lose an estimated $43.0 million. (See Table 10). A far greater number of parcels, 31,117, would experience a loss in value due to diminished quality of the view from their properties.

TABLE 10: Summary of Land Value Effects, by Zone and County

	Effects in Right-of-Way			Effects in Evacuation Zone
County	**Realtor Survey (4.2%)**	**Buyer Survey (10.5%)[a]**	**Impact Studies (13.0%)**	**Boxall Study (3.8%)**
Augusta	-5,201,628	-13,004,069	-16,100,276	-28,380,818
Buckingham	-993,700	-2,484,249	-3,075,737	-2,884,845
Highland	-360,981	-902,453	-1,117,323	-2,094,518
Nelson	-5,082,259	-12,705,646	-15,730,800	-9,596,010
Study Region Total	**-$11,654,492**	**-$29,136,230**	**-$36,073,427**	**-$42,956,191**

TABLE 10: Continued

	Effects Near Compressor	Total of ROW and Evacuation Zone Effects		
	Hancock, NY Finding (25%)	Low	Medium	High
Augusta	n/a	-33,582,445	-41,384,887	-44,481,094
Buckingham	-1,214,140	-5,092,685	-6,583,234	-7,174,722
Highland	n/a	-2,455,500	-2,996,972	-3,211,841
Nelson	n/a	-14,678,268	-22,301,656	-25,326,810
Study Region Total	**-$1,214,140**	**-$55,808,898**	**-$73,266,748**	**-$80,194,467**

Based on median property tax rates in each county, these one-time reductions in property value would result in reductions in property tax revenue of between $281,000 and $408,000 per year (see Table 11). To keep their budgets balanced in the face of this decline in revenue, the counties would need to increase tax rates, cut back on services, or both. The loss in revenue would be compounded by the likelihood that the need for local public services, such as road maintenance, water quality monitoring, law enforcement, and emergency preparedness/emergency response could increase. The ACP, in other words, could drive up expenses while driving down the counties' most reliable revenue stream.[28]

TABLE 11: Effects on Local Property Tax Revenue

	Median Tax Rate (% of Value)[a]	Lost Property Tax Revnue		
		Low	Medium	High
Augusta County	0.47%	-157,837	-194,509	-209,061
Buckingham	0.56%	-28,519	-36,866	-40,178
Highland	0.46%	-11,295	-13,786	-14,774
Nelson	0.57%	-83,666	-127,119	-144,363
Study Region Total		**-$281,318**	**-$372,281**	**-$408,377**

a. Source: Property Taxes By State (Virginia Counties and Independent Cities) (propertytax101.org, 2015)

In addition to factors that make our estimates of the effects on property value itself conservative,[29] there is one other factor that makes the estimates of effects on property taxes lower than what one would expect if the ACP is permitted. Namely, nearly a quarter of the properties in the ROW are currently undeveloped but still assessed at a value that assumes a single house site. Buckingham County has 70 such properties, Nelson has 7, and Augusta has 46.[30] The total assessed value of these

[28] We recognize that ACP anticipates making tax payments, but because those payments are tied to net income from the operation of the pipeline, they may fluctuate from year to year or disappear entirely if pipeline operations become unprofitable.

[29] These factors include using the lower expected price reduction from the buyer survey and applying the same price reduction to the entire evacuation zone (including the HCA).

[30] There are no such properties in Highland County, where the County does not assume any development value until development is imminent. In Buckingham County all unimproved properties are assessed as if they include at least one

properties is $15.1 million. Depending on where and how the ROW crosses these properties, it is likely that some will lose their potential usefulness for future residential or other development. In those cases, the assessed value (which by law reflects market value) will fall, and tax revenue generated by future development will never materialize.

EFFECTS ON ECONOMIC DEVELOPMENT

Across the study region, county-level economic development plans recognize the importance of a high quality of life, a clean environment, and scenic and recreational amenities to the economic future of people and communities. Augusta County's Economic Development Strategic Plan, for example, stresses "Respect for Heritage and Environment: Promote a quality of life that embraces our heritage, preserves the environment and effectively manages the resources we have been given" (Glover & Castle, 2015). In Highland County, the Economic Development Authority states its mission is to "promote sustainable economic development in order to achieve a desirable quality of life for the citizens of Highland County," and it aims to complete that by "preserving our rural heritage and natural beauty, supporting existing businesses, promoting new investment and igniting entrepreneurship" (Billingsley et al., 2015).

The ACP would undermine the progress toward these visions if the loss of scenic and recreational amenities, the perception and the reality of physical danger, and environmental and property damage were to discourage people from visiting, relocating to, or staying in the study region. Workers, businesses, and retirees who might otherwise choose to locate along the ACP's proposed route will instead pick locations retaining their rural character, productive and healthy landscapes, and promise for a higher quality of life.

This is already occurring in the region. With the possibility of the ACP looming, business plans have stalled and the real estate market has slowed (Adler, 2015; R. Smith, 2015a, 2015b). Study region residents are also concerned the ACP could have broad, negative impacts on the economy. Of those

Forgone Economic Development: Eco-Village

In April of 2014 a father and son purchased two parcels near Bold Rock Cidery in Nelson County in order to begin developing a "stunning boutique eco-resort focused on the natural beauty of the Rockfish Valley and the delightful Virginia-Made craft beers, wines, ciders, foods, and handmade goods."

Designed to be a top destination on the East Coast, the developers predict $35 million in investment costs to create this vision. They began developing a plan in April of last year and have already hired a world-class landscape design firm. The eco-resort would provide 50 full-time and 50 or more part-time jobs as well as $15-30 million in annual taxable revenue for Nelson County.

This project, which will be "a pure celebration of Virginia", will be entirely derailed by the ACP, which would cut "right through the heart of this project and destroy any opportunity to develop this land in a meaningful way." This project represents just one of many "small business owners investing in their own ideas and opportunities to serve the exploding tourism market and our local economy."

- Richard Averitt
Developer of Spruce Creek Resort and Market

house site. Nelson County assumes that all unimproved properties of 10 acres or smaller include a single house site. Augusta County applies the single house site assumption to unimproved properties of between 0.5 and 20 acres in size.

who mentioned the economy in written comments to the Federal Energy Regulatory Commission during the scoping phase of its environmental review, 91.4% expressed a belief that the ACP would have a negative effect. Of those who mentioned agriculture, 98.6% thought the effect would be negative, and 99.5% of those who addressed tourism said the effect would be negative.

These fears are consistent with research results from this region and around the country demonstrating that quality of life is often of primary importance when people choose places to visit, live, or do business. As Niemi and Whitelaw state, "as in the rest of the Nation, natural-resource amenities exert an influence on the location, structure, and rate of economic growth in the southern Appalachians. This influence occurs through the so-called people-first-then-jobs mechanism, in which households move to (or stay in) an area because they want to live there, thereby triggering the development of businesses seeking to take advantage of the households' labor supply and consumptive demand" (1999, p. 54). They note that decisions affecting the supply of amenities "have ripple effects throughout local and regional economies" (p. 54).

Along similar lines, Johnson and Rasker (1995) found that quality of life is important to business owners deciding where to locate a new facility or enterprise and whether to stay in a location already chosen. This is not surprising. Business owners value safety, scenery, recreational opportunities, and quality of life factors as much as residents, vacationers, and retirees.

It is difficult to predict just how large an effect the ACP would have on decisions about visiting the study region, or locating, or staying there. Even so, based on information provided by business owners to FERC and as part of this research, we can consider reasonable scenarios for how the ACP might affect key portions of the region's overall economy.

> ***Natural and Scenic Resources [Goals]***
> ***– Recognize that the natural environment is an important facet of our quality of life and efforts should be made to support and enhance that environment.***
> ***– Protect the county's scenic resources as essential to the county's rural character, economic strength and quality of life.***
>
> *- Nelson County Comprehensive Plan*

As noted above, the study region's residents believe the ACP will harm the travel and tourism industry. Wintergreen Resort, located in Nelson and Augusta Counties, expects a 40% drop in business relative to a planned expansion (Theiss, 2015). The nearby Fenton Inn projects it "will be losing at least 10% of projected income for [the life of the pipeline]" and that insurance and other costs will further impact its bottom line (Fenton & Fenton, 2015). In one widely reported case, a planned resort in Nelson County will never be built if the ACP is constructed—effectively a 100% loss for a business that would supply 50 full-time and 50 part-time jobs (Averitt, 2015). Finally, Yogaville in Buckingham County surveyed current and former guests regarding how a pipeline near its campus could affect future demand for its programs and found some 95% of those surveyed responded they would visit less often if the pipeline were constructed.

While more systematic research could provide refined estimates of the impact of natural gas transmission pipelines on recreation and tourism spending, one plausible scenario is that the impact is at least as high as the minimum of these business owners' reported expectations. That is, if the ACP were to cause a 10% drop in recreation and tourism spending from the 2014 baseline, the ACP could mean $41.3 million less in travel expenditures each year. Those missing revenues would otherwise support roughly $7.5 million in payroll, $1.3 million in local tax revenue, $1.8 million in state tax revenue, and 387 jobs in the four-county region's recreation and tourism industry each year.[31] In the short run, these changes multiply through the broader economy as recreation and tourism businesses buy less from local suppliers and fewer employees spend their paychecks in the local economy. As with the reduction in local property taxes, lost tax revenue from a reduction in visitation and visitor spending would squeeze local governments trying to meet existing public service needs as well as those additional demands presented by the ACP.

Along similar lines, retirement income is an important economic engine that could be adversely affected by the ACP. In county-level statistics from the US Department of Commerce, retirement income shows up in investment income and as age-related transfer payments, including Social Security and Medicare payments. In the study region, investment income grew by 1.5% per year from 2000 through 2014, and age-related transfer payments grew by 5.4% per year. During roughly the same time period (through 2013), the number of residents age 65 and older grew by 27.3% (2.1% per year), and this age cohort now represents 17.6% of the total population.[2]

It is difficult to precisely quantify the effect of the ACP on retirement income, but given the strong expression of concern from residents about changes in quality of life, safety, and other factors influencing retirees' location decisions, it is important to consider that some change is likely. Here, we consider what just a *10% slowing of the rate of increase* might entail. Such a scenario entails an annual decrease in investment income and age-related transfer payments of approximately $6.6 million. That loss would ripple through the economy as the missing income is not spent on groceries, health care, and other services such as restaurant meals, home and auto repairs, etc.

The same phenomenon also applies to people starting new businesses or moving existing businesses to communities in the study region. This may be particularly true of sole proprietorships and other small businesses who are most able to choose where to locate. As noted, sole proprietors account for a large and growing share of jobs in the region. If proprietors' enthusiasm for starting businesses in the study region were dampened to the same degree as retirees' enthusiasm for moving there, the 10% reduction in the rate of growth would mean 41 fewer jobs and $1.6 million less in personal income.

For "bottom line" reasons (e.g., cost of insurance) or due to owners' own personal concerns, businesses in addition to sole proprietorships might choose locations where the pipeline is not an issue. If so, further opportunities for local job and income growth will be missed.

[31] Raw data on travel expenditures is from the Virginia Tourism Corporation (2015). This reduction in economic activity would be in addition to the lost recreation benefits (that is, the value to the visitors themselves over and above their expenditures on recreational activity) that are included with ecosystem service costs above.

These are simple scenarios and the actual magnitude of these impacts of the ACP will not be known unless and until the pipeline is built. Even so, and especially because the pipeline is promoted by supporters as bringing some jobs and other economic benefits to the region, it is important to consider the potential for loss.

CONCLUSIONS

The full costs of the proposed Atlantic Coast Pipeline in our four-county study area and beyond are wide-ranging. They include one-time costs like reductions in property value and lost ecosystem services during pipeline construction, which we estimate to be between $72.7 and $141.2 million. Plus there are ongoing costs like lost property tax revenue, diminished ecosystem service value, and dampened economic growth that would recur year after year for the life of the pipeline. These annual costs range from an estimated $96.0 to $109.1 million per year. Most of these costs would be borne by residents, businesses, and institutions in Highland, Augusta, Nelson, and Buckingham Counties.

By contrast, the ACP's one local benefit is much smaller. It is an estimated average tax payment of $3.2 million per year (for the four-counties) through 2025 (Natural Resource Group, 2015b, pp. 5–31). Other ACP-promoted benefits, such as jobs from the ACP's construction and operation and those stemming from lower energy costs, would accrue primarily in other places (Atlantic Coast Pipeline, LLC, n.d.).[32]

The decision to approve or not approve the ACP does not hinge on a simple comparison of estimated benefits and estimated costs. The scope and magnitude of the costs outlined here, however, reflect and are an important component of the full environmental effects that must be considered in making that decision. Impacts on human well-being, including but not limited to those that can be expressed in dollars-and-cents must be taken into account by the Federal Energy Regulatory Commission and others weighing the societal value of the Atlantic Coast Pipeline.

If these considerations and FERC's overall review, under the National Environmental Policy Act, result in selection of the "no-action" alternative and the Atlantic Coast Pipeline is never built, most of the costs outlined in this report will be avoided. It is *most*, but not *all* costs because there has already been the cost of delaying implementation of business plans, the cost of houses languishing on the market, and the cost to individuals of the stress, time, and energy diverted to concern about the pipeline rather than what would normally (and more productively) fill their lives.

Another possible scenario is that the FERC, considering the impacts of the ACP *as currently proposed* on ecosystem services, property values, and economic development, would conduct a thorough analysis of all possible alternatives. Those alternatives may include using existing gas transmission infrastructure (with or without capacity upgrades), routing new gas transmission lines along existing utility and transportation rights-of-way, and/or scaling down permitted new pipeline capacity to match regional gas transmission needs (as opposed to permitting pipelines on a company-by-company basis). In this case, estimates of these impacts should inform the choice of a preferred alternative that minimizes environmental damage and, thereby, minimizes the economic costs to individuals, businesses, and the public at large.

[32] Due to issues with the methods and assumptions used in the ACP-sponsored studies, the benefit estimates they present may be inflated. See Stanton, et al. (2015), and Phillips (2015b) for a review.

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APPENDIX A:
CANDIDATE PER-ACRE VALUES FOR LAND-USE AND ECOSYSTEM SERVICE COMBINATIONS

As explained under "Effects on Ecosystem Service Value," the benefit transfer method applies estimates of ecosystem service value from existing studies of "source areas" to the "study area," which in this case is the proposed ACP corridor. This application is done on a land-use-by-land-use basis. So, for example, values of various ecosystem services associated with forests in the source area are applied to forests in the study area. The table below lists all of the values from source area studies areas considered for our calculations.

Land Use	Ecosystem Service	Minimum $/Acre/year	Maximum $/Acre/year	Source Study
Cropland	Aesthetic	35.01	89.23	(Bergstrom, Dillman, & Stoll, 1985)
	Biological Control	15.21	15.21	(Brenner Guillermo, 2007) *
	Biological Control	14.38	204.95	(Cleveland et al., 2006)
	Erosion	27.31	72.55	(Pimentel et al., 2003) *
	Food	33.25	33.25	(Lex & Groover, 2015)
	Pollination	10.14	10.14	(Brenner Guillermo, 2007) *
	Pollination	13.89	13.89	(Robinson, Nowogrodzki, & Morse, 1989)
	Pollination	47.43	1,987.97	(Winfree, Gross, & Kremen, 2011)
	Recreation	18.77	18.77	(Brenner Guillermo, 2007) *
	Recreation	2.16	5.02	(Knoche & Lupi, 2007)
	Soil Fertility	7.28	7.28	(Pimentel, 1998) *
	Soil Fertility	115.23	115.23	(Pimentel et al., 2003)
	Waste	132.26	132.26	(Perrot-Maiître & Davis, 2001) *
Grasslands	Aesthetic	102.38	116.61	(Ready, Berger, & Blomquist, 1997)
	Biological Control	15.21	15.21	(Brenner Guillermo, 2007) *
	Climate	3.55	3.55	(Brenner Guillermo, 2007) *
	Erosion	17.48	17.48	(Barrow, 1991) *
	Erosion	68.28	68.28	(Sala & Paruelo, 1997) *
	Food	15.50	15.50	(Lex & Groover, 2015) *
	Pollination	16.23	16.23	(Brenner Guillermo, 2007) *
	Soil Fertility	3.55	3.55	(Brenner Guillermo, 2007) *
	Waste	55.28	55.28	(Brenner Guillermo, 2007) *
	Waste	5.88	64.40	(Ministerie van Landbouw & Natuur en Voedselkwaliteit, 2006) *
	Water Flows	2.54	2.54	(Brenner Guillermo, 2007) *
Pasture	Aesthetic	102.38	116.61	(Ready et al., 1997)
	Biological Control	15.21	15.21	(Brenner Guillermo, 2007) *
	Climate	3.55	3.55	(Brenner Guillermo, 2007) *
	Erosion	17.48	17.48	(Barrow, 1991) *
	Erosion	68.28	68.28	(Sala & Paruelo, 1997) *
	Food	15.50	15.50	(Lex & Groover, 2015)
	Pollination	16.23	16.23	(Brenner Guillermo, 2007) *
	Soil Fertility	3.55	3.55	(Brenner Guillermo, 2007) *

Land Use	Ecosystem Service	Minimum $/Acre/year	Maximum $/Acre/year	Source Study
Pasture, cont'd	Waste	55.28	55.28	(Brenner Guillermo, 2007) *
	Waste	5.88	64.40	(Ministerie van Landbouw & Natuur en Voedselkwaliteit, 2006) *
	Water Flows	2.54	2.54	(Brenner Guillermo, 2007) *
Shrub/Scrub	Air Quality	37.26	37.26	(Ministerie van Landbouw & Natuur en Voedselkwaliteit, 2006) *
	Climate	7.27	7.27	(Croitoru, 2007) *
	Erosion	22.75	22.75	(Ministerie van Landbouw & Natuur en Voedselkwaliteit, 2006) *
	Pollination	1.41	7.10	(Robert Costanza, Wilson, et al., 2006)
	Recreation	3.95	3.95	(Haener & Adamowicz, 2000)
	Waste	46.35	46.35	(Croitoru, 2007) *
	Waste	0.10	324.35	(Ministerie van Landbouw & Natuur en Voedselkwaliteit, 2006) *
Forest	Aesthetic	4,439.71	18,141.99	(Nowak, Crane, Dwyer, & others, 2002)
	Air Quality	372.57	372.57	(Ministerie van Landbouw & Natuur en Voedselkwaliteit, 2006) *
	Biological Control	8.91	8.91	(Wilson, 2005) *
	Biological Control	2.54	2.54	(Brenner Guillermo, 2007) *
	Climate	67.45	67.45	(Brenner Guillermo, 2007) *
	Climate	56.89	56.89	(Robert Costanza, d'Arge, et al., 2006)
	Erosion	61.87	61.87	(Brenner Guillermo, 2007) *
	Erosion	3.09	36.09	(Zhou, Al-Kaisi, & Helmers, 2009)
	Extreme Events	797.66	797.66	(Weber, 2007)
	Food	0.13	0.13	(Wilson, 2005) *
	Pollination	202.87	202.87	(Brenner Guillermo, 2007) *
	Raw Materials	24.53	24.53	(Wilson, 2005) *
	Raw Materials	166.82	166.82	(Weber, 2007)
	Recreation	152.66	152.66	(Brenner Guillermo, 2007) *
	Recreation	1.29	4.55	(Cruz & Benedicto, 2009) *
	Recreation	1.56	1.56	(Kniivila, Ovaskainen, & Saastamoinen, 2002) *
	Recreation	37.13	45.50	(Prince & Ahmed, 1989)
	Recreation	2.79	503.97	(Shafer, Carline, Guldin, & Cordell, 1993)
	Soil Fertility	6.09	6.09	(Brenner Guillermo, 2007) *
	Soil Fertility	19.97	19.97	(Weber, 2007)
	Waste	55.28	55.28	(Brenner Guillermo, 2007) *
	Waste	8.66	8.66	(Cruz & Benedicto, 2009) *
	Waste	265.79	266.89	(Lui, 2006)
	Water	204.39	204.39	(Brenner Guillermo, 2007) *
	Water	47.39	47.39	(Cruz & Benedicto, 2009) *
	Water	1,292.23	1,292.23	(Weber, 2007)
	Water Flows	230.01	230.01	(Mates, 2007)
	Water Flows	797.66	797.66	(Weber, 2007)

Land Use	Ecosystem Service	Minimum $/Acre/year	Maximum $/Acre/year	Source Study
Water	Recreation	446.31	446.31	(Brenner Guillermo, 2007) *
	Recreation	155.36	914.10	(Cordell & Bergstrom, 1993)
	Recreation	304.18	437.19	(Mullen & Menz, 1985)
	Recreation	148.68	148.68	(Postel & Carpenter, 1977)
	Waste	10.72	10.72	(Gibbons, 1986) *
	Water	512.74	512.74	(Brenner Guillermo, 2007) *
	Water	22.98	22.98	(Gibbons, 1986) *
Wetland	Aesthetic	38.46	38.46	(Amacher & Brazee, 1989) *
	Air Quality	75.50	98.02	(Jenkins, Murray, Kramer, & Faulkner, 2010)
	Climate	1.84	1.84	(Wilson, 2005) *
	Climate	157.73	157.73	(Brenner Guillermo, 2007) *
	Extreme Events	228.06	369.85	(Wilson, 2005) *
	Extreme Events	110.06	4,583.26	(Brenner Guillermo, 2007) *
	Extreme Events	304.18	304.18	(Robert Costanza, Farber, & Maxwell, 1989)
	Extreme Events	278.77	278.77	(Robert Costanza & Farley, 2007)
	Extreme Events	1,645.59	7,513.98	(Leschine, Wellman, & Green, 1997)
	Raw Materials	50.16	50.16	(Everard, Great Britain, & Environment Agency, 2009)
	Recreation	80.71	80.71	(Bergstrom, Stoll, Titre, & Wright, 1990)
	Recreation	1,716.76	1,761.89	(Brenner Guillermo, 2007) *
	Recreation	109.30	429.97	(Robert Costanza et al., 1989)
	Recreation	1,041.04	1,041.04	(Creel & Loomis, 1992)
	Recreation	88.06	994.50	(Gren & Söderqvist, 1994) *
	Recreation	71.11	71.11	(Gren, Groth, & Sylven, 1995) *
	Recreation	208.01	208.01	(Kreutzwiser, 1981)
	Recreation	209.51	209.51	(Lant & Roberts, 1990) *
	Recreation	648.57	4,203.82	(Whitehead, 1990)
	Waste	141.56	141.56	(Wilson, 2005) *
	Waste	67.02	67.02	(Breaux, Farber, & Day, 1995)
	Waste	1,050.34	1,050.34	(Brenner Guillermo, 2007) *
	Waste	170.05	170.05	(Gren & Söderqvist, 1994) *
	Waste	35.20	35.20	(Gren et al., 1995) *
	Waste	551.02	551.02	(Jenkins et al., 2010)
	Waste	209.51	209.51	(Lant & Roberts, 1990) *
	Waste	5,027.28	5,027.28	(Meyerhoff & Dehnhardt, 2004) *
	Waste	10,881.15	10,881.15	(Lui, 2006)
	Water	1,934.84	2,407.52	(Brenner Guillermo, 2007) *
	Water	622.77	622.77	(Creel & Loomis, 1992)
	Water	18.19	18.19	(Folke & Kaberger, 1991) *
	Water Flows	3,741.87	3,741.87	(Brenner Guillermo, 2007) *
	Water Flows	3,920.69	3,920.69	(Leschine et al., 1997)
	Water Flows	4,329.70	4,329.70	(UK Environment Agency, 1999)

Land Use	Ecosystem Service	Minimum $/Acre/year	Maximum $/Acre/year	Source Study
Urban Open Space	Aesthetic	1,006.06	1,322.31	(Qiu, Prato, & Boehrn, 2006)
	Air Quality	32.46	32.46	(G. McPherson, Scott, & Simpson, 1998)
	Air Quality	192.35	192.35	(G. E. McPherson, 1992)
	Climate	1,134.38	1,134.38	(G. E. McPherson, 1992)
	Extreme Events	315.52	597.01	(Streiner & Loomis, 1995)
	Water Flows	8.32	8.32	(G. E. McPherson, 1992)
	Water Flows	138.22	187.58	(The Trust for Public Land, 2010)
Urban Other	Climate	420.95	420.95	(Brenner Guillermo, 2007) *
	Recreation	2,670.74	2,670.74	(Brenner Guillermo, 2007) *
	Water Flows	7.61	7.61	(Brenner Guillermo, 2007)

All values are adjusted for inflation to 2014 dollars.

* Indicates source is from the TEEB database.