Impact Analysis of the Marcellus Shale Safe Drilling Initiative

Prepared for
Maryland Department of the Environment

September 22, 2014

Regional Economic Studies Institute

TOWSON UNIVERSITY

Towson, Maryland 21252 | 410-704-3326 | www.towson.edu/resi

Table of Contents

Table of Figures

Acknowledgements

Project Management
Daraius Irani, Ph.D., Chief Economist
Raquel Frye, Managing Director
Jessica Daniels Varsa, Senior Research Associate

Research Team
Regina Asala, Research Assistant
Jade Clayton, Research Assistant
Rebecca Ebersole, Senior Research Associate
Jessica Grimm, Research Associate
Katie Radchenko, Research Assistant
Kierran Sutherland, Research Analyst
Susan Steward, Economist

Peer Reviewers

Lucija Anna Muehlenbachs, Ph.D.	University of Calgary Department of Economics
Clifford A. Lipscomb, Ph.D., MRICS	Greenfield Advisors

RESI would like to thank all those who assisted with surveys, data collection, analysis, and feedback during the study period.

Acronyms and Abbreviations

ACS	American Community Survey
bcf	billion cubic feet
CVM	contigent valuation method
DNR	Department of Natural Resources
EUR	estimated ultimate recovery
FMR	fair market rent
Interior AU	Interior Assessment Unit
mcf	thousand cubic feet
MDE	Maryland Department of the Environment
NAICS	North American Industry Classification System
OLS	ordinary least squares
REMI PI+	Regional Economic Modeling, Inc. Policy Insight +
RESI	Regional Economic Studies Institute
TPA	tourism promotion agency
USGS	U.S. Geological Survey
USDA	U.S. Department of Agriculture
WTP	willingness to pay

1.0 Executive Summary

1.1 Project Objective

As part of the Marcellus Shale Safe Drilling Initiative led by MDE and DNR, RESI of Towson University was tasked with examining several of the potential impact areas associated with Marcellus Shale drilling in Western Maryland. RESI's study aims to provide a context-sensitive understanding of the potential impacts of natural gas exploration and extraction in the Marcellus Shale on the following areas:

- Economic and fiscal impacts,
- Housing impacts,
- Tourism-related impacts,
- Infrastructure and road impacts, and
- Other community impacts.

RESI estimated these impacts using research, analyses, surveying, and stakeholder input. The timeframe for this study includes the short-term drilling period in 2017 through 2026 and the ten-year long-term economic impacts following the last well drilled in 2026.

This document reports the results of RESI's independent, third-party analysis for the purpose of informing decision making relating to the topic areas within the scope defined above. Given the scope, budget, and timeframe, this study relies on secondary quantitative data and primary qualitative information. Primary information included in this study is mainly qualitative and limited to information collected through a contingent valuation survey and a stakeholder interview process. In addition, the study is not intended to provide recommendations relating to these topics nor is it intended to provide recommendations and estimated impacts for other topic areas such as health or transportation impacts. Other studies commissioned through the Marcellus Shale Safe Drilling Initiative examine the potential impacts to health and other topic areas.

1.2 Assumptions

RESI estimated the number of wells and well pads that will be developed under two different possible extraction scenarios. RESI selected the two scenarios because they comprise conservative and feasible extraction rates given the total natural gas reserves in Maryland and the production curve of a horizontal well. The two scenarios illustrate the parameters of these recovery expectations:

- **Scenario 1**, where 25 percent of the total shale gas would be extracted, and
- **Scenario 2**, where 75 percent of the total shale gas would be extracted.

RESI also made several other assumptions to estimate impacts throughout the report. These assumptions are discussed fully in each relevant section.

1.3 Economic and Fiscal Impacts

To analyze the economic and fiscal impacts associated with Marcellus Shale drilling in Western Maryland, RESI used several economic modeling tools including a dynamic input/output model (REMI PI+), a WTP model, and a hedonic pricing model. Most prior studies regarding this topic have only used an input/output model. RESI expected that the inclusion of the WTP and the hedonic price models would provide more comprehensive estimates of economic and fiscal impacts**.**

RESI incorporated several key economic drivers into the REMI PI+ model and analyzed the impacts on employment, output, and wages over a twenty-year period. Figures 1 through 4 include the key findings from RESI's economic and fiscal impact analysis.

Figure 1: Economic and Fiscal Impacts for Allegany County—Scenario 1, 25% Extraction

Impact	Total At Peak	Annually, 2017–2026	Annually, 2027– 2036
Employment	492	224	9
Wages	$12.6 million	$5.9 million	-$0.6 million
Output	$49.7 million	$25.5 million	$1.8 million
Tax revenues	$0.9 million	$0.4 million	$0.1 million
Severance tax revenues	$1.0 million	$0.6 million	$6,624

Sources: REMI PI+, RESI

Figure 2: Economic and Fiscal Impacts for Allegany County—Scenario 2, 75% Extraction

Impact	Total at Peak	Annually, 2017–2026	Annually, 2027– 2036
Employment	908	682	67
Wages	$26.4 million	$18.7 million	-$0.9 million
Output	$101.8 million	$76.3 million	$9.2 million
Tax Revenues	$1.8 million	$1.3 million	$0.4 million
Severance Tax Revenues	$2.3 million	$2.0 million	$68,645

Sources: REMI PI+, RESI

Figure 3: Economic and Fiscal Impacts for Garrett County—Scenario 1, 25% Extraction

Impact	Total at Peak	Annually, 2017–2026	Annually, 2027– 2036
Employment	1,240	1,018	136
Wages	$35.4 million	$29.7 million	$0.5 million
Output	$148.4 million	$122.4 million	$16.2 million
Tax Revenues	$2.5 million	$1.9 million	$0.6 million
Severance Tax Revenues	$4.2 million	$3.5 million	$0.3 million

Sources: REMI PI+, RESI

Figure 4: Economic and Fiscal Impacts for Garrett County—Scenario 2, 75% Extraction

Impact	Total at Peak	Annually, 2017–2026	Annually, 2027– 2036
Employment	2,425	1,848	-44
Wages	$76.7 million	$60.6 million	-$3.5 million
Output	$348.6 million	$264.0 million	$12.5 million
Tax Revenues	$3.6 million	$2.9 million	$0.3 million
Severance Tax Revenues	$13.5 million	$9.9 million	$0.6 million

Sources: REMI PI+, RESI

Changes in employment during the "boom" and "bust" are consistent with literature from other regions. The "bust" period, defined as 2027 through 2036, reports minimal gains to some loss in potential employment given the activity from the "boom" period. Scenario 2 indicates larger impacts during the "bust" cycle given the larger amount of industry activity within the region during the "boom" cycle. However, wages will experience a more pronounced fall than employment in Garrett County under Scenario 2 after active drilling ceases. Owing to the larger presence of drilling as well as the structure and composition of Garrett County's economy, the "bust" period will have a more pronounced impact on Garrett County's economy than Allegany County's.

1.4 Housing Impacts

RESI determined estimates of the potential housing impacts of Marcellus Shale drilling based on existing research and projected in-migration of workers as determined by REMI PI+. The following are RESI's key findings from an analysis of existing housing and projected population changes and housing demand based on RESI's two potential drilling scenarios for Western Maryland.

Allegany County

- With no drilling activity, Allegany County has a small surplus of available (for sale or rent) housing units and a large surplus of unavailable (not for sale or rent but physically existent) housing units.
    - Drilling scenarios 1 and 2 result in a shortage of available housing by 2019, but no shortage in unavailable housing during the ten-year period.

Garrett County

- With or without drilling activity, Garrett County maintains an overall surplus of both available and unavailable housing units throughout the ten-year period.
- Excluding the Deep Creek Lake area from the housing analysis, to limit the inclusion of the second-home and vacation rental market, Garrett County has a shortage of available housing units for all ten years between 2017 and 2026.
    - Without drilling activity, the exclusion of the Deep Creek Lake area reveals an existing shortage of total housing for the ten-year period.

  - With drilling activity, the exclusion of the Deep Creek lake area reveals an overall shortage beginning in 2020 and growing through 2026, without any new residential construction.

Existing studies and research on potential housing impacts in areas with drilling activity provide some insight on what the above quantitative changes mean for communities in Western Maryland as well as how to manage these changes:

- A difference of roughly $40,000 in household wages for Western Maryland residents and a typical natural gas industry employee raises concerns of potential rental rate increases displacing local residents with lower income.
- Rental rates of housing are not expected to increase significantly unless more than 340 wells are drilled within a single year. Residents with short-term leases and lower income are the most at-risk of displacement should drilling impact rental rates in Western Maryland.
- Landlords could potentially benefit from higher rental rates as a form of secondary income, though some landlords may prefer stable, permanent tenants over transient workers.
- Research from Pennsylvania points to rental ordinances and exclusionary zoning ordinances as methods of managing severe changes in housing needs in the presence of drilling activity.
  - New construction was seen as a short-sighted solution, which may cause long-term blight following a "bust" in natural gas extraction.
- Higher rental rates and displacement of already marginalized residents in the most intensely drilled counties have ripple effects: increases in homelessness leading to higher demand for foster care services, increases in school dropout rates, and eventually higher demand for public assistance.

Though many studies describe potentially severe direct and indirect housing impacts due to drilling activity, the existing literature also notes the concurrence of the natural gas "boom" with the recent recession and the difficulty in separating the impacts of each event.

1.5 Tourism-related Impacts

RESI attempted to investigate and describe the potential impacts natural gas development could have on Western Maryland's popular tourism industry, including its second-home market. Due to a lack of data regarding the coexistence of tourism and drilling, the possible impacts to tourism activity in Western Maryland were difficult to quantify. The overlap of the Marcellus Shale region's peak years of natural gas extraction, collocation with other extractive industries, and the recent national recession present challenges in predicting the magnitude of the impacts on other areas with new drilling activity in a complex, post-recession economy.

Survey responses revealed strong monthly if not daily participation in outdoor recreation amongst residents and visitors of Western Maryland, in addition to concerns about the quality of local rivers and streams, wildlife habitat, and other open space. In lieu of a quantitative analysis, RESI's research identified some potential qualitative impacts relying on both actual and perceived changes brought on by drilling activity.

The presence of natural gas development has the potential to limit consumers of tourism and recreation by limiting access to tourism destinations in the following ways:

- Increased traffic or road damage reduces tourists' access to Western Maryland;
- Strained hotel and lodging capacity limits options for tourists who are not second-home owners; and
- A reduction in the availability or quality of tourism related products and services can affect the number of visitors and second-home owners.

The presence of natural gas development also has potential to impact firms and businesses by limiting access to and availability of shared resources such as labor, water, and land.

Negative economic impacts on the tourism industry may be offset by increased hotel taxes in the short term, but state and local governments will need to evaluate existing hotel and amusement tax policies to fully capture the expenditures of a transient workforce and to sustain the entire tourism industry in the long term.

1.6 Roads and Infrastructure

During RESI stakeholder meetings, residents of Western Maryland also expressed concerns regarding the possible increase in truck volume due to drilling activity. The true magnitude of impacts will ultimately depend on the number of well pads, number of wells per pad, and the total volume of water needed for each well. To quantify the possible magnitude of impacts to truck trips for each drilling scenario, RESI used data for truck trip estimates provided by MDE. RESI applied these estimates to the projected well pad and well build out from Scenarios 1 and 2. The following are the impacts to truck activity that can be expected for the active drilling period between 2017 and 2026:

- For Scenario 1, the increase in truck activity for Western Maryland amounts to an average annual addition of 22,595 truck trips for heavy-duty trucks and 7,903 for light-duty trucks.
- For Scenario 2, the increase in truck activity for Western Maryland amounts to an average annual addition of 67,785 truck trips for heavy-duty trucks and 23,708 for light-duty trucks.

1.7 Other Community Impacts

To analyze the potential community impacts of Marcellus Shale drilling in Maryland, RESI conducted a thorough review of relevant literature, engaged with and surveyed stakeholders,

and performed a spatial and qualitative analysis of relevant data. RESI's discussions with community members and local representatives revealed several major areas of concern:

- Agriculture,
- Education and schools,
- Public health and safety
- Environmental protection,
- Housing availability and values,
- Infrastructure and investment,
- Economic and fiscal sustainability, and
- Property rights.

Some of the listed topics are covered in other reports as part of the Marcellus Shale Safe Drilling Initiative. Impacts on environmental amenities are broad reaching and have implications throughout the economic, tourism, and community impacts discussed throughout this report.

2.0 Introduction to Western Maryland

The majority of the Marcellus Shale formation that is within Maryland's borders is located beneath Western Maryland—specifically, Allegany and Garrett Counties.[1] Residents and other stakeholders in Western Maryland face unique economic challenges compared to those in other regions of Maryland. The region contends with slower employment growth, higher unemployment rates, and other socioeconomic challenges.

To accurately analyze the impacts of the Marcellus Shale drilling, RESI first collected background information on the counties comprising the impacted region. Such information included the economic conditions and trends in Western Maryland (Allegany and Garrett Counties), the history of energy development in the region, and prospects for Marcellus Shale drilling.

2.1 Economic Conditions and Trends

To provide background on the unique challenges faced by Western Maryland, RESI collected data regarding employment, unemployment, income, and educational attainment. Where appropriate, RESI included state-level statistics for the purpose of comparison.

The labor force[2] of Western Maryland included an estimated 48,839 workers,[3] with Allegany County's labor force comprising 69.3 percent of that total, as of 2012.[4] Of the total civilian labor force, 48.7 percent[5] and 57.5 percent[6] were employed in Allegany and Garrett Counties, respectively, in 2012, compared with 63.6 percent[7] statewide.

Figure 5 shows the top five industries by employment for Allegany and Garrett Counties.

[1] For the purpose of this analysis, RESI considered the Western Maryland region to include Allegany and Garrett Counties.
[2] Note that labor force counts comprise both employed and unemployed workers whereas employment counts comprise only employed workers.
[3] U.S. Census Bureau, "SELECTED ECONOMIC CHARACTERISTICS," in *2008-2012 American Community Survey 5-Year Estimates*, accessed February 7, 2014, http://factfinder2.census.gov/.
[4] Ibid.
[5] Ibid.
[6] Ibid.
[7] Ibid.

Figure 5: Top Five Industries by Private Employment and County, 2012

County/Industry	Employment	Percentage
Allegany County		
Health care and social assistance	6,142	27.3%
Retail trade	3,758	16.7%
Accommodation and food services	3,056	13.6%
Manufacturing	2,511	11.1%
Administrative and waste services	1,351	6.0%
Top 5 Total	**22,537**	**74.6%**
Garrett County		
Retail trade	1,670	17.2%
Accommodation and food services	1,204	12.4%
Manufacturing	1,050	10.8%
Construction	779	8.0%
Arts, entertainment, and recreation	411	4.2%
Top 5 Total	**9,708**	**52.7%**

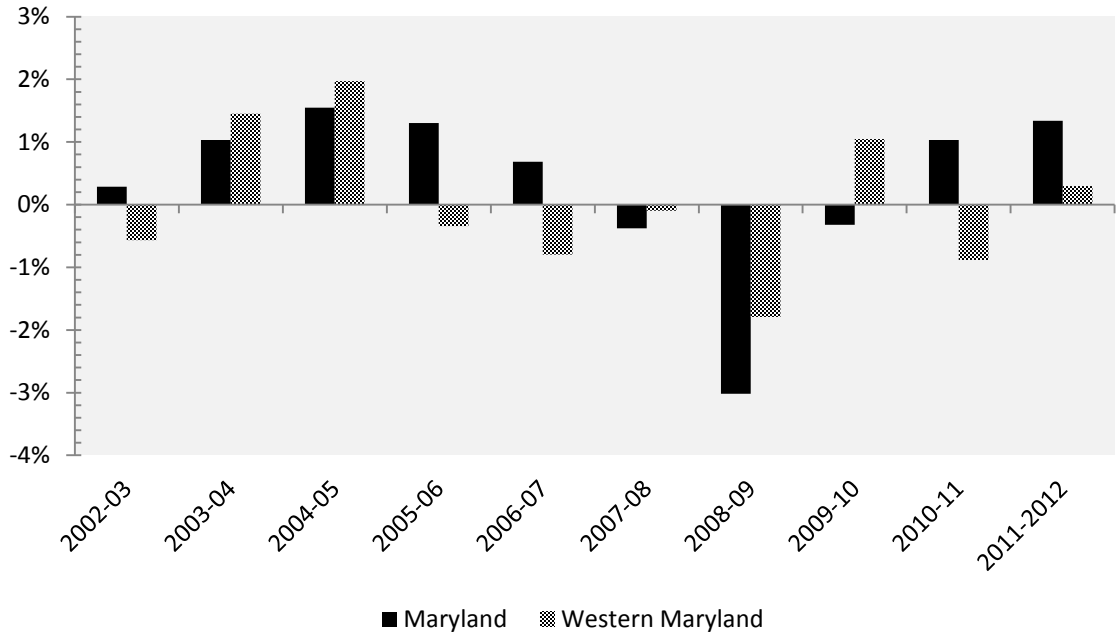
Source: BLS QCEW

The top five industries by employment vary between Allegany and Garrett Counties, with Health Care and Social Assistance and Retail Trade as the largest industries, respectively. The top five industries in Allegany County encompass 74.6 percent of all employment in the county, whereas 52.7 percent of Garrett County employment is captured in its top five industries.

Figure 6 shows the year-over-year change in employment for Western Maryland over the ten-year period between 2002 and 2012.[8]

[8] "Employment" as measured by the Quarterly Census of Employment and Wages refers to the total number of employees who worked or received compensation at some point(s) over a specific period (in this case, a calendar year).

Figure 6: Percent Change in Employment, 2002–2012



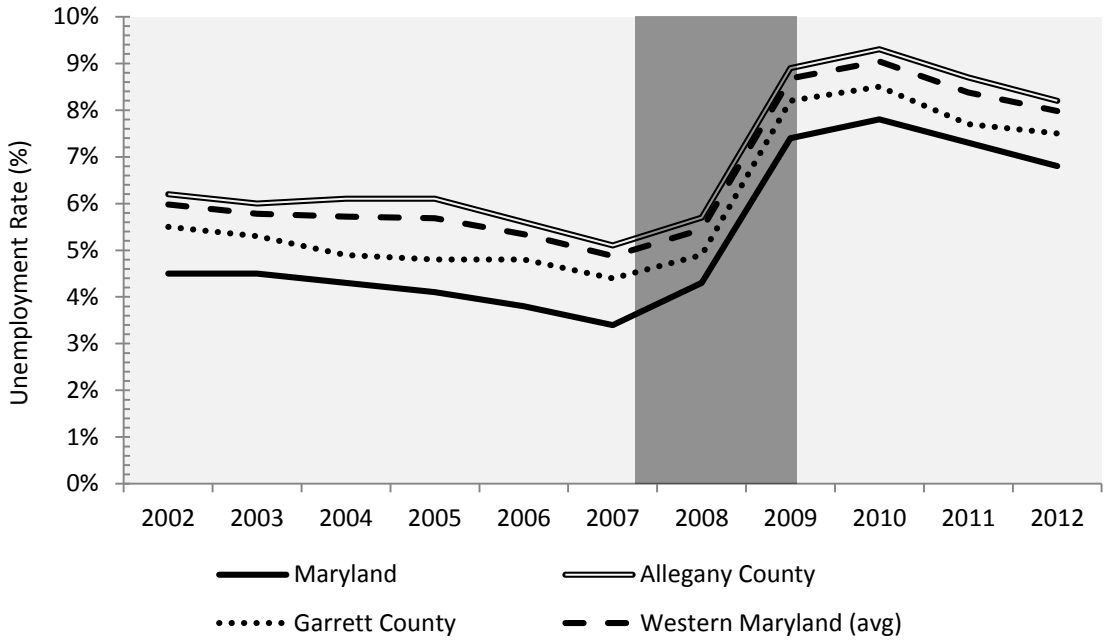
Source: BLS QCEW

Western Maryland's year-over-year change in employment has not always followed the trend for Maryland. Since 2002, the region has lost employment over four different periods during which employment increased statewide. Regional employment growth between 2002 and 2012 was relatively negligible, at 0.2 percent—compared to a 3.5 percent growth rate for the state during the same period.[9]

Figure 7 shows the unemployment rate for Maryland, Western Maryland, and its component counties between 2002 and 2012.

[9] "Quarterly Census of Employment and Wages," U.S. Bureau of Labor Statistics, 2012, accessed February 7, 2014, http://www.bls.gov/qcew/.

Figure 7: Unemployment Rate, 2002–2012[10]



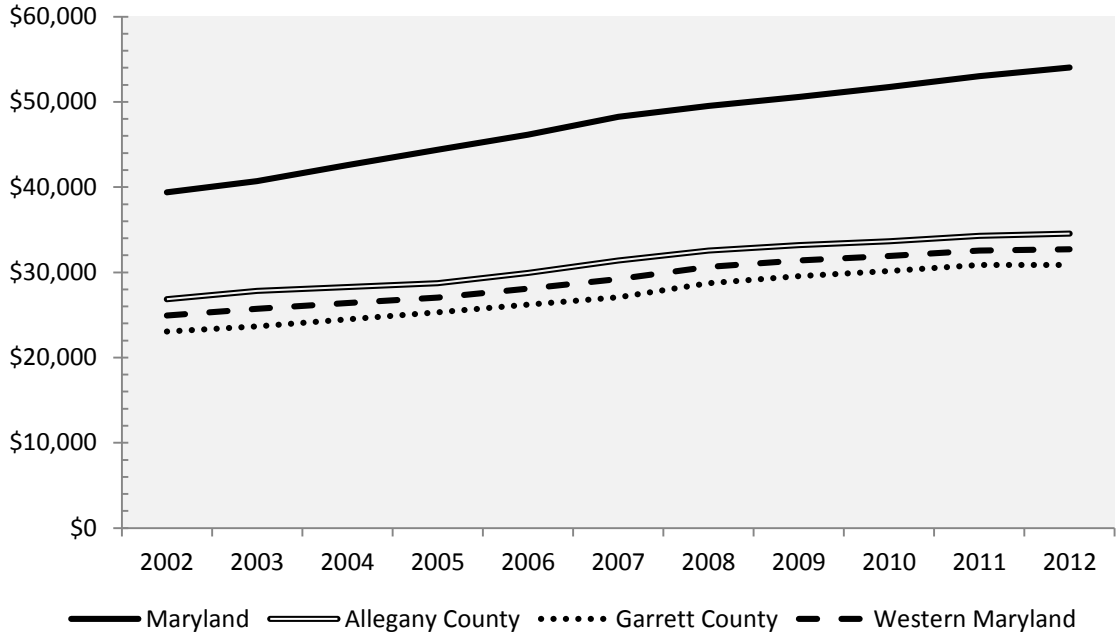
Source: BLS LAUS, NBER

Western Maryland's unemployment rate (expressed as an average between Allegany and Garrett Counties weighted for the total labor force for each county) has been historically higher than that for the state overall between 2002 and 2012. However, the region's unemployment rates appear to have followed a similar trend to Maryland's over the ten-year period, dipping to their lowest in 2007, increasing through 2010 (coinciding with the Great Recession), and then falling again through 2011 and 2012.

Figure 8 shows the average annual pay for all industries in Western Maryland between 2002 and 2012.

[10] The shaded area represents the official time period of the Great Recession according to the National Bureau of Economic Research.

Figure 8: Average Annual Pay, 2002–2012



Source: BLS QCEW

Average annual pay for Western Maryland workers has historically been lower than annual pay statewide, although it has steadily increased since 2002. As of 2012, the average annual pay for a worker in Western Maryland (averaged between Allegany and Garrett Counties) was approximately $32,706, compared with $54,035 for all Maryland workers.[11] Median household income in Western Maryland has fared similarly, at $42,221[12] as of 2012 compared to $72,999 for Maryland overall.[13]

Despite comparatively lower average annual pay and median household income compared to Maryland, Western Maryland's cost of living is lower. According to the Department of Business and Economic Development's Cost of Living Index for Maryland Counties, Allegany and Garrett Counties have indices of 86.7 and 99.8, respectively, as compared with an average index across all Maryland counties of 106.3.[14] The Cost of Living Index uses "a standard set of goods and services based on the Bureau of Labor Statistics' Consumer Expenditure Survey, including

[11] "Quarterly Census of Employment and Wages," U.S. Bureau of Labor Statistics.
[12] U.S. Census Bureau, "SELECTED ECONOMIC CHARACTERISTICS."
[13] Ibid.
[14] "Cost of Living," Department of Business and Economic Development, accessed April 17, 2014, http://www.choosemaryland.org/live/pages/costofliving.aspx.

housing, utilities, transportation, food and clothing, to calculate consumer expenditures for Maryland jurisdictions" and compare those expenditures to the U.S. averages.[15]

Figure 9 includes the educational attainment levels for Allegany and Garrett Counties as well as the state.

Figure 9: Educational Attainment, 2008–2012

Educational attainment	Maryland	Allegany County	Garrett County
Some high school, no diploma	11.5%	13.1%	15.1%
High school graduate (includes equivalency)	26.0%	42.8%	42.7%
Some college, no degree	19.9%	19.9%	17.2%
Associate's degree	6.2%	8.0%	7.0%
Bachelor's degree	20.0%	8.9%	10.2%
Graduate or professional degree	16.4%	7.2%	7.8%

Source: Census 2008-2012 American Community Survey 5-year estimates

The component counties of Western Maryland have lower educational attainment than for the state overall. The plurality of residents of Allegany and Garrett Counties—42.8 and 42.7 percent, respectively—indicated high school as their highest form of completed education.[16] A smaller share of residents of both counties holds a Bachelor's or graduate or professional degree.

After collecting data regarding the current economic conditions of Western Maryland, RESI explored the history of energy development in the region. The following section provides a brief overview of the history of energy development.

2.2 History of Energy Development

Coal and natural gas have historically played a significant role in the economies of Allegany and Garrett Counties. According to representatives from MDE, coal mining began in the 1700s, and production peaked in the early 1900s at over five million short tons per year. It declined to less than one million short tons per year by the 1950s; production fluctuated thereafter, peaking above five million in 2004 but then dropping to between two million and three million short

[15] Jim Palma, "Baltimore's cost of living stacks up well," *MDBIZNews*, August 21, 2012, accessed May 19, 2014, http://mdbiznews.choosemaryland.org/2012/08/21/baltimores-cost-of-living-stacks-up-well/.
[16] U.S. Census Bureau, "SELECTED SOCIAL CHARACTERISTICS," In *2008-2012 American Community Survey 5-year estimates*, accessed February 7, 2014, http://factfinder2.census.gov/.

tons per year between 2007 and 2012.[17] In recent years, employment in coal mines in Maryland has varied between 400 and 500.[18]

Natural gas has been produced in Allegany and Garrett Counties for decades, with production peaking in the 1950s and declining thereafter.[19] There are still a few wells producing natural gas in Garrett County, according to MDE. Natural gas arrives in Garrett County by interstate pipelines and is temporarily stored in the depleted reservoir of the Oriskany sandstone in the Accident Storage Field so that it is available to meet peak demand.[20] The Deep Creek Power Plant, located in Garrett County, is a hydroelectric power station that has been in operation since 1925.[21] According to its website, the plant is capable of producing 18 megawatts of electricity through two turbines. Deep Creek Lake, which is the reservoir that is used to power the turbines, is also an attractive area for recreational activities.

More recently, renewable energy sources in the form of wind turbines have been established in Western Maryland. According to MDE, two installations have been completed; a third one has been approved by the Public Service Commission. In addition, there is interest in the use of forest products in biomass (wood) boilers.[22] Other distributed electricity generation approaches, such as solar and small scale wind, have also gained popularity within the region.[23]

2.3 Prospects for Marcellus Shale Gas Development

Interest in natural gas development in Western Maryland waned until advancements were made in horizontal drilling and high volume hydraulic fracturing. With these technologies, it became potentially economical to extract gas from deep shale deposits like the Marcellus Shale.

According to a 2011 report by the USGS, the Interior AU of the Marcellus Shale region holds approximately 96 percent, or 41,607 bcf, of the total undiscovered resources.[24] USGS estimates

[17] Brigid Kenney, email message to author, February 4, 2014.
[18] Ibid.
[19] Ibid.
[20] Ibid.
[21] "Station Statistics," Deep Creek Hydro, accessed February 26, 2014, http://www.deepcreekhydro.com/StationStatistics.html.
[22] Kenney, email message to author, February 4, 2014.
[23] "Smart Energy Investment Map," Maryland Energy Administration, accessed February 26, 2014, http://energy.maryland.gov/map/index.html.
[24] James L. Coleman et al., "Assessment of Undiscovered Oil and Gas Resources of the Devonian Marcellus Shale of the Appalachian Basin," U.S. Geological Survey (2011): 2, accessed September 18, 2013, http://pubs.usgs.gov/fs/2011/3092/pdf/fs2011-3092.pdf.

that Maryland has approximately 1.69 percent of the Interior AU.[25] Using these numbers, RESI estimated that the total potential undiscovered resources of Marcellus Shale gas in Maryland was approximately 703 bcf—less than 10 percent of the total Shale play in the region.

Beginning in 2009, a few applications were filed with MDE for permits for natural gas wells in the Marcellus Shale, but the applications were withdrawn before any final decision. In 2011, Governor Martin O'Malley issued Executive Order 01.01.2011.11, the Marcellus Shale Safe Drilling Initiative, directing MDE and DNR in consultation with an Advisory Commission to investigate various issues relating to gas development from the Marcellus Shale, including an assessment of the possible economic impacts.

While an assessment of potential impacts may include industry sales, home price valuations, environmental amenities valuation, and royalty payments, royalty payments are harder to quantify for residential increased income. Under Pennsylvania law, the minimum recorded percentage a lease holder can be paid in a royalty for shale drilling is 12.5 percent of the production value.[26]

Given the production levels and potential U.S. Energy Information Administration forecasted prices for natural gas, RESI could quantify the potential royalty payments made to lease holders. However, these payments would be made to mineral rights holders, and under Maryland law an estate can be "split." According to a publication by University of Maryland's Center for Agricultural and Natural Resource Policy, a property owner within Maryland could own both surface and mineral rights, or only one of those rights for the estate.[27] This can be problematic, since it is possible that the owner of the mineral rights doesn't live in the region, but under law they retain some use of the surface rights.[28]

These severed estates may create problems in analyzing the potential increased household income from royalty payments in the region. Due to this issue, RESI has left the royalty payments out of their analysis for households. However, the royalty payments would be paid by firms to individuals for leasing their rights, but at this time is unclear whether or not those individuals reside in Western Maryland.

---

[25] U.S. Geological Survey, presentation on percentage estimates of natural gas share by state, October 18, 2013, email attachment from Brigid Kenney.
[26] Commonwealth of Pennsylvania Legislature, "Oil and Gas – Lease to Remove or Recover Act of July 20, 1979," P.L. 183, No. 60 (1979): 2, http://www.legis.state.pa.us/WU01/LI/LI/US/HTM/1979/0/0060..HTM.
[27] "State Review of Environmental Impacts Could Result in Mineral Leasing Opportunities in Maryland," University of Maryland Center for Agricultural and Natural Resource Policy, (May 2014): EB-418, accessed September 9, 2014, http://drum.lib.umd.edu/bitstream/1903/15075/1/EB%20418%20Natural%20Gas.pdf.
[28] Ibid.

This report seeks to estimate the potential community, economic, and fiscal impacts associated with the Marcellus Shale Safe Drilling Initiative. The report uses current estimates provided by USGS and EIA for potential reserves to build two hypothetical scenarios and estimate impacts.

3.0 Assumptions and Scenarios

To estimate the impacts associated with potential Shale drilling in Western Maryland, RESI first developed a series of assumptions. These assumptions shaped the two scenarios used for analysis. The number of wells, well pads, royalty/lease payments, production decline, and total EUR of a well are some of the assumptions that are outlined in this section. From these assumptions, RESI created two scenarios:

- **Scenario 1**, where 25 percent of the total shale gas would be extracted, and
- **Scenario 2**, where 75 percent of the total shale gas would be extracted.

RESI chose the 25 and 75 percent estimates as these projections are conservative, feasible extraction rates. Although some researchers have cited 30 percent as a minimum rate of total extraction, RESI's lower bound of 25 percent captured the estimated 30 percent with feasible profitability for existing producers.[29] RESI considered these scenarios throughout the analysis to determine the potential impacts of Marcellus Shale drilling in Western Maryland. RESI used these scenarios as guidelines to establish assumptions regarding Marcellus Shale drilling.

3.1 Existing Research

3.1.1 Economic and Fiscal Impacts in Other States

A number of analyses have sought to estimate the traditional economic impacts (employment and output) and fiscal impacts (state and local tax revenues) of shale drilling in other states. Figure 10 summarizes the key findings from these impact analyses.

[29] U.S. Energy Information Administration, "Technically Recoverable Shale Oil and Shale Gas Reserves: An Assessment of 137 Shale Formations in 41 Countries Outside of the United States," (June 2013): 16, accessed February 20, 2014, http://www.eia.gov/analysis/studies/worldshalegas/pdf/overview.pdf.

Figure 10: Summary of Economic and Fiscal Impacts for Other States

State	Jobs	Output	Tax Revenues
Marcellus Shale			
New York[30]	8,136–16,272	$764.9 million–$1.53 billion	$4.3 million–$8.6 million
West Virginia[31]	7,600	$2.4 billion	$14.5 million
Pennsylvania[32]	29,000–48,000	$2.3 billion–$3.8 billion	$240 million–$400 million
Other Shale Plays			
Louisiana[33]	25,000	-	$150 million
Texas[34]	119,216	$13.7 billion	$1.6 billion
Ohio[35]	65,680	$9.6 billion	$433.5 million

Sources: see footnotes

In most cases, these studies estimated impacts based on assumed drilling scenarios. It is important to note that some claims and assumptions made in these and similar analyses have created significant debate. However, these estimates provide general background on the range of economic and fiscal outcomes that have been reported that could result from drilling. For more information regarding these impacts, please refer to Appendix F of this report.

[30] Bernard L. Weinstein and Terry L. Clower, "Potential Economic and Fiscal Impacts from Natural Gas Production in Broome County, New York," July 2009, 10, accessed February 12, 2014, http://www.gobroomecounty.com/files/countyexec/Marcellus-Broome%20County-Preliminary%20Report%20for%20distribution%207-27-09.pdf.

[31] Amy Higginbotham et al., "The Economic Impact of the Natural Gas Industry and the Marcellus Shale Development in West Virginia in 2009," West Virginia University (December 2010): 24, accessed February 12, 2014, http://www.be.wvu.edu/bber/pdfs/BBEr-2010-22.pdf.

[32] Timothy J. Considine, Robert Watson, and Seth Blumsack, "The Economic Impacts of the Pennsylvania Marcellus Shale Natural Gas Play: An Update," Pennsylvania State University (May 24, 2010), accessed February 12, 2014, http://marcelluscoalition.org/wp-content/uploads/2010/05/PA-Marcellus-Updated-Economic-Impacts-5.24.10.3.pdf.

[33] Manfred Dix and Greg Albrecht, "An Economic Impact Analysis of the Haynesville Shale Natural Gas Exploration, Drilling and Production: Some Preliminary Results," August 28, 2008, accessed February 12, 2014, http://dnr.louisiana.gov/assets/docs/mineral/haynesvilleshale/manfred-dix-impact-analysis.pdf.

[34] The Perryman Group, "A Decade of Drilling: The Impact of the Barnett Shale on Business Activity in the Surrounding Region and Texas," August 2011, 18, accessed February 12, 2014, http://barnettprogress.com/media/BarnettShaleStudy11.pdf.

[35] Thomas et al., "An Analysis of the Economic Potential for Shale Formations in Ohio," Ohio Shale Coalition (2012): 2, accessed February 13, 2014, http://urban.csuohio.edu/publications/center/center_for_economic_development/Ec_Impact_Ohio_Utica_Shale_2012.pdf.
Ohio Shale Coalition, 2012, 2.

3.1.2 Stakeholder Perceptions of Economic and Fiscal Impacts in Western Maryland

Marcellus Shale drilling brings hope to rural areas in need of economic opportunity, especially following the recent recession. Stakeholders speculated on the short-term and long-term impacts to the economy based on expected jobs, wages, and market behavior generated by the addition of drilling activity. Discussion also revolved around the potential revenues from impact fees and changes to revenue generation from property taxes dependent on Marcellus Shale drilling's impacts on property values in the region.

Economic Impacts

A common overarching concern for both counties was long-term economic development and sustainability. Both counties have a history of extractive industry development, as well as recent development of wind turbines and hydroelectric power. The two counties are seeking ways to strengthen and diversify their economies; however, neither counties' stakeholders identified shale development as a silver bullet, and they hope for more extensive planning to be completed compared to the rapid development of wind energy.

Ultimately, stakeholders are concerned that development of natural gas in western Maryland will mirror the "boom and bust" cycle observed in other extractive industries, and thereby edge out other sources of growth that provide a more sustainable economic future. Others questioned if the natural gas reserves in western Maryland are abundant enough to attract a damaging rate of development or if market behavior will be enough to keep a manageable pace. Stakeholders seemed split on whether shale development has been managed properly in other states.

Fiscal Impacts

Stakeholders conceded that most leases have expired in Maryland, and property owners had been leasing mineral rights for as low as five dollars per acre. Stakeholders hoped that property owners will use time during the moratorium to become more educated on property rights and get a fair price for leasing mineral rights. A fair price is believed to be valued in thousands of dollars per acre. Stakeholders pointed to a decline in participation in State agricultural and conservation easements as a sign of eagerness to enter into gas leases. If property owners continued participating in such easements, they would be prohibited from allowing industrial activity, including drilling for natural gas, on the eased properties.

Should property owners continue to lease mineral rights for cheap prices, concern arose that the costs of damage to property values and environmental amenities will far outweigh the payout of leases. Allegany and Garrett Counties impose severance taxes of 7.0 percent and 5.5 percent, respectively. The revenues from severance taxes are meant to feed into the general fund and municipalities. Currently, Garrett County's budget is heavily dependent on property taxes generated by properties in the Deep Creek Lake area, an area with over 80 percent of non-residents whose expenditures are not captured within the county year round. Relating to concerns about economic sustainability, some see the potential for growing severance tax

revenues as a method of decreasing dependence on property taxes, if not to offset potential losses in property tax revenue should property values fall.

Retaining the resort community appeal around the lake is important when considering impacts on the local housing market. Home values are down due to the recent housing crisis, and drilling has the potential to further reduce home values. After the "bust," stakeholders are concerned that values may remain low. The lack of zoning in areas outside of the Deep Creek Lake area is also suspected to have impacted property values in Garrett County, and a lack of regulation on land use could be increasingly detrimental with the presence of increased industrial activity.

With over half of Garrett County's budget generated by lake area property taxes, and a majority of sales tax revenues generated by tourism, stakeholders are concerned that natural gas drilling in Maryland could be a zero-sum game. If properties around Deep Creek Lake are devalued by the presence of natural gas drilling, the core of the County's property taxes could deteriorate. In addition, stakeholders noted bonds for reclamation of land are too small and do not encourage commitment to reclaiming land after abandoning a well.

3.2 Assumptions

To determine the potential impacts associated with Marcellus Shale drilling in Western Maryland, RESI assumed some aspects of natural gas drilling. These assumptions reference the following:

- Total natural gas reserves in Maryland,
- Number of wells and well pads for extraction,
- Production curve of a well, and
- Potential industry sales.

Several studies regarding natural gas drilling impacts using direct and indirect methodologies exist. However, since there is no recent natural gas drilling to date in Maryland, RESI made some assumptions to build the model for analysis. To capture the overarching economic and fiscal impacts associated with shale drilling in Western Maryland, RESI considered both industry and indirectly associated data, such as conservation funding and housing prices. Using Scenarios 1 and 2, 25 percent and 75 percent rates of extraction, respectively, RESI built a set of assumptions to define the model development.

3.2.1 Total Natural Gas Reserves in Maryland

According to a 2011 report by the USGS, the Interior AU of the Marcellus formation holds approximately 96 percent of the total undiscovered resources, or 41,607 bcf.[36] The USGS estimates that Maryland holds approximately 1.69 percent of the Interior AU of the Marcellus region. The Interior AU mainly comprises RESI's study area of Allegany and Garrett Counties. Marcellus Shale units are measured in thickness, or size, where the Interior represents shale deposits equal or greater to 50 feet.[37] RESI applied this percentage against the 41,607 bcf total and estimated that the total potential undiscovered resources of shale gas in Maryland are approximately 703 bcf.

Under the low scenario of extraction, or Scenario 1, RESI assumed that producers will extract 25 percent of the total potential recoverable shale gas, or approximately 175 bcf.[38] Alternatively, under the high scenario of extraction, or Scenario 2, RESI assumed producers will extract 75 percent of the total reserves, or approximately 527 bcf.[39] Using these total potential estimates, RESI estimated the number of wells needed to generate the total estimated extraction.

3.2.2 Wells and Well Pads

To determine the number of wells needed under each scenario, RESI projected the total EUR of a well over its lifetime. A 2012 USGS report on well production estimated that an Interior AU Marcellus well could produce 1.158 bcf over its lifetime.[40] Dividing the total potential recovery under Scenario 1 by 1.158 bcf, RESI estimated that producers will need approximately 150 wells for extraction. Under Scenario 2, RESI estimated that producers will need approximately 450 wells for extraction.

Contrary to their historical preference for vertical wells in Allegany and Garrett Counties, natural gas producers are beginning to shift toward horizontal drills in the Marcellus Shale

---

[36] Coleman et al., "Assessment of Undiscovered Oil and Gas Resources of the Devonian Marcellus Shale of the Appalachian Basin," 2.
[37] U.S. Geological Survey Oil and Gas Assessment Team, "Variability of Distributions of Well-Scale Estimated Ultimate Recovery for Continuous (Unconventional) Oil and Gas Resources in the United States," 2012, accessed September 18, 2013, http://pubs.usgs.gov/of/2012/1118/OF12-1118.pdf.
[38] According to EIA, Maryland has approximately 1.09 percent of the areal extent of the Marcellus formation. Considering the three Assessments Units (Interior, Foldbelt, and Western Margin) separately, USGS estimates that Maryland has approximately 1.69 percent of the Interior AU, which contains 96 percent of the total undiscovered resource, 2.28 percent of the Foldbelt AU, and none of the Western Margin AU. The number chosen for the scenarios represents the Interior AU only (703 bcf). The number in the December 2011 report of MDE and DNR used the Interior and the Foldbelt AUs (711 bcf). Based on discussion with Brigid Kenney on October 18, 2013.
[39] Ibid.
[40] U.S. Geological Survey Oil and Gas Assessment Team, "Variability of Distributions of Well-Scale Estimated Ultimate Recovery for Continuous (Unconventional) Oil and Gas Resources in the United States."

region. Since the industry continues to move away from vertical wells, RESI assumed throughout the report that the new wells in the region will all be horizontal wells. No Marcellus Shale wells have been permitted or drilled in Maryland to date; therefore, no data exist for currently active horizontal well pads in Maryland.

To create a potential industry estimate for wells per pad, RESI used historical data from Pennsylvania's drilling activities. Pennsylvania's Department of Environmental Protection Oil & Gas Division is responsible for collecting and publicly distributing reports regarding well activity within the state. Data regarding production reports and active permits are made available through its website. According to the website, for 2012 six-month unconventional wells production reports, more than half of producers are shifting toward a six well per pad setup.[41]

At a total of six wells per pad, RESI assumed the total number of well pads needed under Scenario 1, with a 25 percent extraction rate, and Scenario 2, with a 75 percent extraction rate. A summary of the number of total wells needed and pads to accommodate the wells is reported in Figure 11. Well pads are multi-well pads, and it is feasible that more than one pad can be located on a single property.

Figure 11: Summary of Wells and Needed Well Pads by Scenario

Scenario	Total Wells Needed	Total Well Pads Needed
Scenario 1 (25% extracted)	150	25
Scenario 2 (75% extracted)	450	75

Source: RESI

Using the number of wells and well pads needed for extraction in Figure 10, RESI estimated the build outs for wells and pads for both scenarios from 2017 through 2026. These estimates can be found in Figures 12 and 13 for Scenarios 1 and 2, respectively.

[41] In some cases, producers are filing for well permits to total more than 10 active wells on active well pads. RESI dropped well pads holding more than 15 wells per pad in their average estimate since these pads accounted for a small portion of the total active producing well pads in Pennsylvania.

Figure 12: Well Pad Build Out for Western Maryland—Scenario 1, 25 % Extraction

Year	Number of New Wells	Number of New Well Pads	Total Number of Wells	Total Number of Well Pads
2017	8	4	8	4
2018	16	4	24	8
2019	29	3	53	11
2020	22	3	75	14
2021	18	3	93	17
2022	15	2	108	19
2023	12	2	120	21
2024	12	2	132	23
2025	12	2	144	25
2026	6	0	150	25

Source: RESI

Over the course of the ten-year period, RESI assumed that some wells will be drilled on pads as exploratory wells. Exploratory wells are wells drilled to determine (1) if a given area will be profitable and (2) whether the amount of gas that can be extracted is worth additional drilling. If an exploratory well is successful and produces, it is likely that producers will continue to drill more wells in that location.

Under both scenarios, RESI assumed that producers will be successful with each exploratory well and will complete the build out on a given pad within a few years after exploration. Figure 13 continues this assumption in estimating the number of wells added annually in Western Maryland if producers are able to extract 75 percent of the total undiscovered resources.

Figure 13: Well Pad Build Out for Western Maryland—Scenario 2, 75 % Extraction

Year	Number of New Wells	Number of New Well Pads	Total Number of Wells	Total Number of Well Pads
2017	36	12	36	12
2018	72	12	108	24
2019	63	9	171	33
2020	54	9	225	42
2021	63	9	288	51
2022	42	6	330	57
2023	36	6	366	63
2024	36	6	402	69
2025	36	6	438	75
2026	12	0	450	75

Source: RESI

As reported in Figures 12 and 13, RESI assumed that there will be either 25 or 75 well pads with 150 or 450 wells in operation by 2026. The estimations for the number of wells needed was calculated using the potential achievable recovery rate per well of 1.158 bcf.

The total well pads for each scenario were positioned through GIS mapping to determine the total per county. First, RESI created a grid of points covering Garrett County and the Marcellus Shale study area in Allegany County. In Garrett County, the points of the grid that intersected with the historical data of those landowners approached by producers were used to randomly select potential well locations. In Allegany County, since no existing comparable data exists, all of the potential location points were determined by randomly selecting well locations over the whole area. The random selection was weighted to include more points in Northern Garrett County, as this area was identified through past lease data and conversations with stakeholders as that which would most likely be targeted for Marcellus Shale drilling. Areas that were considered "off-limits" as the likelihood of individuals willing to lease their lands were District 18, and the Accident Storage Dome.[42]

Through this random selection, RESI determined the total number of wells for each county under both Scenario 1 and Scenario 2. Well pad build outs for Allegany and Garrett Counties are reported in Figures 14 and 15, respectively.

Figure 14: Well Pad Build Out for Allegany County

	Scenario 1		Scenario 2	
Year	Total Cumulative Wells	Total Cumulative Well Pads	Total Cumulative Wells	Total Cumulative Well Pads
2017	2	1	6	2
2018	5	0	18	4
2019	8	2	27	5
2020	11	0	33	6
2021	14	3	40	7
2022	17	0	46	8
2023	18	0	52	9
2024	0	0	58	10
2025	0	0	60	0
2026	0	0	0	0

Source: RESI

[42] In meetings with the Public Health working group and MDE, these areas were determined to be unlikely to permit drilling activities.

Figure 15: Well Pad Build Out for Garrett County

Year	Scenario 1		Scenario 2	
	Total Cumulative Wells	Total Cumulative Well Pads	Total Cumulative Wells	Total Cumulative Well Pads
2017	6	3	30	10
2018	19	7	90	20
2019	45	9	144	28
2020	64	12	192	36
2021	79	14	248	44
2022	91	16	284	50
2023	102	18	314	55
2024	114	20	344	60
2025	126	22	378	65
2026	132	0	390	0

Source: RESI

3.2.3 Production Curve

Shale production from a well can vary over time. Here, "production" refers to the amount of shale gas extracted in a given period, whereas "recovery" refers to the overall amount. To determine the level of industry activity, RESI estimated the level of production per well annually over the ten-year period. Unlike vertical wells, horizontal wells do not produce continuously on an exponential decline.[43] Instead, horizontal wells produce high extraction amounts in the first few years, then drop off significantly in later years.[44] To determine the level of industry sales associated with Marcellus Shale production in Western Maryland, RESI estimated the annual extraction for a well.

As previously stated, RESI assumed that the overall EUR of a horizontal well is 1.158 bcf. Horizontal wells can continue to produce well beyond the twenty-year timeframe of this analysis, but most researchers find that a horizontal well produces the largest return in the first

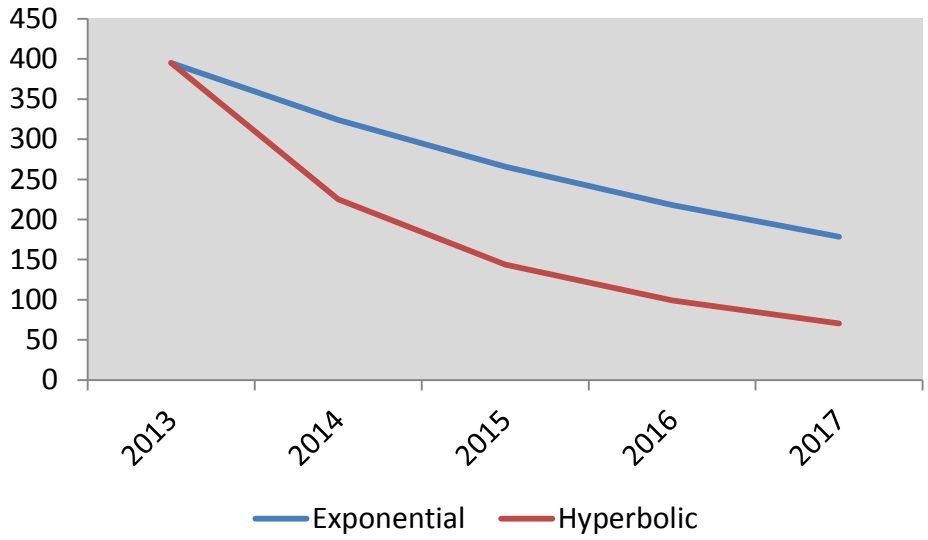
[43] Terry Engelder, "Marcellus Reserves and Estimates Substantiated by Production Data," research presented online through Penn State Extension Webinar on the Marcellus Shale, September 30, 2013, http://extension.psu.edu/natural-resources/natural-gas/webinars/marcellus-reserves-and-estimates-substantiated-by-production-data/marcellus-reserves-and-estimates-substantiated-by-production-data-powerpoint-september-19-2013.
[44] Ibid.

three years with more modest returns in subsequent years.[45] [46] However, returns vary by region, and therefore can lead to some differentiation between wells and locations.[47]
To determine the potential increase in the industry sales associated with Marcellus Shale drilling in the region, RESI created a potential decline curve given the following restrictions:

1. Wells will return 85 percent of their total EUR by the end of year three.
2. Total EUR of a well is assumed to be 1.158 bcf.
3. Production during the first three years will resemble a hyperbolic return.
4. Production after three years will resemble an exponential return with smaller incremental returns.

Hyperbolic returns exhibit very large early declines from initial production, followed by a period of smaller incremental drops. Exponential returns tend to exhibit a steadier annual decline.

Figure 16: Hyperbolic Returns versus Exponential Returns



Source: RESI

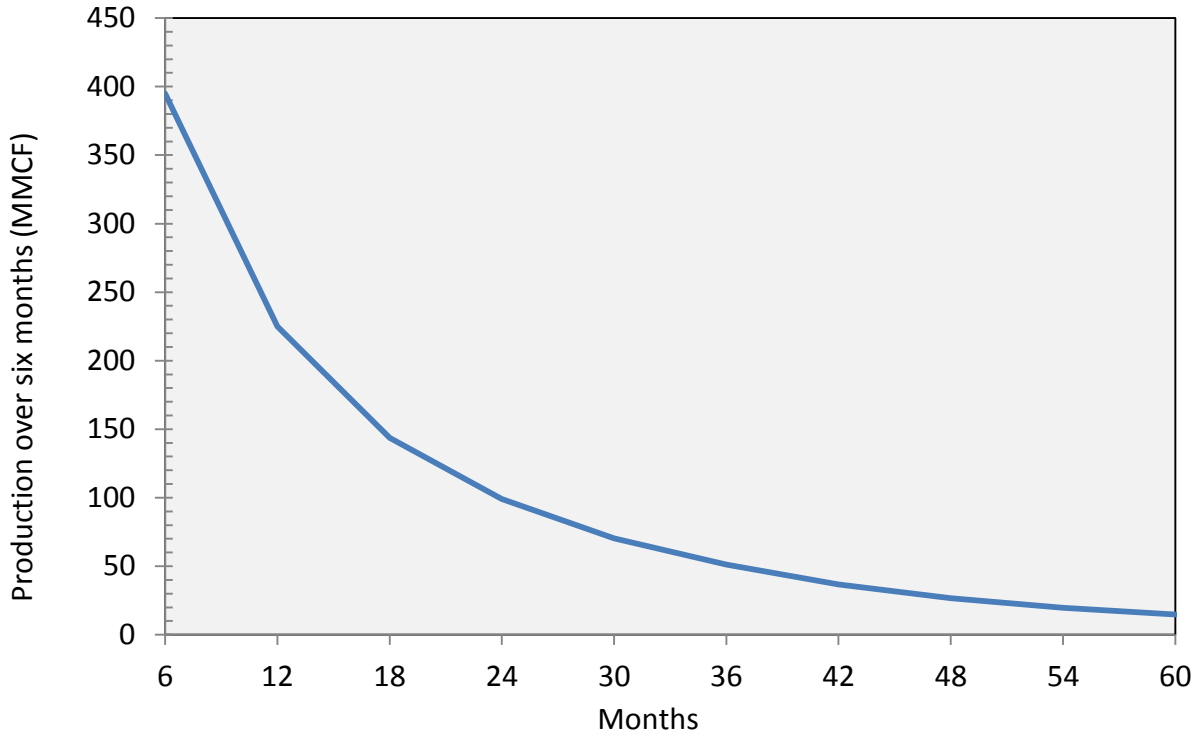
Figure 16 provides an example of the difference between exponential and hyperbolic declines. In the example, the hyperbolic curve declines faster than the exponential curve from the well's initial production. Exponential curves decline at a smoother rate. In nature, the returns of a

[45] J. David Hughes, "Drill, Baby, Drill: Can Unconventional Fuels Usher in a New Era of Energy Abundance?," *Post Carbon Institute* (February 2013): 65, http://www.postcarbon.org/reports/DBD-report-FINAL.pdf.
[46] Engelder, "Marcellus Reserves and Estimates Substantiated by Production Data."
[47] Hughes, "Drill, Baby, Drill," 65.

vertical well have often exhibited an exponential decline curve.[48] This exponential return indicates that vertical wells are fairly linear and consistent in regard to natural gas extraction over time. New horizontal wells, however, have larger returns earlier in their lifespans, with minimal returns and consistent decline later in their lifespans.[49]

To capture this large initial return followed by a period of consistent lower returns, RESI employed both exponential and hyperbolic return functions. Current Marcellus Shale wells in Pennsylvania have exhibited both properties at varying times. RESI used this information to create its own curve along the aforementioned parameters. The production curve used in this analysis is reported in Figure 17 for a potential Marcellus Shale well in Maryland.

Figure 17: Estimated Marcellus Well Production Curve for Maryland for the First Five Years



Source: RESI

By the end of the third year, a Marcellus well in Maryland will have produced 0.9843 bcf, or approximately 85 percent of the well's total EUR. This estimate was used to formulate RESI's

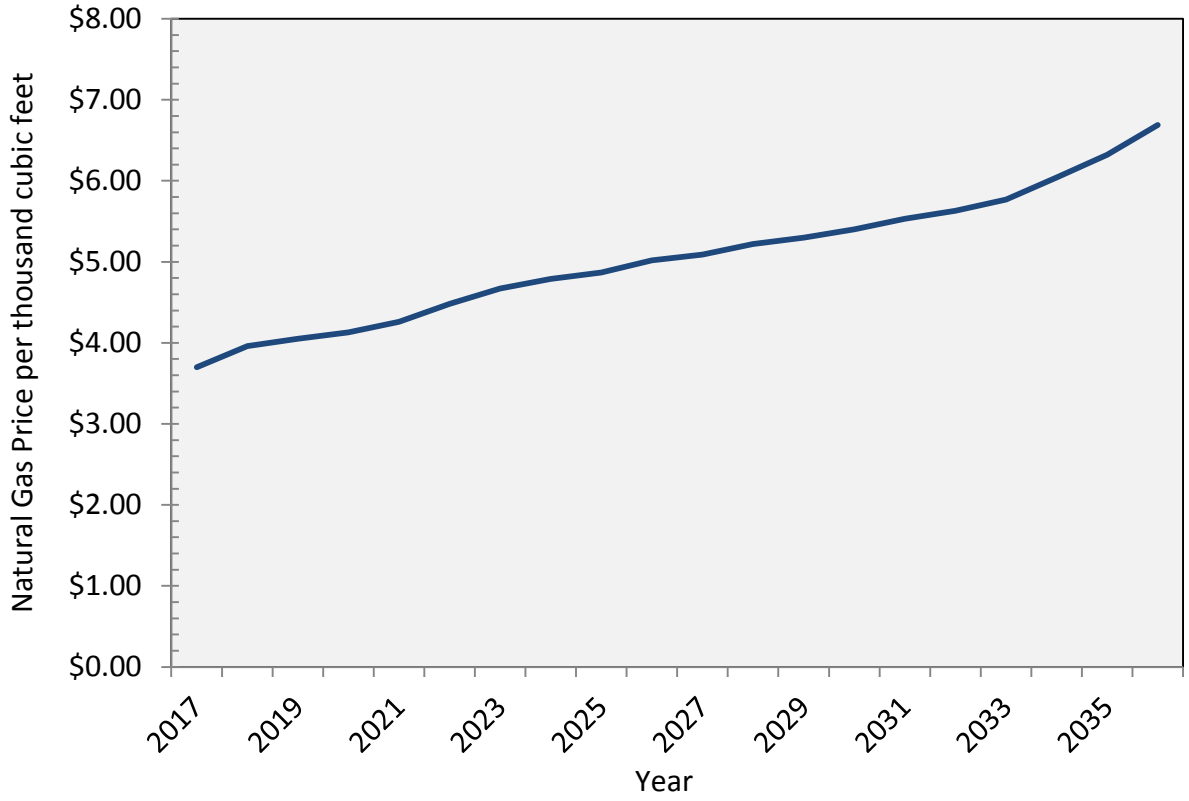
[48] Ibid.
[49] Y. Shen, S. Wang, and S. He, "Improving Decline-curve Analysis of Low-permeability Gas Wells Using Type Curves," *Petroleum Science and Technology* 31 (2013): 1, http://dx.doi.org/10.2118/108176-PA.

estimates for industry sales associated with natural gas production in Western Maryland for the REMI PI+ tool. For more information regarding the calculation of the decline curve, please refer to Appendix A of this report. Using the decline curve in Figure 17, RESI applied the estimated natural gas prices for 2017 through 2036 to the annual production levels to determine industry sales.

3.2.4 Industry Sales

Natural gas prices are forecasted annually by the EIA in its Annual Energy Outlook. To estimate the potential sales revenue generated by the increased level of activity within the region, RESI used the average reference case natural gas price for each year from 2017 to 2036 from the 2013 Annual Energy Outlook. The average reference case prices are reported in Figure 18.

Figure 18: Natural Gas Price Forecast[50]



Source: EIA AEO 2013

[50] U.S. Energy Information Association, "Annual Energy Outlook 2013: with Projections to 2040," April 2013, accessed September 18, 2013, http://www.eia.gov/forecasts/aeo/pdf/0383%282013%29.pdf.

Taking the well build out for Scenario 1, at 25 percent extraction, as an example, RESI applied the ten-year production for each well against the AEO price to determine the increased industry sales for the region. RESI determined the increased level of annual industry sales using the following formula:

$$Total\ Industry\ Sales\ for\ Year\ X = \big(AEO\ price\ in\ year\ x * (number\ of\ new\ wells\ _x * 620{,}001\ mcf)\big) + \big(AEO\ price\ in\ year\ x * (number\ of\ new\ wells_{x-1} * 242{,}751\ mcf)\big) + \big(AEO\ price\ in\ year\ x * (number\ of\ new\ wells_{x-2} * 121{,}522\ mcf)\big) + \big(AEO\ price\ in\ year\ x * (number\ of\ new\ wells_{x-3} * 63{,}340\ mcf)\big) + \big(AEO\ price\ in\ year\ x * (number\ of\ new\ wells_{x-4} * 34{,}339\ mcf)\big) + \big(AEO\ price\ in\ year\ x * (number\ of\ new\ wells_{x-5} * 19{,}021\ mcf)\big) + \big(AEO\ price\ in\ year\ x * (number\ of\ new\ wells_{x-6} * 10{,}537\ mcf)\big)$$

A detailed breakdown of industry sales by year can be found in Appendix A of this report for each scenario. Using the results from this calculation, RESI introduced the sales data into REMI PI+ as an increase in industry sales for natural gas between 2017 and 2036.

3.2.5 Comparison of Assumptions

Previous efforts have aimed to estimate various types of impacts resulting from drilling activity in the Marcellus Shale in Maryland. Analyses conducted by Samson Energy and Sage Policy Group differ in regard to their general scope as well as the assumptions made to estimate the impacts as compared to RESI's methodology. Differences in assumptions included but were not limited to the total extractable gas in the region and the total number of wells. The remainder of this subsection discusses the various assumptions made in these analyses as they compare to RESI's assumptions.

The Samson Energy calculations aimed to estimate the types of revenue and royalty payments that could be generated as a result of drilling activity in the Marcellus Shale in Allegany and Garrett Counties. These calculations assumed total extractable gas between 500 and 4,000 bcf for Allegany County and between 1,000 and 8,000 bcf for Garrett County, or a combined total of between 1,500 and 12,000 bcf of total extractable gas in the region.[51] Instead of using the estimated EUR per well to determine the number of wells, Samson Energy used total "drillable

[51] Samson Energy, "Estimated Marcellus Shale Natural Gas Value," accessed May 16, 2014, http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Economic_Value_Estimates.pdf.

acreage" and acres per well within each county to estimate 637.5 wells for Allegany County and 1,600 wells for Garrett County.[52]
The objective of the Sage Policy Group analysis was "to help stakeholders understand the full potential of Marcellus Shale-related activity" by focusing on "the potential economic activity that could be generated by applying modern technologies to the Marcellus Shale formation in Western Maryland to produce natural gas."[53] The analysis used a low-case, a mid-case, and a high-case scenario. Sage outlined the following assumptions in its report: total extractable gas in the Maryland portion of Marcellus Shale of 1,286 bcf for the mid-case scenario; an EUR per well of 2.5 bcf for all three scenarios; and 199, 365, and 667 total wells for the low-case, mid-case, and high-case scenarios, respectively.[54]

The Samson and Sage reports generally assumed a higher total amount of extractable gas and a greater number of wells than RESI's analysis documented in this report. Sage's analysis also assumed higher extraction from each well. It is important to note that these analyses preceded USGS's 2012 revised estimates of technically recoverable Shale reserves. For more information regarding Samson Energy's and Sage Policy Group's assumptions and scenarios, please refer to the full resources.[55]

3.3 Scenarios

To capture the full effect of the potential for drilling, RESI created a low scenario (Scenario 1, with 25 percent extraction) and a high scenario (Scenario 2, with 75 percent extraction), as previously discussed in Section 3.0 of this report.

To determine the additional impacts to employment, output, and wages associated with each scenario, RESI created a baseline forecast. The baseline forecast represents the status quo in Allegany and Garrett Counties. Detailed information on the baseline forecast for employment, output, and wages can be found in Appendix E of this report. Under the baseline forecast, RESI assumed that no drilling would occur in Allegany or Garrett Counties over the study period of 2017 through 2036. Using this baseline forecast, RESI then applied the change in the economic activity by adding Scenarios 1 and 2. Scenarios 1 and 2 increased the economic activity within the counties from 2017 through 2036. The results from this analysis can be found in Section 4.0 with more detailed impacts in Appendix E of this report.

---

[52] Ibid.
[53] Sage Policy Group, "The Potential Economic & Fiscal Impacts of Natural Gas Production in Western Maryland," March 2012, 8, accessed May 16, 2014, http://marcelluscoalition.org/wp-content/uploads/2012/03/MD-Marcellus-Study.pdf.
[54] Ibid, 24–25.
[55] Please refer to Section 10.0 of this report for the full list of references.

It is important to note that a scenario where 100 percent of reserves are extracted is unrealistic, if only because some owners of mineral rights will likely not lease those rights. Additionally, companies' lease holdings could be interspersed, therefore complicating the potential availability for producers.

The levels of extraction in states bordering Maryland, such as Pennsylvania and West Virginia, are likely not good indicators of the level of extraction in Maryland. Pennsylvania has leased gas rights in state forests, while Maryland's current position is not to lease those rights. Also, start-up in Maryland would be significantly different from start-up in Pennsylvania because the industry has evolved significantly since 2008 in regard to operations. The pace of drilling is affected by many factors, including the availability of pipelines, the price of gas, and the availability of drill rigs. Assuming 25 and 75 percent allowed RESI to capture both a conservative estimate and a more aggressive estimate over a ten-year period.

3.4 Model Development

Key variables, such as forecasted industry sales, housing price fluctuations, and royalty payments, have been identified by existing research as key drivers of economic impacts from Marcellus Shale drilling. In most research, industry sales are often considered as the basis for economic impact in the region. Industry sales directly impact the levels of employment, output, and wages created by the natural gas industry for Western Maryland. If the sales or demand for natural gas are high, then there will be an increase in the demand for labor within that industry. To meet this demand, producers may increase their production levels through expansion of existing operations.

The percentage change associated with home values located near operational wells is considered a direct impact to households. RESI analyzed proximity to operational wells and determined that the closer the wells are to residential areas, the lower those property values will be. The decline in home values may impact resale values for homeowners as well as their tax payments over time. As tax payments are based on the assessor valuation of a home, a significant decline in the valuation may impact future state, county, and local budgets. In RESI's fiscal impact analysis, property tax revenues accounted for nearly 31 percent of total state fiscal revenues on a given year. All else equal, fiscal revenues for a region suffer significantly if homes values do not recover over time.

Royalty payments to landowners from natural gas producers can increase household income within a region. This increase in disposable income can allow residents to purchase goods they once could not afford. However, given the potential for "split estates," where surface and mineral rights might not be owned by the same individual(s), RESI did not determine the residencies (whether local or nonlocal) of recipients of royalty payments. RESI included royalty payments as an increase in production costs to producers in this analysis, but not an increase to

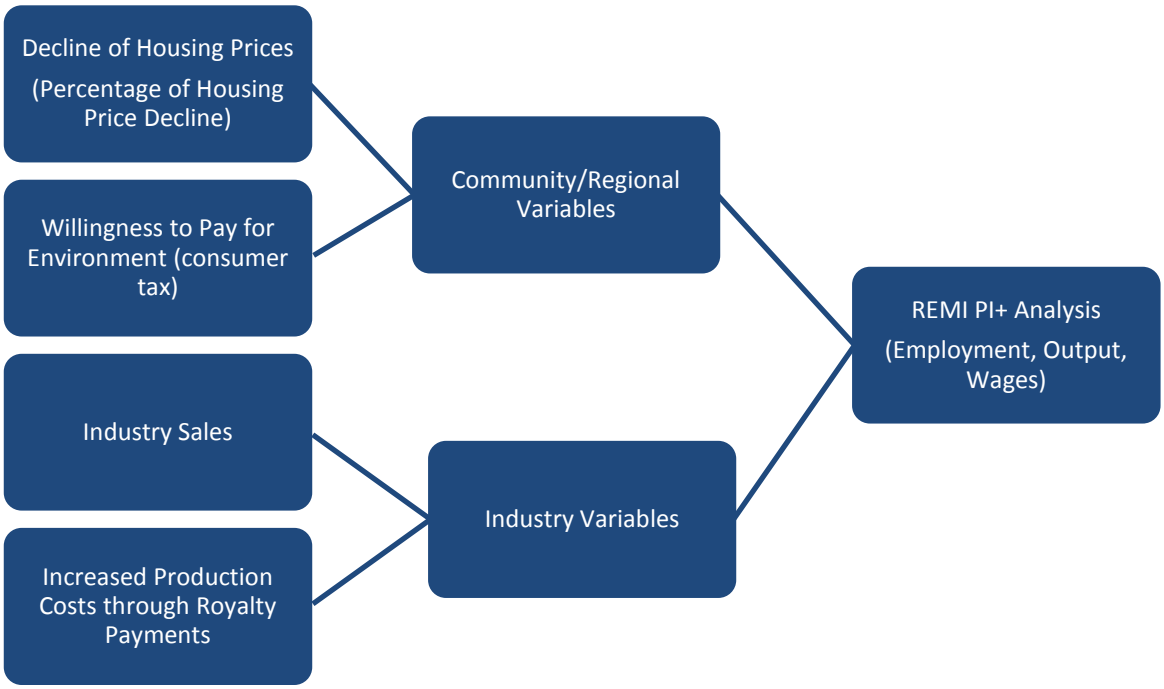
household disposable income. Therefore, RESI did not include royalty payments in the model as an increase in household disposable income.

Western Maryland stakeholders expressed concern regarding the impact of Marcellus Shale drilling on the aesthetic quality of the environment in Western Maryland. Marcellus Shale drilling may deter visitors from the region if the aesthetic impacts are perceived to be significant and apparent. However, if a conservation fund were implemented to mitigate these impacts and help maintain the aesthetic quality, this measure may help to maintain the attractiveness of the region for visitors. The WTP into the conservation fund represents a direct impact to residents to conserve the environment paid through a potential tax. Paying into a conservation fund may ultimately reduce households' disposable income through annual personal tax increases, depending on how such payments are administered in the region. As a result, household spending on goods and services may decrease.

Of the numerous economic drivers associated with Marcellus Shale drilling, RESI identified four key drivers to include in the REMI PI+ analysis: (1) industry sales, (2) decline in housing prices, (3) increased production costs through royalty payments, and (4) WTP for environment.

Figure 19 reports how the variables are captured and include within the REMI PI+ model.

Figure 19: REMI PI+ Model Inputs and Outputs



Sources: RESI, REMI PI+

RESI ran the two drilling scenarios for both Allegany and Garrett Counties. Each REMI PI+ analysis reviewed the impact of Marcellus Shale drilling on each county's employment, output, and wages. Section 4.0 reports the findings from these analyses, and discusses the data inputs and results.

4.0 Economic and Fiscal Impacts

Using a combination of estimates of industry sales, home value changes, environmental conservation payments, and royalty payment costs to producers, RESI developed a model to estimate the potential impacts under each scenario for each county. To date, similar research has been completed in various states after drilling has been present for a few years. RESI's study is unique through the inclusion of a hedonic pricing model and a contingent valuation analysis. RESI used these two methodologies to create a balanced economic impact where households may experience increased costs, unlike previous studies that examine industry-based sales as the sole input. Section 4.1 of this report discusses some of the existing literature on the economic impacts associated with Shale drilling.

4.1 Potential Economic Impacts in Western Maryland

RESI incorporated the key economic drivers discussed in Section 3.3 of this report into the REMI PI+ model and analyzed the results for employment, output, and wages over a twenty-year period. The following subsections detail the economic and fiscal impacts for each county for the baselines and the two drilling scenarios.

Under each scenario, RESI assumed that wells will be drilled from 2017 through 2026. No new wells are assumed to be drilled after 2026 in the region. All wells that are necessary for extraction will be completed within a ten-year timeframe. The baseline forecasts are reported first, and each scenario follows.

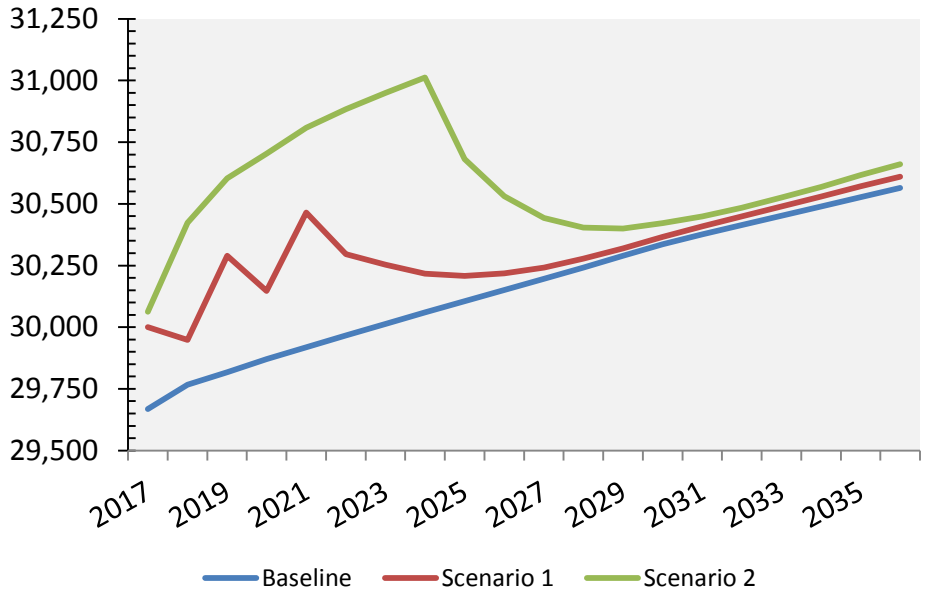
When reading the figures for the scenarios, note that these impacts are additional employment, output, and operation from the baseline forecasts. More detailed impacts reporting the direct, spinoff, and total impacts for employment, output, and wages for each scenario can be found in Appendix E of this report.

4.1.1 Allegany County

To determine the impacts on employment, output, and wages associated with Marcellus Shale drilling, RESI first created a baseline economic forecast for Allegany County's economy. The difference between the baseline and Scenario 1 (25 percent) and between the baseline and Scenario 2 (75 percent) in the forecast is attributable to the amount of Marcellus Shale drilling. More detailed results from the baseline can be found in Appendix E of this report.

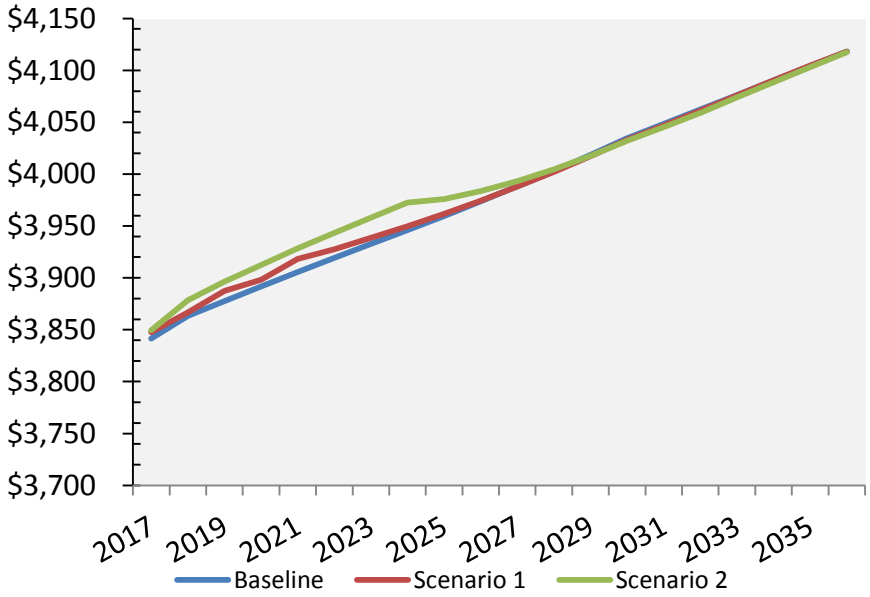
Figures 20 through 22 report the difference between the baseline and Scenario 1 (25 percent), and the baseline and Scenario 2 (75 percent) in the forecast is attributable to the amount of Marcellus Shale drilling. More detailed results from the baseline can be found in Appendix E of this report.

Figure 20: Employment Impacts from Shale Drilling in Allegany County



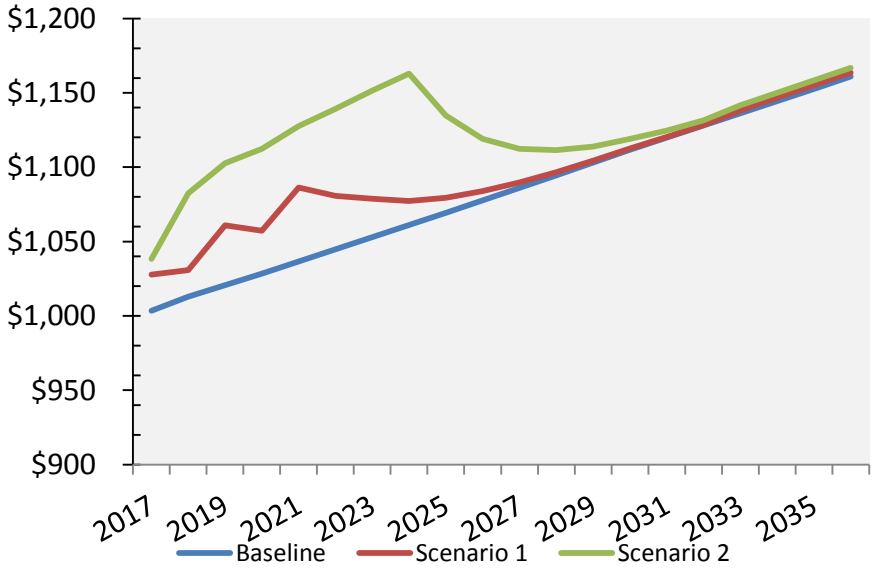
Sources: REMI PI+, RESI

Figure 21: Output Impacts from Shale Drilling in Allegany County (in millions)



Sources: RESI, REMI PI+

Figure 22: Wage Impacts from Shale Drilling in Allegany County (in millions)



Sources: RESI, REMI PI+

Figures 20 through 22 report the economic changes associated with Shale drilling in Allegany County. Under Scenario 1, Allegany would see minimal activity, adding only three additional well pads between 2017 and 2026. The results of this analysis can be found in Figure 23.

When comparing the baseline projections against RESI's scenarios, it is important to remember the following:

1. Wages change more slowly than output. Wages are typically tied to contracts for many employees and, although production may increase, wage levels may not increase at the same pace.
2. After the initial boom (in this case, drilling), an economy may seek to return to its initial growth after a period. Since this shock is short-lived (at approximately ten years), RESI expects that, after a period following the "bust," the economy will attempt to return to the county's economic equilibrium.

Figure 23: Economic Impacts for Allegany County—Scenario 1, 25% Extraction

Year	Number of New Wells	Employment Change	Output Change	Wage Change
2017	2	286.0	$24,383,545	$6,271,300
2018	3	124.9	$17,852,783	$3,578,200
2019	3	413.2	$40,405,273	$9,883,900
2020	3	220.6	$28,717,041	$6,324,800
2021	3	492.3	$49,682,617	$12,611,400
2022	3	279.7	$35,949,707	$8,312,200
2023	1	198.2	$25,817,871	$6,004,300
2024	0	122.2	$16,113,281	$3,635,400
2025	0	69.0	$10,131,836	$1,880,700
2026	0	32.9	$6,164,551	$595,100
2027	0	10.2	$3,601,074	-$312,800
2028	0	-2.8	$2,075,195	-$881,200
2029	0	-8.1	$1,220,703	-$1,197,800
2030	0	-9.2	$854,492	-$1,308,500
2031	0	-10.1	$427,246	-$1,365,700
2032	0	-7.9	$366,211	-$1,293,200
2033	0	21.6	$2,075,195	-$267,000
2034	0	25.9	$2,319,336	$0
2035	0	31.2	$2,624,512	$297,600
2036	0	33.8	$2,685,547	$38,100

Sources: REMI PI+, RESI

RESI expects that, during the "boom" years, the greatest change from the baseline will occur in 2021, adding 492 jobs, $49.7 million in output, and $12.6 million in wages. Under Scenario 1, drilling activities in Allegany County will increase employment over the baseline forecast by approximately 224 jobs on average annually between 2017 and 2026. In the period after drilling, 2027 through 2036, residual economic activity will change forecast baseline employment by an average of approximately 9 additional jobs annually. Additionally, the wages

will increase over the baseline wage forecast between 2017 and 2026. During the ten-year period following no new additional drilling, the results indicate a loss of wages as the employment levels in higher wage earning sectors begin to decline.

Finally, RESI estimated Scenario 2, under which producers extract 75 percent of the total reserves in Maryland's Interior AU. Under this scenario, Allegany County would experience a more aggressive drilling atmosphere, increasing the current well pad total in the county from three to ten when compared to Scenario 1. Differences in employment, output, and wages are reported in Figure 24.

Figure 24: Economic Impacts for Allegany County—Scenario 2, 75% Extraction

Year	Number of New Wells	Employment Changes	Output Changes	Wage Changes
2017	6	346.4	$34,881,600	$8,033,700
2018	12	600.6	$69,610,600	$15,037,500
2019	9	727.6	$82,061,800	$18,783,600
2020	6	777.0	$83,801,300	$20,523,000
2021	7	836.1	$91,186,500	$22,731,800
2022	6	864.4	$94,543,500	$24,059,300
2023	6	889.7	$98,571,800	$25,329,600
2024	6	908.0	$101,806,600	$26,363,300
2025	2	532.6	$65,307,600	$16,292,600
2026	0	334.1	$41,320,800	$9,712,200
2027	0	197.7	$26,306,200	$4,825,600
2028	0	111.5	$16,845,700	$1,419,000
2029	0	58.0	$10,681,200	-$930,700
2030	0	30.7	$7,202,100	-$2,277,300
2031	0	15.1	$4,821,800	-$3,109,000
2032	0	11.1	$3,601,100	-$3,410,300
2033	0	49.7	$5,432,100	-$2,132,400
2034	0	58.5	$5,493,200	-$1,674,700
2035	0	66.8	$5,676,300	-$1,136,800
2036	0	74.6	$5,920,400	-$618,000

Sources: REMI PI+, RESI

RESI expects that, during the "boom" years, the greatest change from the baseline will occur in 2024, adding 908 jobs, $101.8 million in output, and $26.4 million in wages. Under Scenario 2, drilling activities in Allegany County will increase employment over the baseline forecast by approximately 682 jobs on average annually between 2017 and 2026. In the period after drilling, 2027 through 2036, residual economic activity will change forecast baseline employment by an average of approximately 67 additional jobs annually. Additionally, the

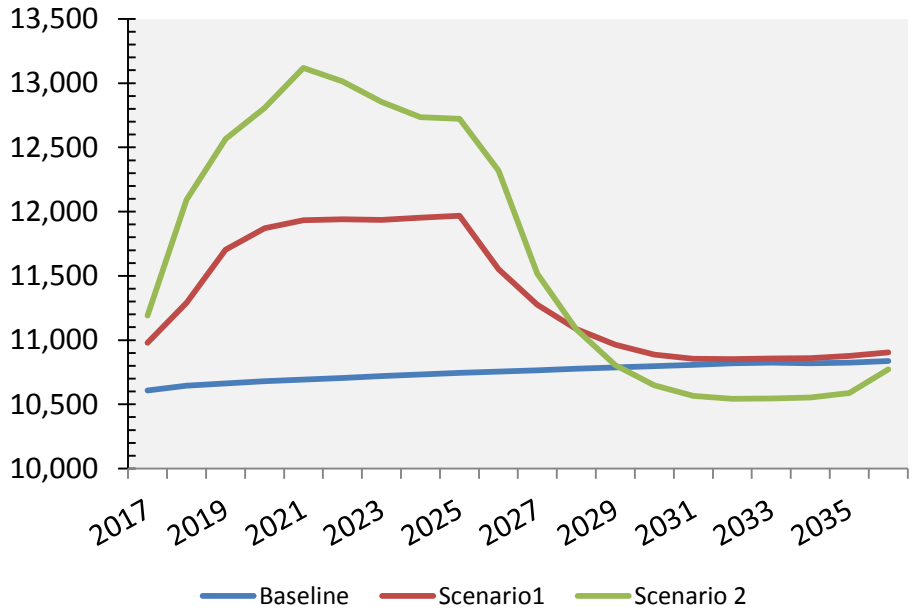
wages will increase over the baseline wage forecast between 2017 and 2026. The results indicate a decline from the initial forecasted income after 2029 as the employment levels in higher wage earning sectors begin to decline.

4.1.2 Garrett County

To determine the impacts on employment, output, and wages associated with Marcellus Shale drilling, RESI first created a baseline economic forecast for Garrett County's economy. The difference between Scenario 1 (25 percent) and Scenario 2 (75 percent) in the forecast is attributable to the amount of Marcellus Shale drilling. More detailed results from the baseline can be found in Appendix E of this report.

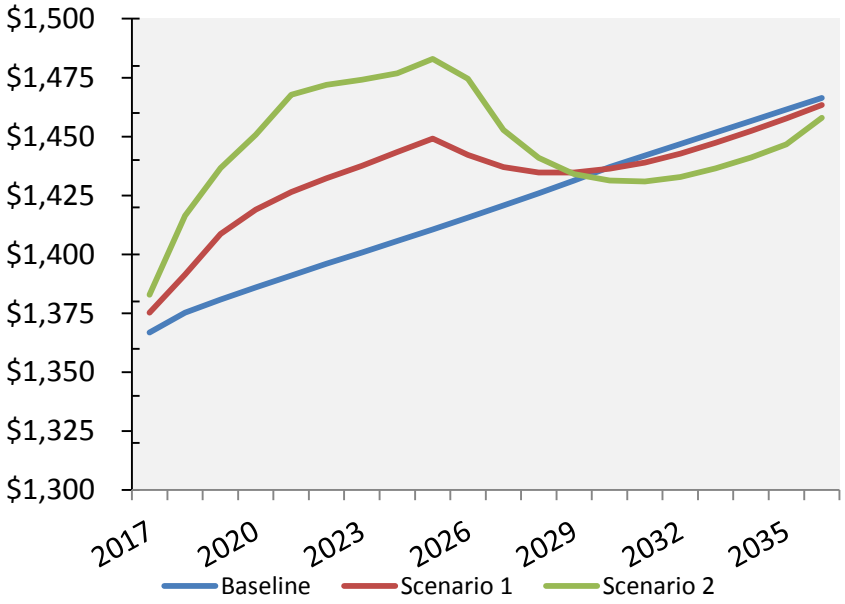
Figures 25 through 27 report the difference between the baseline and Scenario 1 (25 percent), and the baseline and Scenario 2 (75 percent) in the forecast is attributable to the amount of Marcellus Shale drilling. More detailed results from the baseline can be found in Appendix E of this report.

Figure 25: Employment Impacts from Shale Drilling in Garrett County



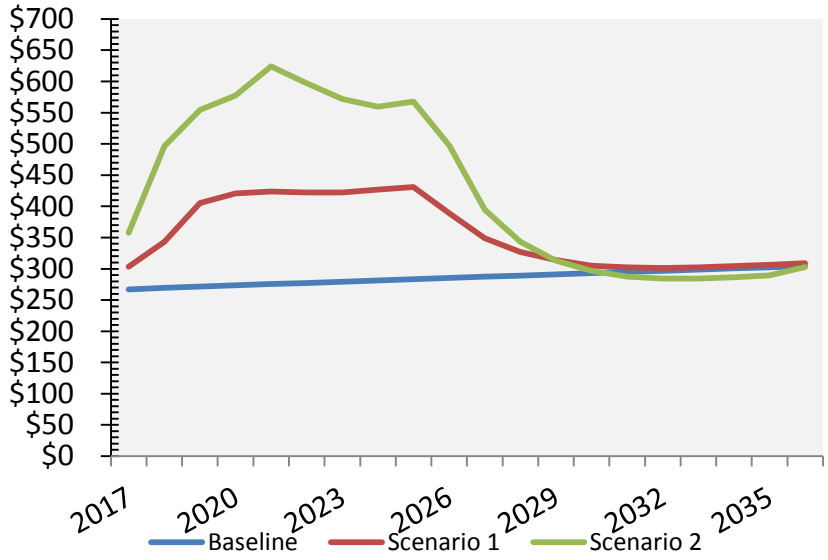
Sources: REMI PI+, RESI

Figure 26: Output Impacts from Shale Drilling in Garrett County (in millions)



Sources: RESI, REMI PI+

Figure 27: Wage Impacts from Shale Drilling in Garrett County (in millions)



Sources: RESI, REMI PI+

RESI first analyzed a 25 percent scenario case for drilling within the region. Under Scenario 1, Garrett would see modest increases in drilling activity, adding 22 additional well pads between 2017 and 2026. The results of this analysis can be found in Figure 28.

When comparing the baseline projections against RESI's scenarios, it is important to remember the following:

1. Wages change more slowly than output. Wages are typically tied to contracts for many employees and, although production may increase, wage levels may not increase at the same pace.
2. After the initial shock (in this case, drilling), an economy may seek to return to its initial growth after a period. Since this shock is short-lived (at approximately ten years), RESI expects that, after a period following the "bust," the economy will attempt to return to the typical steady pace of growth.

Figure 28: Economic Impacts for Garrett County—Scenario 1, 25% Extraction

Year	Number of New Wells	Employment Change	Output Change	Wage Change
2017	6	371.8	$36,224,370	$8,525,850
2018	13	644.7	$73,913,570	$16,056,060
2019	26	1,040.1	$133,666,990	$27,820,590
2020	19	1,191.4	$147,125,240	$32,978,060
2021	15	1,240.1	$148,437,500	$35,442,350
2022	12	1,234.1	$144,897,460	$36,273,960
2023	11	1,217.6	$142,578,130	$36,724,090
2024	12	1,222.2	$145,507,810	$37,723,540
2025	12	1,222.7	$147,705,080	$38,520,820
2026	6	797.9	$103,637,700	$26,668,550
2027	0	509.0	$61,828,610	$16,384,130
2028	0	308.1	$37,780,760	$8,834,840
2029	0	177.3	$22,705,080	$3,341,680
2030	0	90.9	$11,840,820	-$675,200
2031	0	48.8	$7,080,080	-$2,944,950
2032	0	33.6	$4,699,710	-$4,062,660
2033	0	33.1	$3,723,140	-$4,417,420
2034	0	40.3	$3,662,110	-$4,302,980
2035	0	52.3	$4,089,360	-$3,784,180
2036	0	65.5	$4,638,670	-$3,059,390

Sources: REMI PI+, RESI

RESI expects that, during the "boom" years, the greatest change from the baseline will occur in 2021, adding approximately 1,240 jobs, $148.4 million in output, and $35.4 million in wages. Despite no new drilling after 2027, the spinoff effects associated with drilling maintenance and initial industry boom may still linger in the region. Under Scenario 1, drilling activity in Garrett County will increase employment over the baseline forecast by an average of 1,018 jobs annually between 2017 and 2026.

The period after drilling, 2027 through 2036, will experience significantly less job retention, recording an average of approximately 136 additional jobs annually. This result is consistent with the projected experience in Allegany County. However, given the more rural nature of Garrett County and the greater intrusion by Shale operations, it is feasible that factors such as wages and output will experience a greater decline than in Allegany County.

Owing to the larger presence of drilling as well as the structure and composition of Garrett County's economy, the "bust" period will have a more pronounced impact on Garrett County's economy than Allegany County's. Comparatively, Allegany County's baseline economic climate is nearly three times the size of Garrett County's prior to Marcellus Shale drilling. A smaller economy like that of Garrett County may have a more difficult time absorbing the economic losses from a large operation such as Marcellus Shale drilling if activity were to suddenly cease.

Finally, RESI estimated Scenario 2, under which producers extract 75 percent of the total reserves in Maryland's Interior AU. Under this scenario, Garrett would experience a more aggressive drilling atmosphere, increasing the current well pad total in the county from 8 to 65. Differences in employment, output, and wages are reported in Figure 29.

Figure 29: Economic Impacts for Garrett County—Scenario 2, 75% Extraction

Year	Number of Wells	Employment Change	Output Change	Wage Change
2017	30	582.5	$90,972,900	$16,136,200
2018	60	1,446.8	$226,776,100	$41,137,700
2019	54	1,903.9	$282,836,900	$55,748,000
2020	48	2,128.0	$303,863,500	$64,662,900
2021	56	2,424.7	$348,571,800	$76,690,700
2022	36	2,308.1	$319,580,100	$76,007,800
2023	30	2,136.5	$292,358,400	$73,303,200
2024	30	2,003.3	$278,198,200	$71,193,700
2025	34	1,978.5	$284,423,800	$72,387,700
2026	12	1,564.2	$212,341,300	$58,891,300
2027	0	750.1	$107,482,900	$32,043,500
2028	0	306.5	$54,321,300	$15,060,400
2029	0	17.9	$21,850,600	$2,697,000
2030	0	-149.8	$3,295,900	-$5,577,100
2031	0	-240.8	-$7,385,300	-$10,929,100
2032	0	-276.9	-$12,451,200	-$13,950,400
2033	0	-280.2	-$14,221,200	-$15,274,100
2034	0	-265.0	-$14,038,100	-$15,491,500
2035	0	-237.1	-$12,756,300	-$14,808,700
2036	0	-65.3	-$1,464,800	-$8,445,700

Sources: REMI PI+, RESI

RESI expects that, during the "boom" years, the greatest change from the baseline will occur in 2021, adding approximately 2,425 jobs, $348.6 million in output, and $76.7 million in wages. Under Scenario 2, drilling activity will increase employment over the baseline forecast by approximately 1,848 on average annually between 2017 and 2026. The period after drilling, 2027 through 2036, the county will experience significantly less job retention, recording an average of approximately 44 jobs less annually when compared to the baseline forecast.

The results are consistent with the projected experience in Allegany County. However, wages will also experience a more pronounced fall in Garrett County after active drilling ceases under this scenario. Due to the economic climate in Garrett County, it is possible that the rural area will not be able to absorb the loss as well as the less rural Allegany County. Discussion about the variance of these impacts can be found in Section 4.4 of this report.

4.2 Potential Fiscal Impacts in Western Maryland

4.2.1 Allegany County

RESI analyzed the potential fiscal impacts associated with Marcellus Shale drilling in Allegany and Garrett Counties for each scenario. Figure 30 represents the change in tax revenue impacts associated with Marcellus Shale drilling in Allegany under each scenario. These impacts are local tax revenues.

Figure 30: Local Fiscal Revenues for Allegany County, Scenarios 1 and 2

Year	Scenario 1			Scenario 2		
	Property Tax	Income Tax	Severance Tax	Property Tax	Income Tax	Severance Tax
2017	$30,873	$9,366	$321,160	$203,044	$61,597	$963,481
2018	$160,627	$48,729	$650,174	$247,964	$75,224	$2,466,113
2019	$65,454	$19,856	$802,673	$277,216	$84,098	$2,614,479
2020	$198,920	$60,346	$890,284	$311,481	$94,493	$2,238,521
2021	$95,373	$28,933	$957,675	$336,738	$102,155	$2,342,757
2022	$79,235	$24,037	$1,029,832	$363,679	$110,328	$2,271,924
2023	$60,144	$18,246	$681,258	$388,348	$117,812	$2,290,828
2024	$46,019	$13,961	$331,622	$236,181	$71,649	$2,297,707
2025	$35,208	$10,681	$171,553	$184,107	$55,852	$1,450,534
2026	$27,147	$8,235	$89,618	$144,161	$43,733	$701,774
2027	$21,290	$6,459	$43,829	$116,093	$35,219	$362,359
2028	$19,296	$5,854	$18,501	$95,257	$28,898	$186,377
2029	$17,001	$5,158	$3,909	$82,544	$25,041	$91,276
2030	$14,626	$4,437	$0	$72,275	$21,926	$38,277
2031	$15,000	$4,550	$0	$67,095	$20,354	$8,157
2032	$27,603	$8,374	$0	$82,494	$25,026	$0
2033	$29,820	$9,046	$0	$84,925	$25,763	$0
2034	$32,732	$9,930	$0	$87,987	$26,692	$0
2035	$34,866	$10,577	$0	$92,203	$27,971	$0
2036	$35,783	$10,855	$0	$94,822	$28,766	$0

Source: REMI PI+, RESI

RESI expects that Allegany County local property tax revenues at the peak of drilling may increase by $198,920 and income tax revenues may increase by $60,346 in Scenario 1. Under Allegany County's 7.0 percent severance tax, RESI expects that the county will gain an additional $1.0 million at the peak of drilling. Allegany County local property tax revenues may increase by $388,348, and local income tax revenues may increase by $117,812 at the peak in Scenario 2. Allegany County's severance tax revenues at the peak of drilling could increase by $2.3 million.

4.2.2 Garrett County

RESI analyzed the fiscal impacts associated with Shale drilling in Garrett County. Figure 31 represents the change in tax revenues associated with Marcellus Shale drilling in Garrett County under each scenario. These impacts are state tax revenues.

Figure 31: Local Fiscal Revenues for Garrett County, Scenarios 1 and 2

Year	Scenario 1			Scenario 2		
	Property Tax	Income Tax	Severance Tax	Property Tax	Income Tax	Severance Tax
2017	$223,136	$61,802	$757,021	$398,175	$110,283	$3,785,103
2018	$338,088	$93,641	$2,072,697	$529,947	$146,780	$9,688,302
2019	$396,751	$109,889	$4,456,094	$616,345	$170,710	$11,514,115
2020	$434,014	$120,210	$4,554,668	$731,010	$202,469	$11,825,455
2021	$457,847	$126,811	$4,241,137	$738,827	$204,634	$13,534,309
2022	$480,766	$133,159	$3,843,243	$734,181	$203,347	$11,777,553
2023	$507,155	$140,467	$3,586,302	$734,787	$203,515	$10,401,480
2024	$531,701	$147,266	$3,636,299	$763,049	$211,343	$9,777,164
2025	$361,057	$100,003	$3,642,838	$672,256	$186,196	$10,096,193
2026	$284,649	$78,840	$2,674,197	$383,265	$106,154	$6,639,260
2027	$225,355	$62,417	$1,242,668	$251,869	$69,761	$3,149,427
2028	$181,456	$50,258	$642,231	$152,884	$42,345	$1,605,454
2029	$149,120	$41,302	$331,223	$84,825	$23,494	$820,384
2030	$127,803	$35,398	$166,537	$37,340	$10,342	$408,343
2031	$115,849	$32,087	$73,168	$5,805	$1,608	$178,383
2032	$110,430	$30,586	$19,576	-$13,459	-$3,728	$39,152
2033	$106,932	$29,617	$0	-$26,204	-$7,258	$0
2034	$108,619	$30,084	$0	-$27,770	-$7,691	$0
2035	$112,051	$31,035	$0	$49,179	$13,621	$0
2036	$115,566	$32,009	$0	$65,661	$18,186	$0

Source: REMI PI+, RESI

RESI expects Garrett County local property tax revenues at the peak of drilling may increase by $531,701 and income tax revenues may increase by $147,266 in Scenario 1. Under Garrett County's 5.5 percent severance tax, RESI expects that the county will gain an additional $4.2 million at the peak of drilling. Garrett County local property tax revenues may increase by $763,049 and local income tax revenues may increase by $211,343 at the peak in Scenario 2. Garrett County's severance tax revenues at the peak of drilling could increase by $13.5 million.

4.3 Interpreting the REMI PI+ Results

Figures 23, 24, 28, and 29 reference the difference of industry impact to the regions under each scenario against RESI's baseline forecast for both counties. Under each scenario, RESI assumed that drilling will begin in 2017 and culminate in 2026. From 2027 through 2036, RESI assumed that no new wells will be drilled and that any remaining economic changes will be associated with the ongoing operation of the wells and residual impacts. Under this assumption, the wells are operational with minimal direct employment. However, conservation fund spending and changes in home values remain in the region. Therefore, economic activity remains different

from the baseline scenario because, without the drilling in the previous ten years, the residual economic impacts in the latter ten years would be nonexistent.

The positive growth in jobs with negative wage and output expectations is reflective of the types of jobs being gained and the losses incurred. The phenomenon can be better illustrated using an example. For instance, under the Allegany County Scenario 1 estimates, in 2036 the economy will gain seven jobs in Retail Trade and lose five jobs in Construction compared to baseline projections. The net change in terms of employment appears to be a gain of two jobs, but these jobs offer varied median income per worker.

The negative wage change references the pay in the region. Although there are seven new jobs in the Retail Trade sector, these jobs are much lower paying than those within the Construction sector. According to RESI's analysis, the wages lost in Construction totaled $392,900 in 2036 for Allegany County under Scenario 1. However, the wages gained in Retail Trade during that same year totaled $137,300. Taking the difference from wages gained in the Retail Trade sector and wages lost in the Construction sector yields a net loss of $255,600 in wages in 2036, which is why the analysis can report net positive gains in employment with negative net wage impacts.

In each scenario in Section 4.2, total employment growth is shared by existing residents, new residents, and commuters. Existing research estimates that approximately 37 percent of gas workers will move in from out of state. Earlier research estimated a higher percentage of in-migration; however, as an increasing share of the local workforce was trained for gas sector jobs, a smaller portion of out-of-state employment was needed.[56]

Findings from REMI PI+ project that roughly 65 percent of Western Maryland residents will be able to support new labor demand created by drilling activity. Maryland benefits from proximity to drilling in Pennsylvania and West Virginia in terms of employment, as firms such as Beitzel Corporation and Pillar Innovations currently employ and train Maryland residents working in shale and related industries in nearby states.[57] Roughly 10 percent of each counties' residents are employed in West Virginia or Pennsylvania, particularly in Mineral County, West Virginia, and Somerset County, Pennsylvania—areas with existing gas wells.[58]

[56] Partridge et al., "Final Report: Assessing the Impact of Shale Energy Boom on Ohio Local Housing Markets," 9.
[57] "Brief Economic Facts: Garrett County, Maryland," Maryland Department of Labor, Licensing, and Regulation, 2013, accessed May 22, 2014, http://www.choosemaryland.org/factsstats/Documents/briefeconomicfacts/GarrettBef.pdf.
[58] U.S. Census Bureau, *OnTheMap*, from *2011 Longitudinal Employer-Household Dynamics 1-year Estimates*.

Employment figures from the Bureau of Labor Statistics, cross-referenced with local data, estimate natural gas sector employment to be fewer than 300 jobs between Allegany and Garrett Counties as of 2012.[59] [60] An estimated 62.2 percent and 57.2 percent of residents live and work in Allegany and Garrett Counties, respectively. The remaining 40 percent of people employed within either county commute to jobs in other counties.[61] With Maryland residents trained to work in the natural gas industry, fewer out-of-state workers may be needed, and residents commuting out of Western Maryland may find work closer to home, based on the trend in other drilling communities. RESI does not, however, assume these residents will take a job in the county instead of continuing to commute to their current jobs.

4.4 Summary

Short-term "Boom"

The natural gas industry, like most businesses, experiences a "boom and bust" cycle. Essentially, a period of increased activity, or "boom," is followed by a period of decreased activity, or "bust." From the housing market to the stock market, most goods and services experience this trend. The natural gas industry is not an exception to the rule. The majority of the intense labor occurs during the active drilling period, with a minimal need for labor after active drilling.

A 2012 study by Weber found that counties where drilling did occur saw modest increases in their employment and wages, as did adjacent regions.[62] It has been noted in Pennsylvania that, after a well is drilled, the number of direct full-time equivalent employment drops significantly to less than one annually.[63]

The main driver of the economic activity during the "boom" cycle relies upon the drilling of new wells and creation of well pads through 2026. In Allegany County, where the number of total wells and well pads is assumed to be significantly fewer than for Garrett County, the "bust" will likely occur soon after 2027 with minimal impact on the economy from the loss of economic activity. Since Allegany County is less rural than Garrett County, Allegany County may be able to absorb more of the decline from the receding economic activity associated with active drilling in the region. In Garrett County, the "bust" is likely to occur much later due to the greater

[59] "Quarterly Census of Employment and Wages," U.S. Bureau of Labor Statistics.
[60] Maryland Department of Labor, Licensing and Regulation, "County Industry Series," in *Employment and wages by County*, 2012, accessed February 10, 2014, http://www.dllr.state.md.us/lmi/emppay/.
[61] Ibid.
[62] Jeremy G. Weber, "The Effects of a Natural Gas Boom on Employment and Income in Colorado, Texas, and Wyoming," *Energy Economics* 34 (2012): 1587, http://dx.doi.org/10.1016/j.eneco.2011.11.013.
[63] Kelsey et al., "Economic Impacts of Marcellus Shale in Pennsylvania: Employment and Income in 2009," 12.

number of wells still producing after 2027, but will likely be a more intense "bust" due the more significant economic change.

Increased economic activity in the region may incentivize some individuals previously commuting to relocate to the region. To date, RESI in discussions with local stakeholders, found that more than 60 percent of their current workforce used in Pennsylvania or West Virginia operations were from Maryland. Using this assumption, this could indicate that of the new jobs in the region, more than 30 percent will be taken by commuters into the area.[64] Using the REMI PI+ model to forecast economic migration, RESI recorded growth in the number of individuals relocating to the area for economic gain. This increased residential activity may drive the increase for new households in a limited market during the "boom" period. The increased residential activity would also increase consumer spending in the region during this period.

Long-term "Bust"

As the economies of Allegany and Garrett Counties expand from drilling activities until 2026, the underlying loss in property values and continued environmental tax for retention of amenities will remain following the end of the drilling. During the period of drilling, these economic drivers were less noticeable, given the larger economic impact from the industry development. However, as the industry begins to pull away from the region, RESI recorded a "bust" period of economic decline from the baseline for both counties.

According to RESI's hedonic model for housing in the region, the current vertical wells in the area have weakened property values for those properties within a half-mile of a well by 7 to 9 percent from a comparable home more than two miles away. This analysis was done over time, indicating that wells within the region have some underlying impact on people's perception of a home. Despite the wells being drilled in some cases more than 50 years prior, the environmental and health concerns may still affect an individuals' decision when purchasing a home. To date, there are no horizontal wells within the region, but this information about existing historical wells provides some knowledge of the potential impact of more intrusive wells.

A decline in property valuation has a significant impact on resale value as well as fiscal revenues. The local share of property taxes begins to demonstrate the impact of the property value decline by 2032. Revenues by 2032 in Garrett County, where the majority of the drilling would take place in RESI's analysis, begins to fall below baseline projections. The fall in property tax revenues is a direct result of the decline in the property values associated with those homes within a half- to one-mile of natural gas wells.

[64] RESI discussions with Bietzel Corporation.

RESI's analysis further incorporated a potential environmental tax to help offset any impacts from drilling in the area. RESI assumed this tax would continue for the remainder of the active well production phase, or at least until the producer reclaimed the area. After reclamation, RESI assumed the tax would be lifted. A tax on households decreases their disposable income, therefore allowing less money for households to spend on consumer goods and services. As a result, fewer individuals may be going out for dinner or a movie in the region annually. This tax would potentially provide state and local governments with the funds to offset some of the losses from the property tax revenue due to devaluation of homes. After the tax is lifted, the property value decline would remain and continue to impact property tax revenues indefinitely.

RESI analyzed both the industry impacts and potential household impacts on the economies from shale drilling. Under this analysis, RESI found that the more rural economy with a more pronounced drilling presence may experience larger gains through 2027, but will also experience greater declines through the study period of 2036. It should be noted that the less rural Allegany County economy was given the lower number of wells due to the amount of potential gas. Allegany County experienced a less pronounced "boom" in 2017 through 2026. However, after 2027 the decline in property values and continued environmental tax weighed on the economy, creating a decline in jobs, wages, and output similar to the more rural economy of Garrett County. Therefore, both Garrett and Allegany Counties could experience a "boom" and "bust" period. However, the impacts for both periods will be more evident in Garrett County than Allegany County.

5.0 Housing Impacts

In addition to the impacts on the regional economy as a whole, drilling for natural gas evokes major concerns over how the influx of workers will impact the housing market in Western Maryland, and, in turn, how changes in the housing market will impact the community in the short and long terms. Potential housing issues include housing supply shortages, rental rate increases, and infrastructure deficiencies. RESI considered Western Maryland's unique economic, political, and social environment as well as the experience of other areas to estimate the potential for housing shortages, rent increases, and displacement of residents, among other potential impacts.

Stakeholder concerns in Western Maryland stem from reports describing unmanageably large populations of predominantly young male workers moving into communities within intensely drilled areas. To determine if Western Maryland will have similar experiences to other states, it is important to assess any existing housing gaps in Allegany and Garrett counties. Stakeholders interviewed by RESI suggested both counties, especially Allegany County, have an existing surplus of housing in addition to planned new developments that are ready to absorb new residents. Conversely, one stakeholder suggested Maryland's new septic laws may slow the pace of development as landowners and local government work to meet stricter requirements and best practices.

RESI's housing analysis found that stakeholders' assumptions about the existing housing supply in Western Maryland are accurate regarding observations that Allegany County has an existing surplus of housing units. Regarding concerns about the county's ability to develop new housing fast enough, existing research reports that new development is an inferior solution to meet new and transient housing demand as opposed to improving existing housing units which are currently unavailable to own or rent but are physically existent. The county's ability to take advantage of its surplus of vacant housing units may be reliant on the situation of the property owners and their ability or willingness to sell or rent to a transient workforce. The creative use of temporary housing or non-residential vacant units is an alternative solution described in case studies and reports from other regions with drilling activity.

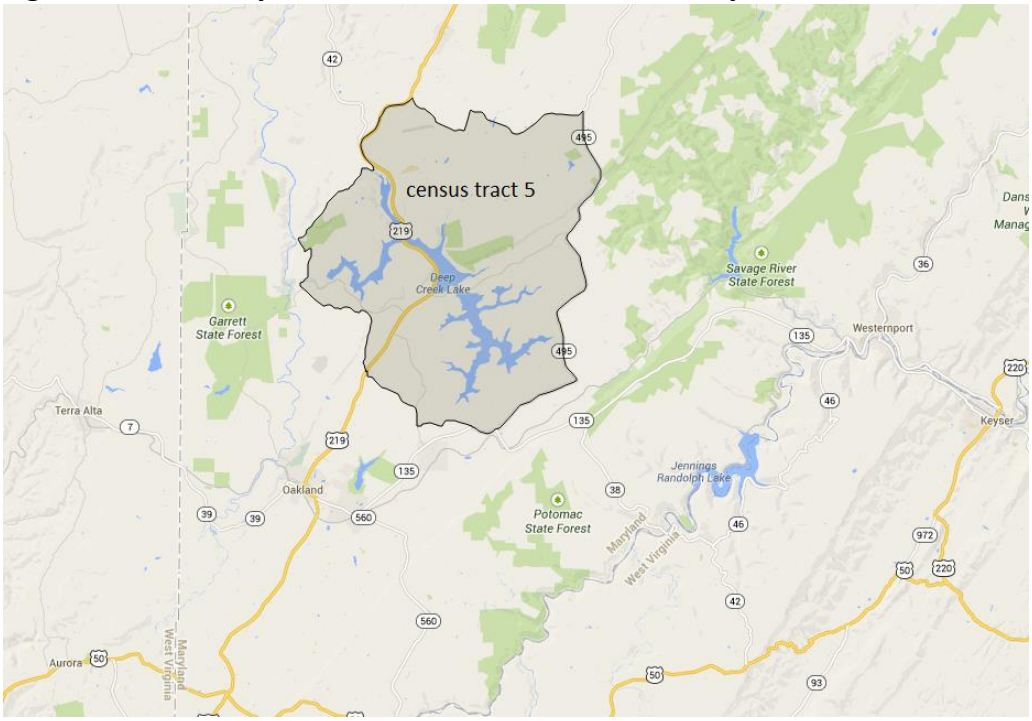
5.1 Existing Housing in Western Maryland

RESI analyzed Allegany and Garrett Counties' existing housing demand and supply using methodology defined by Oklahoma State University's Division of Agricultural Sciences and Natural Resources as part of the Oklahoma Cooperative Extension Service. The methodology outlined in the Oklahoma State University report was predominantly derived from Jerry Knox of the Community and Regional Planning Department at Iowa State University.

The first step in assessing existing housing demand involved collecting housing data; RESI used county level data from the U.S. Census Bureau's 2012 American Community Survey. The U.S. Census Bureau does not calculate single-year estimates for areas with populations below 60,000, and three-year ACS data is not calculated for areas with populations below 20,000. Due to the relatively small populations of both counties, only three-year estimates were available at the county level. To conduct a housing analysis using census tracts, only five-year ACS estimates were available.

To simplify the housing analysis, RESI originally analyzed countywide housing data. However, a third analysis has also been conducted which excludes Census Tract 5 of Garrett County, shown in Figure 32.

Figure 32: Boundary of Census Tract 5 in Garrett County



Sources: Google Maps, Open Street Map

Census Tract 5 encompasses the Deep Creek Lake area, which is a popular tourism and recreation area. While data is not available defining the exact number of second homes and vacation homes in Garrett County, feedback from the Safe Drilling commission and from the public encouraged RESI to consider excluding homes in the Deep Creek Lake area which may not be classified as vacation or seasonal housing by the ACS but are considered second homes. Housing units in the second home market may be unavailable as housing for transient workers.

Exclusion of Group Quarters and Vacation and Seasonal Housing

Garrett County has a prominent tourism industry that includes resort, recreation, amusement, and outdoor sports attractions. The county, and specifically its Deep Creek Lake area, is popular for second homes and vacation rentals. The Deep Creek Lake area represented at least 74.1 percent of the county's vacation and seasonal housing units, based on census tract boundaries.[65] In Garrett County, more than 25 percent of total housing units, or 4,768 units, includes vacation and seasonal housing. The share of vacation and seasonal housing in Allegany

[65] U.S. Census Bureau, "VACANCY STATUS," in *2008–2012 American Community Survey 5–year Estimates*, accessed February 7, 2014, http://factfinder2.census.gov/.

County was considerably smaller, at just over two percent of total housing units in the county.[66] To prevent the second home market from skewing the analysis, RESI did not include vacation and seasonal homes as part of total housing supply.

The other half of Western Maryland is skewed by a large population living in group quarters, defined as institutional (e.g., nursing homes, hospitals, and prison wards) and non-institutional (e.g., military bases, group homes, and college dorms) living quarters. Allegany County has a higher number of institutionalized individuals due to the presence of two state prisons. The prison population is all male, and the majority is between the ages of 22 and 30, skewing the county's demographics.[67] The institutionalized population for each county was subtracted from total population when counting total housed population in an area.

Multifamily and Temporary Housing in Western Maryland

Both counties have few multifamily units, most of which are used for senior housing in Cumberland or student housing in Frostburg.[68] If such housing is part of an institution, it was not included in RESI's analysis. However, if student or senior housing is outside an institution and not rented out exclusively to those two populations, it may have been included based on Census definitions of housing types. Various reports indicate that many shale workers reside in hotels, or other temporary housing, in areas where housing is in short supply and cannot be built fast enough to accommodate the influx of new residents. However, Western Maryland appears to have a sufficient housing stock, including other vacant housing, based on expected levels of natural gas extraction in RESI's analysis.

If the existing housing supply proves insufficient, Garrett County's recently closed schools could be used to soften housing impacts. For example, a school in Washington County, Pennsylvania, was converted into one-bedroom units to house workers.[69] Garrett County has at least three closed schools with potential to be similarly converted to housing. This would, however, be a temporary solution to school closures in the area due to the short-term nature of the natural gas "boom" phase.

Supply and Demand of Existing Housing in Western Maryland

The surplus or shortage of housing based on RESI's analysis is not equivalent to the vacancy rates provided by the U.S. Census Bureau's ACS. In RESI's analysis, the number of occupied units

---

[66] U.S. Census Bureau, "VACANCY STATUS," in *2010–2012 American Community Survey 3–year Estimates*, accessed May 12, 2014, http://factfinder2.census.gov/.
[67] National Center for Smart Growth, "STAR Data Brief: Population and Demographics," 4.
[68] David K. Nedved, personal communication, October 18, 2013.
[69] Ibid, 14.

was increased by four percent to account for both existing residents and potential residents looking to occupy a home in Western Maryland. This four percent increase is a standard rate recommended by Jerry Knox from the Community and Regional Planning Department at Iowa State University.[70] Knox suggested that an efficient housing market provides potential residents with a variety of options for a new home.[71]

Figure 33: Existing Housing Demand and Supply, 2012

Category	Allegany County	Garrett County	Garrett County (w/o DCL)
Supply			
Available housing	30,105	12,932	10,635
Owned or for sale	*20,598*	*9,382*	*7,867*
Rented or for rent	*9,507*	*3,550*	*2,769*
Unavailable housing	2,515	1,220	949
Other vacant (not for sale or rent)	*2,515*	*1,220*	*949*
Total Supply	**32,620**	**14,152**	**11,579**
Demand			
To own	20,700	9,525	8,002
To rent	9,282	3,104	2,764
Total Demand	**29,982**	**12,629**	**10,761**
Surplus (Shortage)			
Available housing	123	303	(130)
Owned or for sale	*(102)*	*(143)*	*(135)*
Rented or for rent	*225*	*446*	*5*
Unavailable housing	2,515	1,220	949
Other vacant (not for sale or rent)	*2,515*	*1,220*	*949*
Total Surplus (Shortage)	**2,638**	**1,523**	**818**
Vacation/Seasonal Housing	**708**	**4,768**	**1,233**

Sources: RESI, Barta and Woods, U.S. Census Bureau

[70] Suzette Barta and Mike D. Woods, "Constructing a Community Housing Profile: Estimating Supply and Demand in Your Local Housing Market," Oklahoma State University–Division of Agricultural Sciences and Natural Resources, Oklahoma Cooperative Extension Service AGEC-919, 2, accessed September 11, 2013, http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2185/F-919web.pdf.
[71] Ibid.

Current ACS estimates show an overall surplus of total housing in both Allegany and Garrett Counties, if including all housing units in each county except for vacation and seasonal units. Excluding housing units from the Deep Creek Lake (DCL) area, or census tract 5, results in an existing shortage of available housing. Excluding DCL housing units removed 22.0 percent of the county's rental housing supply and 16.1 percent of for sale units. Another 22.0 of the county's housing was excluded by excluding DCL, representing units that are vacant but not for sale or rent.

Findings analyzing both counties entirely are supportive of claims made during stakeholder interviews. The overall housing surplus results from surpluses in both rental and other vacant units being greater than the shortage of for-sale units.[72] [73] The shortage of for-sale-units in both counties represents households looking to own, not rent, a home in Western Maryland. The shortage may not mean they will choose not to move to the area but may mean they will have to rent until another vacant unit becomes available for sale. The remainder of total housing supply (classified as "other vacant" in the ACS) may represent foreclosed units or vacant units not currently for sale or rent, meaning units which physically exist but are not available.[74]

Both Allegany and Garrett Counties have a large surplus of vacant units not currently on the market, with a combined total of nearly 4,000 unavailable and vacant housing units. Excluding vacation and seasonal housing, the total surplus for Allegany County totaled 2,638 units. Garrett County's housing surplus was smaller, with a total of 1,523 units. Drilling down further by excluding vacant units not currently for sale or rent, the two counties still have a housing surplus.

Census tract level data show the western portion of Allegany County, from Cumberland to the Garrett County border, makes up over 60 percent of the total housing surplus of the entire county.[75] Excluding DCL from Garrett County's housing analysis, RESI found a smaller surplus in rental units, resulting in an overall existing shortage of available housing, but a surplus still exists when including off-the-market units in total supply.

---

[72] U.S. Census Bureau, "HOUSING CHARACTERISTICS," in *2010–2012 American Community Survey 3–Year Estimates*, accessed May 12, 2014, http://factfinder2.census.gov/.
[73] U.S. Census Bureau, "VACANCY STATUS," in *2010–2012 American Community Survey 3-Year Estimates*.
[74] U.S. Census Bureau, "American Community Survey and Puerto Rico Community Survey 2012 Subject Definitions," 39, accessed May 14, 2014, http://www.census.gov/acs/www/Downloads/data_documentation/SubjectDefinitions/2012_ACSSubjectDefinitions.pdf.
[75] U.S. Census Bureau, "VACANCY STATUS," in *2008–2012 American Community Survey 5–year Estimates*.

In line with observations from area stakeholders, a majority of the vacancies are off the market due to the recent housing crisis and economic downturn. Between the two counties, approximately 81.5 to 90.4 percent of the housing surplus is represented by housing not currently for sale or rent.[76] Out-migration from Allegany and Garrett Counties to nearby Washington and Frederick Counties has also opened up housing in the area.[77]

5.2 Potential Housing Impacts in Western Maryland

As stated in Section 4.3, RESI does not assume that the 65 percent of residents able to take a job in Western Maryland's natural gas industry will take a job in the county instead of continuing to commute to their current out-of-state jobs. Instead, RESI used projected in-migration directly related to a growth in employment in the natural gas industry to form a conservative estimate of the resident share of new direct jobs. Based on current commuting patterns in Western Maryland, RESI assumed an estimated 58.9 percent and 61.4 percent of spinoff jobs in Allegany and Garrett Counties, respectively, would be acquired by new residents living and working in each county. Combining projected in-migration and resident share of spinoff jobs, RESI determined the total new households added to Allegany and Garrett Counties for Scenarios 1 and 2.

While the data show that there is room for new residents in both counties, the following figures and analyses estimate whether or not population growth will be too much, too fast for the area's housing market should drilling create a large influx of workers and new residents. To fully understand the potential changes in the housing market, RESI created a baseline of Western Maryland's housing supply and demand for a ten-year period between 2017 and 2026. The baseline represents expected population and housing changes without the presence of drilling.

[76] U.S. Census Bureau, "VACANCY STATUS," in *2008–2012 American Community Survey 5–year Estimates*.
[77] National Center for Smart Growth, "STAR Data Brief: Population and Demographics," 4.

Figure 34: Projected In-migration of New Households in Allegany County, 2017–2026

Scenario	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Baseline (no drilling)	**28,802**	**28,936**	**29,093**	**29,809**	**30,028**	**30,273**	**30,542**	**30,819**	**31,386**	**31,682**
Scenario 1 (25%)										
Direct	136	131	138	131	116	96	83	71	61	-78
Spinoff	86	38	125	67	148	85	60	37	21	10
Total HHs	29,024	29,105	29,355	30,006	30,292	30,453	30,685	30,927	31,469	31,614
Scenario 2 (75%)										
Direct	151	163	157	156	125	98	75	62	26	-131
Spinoff	104	181	219	234	252	261	269	274	162	102
Total HHs	29,057	29,280	29,469	30,199	30,405	30,632	30,885	31,155	31,574	31,653

Sources: REMI PI+, RESI

Following peak years of drilling in Allegany County, the influx of new residents peaks in 2021 with 264 new residents in Scenario 1 and 377 new residents in Scenario 2. By the tenth year of drilling activity, REMI PI+ projects that in-migration will be negative, representing workers leaving the area as drilling activity subsides. In-migration is projected to reverse in Garrett County in Scenario 2, but after the ten-year period studied in this section.

Figure 35: Projected In-migration of New Households in Garrett County, 2017–2026

Scenario	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Baseline (no drilling)	**11,688**	**11,743**	**11,806**	**12,190**	**12,279**	**12,380**	**12,490**	**12,603**	**12,999**	**13,121**
Scenario 1 (25%)										
Direct	103	-18	98	-22	90	-25	-22	-23	-23	-22
Spinoff	117	203	327	374	390	388	383	384	385	252
Total HHs	11,908	11,927	12,231	12,542	12,759	12,742	12,850	12,964	13,360	13,351
Scenario 2 (75%)										
Direct	126	122	116	102	93	78	68	62	-74	-75
Spinoff	183	455	598	668	761	724	671	629	622	492
Total HHs	11,998	12,320	12,521	12,960	13,134	13,182	13,228	13,294	13,547	13,538

Sources: REMI PI+, RESI

Following peak years of drilling in Garrett County, the influx of new residents peaks in 2021 with 480 new residents in Scenario 1 and 854 new residents in Scenario 2. Though the total number of households continues to increase over the ten-year period, the presence of drilling in Scenarios 1 and 2 will create a large, transient influx of residents at the early stages of drilling followed by slower year-over-year growth in household population compared to the baseline scenario. The slower growth is due to the projected out-migration of new residents directly employed by the natural gas industry.

Projected Housing Needs With and Without Drilling

RESI's analysis uses a fixed supply of housing units. Detailed permit data provided by both counties, in addition to estimates on the timeline from authorization to completed construction, allowed RESI to estimate housing supply in future years up to 2014. According to Census estimates, the average length of time from authorization to completed construction of a single-family home is six months, while multifamily units can take up to one year to be constructed depending on the number of units built.[78]

For years beyond 2014, RESI assumed a fixed supply to show how much of Western Maryland's existing housing stock will be consumed by new residents as a result of projected drilling activity. Given the existing share of housing in each county, projected household sizes as determined by Maryland's Department of Planning, and REMI PI+ projections of in-migration, RESI projected growth in housing demand in Western Maryland should drilling occur.

Figures 36 and 37 show the housing surplus or shortage expected for both counties for the no drilling scenario as well as for drilling Scenario 1 and Scenario 2. RESI analyzed potential housing shortages broken when taking into account available housing as well as unavailable housing. As previously stated, vacation and seasonal housing and group quarters were excluded from the analysis to avoid skewing results for Allegany and Garrett Counties.

[78] "New Residential Construction: Length of Time, 1976–2012," U.S. Census Bureau, accessed February 7, 2014, https://www.census.gov/construction/nrc/lengthoftime.html.

Figure 36: Projected Housing Surplus or Shortage—Allegany County

Category	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Baseline (No Drilling)										
Available housing	129	85	34	(198)	(269)	(348)	(435)	(525)	(709)	(805)
Owned or for sale	*(99)*	*(124)*	*(152)*	*(282)*	*(322)*	*(367)*	*(416)*	*(466)*	*(570)*	*(623)*
Rented or for rent	*228*	*209*	*186*	*85*	*54*	*19*	*(19)*	*(59)*	*(139)*	*(181)*
Unavailable housing	2,527	2,451	2,364	1,963	1,840	1,703	1,553	1,398	1,080	915
Total Surplus (Shortage)	**2,655**	**2,536**	**2,398**	**1,765**	**1,572**	**1,355**	**1,118**	**873**	**371**	**110**
Scenario 1 (25%)										
Available Housing	57	30	(51)	(262)	(354)	(407)	(482)	(560)	(735)	(783)
Owned or for sale	*(139)*	*(154)*	*(200)*	*(318)*	*(370)*	*(400)*	*(442)*	*(486)*	*(585)*	*(611)*
Rented or for rent	*196*	*185*	*149*	*57*	*16*	*(7)*	*(40)*	*(74)*	*(151)*	*(171)*
Unavailable housing	2,402	2,357	2,217	1,852	1,692	1,602	1,473	1,337	1,034	953
Total Surplus (Shortage)	**2,459**	**2,387**	**2,166**	**1,591**	**1,338**	**1,196**	**991**	**777**	**299**	**170**
Scenario 2 (75%)										
Available housing	46	(27)	(88)	(324)	(391)	(464)	(546)	(634)	(770)	(795)
Owned or for sale	*(146)*	*(186)*	*(221)*	*(353)*	*(391)*	*(432)*	*(478)*	*(528)*	*(604)*	*(618)*
Rented or for rent	*191*	*160*	*133*	*29*	*0*	*(32)*	*(68)*	*(106)*	*(166)*	*(177)*
Unavailable housing	2,384	2,259	2,153	1,745	1,629	1,502	1,360	1,210	975	931
Total Surplus (Shortage)	**2,430**	**2,232**	**2,065**	**1,421**	**1,238**	**1,038**	**814**	**576**	**206**	**136**

Sources: Allegany County Land Development Services, Barta and Woods, REMI PI+, RESI, U.S. Census Bureau

Figure 37: Projected Housing Surplus or Shortage—Garrett County

Category	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Baseline (No Drilling)										
Available housing	403	394	384	324	310	294	277	260	198	178
Owned or for sale	*(107)*	*(110)*	*(114)*	*(138)*	*(144)*	*(150)*	*(157)*	*(164)*	*(189)*	*(197)*
Rented or for rent	*509*	*504*	*498*	*462*	*454*	*445*	*434*	*424*	*387*	*375*
Unavailable housing[79]	1,348	1,338	1,326	1,257	1,241	1,223	1,203	1,183	1,111	1,089
Total Surplus (Shortage)	**1,750**	**1,732**	**1,710**	**1,581**	**1,551**	**1,517**	**1,480**	**1,442**	**1,309**	**1,268**
Scenario 1 (25%)										
Available housing	368	365	318	269	235	238	221	203	141	142
Owned or for sale	*(120)*	*(122)*	*(141)*	*(160)*	*(174)*	*(173)*	*(180)*	*(187)*	*(212)*	*(211)*
Rented or for rent	*489*	*487*	*458*	*429*	*409*	*411*	*401*	*390*	*353*	*354*
Unavailable housing	1,308	1,304	1,250	1,194	1,155	1,158	1,138	1,118	1,046	1,048
Total Surplus (Shortage)	**1,676**	**1,670**	**1,567**	**1,463**	**1,390**	**1,395**	**1,359**	**1,321**	**1,187**	**1,190**
Scenario 2 (75%)										
Available housing	354	321	294	227	202	193	184	172	128	126
Owned or for sale	*(126)*	*(129)*	*(138)*	*(164)*	*(172)*	*(177)*	*(181)*	*(187)*	*(207)*	*(211)*
Rented or for rent	*480*	*450*	*431*	*390*	*374*	*370*	*365*	*359*	*336*	*337*
Unavailable housing	1,292	1,234	1,198	1,118	1,087	1,078	1,070	1,058	1,013	1,014
Total Surplus (Shortage)	**1,646**	**1,537**	**1,470**	**1,322**	**1,264**	**1,247**	**1,232**	**1,210**	**1,125**	**1,128**

Sources: Barta and Woods, Garrett County Permits and Inspections Services, REMI PI+, RESI, U.S. Census Bureau

[79] The U.S. Census Bureau defines available housing as any housing vacant-for-sale or vacant-for-rent housing unit. There are also vacant housing units currently not for sale or rent; these are either "other vacant" housing units or vacation and seasonal housing.

In both Scenarios 1 and 2, Garrett County will not experience a housing shortage in either available or unavailable housing units. Allegany County will experience a shortage in available housing as early as the second year of drilling in Scenario 2. When including vacant housing units not for sale or rent, Allegany County is not projected to experience a shortage within the ten-year period under either scenario.

Figure 38 shows a revised housing analysis for Garrett County excluding the Deep Creek Lake area as defined by census tract 5.

Figure 38: Projected Housing Surplus or Shortage—Garrett County, excluding Deep Creek Lake[80]

Category	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Baseline (No Drilling)										
Available housing	(272)	(280)	(289)	(348)	(361)	(377)	(393)	(411)	(471)	(489)
Owned or for sale	*(227)*	*(232)*	*(239)*	*(276)*	*(285)*	*(295)*	*(305)*	*(316)*	*(355)*	*(367)*
Rented or for rent	*(44)*	*(47)*	*(51)*	*(72)*	*(76)*	*(82)*	*(88)*	*(94)*	*(116)*	*(122)*
Unavailable housing[81]	624	604	580	435	401	364	322	279	130	84
Total Surplus (Shortage)	**353**	**324**	**290**	**88**	**40**	**(13)**	**(71)**	**(131)**	**(340)**	**(405)**
Scenario 1 (25%)										
Available housing	(305)	(308)	(354)	(401)	(434)	(432)	(448)	(466)	(526)	(524)
Owned or for sale	*(249)*	*(251)*	*(280)*	*(311)*	*(332)*	*(330)*	*(341)*	*(352)*	*(391)*	*(390)*
Rented or for rent	*(56)*	*(57)*	*(74)*	*(91)*	*(103)*	*(102)*	*(108)*	*(114)*	*(135)*	*(135)*
Unavailable housing	541	534	419	302	220	226	186	143	(7)	(3)
Total Surplus (Shortage)	**236**	**226**	**65**	**(99)**	**(214)**	**(205)**	**(262)**	**(323)**	**(532)**	**(527)**
Scenario 2 (75%)										
Available housing	(319)	(351)	(377)	(443)	(467)	(475)	(484)	(496)	(538)	(541)
Owned or for sale	*(257)*	*(272)*	*(288)*	*(329)*	*(344)*	*(350)*	*(356)*	*(364)*	*(393)*	*(396)*
Rented or for rent	*(61)*	*(79)*	*(90)*	*(114)*	*(123)*	*(126)*	*(128)*	*(132)*	*(145)*	*(145)*
Unavailable housing	507	386	310	144	79	60	43	18	(77)	(74)
Total Surplus (Shortage)	**189**	**18**	**(88)**	**(321)**	**(413)**	**(438)**	**(463)**	**(497)**	**(631)**	**(626)**

Sources: Barta and Woods, Garrett County Permits and Inspections Services, REMI PI+, RESI, U.S. Census Bureau

[80] For the purpose of this housing analysis, RESI defines Deep Creek Lake by the boundaries of census tract 5 of Garrett County, which encompasses the Deep Creek Lake area.

[81] The U.S. Census Bureau defines available housing as any housing vacant-for-sale or vacant-for-rent housing unit. There are also vacant housing units currently not for sale or rent; these are either "other vacant" housing units or vacation and seasonal housing.

Excluding housing in the Deep Creek Lake area, Garrett County's total existing housing supply would fail to meet new demand by 2022 without any drilling activity. With drilling activity, a housing shortage is probable in Scenarios 1 and 2 by 2020. Removing the Deep Creek Lake area from the housing analysis also reveals a persistent shortage of available housing for all ten years. The population left without housing for sale or rent will be faced with the dilemma of finding alternative housing in the county or moving to another county if economically feasible.

Affordability of Housing with Drilling Activity

Average household income in Allegany County is $53,000 and in Garrett County is $59,000 based on three-year estimates from the 2012 American Community Survey. Workers in the ancillary and core sectors of the natural gas industry in nearby Pennsylvania earned average annual wages between $64,000 and $81,000 depending on occupation between 2009 and 2011. The roughly $10,000 to $30,000 difference in average annual wages between existing and potential new residents presents a risk of increases in rental rates and displacement of residents who earn lower wages.[82] Roughly half of households in Allegany and Garrett Counties earn annual income below $39,000 and $44,000, respectively.[83] Therefore, half of the counties' respective populations earn roughly $40,000 less than employees of the natural gas industry.

Due to the relatively small number of expected wells drilled in both scenarios and the substantial total surplus of housing in the area, RESI does not expect rental housing to become unaffordable. Maryland does not have rent control, but landlords must wait until the end of existing leases before raising the rent, especially if the lease is subject to automatic renewal.[84] If the influx of workers is relatively short-term, renters in Maryland may not be impacted if long-term leases are held, but month-to-month leases, or daily rates for temporary housing such as hotel rooms, would be more vulnerable to rising rates.

Data from the United States Housing and Urban Development office reports two-bedroom fair market rent (FMR) of $699 in Garrett County and $632 in Allegany County in 2013. Rental rates in Western Maryland are similar to those reported in other rural areas where drilling has occurred, but upward pressure on rental rates is different dependent on proximity to less rural areas. Washington County, Pennsylvania, had relatively stagnant rental rates, around $520 to

[82] Center for Workforce Information and Analysis, Pennsylvania Department of Labor and Industry, Marcellus Shale Fast Facts: July 2012 Edition, 4.
[83] U.S. Census Bureau, "ECONOMIC CHARACTERISTICS," in *2010–2012 American Community Survey 3–Year Estimates*, accessed May 12, 2014, http://factfinder2.census.gov/.
[84] "Landlords and Tenants: Tips on Avoiding Disputes," Maryland Attorney General's Office, accessed April 16, 2014, http://www.oag.state.md.us/Consumer/landlords.htm#renewals.

$620 per month in pre-drilling years. Demand was absorbed by nearby cities once drilling occurred.

An Ohio State University study on the subject indicates that rent was only raised modestly, if at all, in areas with a moderate amount of drilling activity. According to the University's study analyzing counties in Pennsylvania during a five-year "boom" period for drilling between 2007 and 2011, FMRs have a positive relationship with the number of gas wells in intensely drilled areas. However, the study emphasized that the relationship between oil and gas sector employment and FMR is not statistically significant, and the relationship was only observed in areas of intense drilling (Bradford, Tioga, and Lycoming Counties). The estimated breakeven point between drilling having no impact or modest impacts on FMR is between 340 to 430 wells drilled annually; drilling more than 340 to 430 wells in a single year may result in increasing rental rates.[85] The number of wells predicted in RESI's Scenario 2 does not exceed more than 72 wells drilled within a single year.

Bradford County had 397 new wells drilled in 2011, for a total of 962 wells by 2011. An analysis of FMR reported by Housing and Urban Development determined a high rate of drilling activity to explain a 3.6 percent increase in FMR for Bradford County in 2011.[86] Alternatively, an analysis of drilling activities' relationship with Census-reported rental rates provided contradictory results. Both data sources for rental rates have limitations for the purpose of identifying relationships between wells drilled and rent increases.

Anecdotally, the study mentioned Williston, North Dakota, an area with the most pronounced shale boom in the nation. The area experienced an increase in two-bedroom monthly rent from $350 to $2,000 (up 471.4 percent). FMR for Williston County's one-bedroom apartments increased by 59 percent between 2003 and 2013, higher than the national average growth in FMR by 34 percent in the same period.[87] A case study of Greene County, Pennsylvania, found rents increased by 7 to 12 percent pre- and post-recession, also coinciding with an uptick in drilling activity.[88] Anecdotal evidence from Greene County also found specific cases wherein rents doubled or tripled, but the study also noted that the share of renters paying more than 30

[85] Partridge et al., "Final Report: Assessing the Impact of Shale Energy Boom on Ohio Local Housing Markets," 20.
[86] Ibid.
[87] Ibid, 4.
[88] Stephen Herzenberg, Diana Polson, and Mark Price, "Measuring the Costs and Benefits of Natural Gas Development in Greene County, Pennsylvania: A Case Study," Multistate Shale Research Collaborative (April 2014): 1, accessed April 18, 2014, https://pennbpc.org/sites/pennbpc.org/files/greeneCASESTUDY.pdf.

percent of their incomes on rent increased at a slower rate than for the rest of the state due to a rise in income associated with higher paying occupations.[89]

Lycoming County, Pennsylvania, has a population of over 100,000, including the metropolitan statistical area of Williamsport.[90] Smaller communities in Lycoming County had a smaller supply of rental units, similar to the case in Allegany and Garrett Counties. One study reported that landlords in these smaller communities used rental income to supplement their primary income. Because these landlords earned other income, renting to long-term residents or workers was preferred over the cost and effort of finding new tenants between high-turnover, transient workers. In such areas, landlords hardly raised rental rates, and if they did, rents were raised by 5 to 10 percent.[91]

A 2011 study interviewed various stakeholders across six Pennsylvania counties on topics relating to drilling and housing. The counties varied in terms of shale drilling progress. From these interviews, the authors cited three major findings:

- "First, the severity of the housing problem…depends on the nature and scale of the growth of the natural gas industry in a given county or community and on the existing pre-Marcellus capacity of that county or community to absorb the increased demand for housing."[92]
- "Second, the effects of increased housing demand are broad-based, but the negative impacts are felt heaviest by those living at the economic margins."[93]
- "Finally, the capacity of the development community varies considerably from county to county in its ability to meet the need for additional housing."[94]

These findings seem to suggest that the potential for adverse effects on housing may vary depending on a multitude of factors. Therefore, determining and employing the best policies relating to land use planning, zoning, etc. may provide the best possible outcome.

[89] Herzenberg, Polson, and Price, "Measuring the Costs and Benefits of Natural Gas Development in Greene County, Pennsylvania: A Case Study," 1.
[90] U.S. Census Bureau, "DEMOGRAPHIC AND HOUSING ESTIMATES," in *2012 American Community Survey 1-year Estimates*, accessed May 12, 2014, http://factfinder2.census.gov/.
[91] Jonathan Williamson and Bonita Kolb, "Marcellus Natural Gas Development's Effect on Housing in Pennsylvania," Center for the Study of Community and the Economy–Lycoming College (September 31, 2011): 11, accessed February 28, 2014, http://www.cohhio.org/files/HOUSING%20PHFA%20Marcellus_report.pdf.
[92] Ibid, 1.
[93] Ibid.
[94] Ibid, 2.

A similar study from the Institute for Public Policy & Economic Development analyzed drilling activity and housing in twelve counties in Pennsylvania and found that the financial and human capacity strains to local government and construction presented housing challenges, but noted that "the shale play is not necessarily the cause of a housing crisis in Pennsylvania" as "any catalytic event causing growth or change would have affected these communities in the same way."[95] The report provides a number of policy recommendations aimed at reducing the impact on housing, among them rental ordinances and exclusionary zoning ordinances.

Impacts of Potential Housing Shortages or Rental Rate Increases

Should the pace of drilling in Allegany and Garrett Counties exceed projections, it may be necessary for housing authorities to create contingency plans for the possibility of severe housing shortages, based on the threshold provided by the Ohio State study. In counties where drilling activity was most intense, the response to increasing rental rates was to increase supply of housing, which could lead to long-term blight following a "bust" in drilling activity. While new housing was being built, workers turned to temporary housing, such as hotels. However, more creative responses such as the converted school facility in Washington County, Pennsylvania, could also be considered to reduce potential blight after the drilling industry "bust."[96]

Temporary housing is not included in this analysis, but workers' preferences for temporary housing are detailed in Section 6.0 of this report. Section 6.0 discusses tourism-related impacts and details the greater expectation of increases in hotel occupancy from an influx of workers, rather than increased homeownership or renting. One stakeholder in Washington County, Pennsylvania, speculated that continuing attempts to ban drilling activity lead to workers' uncertainty in the length of their employment within an area, adding to their preference for temporary housing, shown by the high occupancy rates of hotel rooms.[97]

Experiences of other counties with intense drilling activity indicate potential for blight and high vacancy rates in Western Maryland should drilling activity occur. In RESI's scenarios, the period between 2027 and 2036 represents the likely "bust" period of drilling activity in Western Maryland. RESI's housing analysis does not predict how many new housing units would be built in response to drilling activity.

---

[95] Institute for Public Policy & Economic Development, "Impact on Housing in Appalachian Pennsylvania as a Result of Marcellus Shale," November 2011, 16, accessed February 28, 2014, http://www.institutepa.org/PDF/Marcellus/housing11.pdf.
[96] Ibid, 9.
[97] Williamson and Kolb, "Marcellus Natural Gas Developments Effect on Housing in Pennsylvania," 9.

Understanding existing and potential levels of housing stock and identifying alternative housing options for transient workers can help to avoid over-development during a boom period. Over-development in response to a short-term increase in resident population could lead to blighted communities after drilling ends. The Director of Greene County, Pennsylvania's Department of Human Services, Karen Bennett, was quoted as saying "every program I have is impacted by housing—foster, drug and alcohol, disability, [and] mental health."[98]

Inadequate housing in Bennett's jurisdiction, according to a 2014 case study, drove up rents and increased the preexisting housing shortage, which led to higher demand of foster care services and increased high school dropout rates, followed by an increase of high school dropouts applying for public assistance after being laid off by out-of-state companies.[99] The Greene County case study provides a balanced overview of the benefits and costs of the heavy drilling that has occurred in recent years. Greene County has, however, also experienced an uptick in coal extraction in addition to natural gas extraction.[100]

The differences between Greene County and Western Maryland are the level of drilling activity and the housing conditions before drilling. While Greene County had an existing shortage prior to drilling, Western Maryland has a surplus of housing. Green County had over 500 unconventional gas wells drilled within a six-year period, while Western Maryland may not see more than 350 wells in its first six years of drilling. In addition, drilling impacts in Pennsylvania and other states occurred in the midst of the most recent recession.

5.3 Summary

Housing is an area of concern that experiences direct impacts from drilling activity, but those impacts overlap with existing issues and expected impacts on schools, agriculture, roads, and other issues brought up by area stakeholders. RESI's research and analysis of housing impacts indicated that Western Maryland has a sufficient total housing surplus, not accounting for construction of new units or deterioration of existing units, to handle the projected population growth attributable to drilling activity. However, excluding the Deep Creek Lake area, which has a large second-home and vacation rental market, RESI found that Garrett County may in fact face total housing shortages in the ten-year drilling scenarios 1 and 2. Again, this analysis does not account for the construction of new homes or the deterioration of existing homes over the ten-year period; it assumes a fixed housing supply.

---

[98] Herzenberg, Polson, and Price, "Measure the Costs and Benefits of Natural Gas Development in Greene County, Pennsylvania," 2.
[99] Ibid, 1.
[100] Ibid, 11.

Because Western Maryland is a primarily rural area, it may not benefit from proximity to densely populated urban areas whose rental market would absorb the impacts of sudden population growth. Still, recent studies determined a weak relationship between drilling activity and rental rate growth unless more than 340 wells were drilled in a single year, and Western Maryland is not expected to experience such intense drilling activity. Natural gas workers' use of temporary housing further complicate estimating impacts on housing. As discussed in Section 6.0 of this report, comparable counties with drilling activity in Pennsylvania and West Virginia did experience an increase in hotel occupancy by the natural gas workforce, based on anecdotal evidence.

Data exists to prove that hotel occupancy and revenues were in fact up during drilling years, but there is no hard data on the exact number of occupants who were tourists or workers. In addition, areas like Greene County where housing shortages existed prior to the natural gas "boom" and where new construction could not keep up with the worker population make it difficult to determine if workers prefer temporary housing or occupied temporary housing out of necessity. The unique housing stock of Western Maryland in addition to different economic, social, legal, and political conditions compared to other states drilling in the Marcellus Shale region will ultimately determine very similar or very different impacts to Western Maryland if drilling is permitted.

6.0 Tourism Impacts

In addition to understanding the potential impacts that drilling may have on the regional economy as a whole, stakeholders would like to know how drilling will impact tourism in per dollar terms, with the expectation that potential environmental damage could render areas like Deep Creek Lake unsuitable for their primary uses: tourism and recreation.

Proprietors of ecotourism and recreation businesses who participated in stakeholder interviews note that chemical leaks, spills, and other contamination near the Deep Creek Lake area are reported in the news—for example, a sewage spill from a nearby pump station—leading to cancellations of reservations and loss of business. Wind farms are another point of contention for stakeholders regarding energy development impacting the quality of the environmental amenities paramount to a thriving tourism and recreation industry. A history of coal mining and the addition of new wind turbines in Western Maryland has already interrupted mountain views, fragmented forests, and disrupted habitats.

The concern of community stakeholders is that drilling, if implemented with the same lack of research and planning as other extractive or energy-related industries, would further destroy the environmental and rural amenities that bring so many visitors to Allegany and Garrett Counties. The community's experience with the risk of leaks, spills, and other preventable accidents in extractive industries and the proceeding impacts on the scenic viewsheds,

abundant wildlife, natural watersheds, and open space in Western Maryland create concerns regarding future impacts to tourism, especially if drilling occurs.

Tourism and other industries can suffer from bad press from events like the spill in Deep Creek Lake, but general economic downturn plays a role as well. Stakeholders who own businesses in Western Maryland estimated a 30 to 40 percent loss of revenue in recent years; revenues were down by an estimated 60 percent for construction and related businesses. The losses attributable to local versus national economic issues is, however, difficult to distinguish. The overlap of the Marcellus Shale region's peak years of natural gas extraction, collocation with other extractive industries, and the recent national recession present challenges in predicting the magnitude of the impacts on other areas with new drilling activity in a complex, post-recession economy.

6.1 Existing Research

RESI researched changes in availability and quality of lodging, tourism activities, and parks and recreational areas as a result of drilling activity in other areas. The following subsections summarize existing research on the vulnerabilities of rural economies when presented with opportunities for energy investment, the importance of economic diversity, and the economic impacts of tourism. In addition, the analysis contains findings from RESI's survey questions regarding recreational activity and residents' and visitors' preferences, followed by quantitative and qualitative analysis of shale development's potential impact on tourism.

6.1.1 Tourism Impacts in Other States

William R. Freudenburg, a prominent researcher of rural struggles with energy development, has authored numerous studies on rural economies. In a 1992 *Rural Sociology* article, Freudenburg labeled rural areas' tendency to depend on extractive industry development as an "economic addiction."[101] Areas vulnerable to such addiction or dependence on energy development are typically geographically isolated. Even though the physical drilling and production processes take place within these rural areas, the price of gas and labor is determined by the larger industry as well as national and global economic conditions. Essentially, rural areas are not in control of changes in the larger natural gas industry and become most vulnerable when they lack viable alternatives for economic prosperity or lack

[101] William R. Freudenburg, "Addictive Economies: Extractive Industries and Vulnerable Localities in a Changing World Economy," *Rural Sociology* 57 no. 3 (1992): 305, accessed February 18, 2013, DOI: 10.1111/j.1549-0831.1992.tb00467.x.

economic diversity to remain sustainable after a mobile industry, such as natural gas extraction, comes and goes.[102]

More recent literature on towns with intense shale development confirms Freudenburg's findings. A 2009 study of drilling impacts in Pennsylvania stresses the importance of a diverse economy and the tendency for rural areas to consist primarily of natural resource-dependent industries such as energy, tourism, and agriculture.[103] Drilling activity in Pennsylvania continued to grow after 2009, and cumulative impacts to other industries can change as the scale of drilling increases in a specific area. The impacts on tourism are due to either physical changes to the landscape or changes in tourists' perceptions of the area.[104]

A 2011 analysis found that tourism was impacted in Pennsylvania, Texas, and Wyoming by shale development, and similar impacts could be felt in the New York Southern Tier Central Region—among them, availability of accommodations, changes to view sheds, and increased truck traffic.[105] Tourism in the Southern Tier surrounds the "agriculture; rolling hills, scenic farmlands, rural vistas, and viticulture" of the area. [106] Stakeholders in the region expressed concern over whether or not the value of these features, as well as the appeal and impacts of these elements, would be permanently damaged by drilling.

Tourism-related businesses (hotels, restaurants, retail, etc.) can provide the amenities needed by shale drilling workers and create an alternative consumer base to support local businesses in the "shoulder season," or times between peak tourism months. These businesses may, however, find themselves stretched thin during peak seasons when both tourists and natural gas workers demand use of local services, lodging in particular. Tourism can be part of a long-term economic development strategy, whereas employment growth in the natural gas industry, and the income and spending associated with those jobs, are typically short-term.[107] Existing studies have estimated the long-term consequences of drilling activity, stating that "the regional industrialization associated with widespread drilling could do substantial

---

[102] Freudenburg, "Addictive Economies," 305.
[103] Timothy W. Kelsey et al., "Economic Impacts of Marcellus Shale in Pennsylvania: Employment and Income in 2009," Marcellus Shale Education & Training Center (August 2011): 38, accessed October 7, 2013, http://www.shaletec.org/docs/economicimpactfinalaugust28.pdf.
[104] Ibid.
[105] Andrew Rumbach, "Natural Gas Drilling in the Marcellus Shale: Potential Impacts on the Tourism Economy of the Southern Tier," Cornell University, 1, accessed February 12, 2014, http://www.greenchoices.cornell.edu/downloads/development/shale/Impacts_on_Tourism_Economy.pdf.
[106] Ibid, 6.
[107] Ibid, 9.

damage…threatening the long-term growth of tourism."[108] RESI's findings regarding potential overall economic impacts to Western Maryland are comparable to previous studies, showing significant short-term benefits followed by potential losses in the long-term.

6.1.2 The Role of Tourism in Economic Diversity

The magnitude of potential tourism impacts for Western Maryland greatly depends on the intensity of drilling activity and how it will change the landscape and perceptions of Western Maryland. Whether or not drilling activity can coexist with the tourism industry will determine if the area's level of economic diversity will be maintained, worsened, or improved. At present, Western Maryland could benefit from greater economic diversity as tourism and recreation businesses struggle to make money during shoulder seasons. A permanent resident population of approximately 30,000 cannot support retail year-round without the additional patronage of tourists and non-permanent residents during peak travel seasons.

As discussed in Section 2.0 of this report, Allegany and Garrett Counties each have a few industries employing the majority of area residents. In Allegany County, nearly three quarters of its residents are employed by the Health Care and Social Assistance, Retail Trade, Accommodation and Food Services, Manufacturing, and Administrative and Waste Services industries. Garrett County is slightly more diversified, with just over half of its residents employed in these top five industries: Retail Trade, Accommodation and Food Services, Manufacturing, Construction, and Arts and Entertainment. Garrett County's top five industries in Western Maryland are fairly reliant on tourism activity. The following subsection attempts to characterize how the presence of drilling may change tourism activity, and, in the larger report, how the entire economy is impacted.

Garrett County has become a case study in the importance of economic diversity in the strategic development of rural areas. In a report prepared for the Appalachian Regional Commission, Garrett County is applauded for its success in recovering from the sudden loss of a major employer in the manufacturing industry who relocated 600 jobs to San Antonio, Texas.[109] The county now focuses its planning and development efforts in diverse and local opportunities for employment, which has led to above average employment and income growth between 2002 and 2009. The county is considered one of the most diverse and fastest growing counties

[108] Rumbach, "Natural Gas Drilling in the Marcellus Shale," 19.
[109] Mark White et al., "Economic Diversity in Appalachia: Case Studies in Economic Diversification," University of Illinois at Urbana-Champaign's Regional Economics Applications Laboratory and the Center for Regional Economic Competitiveness (February 2014): 13, accessed August 27, 2014, http://www.arc.gov/assets/research_reports/EconomicDiversityinAppalachia-CaseStudiesinEconomicDiversification.pdf.

in the Appalachian region and the report states that "tourism and second-home demand have been an important component of that growth."[110]

In fact, tourism is mentioned as a targeted industry for economic diversity and growth in a number of counties studied in the Appalachian region, and in some cases tourism is pursued in the long-term while simultaneously pursuing opportunities in extractive industries for a short-term economic boost. Overall, the Appalachian region's counties who have achieved success in economic development are those whose "focus has been primarily on business retention and growth, rather than recruitment."[111] Another common theme throughout the Appalachian Regional Commission's multiple case studies is the importance of access, or transportation and roads, from densely populated metropolitan regions to the tourism destinations throughout Western Maryland, West Virginia, and Pennsylvania. The impact natural gas development will have on traffic and roads is of concern to area stakeholders and may have direct impacts on tourism. An in-depth analysis of potential impacts on roads is not within the scope of RESI's study but has been conducted separately as a part of Maryland's Safe Drilling Initiative.

6.1.3 Tourism's Impact on Western Maryland

The nature of Western Maryland's economy is known to be reliant on tourism and related industries; therefore, it is important to consider how a new industry such as natural gas drilling will impact one of the area's major economic drivers. This section looks at recent studies which analyzed tourism impacts in Western Maryland followed by a summary of RESI's survey responses regarding perceptions of the quality of recreational activities in the area.

Economic Impact of Tourism

A 2010 study commissioned by the Garrett County Chamber of Commerce used non-local visitor survey responses to determine the impacts of tourism in Garrett County. The survey covered areas of interest such as the reason for visiting, the length and frequency of visits, and accommodations and activities. Most survey respondents indicated that their reason for visiting Garrett County was leisure or vacation.[112] As a resort destination, Garrett County is comparable to tourist destinations found in West Virginia and Pennsylvania.

[110] White et al., "Economic Diversity in Appalachia," 14.
[111] Ibid, 17.
[112] Jinyang Deng, Steve Selin, and Kathryn Arano, "Travel/Tourism Related Economic Analysis for Garrett County, Maryland," Appalachian Regional Commission (January 30, 2010): 7, accessed February 28, 2014, http://www.deepcreekanswers.com/info/studies/Travel_Tourism_Related_Economic_Impact_Analysis.pdf.

Compared to other Maryland counties, Garrett County is estimated to see more "person-trips" than most other counties within Maryland.[113] On average, visitors stayed in Garrett County for 4.7 nights and visited the county 6.8 times in a twelve-month timespan.[114] According to survey responses, daily spending per person and total trip spending per person totaled $94 and $257, respectively.[115] Survey responses were extrapolated to estimate that Garrett County saw more than 1.1 million person-trips during the year-long survey period, and visitor spending totaled more than $243.3 million.[116]

The report estimated that visitor spending had a total economic impact of nearly $347.7 million in sales, generated more than 5,000 jobs, and contributed $193.4 million in value added.[117] Those owning second homes in Garrett County visited most frequently, 16.8 times in a twelve-month timespan, and contributed the most to the overall economic impacts—$156.5 million in sales, nearly 2,300 jobs, and $81.5 million in value added.[118]

To represent the broad reach of the tourism industry, the Maryland Office of Tourism estimated tourism-induced sales tax revenue, which increased by 7.3 percent in Allegany County and by 6.3 percent in Garrett County between fiscal years 2012 and 2013.[119] The two counties' growth in tourism sales exceeded statewide growth rates of 1.0 percent for tourism sales tax and 0.8 percent for all sales tax collected in the same period, a promising sign of growth for a region that represents less than ten percent of the state's tourism activity.[120]

Common sources of tourism and visitor data primarily represent major hotel chains, of which there are few in smaller, rural counties. The small number of major hotels results in data being confidential or not representative of the area's entire hospitality and lodging industry. For instance, in a Maryland Office of Tourism report, Garrett County's hotel market data from Smith Travel Research is not disclosed.[121]

---

[113] Deng, Selin, and Arano, "Travel/Tourism Related Economic Analysis for Garrett County, Maryland," 48.
[114] Ibid, 1.
[115] Ibid.
[116] Ibid, 40.
[117] Ibid, 45.
[118] Ibid, 9, 45.
[119] Maryland Department of Business and Economic Development's Office of Tourism, Tourism Development Annual Report Fiscal Year 2013, 6.
[120] Ibid, 5.
[121] Ibid, 12.

RESI collected data on hotel tax revenues through phone calls and secondary data collection in an effort to distinguish shale workers' impacts on hotel occupancy. However, no clear pattern emerged as the data did not distinguish shale workers share of hotel occupancy or reveal how hotel tax policy determines the impact of shale workers occupying hotel rooms. The following tourism analysis remains reliant primarily on qualitative research and highlights a need for better data in the tourism industry. It is important to note that a lack of data is not equivalent to a lack of impacts, positive or negative, but represents an unknown impact which could be revealed given better data allowing for an in-depth quantitative analysis.

Stakeholder Feedback and Survey Responses

Several of Garrett County's top employers and small businesses spread throughout the county include recreation and tourism businesses that are owned and operated by local residents. A discussion with stakeholders in the tourism and recreation industries revealed a number of concerns regarding how shale development may impact these businesses. Key concerns regarding the tourism industry were how shale development may impact the following:

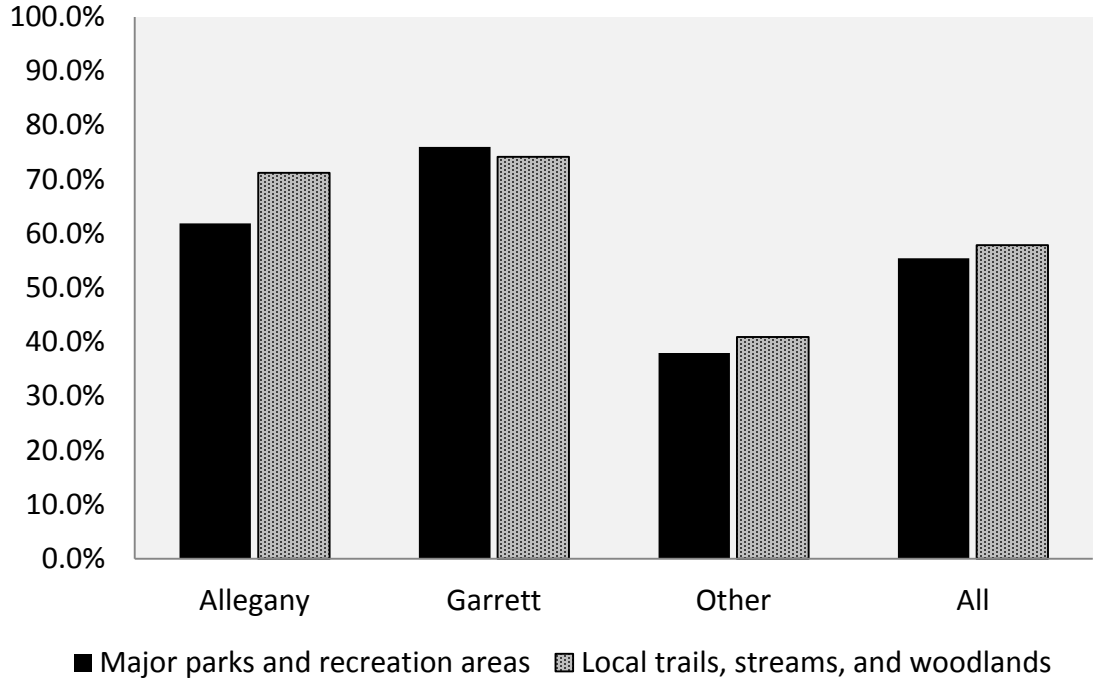
- Visitor and resident perceptions of Garrett County,
- The local supply of labor for the industry, and
- The availability and cost of resources.

Perceptions can cripple an area during and after an extractive industry "boom." A sewage leak contained within a small section of Deep Creek Lake proved enough to prompt visitors to cancel rentals and other reservations with tourism businesses in the area, according to stakeholders interviewed. Continued news coverage of more intense contamination from natural gas extraction elsewhere in the Marcellus Shale region raises concerns for the future of Western Maryland's tourism sector should similar events occur.

Maryland shares borders with two states that currently allow shale drilling, and storage wells and other related activity already exist in Western Maryland. RESI's survey, detailed in Appendix D of this report, reveals that approximately 40 percent of combined respondents from Allegany and Garrett Counties self-reported being extremely informed on the benefits and concerns of natural gas exploration. Nearly 54 percent of survey respondents indicated being moderately to very informed, and the remaining 6 percent felt that they were not at all or only slightly informed.

Figure 39 shows the percentage of survey respondents who participate in outdoor recreation in Western Maryland and how frequently they participate in outdoor recreation. For this particular survey question, the number of survey respondents living within Western Maryland was just over half of the total respondents, while the other half reported living elsewhere.

Figure 39: Respondents Participating in Outdoor Recreation at Least Once a Month



Source: RESI

The majority of respondents from Allegany and Garrett Counties participate in outdoor recreation at popular attractions, such as Deep Creek Lake, Swallow Falls State Park, and Wisp Mountain Resort, at least once a month if not daily. Daily to monthly participation in outdoor recreation at smaller, local streams and attractions in the same areas was also popular among respondents in both counties. Outdoor recreation in Western Maryland was also popular among respondents from outside Allegany and Garrett Counties; a majority of nonresidents participate in outdoor recreation a few times per year.

Regarding drilling activity's impacts on recreational activities in local trails, streams, and woodlands, overall participation amongst residents is less likely to change compared to nonresident participation. Residents' use of trails, streams, and woodlands in Western Maryland is more a question of where they will recreate rather than how often. Residents may recreate in different areas within Western Maryland but farther away from tourism amenities near drilling activity.

Conversely, nonresidents may still find time to visit trails, streams, and woodlands, but may look outside Western Maryland should the quality of such amenities decline or be perceived to have declined due to drilling. Hard data to support this claim has been difficult to locate. The following source serves as anecdotal evidence of the possibility. A dissertation from the

University of South Florida included interviews of residents in the Laurel Highlands of Pennsylvania. The following excerpt from one resident's response supports how residents' recreation changes, in terms of location and not frequency, with the presence of an extractive industry:

> Personally, my recreational activities have changed….One reason that I really enjoy living here is that I can roll out of my driveway on my road bike and ride sixty miles and pass probably six cars and ride through some of the most scenic landscapes in Southwestern Pennsylvania, and now I can tell you that my husband and I tailor the routes that we ride and the roads that we take, based on gas extraction and truck traffic.
> I think it left a lot of us who own small parcels of land that were carved out of farms a hundred years ago and who have well water, they're pretty vulnerable. I think that has been frustrating. There's just an edginess…My personal concerns are water contamination and disruption of my quality of life… (Resident 12).[122]

Just over half of respondents residing in Allegany County reported hiking as their primary outdoor activity; swimming and fishing were the next most popular activities. The popularity of such activities is likely due to the presence of the Great Allegheny Passage, also known as the GAP Trail. This world-class trail system crosses through many states including southwestern Pennsylvania and Western Maryland. In Garrett County, hiking was also the primary recreation activity for most respondents, with boating and fishing as other popular activities.

Eighteen and twelve percent of respondents from Allegany and Garrett Counties, respectively, responded "other" when asked which activity they participate in most often. A number of those who responded "other" described primary activities such as biking, whitewater rafting, kayaking, golfing, and sightseeing. Western Maryland residents indicated that they currently enjoy diverse options for recreation, so changes to how and where they choose to recreate will depend on the number and location of wells and how each type of activity is impacted.

6.2 Potential Tourism Impacts in Western Maryland

Quantifying the magnitude of tourism impacts proved challenging due to the lack of data on the impacts on tourism from drilling activities in comparable areas. However, RESI was able to develop some estimates for the possible impact to tourism's workforce and how they could impact the industry if shale drilling moves forward.

---

[122] Katherine D. Ferrari, "Rural Communities: How do Individuals Perceive Change When Industry Enters the Area?," dissertation, University of South Florida School of Social Work (October 15, 2013): 87, accessed May 21, 2014, http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=6009&context=etd.

6.2.1 Finding Comparison Cases

A Cornell University study on multiple shale plays included supportive findings regarding wage increases for existing occupations and industries, especially for trucking.[123] For general tourism employment, areas like Somerset and Fayette Counties in Pennsylvania experienced declines in employment between 2004 and 2009, representative of periods before and during drilling booms.[124] The same study found that changes in total employment, covering all industries, were not correlated with the presence of natural gas drilling in areas considered small metro or non-metro-adjacent urban counties with tourism employment of 3.0 percent or more of total employment.[125]

The Cornell University study observed changes to tourism employment based on rural-urban classification and found severe decline in rural counties, modest decline in rural-urban counties, and modest growth in urban counties. County-level data do not, however, fully represent the varying impacts between communities within a county, and the authors recognize that impacts are difficult to separate from other economic trends, such as the recent recession or local economic factors.[126]

RESI compared counties with tourism activity and other characteristics similar to Western Maryland. Comparable counties were determined through communication with stakeholders and tourism bureaus within and outside Maryland and by using a comparison of the USDA rural-urban designations identified as significant through Cornell's findings. The USDA's rural-urban designations are defined in Figure 40.

[123] Diaz et al., "Economic Implications of Marcellus Shale Natural Gas Development: Understanding Potential Impacts on Tourism, Agriculture and Housing," presentation, May 9, 2011, 8, http://cardi.cornell.edu/cals/devsoc/outreach/cardi/training/economic-implications-of-marcellus-shale-natural-gas-development.cfm.
[124] Ibid, 70.
[125] Ibid, 64.
[126] Ibid, 70.

Figure 40: USDA 2013 Rural-Urban Continuum Codes

Code	Designation	Population
1	Metro	1 million or more
2	Metro	250,000 to 1 million
3	Metro	Less than 250,000
4	Nonmetro (metro adjacent), Urban	20,000 or more
5	Nonmetro (not metro adjacent), Urban	20,000 or more
6	Nonmetro, (metro adjacent) Urban	2,500 to 19,999
7	Nonmetro, (not metro adjacent) Urban	2,500 to 19,999
8	Nonmetro (urban adjacent), Rural	Less than 2,500
9	Nonmetro (not metro adjacent), Rural	Less than 2,500

Source: U.S. Department of Agriculture

As of 2013, the USDA designated Allegany and Garrett Counties by codes 3 and 6, respectively.[127] Popular tourism activities in both counties, based on survey results and stakeholder interviews, include hiking, biking, whitewater rafting, and kayaking. Resort-themed activities, such as skiing, golfing, and relaxing, also proved popular. For comparison, RESI studied the tourism industry in two counties outside Maryland: Somerset County, Pennsylvania, and Lewis County, West Virginia. The counties are comparable to Allegany and Garret Counties in terms of their tourism industries and the levels of drilling activity. RESI also researched other counties' tourism promotion agencies for further comparison. Drilling areas such as Pittsburgh, Pennsylvania with less rural settings and economic diversity were not compared to Western Maryland.

Somerset County is considered a code 4 in the rural-urban continuum and is part of the Laurel Highlands region of Pennsylvania. The Laurel Highlands Region shares the Great Allegheny Passage with Allegany County, Maryland.[128] Comparable tourism attractions include the Seven Springs Mountain Resort and various biking, golfing, fishing, sightseeing, and other recreational and historical attractions. Lewis County is defined as code 7 and is home to Stonewall Jackson Lake and State Park, and the Stonewall Resort and Golf Course.[129] Lewis County is also home to a number of other scenic and protected lands, outdoor recreation areas, and historical attractions. In addition to similarities in tourism, Somerset and Lewis Counties have

[127] U.S. Department of Agriculture, "2013 Rural-Urban Continuum Codes," updated May 5, 2013. http://www.ers.usda.gov/datafiles/RuralUrban_Continuum_Codes/ruralurbancodes2013.xls.
[128] Ibid.
[129] Ibid.

experienced relatively low-level drilling activity—similar to what is projected for Allegany and Garrett Counties in Maryland.

Beyond Cornell's findings of more intense impacts on rural areas' tourism and non-extractive industries, RESI did not find reliable data to perform an independent analysis of drilling activity's impact on local tourism and recreation in comparable counties. Where available, RESI cited existing qualitative research from these comparable counties that characterizes tourism impacts based on surveys, testimony, or interviews stating perceived or observed changes to tourism where drilling has occurred.

6.2.2 Tourism Workforce

Tourism, recreation, and entertainment industries are vulnerable to changes in labor costs and supply when higher paying industries move in, especially if occupational skills from one industry to the other are easily transferable. Nearby drilling activity in Pennsylvania and West Virginia has already attracted licensed commercial drivers away from Garrett County businesses and into higher paying jobs in the natural gas industry. This transfer of labor from tourism to energy can place upward pressure on labor costs at rates that some employers will simply be unable to afford, but new occupations will present residents with higher earning opportunities.

The loss of revenue for tourism and construction businesses has been compounded by difficulty in retaining workers. Similar to workers in the agricultural industry, workers in tourism and construction possess the applicable skills and knowledge to easily migrate to higher paying jobs in the natural gas industry. Such jobs are currently concentrated outside Maryland, but the distance is not great enough to prevent withdrawal of workers from Maryland. It is possible that Maryland workers commuting to well sites out of state would otherwise be unemployed or earning significantly lower wages.

Figure 41 compares annual salary and employment for heavy and tractor-trailer truck drivers in natural gas and tourism-related industries in the United States. RESI highlighted the heavy and tractor-trailer truck driver occupation because it was mentioned in both stakeholder interviews and existing research as an occupation found in both tourism- and natural gas-related sectors. The skills and training used to drive a truck in the tourism industry are similar enough to driving a truck in the natural gas industry. Therefore, a person with this occupation could quickly find higher paying employment in the natural gas industry.

Figure 41: Heavy and Tractor-Trailer Truck Drivers by Industry in 2012

Industry Sector (NAICS code)	Employment	Median Annual Wages
Natural Gas and Related Sectors		
Natural Gas Distribution (221200)	640	$52,390
Oil and Gas Extraction (211000)	1,040	$37,410
Support Activities for Mining (213000)	20,790	$37,330
Tourism and Related Sectors		
Performing Arts & Spectator Sports (711000)	370	$50,420
Amusement Gambling and Recreation (713000)	100	$31,310
Food Services and Drinking Places (722000)	480	$28,530
Membership and Civic Organizations (813000)	Not reported	$24,020

Sources: Bureau of Labor Statistics, RESI

Heavy and tractor-trailer truck drivers in tourism-related industries earned median annual wages up to $28,370 fewer than heavy truck drivers in the natural gas distribution sector. Employment and wages come from the Bureau of Labor Statistics' 2012 Current Employment Survey. Heavy and tractor-trailer truck drivers are paid slightly less in the extraction process but still paid up to $13,390 more than those workers in some of the tourism-related industries shown in Figure 41. The median hourly wage for a heavy truck driver in the natural gas distribution sector was $25, compared to median hourly wages of $12 to $15 per hour for tourism and related sectors.[130]

Other occupations that exist in both tourism and natural gas industries reveal similar differences in annual wages. Payroll and Timekeeping Clerks make nearly $4,000 more in median annual wages working in the natural gas industry compared to those in the tourism industry.[131] Mobile Heavy Equipment Mechanics earn nearly $13,000 more in the natural gas industry.[132] Conversely, Bureau of Labor Statistics data show that construction managers and trade workers earn less in the natural gas industry than the same occupations in the tourism industry, with median annual wages approximately $4,000 to $5,000 fewer in the natural gas industry.[133]

[130] U.S. Bureau of Labor Statistics, "Occupation: Heavy and Tractor-Trailer Truck Drivers (SOC Code 533032)," from *Occupational Employment Statistics Query System*, May 2012, http://data.bls.gov/oes/.
[131] Ibid.
[132] Ibid.
[133] Ibid.

6.2.3 Hotels and Accommodation

Hotels became a common housing choice for workers in the natural gas industry and a number of hotels began marketing directly to those working in the Marcellus Shale region. The Shaner Hotel Group created a standalone website specifically marketed to the state's Marcellus Shale workers, with locations in Pittsburgh and State College, Pennsylvania.[134] Many Holiday Inn locations in and around the Marcellus Shale region have dedicated web pages marketed specifically toward worker accommodations. The Holiday Inn of Downtown Cumberland in Maryland had a page for the Marcellus Region before it became a Ramada Inn.[135]

While a number of news articles have discussed hotel tax revenue growth as a boon for tourism in shale boomtowns, only a few of those articles have investigated (1) the share of hotel occupants who are shale workers versus tourists and (2) the share of hotel tax revenues spent on tourism promotion instead of other local services. Existing data is too high-level to distinguish the impacts hotel occupancy and tax revenues have on the tourism industry as a whole, in addition to how these impacts may have been affected by the recession or local economic events.

If workers comprise a majority of hotel visits in the Marcellus Shale region, tourists may be turned away from hotels. As reported in a recent article from Marietta, Ohio, the increase in hotel and motel occupancy was, during the most intense drilling phases, approximately 75 percent attributable to the transient workforce.[136] Lodging owners and managers interviewed in the Marietta area noted the transient nature of oil and gas workers' occupation of their rooms. In some cases, the trend has already begun to reverse as other types of travelers return to the area as drilling activity falls.

Marietta is the county seat of Washington County, Ohio and its most intense years of drilling occurred between 2005 and 2010, peaking in 2006 just before the recession.[137] A Councilperson for Marietta reported a decline in tourism during the recession, with visitation only recently recovering. The influx of hotel tax revenues to the Convention and Visitors Bureau are expected

[134] "Marcellus Shale Hotels," The Shaner Hotel Group, accessed March 10, 2014, www.marcellusshalehotels.com.
[135] "Marcellus Shale Region of PA Hotel Accommodations," Ramada Inn Cumberland-Downtown, accessed February 14, 2014, http://www.hicumberland.com/lp-marcellus-shale-region-pa/.
[136] Evan Bevins, "Is upswing in hotel/motel tax tourism or oil and gas?" *Parkersburg News and Sentinel*, January 5, 2014, accessed February 23, 2014, http://www.newsandsentinel.com/page/content.detail/id/581858/Is-upswing-in-hotel-motel-tax-tourism-or-oil-and-gas-.html?nav=5054.
[137] Ohio Oil and Gas Association, "Summary of Ohio and Gas Activities (ODNR)," in *Downloadable Resources, 2004–2012*, accessed February 24, 2014, http://ooga.org/our-industry/ohio-oil-gas-activity/.

to improve tourism through increased marketing efforts as drilling subsides and hotel rooms become available for other travelers.[138]

Chris Richards, Executive Director of the Lewis County, West Virginia Convention and Visitors Bureau described natural gas activity as "a double-edged sword."[139] While lodging businesses in the Stonewall Lake area benefit from high occupancy rates providing rooms for shale workers, a drawback has been instances when lodging facilities have turned visitors away on weekdays due to full occupancy. Visitors tend not to return on the weekends after being turned away on weekdays.[140] Hotels in Marietta described a similar scenario of full occupancy during the workweek followed by quiet weekends, when workers return to their families, until the work week began again.[141]

In Pennsylvania, West Virginia, and Ohio, a hotel tax is collected for room stays of fewer than thirty consecutive days. After thirty consecutive days, a hotel guest is considered a resident and is no longer charged the hotel tax. This policy has kept states in the Marcellus and Utica Shale regions from fully capturing tax revenues collected from the workers who have booked rooms for six months to a year in response to housing shortages. Still, overall revenue generated from hotel taxes increased for many of the drilling counties, but without comprehensive data it is difficult to estimate how much of this revenue benefits the broader tourism industry[142]

If counties are struggling to keep up with increased demand on local infrastructure and services, funding may be pulled away from tourism promotion agencies and used for other projects loosely defined as "tourism development."[143] Despite the increase in occupancy, the City of Marietta splits its 6.0 percent hotel tax evenly with the Marietta-Washington County Convention and Visitors Bureau. The County expressed no intentions to reduce the Convention and Visitors Bureau's share of revenue unless state funding to Washington County continued to be cut.[144]

---

[138] Bevins, "Is upswing in hotel/motel tax tourism or oil and gas?"
[139] Chris Richards, Executive Director of Lewis County Convention and Visitors Bureau, personal communication, October 16, 2013.
[140] Ibid.
[141] Bevins, "Is upswing in hotel/motel tax tourism or oil and gas?"
[142] Paula A. Duda Holoviak, "An Evaluation of Strategies and Finances of the Rural Tourism Industry," The Center for Rural Pennsylvania (April 2012): 23, accessed October 7, 2013, http://www.rural.palegislature.us/documents/reports/Evaluation_Rural_Tourism_Industry.pdf.
[143] PATT/PRLA Room Tax Task Force, "Statewide Policy Recommendations 2013," presentation, accessed February 7, 2014, https://www.patravelandtourism.org/sites/default/files/Hotel%20Tax%20Taskforce%20-%20Statewide%20Policy%20Recommendations%202013.pptx.
[144] Ibid.

Data on hotel tax revenues from both Lewis and Somerset Counties are not sufficient to determine fiscal impacts on tourism attributable to the presence of natural gas workers. Data are reported on an annual basis, and the coming and going of out-of-state workers appears to span weeks and months, not years. Monthly data on levels of hotel occupancy and numbers of taxable rooms may provide greater detail on how drilling activity affects tourists and other visitors. A representative from the Laurel Highlands tourism region did not have hotel tax data for the counties but noted an increase in exempt rooms more than likely related to workers occupying rooms for more than thirty consecutive days, qualifying their stay as exempt from hotel taxes.[145]

6.2.4 Water Resources

Aside from concerns about labor supply and access to tourism destinations, the presence of drilling activity can greatly impact the availability and cost of other resources shared between related tourism and energy sectors. Water is one of the most widely used and scarce resources shared between existing businesses and residents in Western Maryland. The addition of another industry that uses significant amounts of water and other natural resources is cause for concern, based on stakeholder comments to RESI.

The Savage River and Youghiogheny River Watersheds are two major watersheds that flow into the Potomac and Mississippi rivers, respectively. The Youghiogheny Watershed occupies roughly two-thirds of Garrett County, including land susceptible to drilling activity. Even with best practices regarding water quality in place, Garrett County is already stretching its water resources thin, making overall use and conservation a paramount issue. Some stakeholders feel that the preservation of pristine water resources may hold more value than the consumption of natural gas. Furthermore, the State does not own mineral rights to all public land, which leads to concerns regarding drilling on or below public forest land; roughly 70 percent of the Savage River Watershed is covered by forested land, according to one stakeholder.

The impacts of increased water use will depend on whether businesses are pulling from the same sources, how intensely each is used, and how quickly the most used groundwater can recharge. Water use is an important aspect of tourism and related businesses in many ways, especially in Western Maryland, where the Youghiogheny watershed provides a prime whitewater rafting environment. Resort and recreation businesses in Garrett County's Deep Creek Lake area use water for various purposes, from drinking water for lodges and restaurants

[145] Nadine Yanarella, Vice President and Chief Financial Officer of Laurel Highlands Visitors Bureau, personal communication, October 7, 2013.

to snowmaking for over 170 acres of skiable slopes.[146] The policy of Maryland's water appropriation program is to issue permits to make reasonable use of water resources without unreasonable interference with other persons also attempting to make reasonable use of water. The permittee may not unreasonably harm water resources.[147]

The most recent data from USGS on water use at the county level reveals that industrial usage of 42.3 million gallons per day far exceeds usage by all other categories. Purposes of industrial water use are typically fabrication, processing, washing, diluting, cooling, or transportation of manufactured materials such as metals, wood and paper products, chemicals, and gasoline and oils.[148] Domestic, self-supplied use is second highest, at 9.6 million gallons per day, and public supply ranks third, at 3.9 million gallons per day.[149] Commercial use of water was not reported in the most recent estimates from 2005.

Allegany County's major sources of public water are located in either Garrett County, Maryland, or Bedford County, Pennsylvania. Garrett County's water and sewerage plan acknowledges a lack of adequate data to determine actual usage and recharge rates, so actual usage could be higher or lower than estimated. The most recent water usage data from USGS was from 2005, indicating total withdraws of 8.4 million gallons per day in Garrett County. Public supply withdraws totaled 0.8 and 3.1 million gallons per day in Allegany and Garrett Counties, respectively.[150]

An increase in the use of water and other natural resources potentially impacts not only tourism-related businesses but also recreational users. Allegany County's water and sewerage plan lists a total of 69 impaired waterways, the majority of which were designated for aquatic life and wildlife, fishing, or recreational uses.[151] As indicated by stakeholder interviews and survey responses, residents highly value the quality of waterways for recreational use and

[146] "Mountain Information," Wisp Resort, accessed February 21, 2014, http://www.wispresort.com/mountain-information.php.
[147] Maryland Division of State Documents, "26.17.06.02", COMAR Online, accessed February 21, 2014, http://www.dsd.state.md.us/comar/.
[148] U.S. Geological Survey, "Industrial Water Use," The USGS Water Science School (March 17, 2014), accessed April 30, 2014, http://water.usgs.gov/edu/wuin.html.
[149] U.S. Geological Survey, "Estimated Use of Water in the United States: County-Level Data for 2005," National Water Information Service, last modified February 24, 2014, accessed March 10, 2014, http://water.usgs.gov/watuse/data/2005/.
[150] Ibid.
[151] Allegany County Department of Community Services and Allegany County Department of Public Works, "Allegany County Water and Sewerage Plan 2011," November 29, 2012, 15–19.

preservation, and perceptions of impaired quality could change tourism activity in Western Maryland.

6.3 Summary

Tourism impacts alone are difficult to accurately quantify, and definitions of tourism activity can vary. Furthermore, while significant impacts have been observed and trends have been identified in mostly rural areas, the variance of impacts indicates a need for more detailed analysis. Nearly a decade after the drilling boom started in other states, existing research still does not differentiate impacts between types of tourism (entertainment, accommodation, recreation, etc.) and how each are impacted by natural gas extraction.

The lack of research is partially attributable to a lack of availability of uniform data for comparison across counties and across shale plays. State and local governments could benefit from evaluating existing hotel and amusement tax policies to ensure the full capture of expenditures from a transient workforce. RESI's research found that more accurate and robust data on tourism and visitation are necessary, including monthly, if not weekly, data on hotel tax revenues, industry-level employment, and other key indicators with which to compare the tourism and natural gas industries' coexistence over time.

Beyond identifying the need for more detailed tourism data, RESI's research did identify some potential impacts of the presence of drilling activity in Western Maryland. These impacts on tourism are reliant both on actual and perceived changes brought on by drilling activity. Survey responses revealed potential for changes in how and where people participate in outdoor recreation in Western Maryland. Specifically, nonresidents may have more flexibility to avoid Western Maryland if they perceive the local trails, streams, and woodlands to be of lesser quality near drilling activity, ultimately impacting the popular second-home market of Garrett County.

For tourism businesses, annual wages in certain tourism sector occupations, such as trucking, would have to increase by up to $30,000 to compete with higher wages in natural gas and related sectors. Increased labor costs will not be limited to the tourism industry, but other industries requiring use of occupations such as heavy truck drivers will struggle to compete for qualified workers. Another cost of doing business is water use. As described by the USGS reports, industrial water use is more intensive than nonindustrial and residential uses. It is well known that new technology for natural gas extraction is water-intensive and will potentially impact water use by other users, including recreational users.

In addition, tourists may have to compete with shale workers for hotel rooms both in terms of availability and room rates, depending on the level of drilling activity. Negative impacts on the tourism industry may be offset by increased hotel taxes in the short term, but state and local governments will need to evaluate existing hotel and amusement tax policies to fully capture

the expenditures of a transient workforce, in addition to recognizing and managing impacts on tourism to sustain this long-term economic driver for Western Maryland.

Survey responses revealed potential for changes in how and where people participate in outdoor recreation in Western Maryland should the quality of environmental amenities be impacted by drilling activity. Negative impacts on the tourism industry may be avoidable if the region is able to recognize and manage the impacts on tourism to sustain this long-term economic driver for Western Maryland.

7.0 Infrastructure and Roads

The presence of compressor stations and truck traffic related to drilling increases noise and road usage—the opposite of what tourists seek when visiting Western Maryland. In addition to presenting an issue for tourism, noise and traffic also impact the quality of local health, safety, and infrastructure. Management of inspections and enforcing compliance of drilling activity can be costly for local government. Health, safety, and public works departments in Maryland are concerned about their capacity for handling increased demand for various services such as water quality testing, infrastructure maintenance, and emergency response. Garrett County's Health Department has experienced large budget cuts, which adds to the stress experienced by environmental and public health officials. This report will not cover environmental and health issues in detail, as those topics will be covered by other studies being conducted in Maryland.

Use of heavy truck transportation in the natural gas industry impacts Western Maryland's tourism industry in addition to overarching economic and fiscal impacts. Shale drilling requires near-continuous truck trips as water and chemicals are transported to development sites and wastewater is transported away. As a result, shale development often has a significant impact on traffic flow and roads surrounding development sites. Damage to roads caused by intense heavy-truck traffic create additional costs to repair roads and manage traffic impacts.

If roads are not properly bonded, heavy truck traffic from any existing or future construction and industrial activity is expensive to repair. If roads are properly bonded, increased usage does not pose a significant problem. Truck traffic is already evident in Oakland, Maryland, where trucks travel through to West Virginia. Alternatively, some stakeholders view the increased truck traffic as sign of growing job opportunities in the area.

Companies drilling near the Maryland border and using Maryland roads have voluntarily entered into bonding agreements with Garrett County, but such agreements are not currently required. The perception is that most companies have willingly entered into such agreements. Setback requirements from protected land and watersheds can protect some roads from damage, but stakeholders wonder if certain routes, especially unpaved, private roads, can be protected from shale-related traffic. Enforcement can be difficult not only between government and drilling companies but also between companies and their subcontractors.

7.1 Existing Research

A 2010 guide of best practices to protecting roads impacted by drilling noted, "Dust, noise, and road damage from industry truck travel are tops on the list of citizen complaints in areas where shale gas is extracted via shale gas drilling."[152] In addition, existing road infrastructure is frequently inadequate to handle the volume and load of such truck travel. The guide recommends the following measures for areas impacted by shale drilling:

1. Studying traffic flow impacts,
2. Collecting data regarding road conditions,
3. Adopting Road Use Agreements,
4. Managing trucking routes, and
5. Enforcing traffic and road regulations.[153]

A 2012 Wall Street Journal article discussed similar infrastructure impacts in Texas around the Eagle Ford shale play. The chief administrator of one of the impacted counties estimated that the "cost of building up the county's 230 miles of rudimentary roads to withstand the inflow of drilling-related traffic exceeds $100 million," whereas the county's entire budget comes to approximately $6 million.[154] County governments are not able to collect taxes relating to energy production as the state government does; therefore, they experience significant financial issues in keeping up with infrastructure needs stemming from shale development.[155]

7.1.1 Truck Trip Impacts in Other States

The active drilling process that is necessary to extract natural gas from the Marcellus Shale has an impact on the volume of truck activity to and from drilling sites and a direct impact on the communities, particularly the local roads, surrounding those sites. The truck traffic associated with drilling horizontal wells is often "2 to 3 times higher than the traffic associated with drilling a vertical well."[156] This increase in truck volume is mainly a result of the need for water transportation during the hydraulic fracturing of horizontal wells. Such an increase in truck traffic can adversely impact a community through increased road dust, traffic noise, and

---

[152] CJ Randall, "Hammer Down: A Guide to Protecting Local Roads Impacted by Shale Gas Drilling," *Working Paper Series: A Comprehensive Economic Impact Analysis of Natural Gas Extraction in the Marcellus* Shale (December 2010): 2, accessed February 28, 2014, http://www.greenchoices.cornell.edu/downloads/development/shale/Protecting_Local_Roads.pdf.

[153] Ibid, 4–7.

[154] Ana Campoy, "Drilling Strains Rural Roads," *The Wall Street Journal*, July 26, 2012, accessed February 28, 2014, http://online.wsj.com/news/articles/SB10000872396390444840104577551223860569402.

[155] Ibid.

[156] New York State Department of Environmental Conservation, "Supplemental Generic Environmental Impact Statement," September 7, 2011, 6-301, accessed February, 14 2014, http://www.dec.ny.gov/data/dmn/rdsgeisfull0911.pdf.

pollution. It has been noted in other states' experiences that increased truck activity is especially detrimental to the local roads surrounding wells that are not equipped or designed to handle the weight and frequency of truck traffic to and from the drilling sites.[157]

Increased truck volume attributed to drilling is a result of additional activity during site preparation and the hauling of equipment, materials, water, and supplies. The transportation of all these requires truck transport to the well pad site, particularly during early well pad development when no other infrastructure, such as water pipelines, is present.[158] In horizontal hydraulic fracturing, the primary purpose of truck trips is water delivery to the well. In addition, any wastewater that is generated during the hydraulic fracturing process is later removed by truck and either disposed or reused at other sites unless it is recycled onsite.[159]
In various studies, impacts related to increased truck traffic are generally listed among the top community complaints related to shale drilling. During RESI's stakeholder meetings, residents of Western Maryland expressed the following concerns and anecdotes regarding increased truck activity as a result of drilling:

- Access roads, long driveways, and residential roads will get worn down if repeatedly used.
- Traffic could adversely affect tourism and other industries.
- Some residents had to wait up to a half hour for a convoy of trucks to pass just to get home.
- Traffic impacts are already apparent in Oakland, Maryland, from trucks traveling through to West Virginia.

To accurately analyze the impacts of increased truck activity directly related to Marcellus Shale drilling in Western Maryland, RESI collected research and data regarding the experiences and estimates from other areas. In particular, RESI used data for truck trips estimated by MDE using source data, MDE calculations, and several assumptions. More description of the process can be found in the methodology section below. The preliminary source used for the calculations and analysis has been widely cited and used in many different transportation studies and analyses. Using the estimates compiled by MDE for estimated truck trips as well as RESI's projections for well pad and well build out, RESI calculated figures for the potential increase in the number of truck trips in Western Maryland attributable to Marcellus Shale drilling.

---

[157] New York State Department of Environmental Conservation, "Supplemental Generic Environmental Impact Statement," 6-311.
[158] Ibid, 6-301.
[159] Heather Cooley and Kristina Donnelly, "Hydraulic Fracturing and Water Resources," Pacific Institute (June 2012): 25, accessed March 4, 2014, http://pacinst.org/wp-content/uploads/sites/21/2014/04/fracking-water-sources.pdf.

7.1.2 Truck Trips in the Marcellus Shale Region

The active drilling process to extract natural gas from the Marcellus Shale can lead to a significant increase in truck traffic, particularly on the access and local roads surrounding well pads.[160] Although RESI's estimated number of well pads in Western Maryland is smaller than that of development expectations and actual activity for other locales in the Marcellus Shale, the expected increase in activity will still have some impact on the volume of truck traffic in the area.

According to the draft report published by the New York State Department of Environmental Conservation (NYSDEC) titled "Supplemental Generic Environmental Impact Statement (SGEIS) On the Oil, Gas and Solution Mining Regulatory Program", both light- and heavy-duty truck trips increase during development of well pads and subsequent well drilling. In the study, *early well* development is defined as the period in the development of new wells when no water pipeline infrastructure exists. During this timeframe, all water is transported by trucks to sites and has a significant impact on truck traffic. However, during *peak well* scenario, truck trips decrease significantly when water is delivered via pipelines instead of trucks, reducing the level of truck activity by as much as 30 percent.[161] Furthermore, discussion between MDE and Jim Fuller, the head of the mining program in Pennsylvania, revealed that this reduction in truck activity may be overstated according to Pennsylvania's experience. According to Mr. Fuller the majority of the water is still trucked to each individual drilling site; however, "there is an encouraged trend to centralize water from a reservoir where there is concentrated drilling and overland pipe from that but that is only 10 to 20 percent of the time and tends to be in the area of heavy concentration."[162]

Due to RESI's assumptions regarding the modest number of wells and low level of well concentration, for the purposes of this analysis, RESI assumed that there will not be a significant reduction in truck traffic as indicated in the peak well development scenario. As a result, only early well development estimates were used in the analysis.

[160] New York Municipal Insurance Reciprocal, "Protecting Our Local Roads," 2, accessed February 26, 2014, http://www.nymir.org/pdf/NYMIR%20Marcellus%20Roads%20FINAL.pdf.
[161] New York State Department of Environmental Conservation, "Supplemental Generic Environmental Impact Statement," 6-302.
[162] Jim Fuller, discussion with MDE, April 3, 2014.

7.2 Potential Truck Trip Impacts in Western Maryland

7.2.1 Methodology

RESI utilized the truck estimates calculated by MDE as the basis for the truck trip analysis. MDE's estimates were based on figures in a report prepared by NTC Consultants for the New York State Energy Research and Development Authority and based on several assumptions:

- First, their truck trip estimates were scaled from eight wells per pad to one well per pad to coincide with build out assumptions of RESI's well development scenario as discussed in Section 3.0 of this report.
- Second, given the assumption of the need for 5 million gallon of water-per-well in the report, the number of truck trips for water hauling was scaled up to account for the size of water-hauling trucks (5,000 gallons per truck).
- Finally, water disposal activity was scaled to account for the expected 30 percent in flowback volume from each site. Maintenance activities during the long term production life of a well are relatively insignificant and are limited to just weekly truck visits to empty condensate collection tanks, and the twice a year mowing of the well pad area.[163]

As a result, no truck activity during this time frame is taken into account in RESI's truck trip estimates. Figure 42 defines the purpose of truck trips as well as the number of truck trips as estimated by MDE broken out by pad and well activity that can be expected during well development and drilling.

[163] New York State Department of Environmental Conservation, "Supplemental Generic Environmental Impact Statement," 6-300.

Figure 42: Estimated Number of One Way (Loaded) Trips for One Well and One Pad—Horizontal Well

Well Pad Activity	Early Well Pad Development	
	Heavy Truck	Light Truck
Drill pad construction	45	90
Rig mobilization	95	140
Non-rig drilling equipment	45	-
Completion equipment	5	-
Hydraulic fracturing equipment (trucks & tanks)	175	-
Final pad prep	45	50
Miscellaneous	0	85
Total Per Pad	**410**	**365**
Drilling fluids	45	-
Drilling (rig crew, etc.)	50	140
Completion chemicals	20	326
Hydraulic fracturing water hauling	1,000	-
Hydraulic fracturing sand	23	-
Produced water disposal	300	-
Total Per Well	**1,438**	**466**

Sources: All Consultants 2010, NTC Consultants 2011, NYSDEC 2011, MDE

7.2.2 Estimates of Truck Trips in Western Maryland

The true magnitude of the impacts to truck traffic will ultimately depend on a number of factors: the number of well pads being developed, the number of wells per pad, and the total volume of water needed. The truck trip estimates in by NYSDEC assume that each well will require five million gallons of water.[164] However, the actual volume of water required can vary substantially. A typical hydraulic fracturing operation in a horizontal well could require between three and five million gallons of water per well.[165] According to an analysis by Penn State, a horizontal well uses approximately 4.2 million gallons of water on average. Given the 5 million gallon estimate for MDE's truck trip numbers, the magnitude of truck trips estimated in this study falls in line with average expectations.

[164] New York State Department of Environmental Conservation, "Supplemental Generic Environmental Impact Statement," 6-302.
[165] Arthur et al., "Water Resources and Use for Hydraulic Fracturing," 2.

Truck Trip Estimates

To estimate the total number of truck trips per year, RESI used the estimated well pad and well build out estimates provided in Section 3.1.2 of this report. RESI multiplied these estimates by the new well pad and new well estimates for both light-duty trips and heavy-duty trips depicted in Figure 42. Figures 43 and 44 estimate the number of truck trips expected under Scenario 1 and Scenario 2.

Figure 43: Estimated One Way (Loaded) Truck Trips in Western Maryland for Horizontal Wells, Scenario 1—25% Extraction

Year	Number of New Wells	Number of New Well Pads	Heavy-Duty Truck (new well and new pad)	Light-Duty Truck (new well and new pad)	Total
2017	8	4	13,144	5,188	18,332
2018	16	4	24,648	8,916	33,564
2019	29	3	42,932	14,609	57,541
2020	22	3	32,866	11,347	44,213
2021	18	3	27,114	9,483	36,597
2022	15	2	22,390	7,720	30,110
2023	12	2	18,076	6,322	24,398
2024	12	2	18,076	6,322	24,398
2025	12	2	18,076	6,322	24,398
2026	6	0	8,628	2,796	11,424

Sources: All Consultants 2010, NTC Consultants 2011, NYSDEC 2011, MDE, RESI

The increased truck activity amounts to an average annual increase of 22,595 trips for heavy-duty trucks and 7,903 for light-duty trucks for the ten-year drilling timeframe for Scenario 1.

Figure 44: Estimated One Way (Loaded) Truck Trips in Western Maryland for Horizontal Wells, Scenario 2—75% Extraction

Year	Number of New Wells	Number of New Well Pads	Heavy-Duty Truck (new well and new pad)	Light-Duty Truck (new well and new pad)	Total
2017	36	12	56,688	21,156	77,844
2018	72	12	108,456	37,932	146,388
2019	63	9	94,284	32,643	126,927
2020	54	9	81,342	28,449	109,791
2021	63	9	94,284	32,643	126,927
2022	42	6	62,856	21,762	84,618
2023	36	6	54,228	18,966	73,194
2024	36	6	54,228	18,966	73,194
2025	36	6	54,228	18,966	73,194
2026	12	0	17,256	5,592	22,848

Sources: All Consultants 2010, NTC Consultants 2011, NYSDEC 2011, MDE, RESI

The increased truck activity amounts to an average annual increase of 67,785 trips for heavy-duty trucks and 23,708 for light-duty trucks for the ten-year drilling timeframe for Scenario 2.

According to various sources and anecdotal evidence, truck traffic associated with active drilling at horizontal wells is significant. Most of the increase in truck activity can be attributed to the hauling of water to and from well sites. Increased noise, pollution, and damage to local roads are all concerns that have been widely documented in previous literature and during RESI's stakeholder interviews. Although these impacts may not be present for the total lifecycle of each well pad, increased volume during well pad development and drilling is significant enough to warrant further investigation into the impacts to communities and costs to those responsible for the maintenance of impacted roadways.

7.3 Summary

Working with MDE, Pennsylvania's mining program, and existing studies on truck traffic in the natural gas industry, RESI's analysis determined 410 heavy truck trips per well pad and 1,438 heavy truck trips per well in the early development phase. A total of 365 light truck trips per well pad and 466 light truck trips per well were determined for the early development phase of drilling in Western Maryland. The number of truck trips are one-way, loaded trips based on assumptions for horizontal drilling.

The estimates of average heavy and light truck trips per well or well pad were inputted into RESI's analysis of the number of truck trips per year in each drilling scenario. For Scenario 1, the increase in truck activity for Western Maryland amounts to an average annual addition of 22,595 truck trips for heavy-duty trucks and 7,903 for light-duty trucks. For Scenario 2, the

increase in truck activity for Western Maryland amounts to an average annual addition of 67,785 truck trips for heavy-duty trucks and 23,708 for light-duty trucks.

Most of the increase in truck activity can be attributed to the hauling of water to and from well sites. Increased noise, pollution, and damage to local roads are all concerns that have been widely documented in previous literature and during RESI's stakeholder interviews. Although these impacts may not be present for the total lifecycle of each well pad, increased volume during well pad development and drilling is significant enough to warrant further investigation into the impacts to communities and costs to those responsible for the maintenance of impacted roadways. Additional research has been conducted as part of a separate report by another organization for Maryland's Marcellus Shale Safe Drilling Initiative.

8.0 Other Community Impacts

The following subsections summarize potential community impacts which are of concern to stakeholders in Western Maryland but are difficult to quantify or end up undervalued within an economic impact analysis. The lack of concrete data and quantitative findings regarding some community impacts leave room for heightened perceptions of risk regardless of actual impacts.[166] In areas of drilling activity, time spent managing expectations and perceptions of risk are managed as much or more than the actual impacts of natural gas extraction. RESI summarizes the issue of risk perception in Section 7.1, followed by a summary of the perceived and potential risks associated with extractive industries in rural communities including impacts on agriculture, schools, public health and safety, and infrastructure.

Maryland's Marcellus Shale Safe Drilling Initiative has resulted in a number of studies and research papers identifying best practices and potential economic, community, and environmental impacts associated with unconventional extraction of natural gas. As such, community and environmental impacts are touched on briefly within this report, and are analyzed in greater detail within other reports associated with the Marcellus Shale Safe Drilling Initiative. [167]

[166] Jeffrey B. Jacquet, "Risk to Communities from Shale Gas Development," South Dakota University, presentation at the National Research Council Workshop on Risks from Shale Gas Development, May 31, 2013, http://sites.nationalacademies.org/DBASSE/BECS/DBASSE_083187.
[167] "Marcellus Shale Safe Drilling Initiative," Maryland Department of the Environment, accessed February 10, 2014, http://www.mde.state.md.us/programs/land/mining/marcellus/pages/index.aspx.

8.1 Impacts of Risk Perception

At the National Research Council's workshop on the risks of unconventional shale development, research was presented on the benefits and risks of natural resources. Benefits were described as varying and short-term and include jobs, tax revenue, royalty income, and local investment. Four potential risks were identified as industrialization, corrosion, contamination, and disruption of communities with drilling activity.

Similar to economic benefits, the magnitude of perceived risks' impact on a community is dependent on the pace and scale of drilling activity. In contrast to the short-term benefits observed with drilling activity, risks are observed over the long term and the associated physical and emotional costs continue after production has ended.[168] If risk perception is not acknowledged or managed effectively, residents may begin to distrust government and eventually disinvest physically, emotionally, and financially from their communities.[169] Below are definitions of each risk as identified at the National Research Council's workshop.

Industrialization

Rapid industrialization and the jobs that come with it can lead to rapid population growth that strains public services and disconnects long-term residents from their communities. During a boom cycle, local investment leads to high annual economic growth rates in once sparsely populated rural towns.[170] The capacity for small, rural communities to handle rapid industrialization is limited, and problems arise as communities strain already limited resources in response to increased demand on local infrastructure and services. The potential benefits of rapid industrialization may be great, but communities with little knowledge of or ability to prepare for rapid industrialization may not fully capture these benefits.

Corrosion

Following rapid industrialization, any benefits successfully captured within the community may not be distributed evenly amongst residents—creating winners and losers.[171] If Marcellus Shale gas development moves forward, an imbalanced distribution of benefits amongst residents can corrode the community, or divide the community by perceived winners and losers. Jeffrey Jacquet, a sociologist who has studied past and present boomtowns in the United States, surveyed nearly 1,000 landowners with or without mineral leases in the Armenia Mountain area of Bradford and Tioga Counties in Pennsylvania in 2012 to reveal their perceptions

[168] Jacquet, "Risk to Communities from Shale Gas Development."
[169] Ibid.
[170] Ibid, 1–2.
[171] Ibid.

regarding whether or not natural gas development left them better off, neither worse nor better off, or worse off than five years ago.

- Of 358 cases with no lease and no development, just over 60 percent of landowners reported feeling worse off;
- Of over 50 landowners with leases and natural gas development, roughly 60 percent reported feeling better off; and
- Over 500 landowners with leases but no development reported mixed perceptions between feeling better off, worse off, or neither.[172]

In addition to landowners' possession of mineral leases and development affecting their perceptions, being employed by the gas industry appeared to have an impact on attitudes and perceptions of the impacts of natural gas development.

Contamination

Risks from contamination, in the form of chemical leaks and spills, create lasting stigma and negative perceptions of a community, regardless of the actual presence of contamination. This issue was highlighted in Section 6.0 describing a sewage spill which deterred visitors from the Deep Creek Lake area. Media coverage speculating connections between natural gas extraction and seismic activity, gas leaks, and water pollution heighten Western Maryland's perception of the risks associated with drilling should it be permitted in the state. Actual or perceived contamination could be one factor reducing the attractiveness of the area to visitors and new residents. In a survey conducted by RESI, over three-quarters of nearly 800 total viable survey respondents, roughly 80.6 percent of the 377 respondents not currently residing in either county, stated the presence of drilling would deter them from moving into Western Maryland.

Disruption

The Boomtown Impact Model associates rapid population growth and rapid energy development with increases in stress, changes in individuals' interactions within the community, decreased community cohesion, and poor community character; all of these changes are a disruption to the community.[173] When a resident can quickly identify the type of place in which he or she lives (a farm town, a resort town, etc.), what his or her role in that place is (a farmer, business owner, or community leader), and what his or her relationship is to others (a friend, partner, or employer), then that resident is strongly tied to his or her

[172] Jeffrey B. Jacquet, "Landowner Attitudes toward Natural Gas and Wind Farm Development in Northern Pennsylvania," *Energy Policy* 50 (2012): 684, accessed July 25, 2013, http://dx.doi.org/10.1016/j.enpol.2012.08.011.

[173] Jeffrey B. Jacquet, "Energy Boomtowns & Natural Gas," Pennsylvania State University–The Northeast Regional Center for Rural Development, Paper No. 43 (January 2009): 4–5, accessed July 11, 2013, http://aese.psu.edu/nercrd/publications/rdp/rdp43/view.

community. Formerly strong ties to the community are hard to repair when those roles and relationships are disrupted by an imbalance of benefits and costs throughout the community.

RESI's engagement with local stakeholders and residents indicate strong ties to agriculture, tourism, construction, and existing energy activities. Based on feedback during the stakeholder engagement process, Western Maryland residents appear very clear on their roles in the community. However, the stress of potential changes to the community could impact relationships and trust in political leadership. Stress can lead to increases in social problems (crime, substance abuse, etc.), a lowered standard of living, strained local services, and general disorganization.[174] This tendency is especially true for rural communities. Conversely, urban communities are more able to absorb rapid population growth and industrial development.[175]

8.2 Perceived Risks in Western Maryland

Existing research does not clearly identify how to maximize and transfer economic benefits for more equitable and sustainable growth.[176] Thus, the equity of benefits remains difficult to measure when attempting to understand the total impact of natural gas development. Ultimately, the depth of the impacts relies on the pace and scale of drilling activity. Pace is determined by the number of wells drilled in a year, and scale is the geographic area in which drilling is concentrated. The pace and scale of drilling can be influenced by domestic and global industry behavior.[177] The pre-drilling conditions of an area are another major factor when considering the intensity of potential impacts, as well as that area's capacity to prevent or mitigate impacts.[178]

The Cornell Cooperative Extension's Marcellus Shale Team and Penn State's Marcellus Shale Center for Outreach and Research have contributed an abundance of data and research assessing the impacts specific to Marcellus Shale development. While research is readily available, the industry has changed over the years and has therefore created demand for a continuous supply of new studies and new findings. Phases of natural gas development,

---

[174] Brasier et al., "Residents' Perceptions of Community and Environmental Impacts," *Journal of Rural Social Science* 26 No.1 (2011): 37, accessed July 11, 2013, http://www.ag.auburn.edu/auxiliary/srsa/pages/Articles/JRSS%202011%2026%201%2032-61.pdf.37.
[175] Ibid.
[176] Ibid.
[177] Michelle Haefele and Pete Morton, "The Influence of the Pace and Scale of Energy Development on Communities," *Western Economics Forum* 8 No. 2 (Fall 2009): 3, accessed July 23, 2013, http://purl.umn.edu/92810.
[178] Susan Christopherson and Ned Rightor, "The Boom-Bust Cycle of Shale Gas Extraction Economies," Cardi Reports No. 14 (September 2011): 4, accessed June 4, 2013.

extraction, and production have been compressed to shorter timelines, impacts have varied from county to county, and companies have worked harder to improve community perceptions. The continual changes within the natural gas sector lead to difficulty in assessing its true impact.

A majority of the research on community impacts refers to the boom-bust cycles often observed in extractive industries. Literature on recent shale "booms" has drawn parallels from the decades-old boom-bust impacts of coal mining, oil production, and conventional gas extraction. The industry's workforce is massive and includes primary contractors, subcontractors, and sub-subcontractors. The impacts of rapid paces of development and unmanageable population growth are further compounded by a mixture of regulations and standards set by both public and private entities, some representing community needs and others representing industry needs.

Stakeholder interviews revealed major areas of concern regarding impacts to agriculture, schools, public health and safety, rural character, the environment, other major infrastructure, and prominent industries in the region. While other studies on more specific impacts will be published as part of the Marcellus Shale Safe Drilling Initiative, this section and its subsections will briefly summarize some major concerns revealed during stakeholder interviews and from existing studies about the impact of drilling on other states. Impacts on environmental amenities are broad reaching and have implications throughout the economic, tourism, and community impacts discussed throughout this report.

8.2.1 Agriculture

Stakeholders in Western Maryland indicated support from the farming community for responsible natural gas development. Agribusiness and natural gas development currently coexist in Accident, Maryland (in Garrett County), where gas pipelines, storage wells, and a large compressor station are located. Farmers' positive perceptions of drilling in Western Maryland are credited to farmers currently farming around storage wells without significant health or environmental impacts.

Stakeholders identified the largest perceived impact to be the stigma of the industry and occasional small leaks. Stigma and negative perceptions, in comparison to environmental and economic impacts of an area, can be difficult to eliminate through policy changes, and interviewees acknowledged that larger wells with greater impacts are anticipated should

horizontal drilling occur. The well pad itself takes up between four and six acres of land.[179] However, including the associated roads, water impoundments, pipelines and consequential edge space (or buffering) has been estimated to require roughly 30 acres of land per well pad, based on a study of drilling sites in Pennsylvania.[180] According to the 2012 Census of Agriculture, the average size of farms in Allegany and Garrett Counties is 125 and 143 acres, respectively.[181]

Farmland is often protected from extractive industries, especially surface mining, by conservation easements which serve the purpose of protecting natural ecosystems, recreational areas, and other important open spaces. Different laws regarding conservation easements and split estates complicate farmers' rights to lease property for natural gas drilling.[182] There are conservation groups in support of drilling and conservation groups against drilling on eased land. Pennsylvania has been more supportive of drilling on eased land compared to West Virginia. For example, the Pennsylvania Farmland Protection Program goes out of its way to promote drilling on eased land and does not limit the construction of pipelines, roads, and other infrastructure, according to a note in the Virginia Environmental Law Journal. The West Virginia Farmland Protection Board requires that mineral rights be severed or that the mineral rights' owner is not likely to allow drilling.[183]

Because the hydraulic fracturing process requires the use of large amounts of water treated with chemicals, stakeholders often voice concerns regarding water supply and availability, which could impact not only residents but also one of Western Maryland's prominent industries: agriculture. In South Texas, numerous stakeholders expressed concern regarding the

[179] Keith N. Eshleman and Andrew Elmore, "Recommended Best Management Practices for Marcellus Shale Gas Development in Maryland," Appalachian Laboratory–University of Maryland Center for Environmental Science (February 18, 2013): 4–14, accessed August 28, 2014, http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Eshleman_Elmore_Final_BMP_Report_22113_Red.pdf.
[180] E.T. Slonecker et al., "Landscape Consequences of Natural Gas Extraction in Bradford and Washington Counties, Pennsylvania, 2004–2010," U.S. Geological Survey (2012): 10, accessed August 28, 2014, http://pubs.usgs.gov/of/2012/1154/of2012-1154.pdf.
[181] U.S. Department of Agriculture, National Agricultural Statistics Service, "Table 8. Farms, Land in Farms, Value of Land and Buildings, and Land Use: 2012 and 2007," in *2012 Census of Agriculture - County Data*, 250–251, accessed August 28, 2014, http://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Maryland/st24_2_008_008.pdf.
[182] Paige Anderson, "Reasonable Accommodation: Split Estates, Conservation Easements, and Drilling in the Marcellus Shale," *Virginia Environmental Law Journal* 31 (2013): 136, accessed August 29, 2014, http://lib.law.virginia.edu/lawjournals/sites/lawjournals/files/Reasonable%20Accommodation.pdf.
[183] Ibid.

demand that drilling of the Eagle Ford shale play put on the water supply during a drought in 2011. The drought caused "widespread pasture losses, crop failures and shortages of water in rivers, reservoirs and wells."[184] With expectations of many more wells to be drilled in that region over the next twenty years, demand for water is likely to increase. Due in part to stakeholders' concerns in South Texas, companies involved in hydraulic fracturing in the region have offered to consider using alternate water sources or recycling their wastewater.[185]

One stakeholder noted that farmers have begun to take jobs out of state to work on shale development where it is currently permitted. As discussed in the tourism section, extractive industries provide new and higher paying job opportunities for workers whose former occupations involved similar skill sets. For example, a worker experienced in operating heavy machinery and performing physical labor, such as a farmer, could perform many of the job duties required in extractive industries. Additional training to perform industry-specific tasks is completed within months, and programs are provided throughout Pennsylvania. The closest training program is available in Somerset County, Pennsylvania, though plans are said to be in place to provide training in Garret County to prepare the local workforce for jobs in the natural gas industry.

Migration of labor from farms to out-of-state well pads can reduce the time spent maintaining local agri-business. Allowing Marcellus Shale drilling in Maryland could allow these farmers to spend more time on the farm and with their families, while also earning supplemental income working in the natural gas industry or through leasing of mineral rights. Furthermore, stakeholders believe one of two scenarios could occur if drilling is permitted on agricultural land:

1. Lease and royalty payments from shale development would sustain farmers who are otherwise losing money, allowing farmers to sustain their farms after the inevitable "bust" phase of drilling, or
2. Farmers will use the lease and royalty payments to retire from farming, creating a near extinction of agribusiness in Western Maryland, and therefore less economic diversity.

8.2.2 Schools

Drilling is expected to bring a significant number of jobs into Maryland. As a result, there is the potential for overcrowding of schools if new workers bring young families with them. This possibility is of particular concern for Garrett County, where an education funding deficit in the

[184] Tracey Idell Hamilton, "Drought spurring fracking concerns," *mySA*, July 2, 2011, accessed February 17, 2014, http://www.mysanantonio.com/news/energy/article/Droughtspurringfrackingconcerns-1450808.php.
[185] Ibid.

millions and a decline in the population of school-aged children have led to school closures. A study from the University of Maryland reported the following data for K-12 schools in Western Maryland as of August 2012:

- Allegany County Public Schools comprised 22 schools, with renovations for two middle schools and new construction of a high school facility, and Garrett County Public Schools comprised 14 schools, with two middle school closures expected.[186]
- Garrett County Public Schools ultimately made the decision to close three schools in 2012.[187]

Meanwhile, Maryland's education formula has determined a decreased need for funding Garrett County's school system; Garrett County is the fifth wealthiest in Maryland.[188] Maryland's education formula, known as the Thornton Plan, is part of the Bridge to Excellence in the *Public Schools Act of 2002*. The formula was built to ensure that poorer counties "receive a larger per-pupil share of state funding than wealthier counties" and considers each county's total enrollment, number of children living in poverty, children with limited English proficiency, and use of other aid programs as factors for the formula.[189] The Thornton Plan is now twelve years old, and is hoped to be adjusted to better represent the current conditions of public school systems in Maryland.

If the population of young families suddenly increases, the remaining facilities may not have the capacity for more students. Stress on teachers and administrators could present both health risks and a potential decline in the quality of education in the area. In addition, increased truck traffic is expected, and raises concerns regarding increases in traffic along school bus routes. Both counties may need to consider either regulating traffic so that trucks and school buses are on the road during separate hours or assuring that trucks and buses use separate routes. Stakeholders stressed that, in existing conditions, Garrett County graduates a number of bright students from high schools and nearby colleges but does not currently provide the requisite balance of job opportunities for its graduates. Graduates either struggle to find gainful

[186] National Center for Smart Growth Research and Education–University of Maryland, "Sustainable Transformation of the Appalachian Region Data Brief: Transportation and Infrastructure," Sustainable Transformation of the Appalachian Region, Appalachian Regional Commission (2012): 5, accessed July 11, 2013, http://smartgrowth.umd.edu/assets/documents/star/star_population_brief.pdf.
[187] Janet Wilson, "Dr. Wilson's Facility Presentation," presentation, October 28, 2013, accessed February 28, 2014, http://www.garrettcountyschools.org/resources/public-information/pdf/Garrett-County-Schools---Dr.-Wilsons-Facility-Presentation-10-28-13.pdf.
[188] "School Funding," Maryland State Education Association, accessed March 13, 2014, http://www.marylandeducators.org/hot-issues/school-funding.
[189] Ibid.

employment within Western Maryland or leave the region. Graduates may leave to work in the natural gas industry in other states. A potential positive impact of allowing drilling in Western Maryland would be an increase in job opportunities for residents.

A 2012 Penn State research brief discussed shale development's potential effects on schools, including "school demographics; student outcomes and workforce development; effects on local roads and transportation; broader community services and infrastructure."[190] The study team surveyed educational leadership and interviewed educational and community stakeholders. The results indicated that survey respondents expected the potential influx of workers to impact school demographics, student needs, social services, and housing.[191] The potential impacts for schools are important considerations for educational leadership in areas where drilling has occurred or is expected to take place. The research brief closed with the following thoughts for additional consideration:

> A pressing—and difficult—question is how the shorter term economic boom of Marcellus development can be strategically managed so that Pennsylvania schools and communities can maximize their opportunities for long-term social, economic, and environmental sustainability.[192]

In some cases, schools have capitalized on the presence of shale development in their areas. The Blackhawk School District in Pennsylvania leased land to a shale developer in 2011 following an $800,000 budget cut.[193] Other school districts, primarily in Pennsylvania and Texas, "have struck deals with natural gas companies, either for underground mineral rights or for rights to drill on the earth's surface" due in part to the fact that they "are experiencing an energy boom at the same time that they've been cutting state aid for K-12 education."[194] For the Blackhawk School District, the lease agreement also provided an additional $300,000 for its $30 million budget.[195]

---

[190] Penn State Cooperative Extension, "Marcellus Shale Gas Development: What Does It Mean for Pennsylvania Schools?" *Marcellus Education Fact Sheet* (2012): 3, accessed February 28, 2014, http://pubs.cas.psu.edu/freepubs/pdfs/ee0019.pdf.
[191] Ibid, 7.
[192] Ibid, 8.
[193] Ben Wieder, "Schools Fill Budget Holes With Fracking Revenues," *STATELINE*, August 30, 2011, accessed February 28, 2014, http://www.pewstates.org/projects/stateline/headlines/schools-fill-budget-holes-with-fracking-revenues-85899375145.
[194] Ibid.
[195] Ibid.

8.2.3 Public Health and Safety

The health and safety topic area is perhaps the top concern for stakeholders in areas considering or pursuing shale drilling. Generally, concerns regarding health and safety fall under the following categories:

- Water contamination,
- Air contamination,
- Blowouts, and
- Seismic risks.

A preliminary EPA document following up a 2012 investigation into water-related issues in Dimock, Pennsylvania, suggested that "drilling or fracking, in which water, sand and chemicals are shot underground to free trapped gas, caused methane to leak into domestic water wells."[196] However, Cabot Oil and Gas Corporation, the company involved in drilling in Dimock, has refuted these assertions, and the EPA has publicly stated that such findings are preliminary in nature and require additional investigation.[197]

In addition to the possibility of underground water contamination, shale drilling activities above ground can also lead to water contamination. A Right-to-Know request submitted to the Pennsylvania Department of Environmental Protection in 2010 revealed "hundreds of examples of spills at natural gas drilling sites in the state…recorded by at least 92 different drilling companies."[198]

There is some evidence that suggests that air emissions related to gas drilling could also be a health risk. A 2012 University of Colorado report estimated the "health risks for exposures to air emissions from a NGD [natural gas development] project in Garfield County, Colorado with the objective of supporting risk prevention recommendations in a health impact assessment."[199] The report found that residents living closer to well pads were more likely to experience adverse health effects, although the authors recommended further research. According to the

[196] Mark Drajem, "EPA official links fracking and drinking water issues in Dimock, Pa." *The Washington Post*, July 29, 2013, accessed April 16, 2014, http://www.washingtonpost.com/politics/epa-official-links-fracking-and-drinking-water-issues-in-dimock-pa/2013/07/29/7d8b34b2-f8a1-11e2-afc1-c850c6ee5af8_story.html.
[197] Ibid.
[198] Laura Legere, "Hazards posed by natural gas drilling not always underground," *thetimes-tribune.com*, June 21, 2010, accessed February 16, 2014, http://thetimes-tribune.com/news/hazards-posed-by-natural-gas-drilling-not-always-underground-1.857452.
[199] Lisa M. McKenzie et al., "Human health risk assessment of air emissions from development of unconventional natural gas resources," *Science of the Total Environment* (2012): 1, accessed February 17, 2014, DOI: 10.1016/j.scitotenv.2012.02.018.

report, "Risk prevention efforts should be directed toward reducing air emission exposures for persons living and working near wells during well completions."[200]

Significant interest surrounds the effects of gas drilling on human and animal health. A 2012 analysis that involved "interviews with animal owners who live near gas drilling operations" in six states found that high-volume hydraulic fracturing of horizontal wells was "more commonly associated with animal health problems" than conventional well drilling.[201] However, the authors note that there was significant "difficulty in obtaining definitive information on the link between hydrocarbon gas drilling and health effects."[202] Due to these difficulties, the authors provided the following recommendations to improve analysis:

- Full disclosure of air and water testing data,
- More food safety research relating to chemical contaminants,
- More air sampling to expand knowledge of various routes of exposure,
- Comprehensive air and water testing before and during drilling.[203]

Given the findings, the authors concluded that "the use of commonsense measures to reduce the impact on human and animals must be required in addition to full disclosure and testing of air, water, soil, animals, and humans" in states that allow drilling.[204] Best practices in regard to human and animal health are essential in avoiding adverse impacts.

A 2010 briefing paper from Worldwatch Institute, which supported the correlation between gas drilling and groundwater, soil, and air contamination, also explored the possibilities of blowouts and seismic risks. The report cited gas well blowouts that had recently occurred as a result of drilling of the Marcellus Shale in Pennsylvania and West Virginia. While adherence to regulations and best practices is important, the report also stressed that proper training of personnel is "critical to the protection of the public and the environment."[205]

---

[200] McKenzie et al., "Human health risk assessment of air emissions from development of unconventional natural gas resources," 8.
[201] Michelle Bamberger and Robert E. Oswald, "Impacts of Gas Drilling on Human and Animal Health," *New Solutions* 22 (2012): 54, accessed February 17, 2014, http://www.psehealthyenergy.org/data/Bamberger_Oswald_NS22_in_press.pdf.
[202] Ibid, 66.
[203] Ibid, 67–70.
[204] Ibid, 72–73.
[205] Mark Zoback, Saya Kitasei, and Brad Copithorne, "Addressing the Environmental Risks from Shale Gas Development," *Worldwatch Institute* (July 2010): 9, accessed February 17, 2014, http://www.worldwatch.org/files/pdf/Hydraulic%20Fracturing%20Paper.pdf.

In addition to blowouts, low-magnitude earthquakes experienced in Texas in 2008 and 2009 point to the possible risk of seismic activity relating to "the injection of waste water from gas operations into numerous saltwater disposal wells that were being operated in the vicinity."[206] More recently, officials have begun an investigation into whether earthquakes in northeastern Ohio in early March could have been caused by hydraulic fracturing itself.[207] As a result, proper monitoring of drilling operations and their seismic impacts is another best practice to be considered during hydraulic fracturing.

8.3 Summary

The numerous concerns regarding natural gas drilling's impact on Western Maryland's communities are difficult to quantify, but this should not be equated with a lack of impacts. The difference in the legal, natural, and political environments of Western Maryland, West Virginia, and Pennsylvania produce different results for the impact drilling may have on communities. Consider the different approaches allowing or restricting horizontal drilling on farmland with conservation easements in West Virginia and Pennsylvania. Many studies describe potentially severe direct and indirect impacts to rural communities such as Western Maryland, but the existing literature also notes the concurrence of the natural gas "boom" with the recent recession and the difficulty in separating the impacts of each event.

9.0 Summary and Conclusion

Given the broad range of potential impacts of Marcellus Shale drilling, RESI focused on several topic areas for review: economic and fiscal impacts, tourism-related impacts, and community impacts. RESI's approach to estimating these potential impacts involved three main tasks: (1) an input/output analysis; (2) research and data collection and analysis regarding housing, truck trips, and tourism; and (3) stakeholder engagement.

Economic and Fiscal Impacts

RESI's findings from the economic and fiscal impact analysis supported the natural gas "boom and bust" cycle model. In the case of both scenarios modeled by RESI, both counties will feel an economic "boom" and then a "bust" associated with Marcellus Shale drilling. Factors such as housing values, industry sales, royalty payments, and WTP for wilderness conservation were determined to be key indicators of economic change associated with Marcellus Shale drilling.

---

[206] Zoback, Kitasei, and Copithorne, "Addressing the Environmental Risks from Shale Gas Development," 9.
[207] Hunter Stuart, "Ohio Fracking Operations Halted Following Area Earthquakes," *Huffington Post*, March 12, 2014, accessed April 16, 2014, http://www.huffingtonpost.com/2014/03/12/fracking-earthquakes-ohio-hilcorp_n_4950768.html.

These indicators were included in the input/output model as they were likely to capture all the factors that could influence the impacts of shale gas drilling.

The size and scope of the economy prior to shale drilling and the amount of drilling to take place can affect how heavily a region is impacted. Garrett County is likely to experience greater build out fluctuations with an equally great economic decline when drilling ends. For Allegany County, the same trend occurs but is less pronounced due to the economy's existing size and the lower magnitude of drilling compared to Garrett County. Furthermore, the lasting impacts from drilling such as the decline in property values, impacted the region adversely after the "boom" from the drilling period ending.

Housing Impacts

As well as being an area of concern for stakeholders, housing is one of the most studied impacts on drilling communities. RESI's research and analysis of housing impacts indicated that Western Maryland has a sufficient total housing surplus, not accounting for construction of new units or deterioration of existing units, to handle the projected population growth attributable to drilling activity. However, excluding the Deep Creek Lake area which has a large second-home and vacation rental market, RESI found that Garrett County may in fact face total housing shortages in the ten-year drilling scenarios 1 and 2. Again, this analysis does not account for the construction of new homes or the deterioration of existing homes over the ten-year period; it assumes a fixed housing supply.

The area's housing surplus is due to the large number of vacant housing that is physically existent but off the market. These homes are considered unavailable for sale or rent, but were included in the total housing surplus. The breakout of available housing units for sale or rent reveal some shortages in both counties throughout the ten-year period, especially due to the lack of non-vacation rental properties in Western Maryland. As Western Maryland is a primarily rural area, it may not benefit from proximity to densely populated urban areas whose rental market would absorb some of the sudden population increase caused by the presence of drilling activity. Still, recent studies determined a weak relationship between drilling activity and rental rate growth unless more than 340 wells were drilled in a single year, and Western Maryland is not expected to experience such intense drilling activity.

Tourism-related Impacts

Tourism-related impacts are less well documented than other economic and community impacts. The lack of research is partially attributable to a lack of availability of uniform data for comparison across counties and across shale plays. State and local governments could benefit from evaluating existing hotel and amusement tax policies to ensure the full capture of expenditures from a transient workforce. RESI's research also indicated that more accurate and robust data on tourism and visitation are necessary, including monthly, if not weekly, data on

hotel tax revenues, industry-level employment, and other key indicators with which to compare the tourism and natural gas industries' coexistence over time.

Tourism impacts alone are difficult to accurately quantify, and definitions of tourism activity can vary. Furthermore, while significant impacts have been observed and trends have been identified in mostly rural areas, the variance of impacts indicates a need for more detailed analysis. Nearly a decade after the drilling boom started in other states, existing research still does not differentiate impacts between types of tourism (entertainment, accommodation, recreation, etc.).

Survey responses revealed strong monthly if not daily participation in outdoor recreation amongst residents and visitors of Western Maryland, in addition to concerns about the quality of local rivers and streams, wildlife habitat, and other open space. In lieu of a quantitative analysis, RESI's research identified some potential qualitative impacts relying on both actual and perceived changes brought on by drilling activity:

- Tourism and related business will need to share already limited resources—labor, water, and land—with the natural gas industry.
    - Tourism businesses may have to increase wages by up to $30,000 to compete with higher wages in occupations with transferrable skills in natural gas and related sectors.
    - Already limited water resources will be shared by tourism industries, residential and commercial users, and additional industrial uses in the presence of drilling activity.
    - Open space and farmland contributing to the appeal of existing tourism and related uses may be converted to drilling sites.
- Residents may simply change how and where they recreate within Western Maryland, but nonresidents and second-home owners will have more flexibility to avoid Western Maryland if they perceive the local trails, streams, and woodlands to be of lesser quality near drilling activity. Several factors that may impact such decisions include the following:
    - Increased traffic or road damage, which may reduce tourists' access to Western Maryland;
    - Strained hotel and lodging capacity, which may limit options for tourists who are not second-home owners; and
    - A reduction in the availability or quality of tourism-related products and services, which may affect the number of visitors and second-home owners.

Negative economic impacts on the tourism industry may be offset by increased hotel taxes in the short term, but state and local governments will need to evaluate existing hotel and amusement tax policies to fully capture the expenditures of a transient workforce and to sustain the entire tourism industry in the long term.

Infrastructure and Roads

Added truck traffic by natural gas extraction and distribution has potential impacts for Western Maryland should drilling occur. Existing studies and research discuss not only the cost of maintaining and repairing roads when the use by heavy trucks suddenly increases but also other impacts on the community have also been observed. Existing research assumed a significant decline in truck traffic once water pipelines are constructed. However, discussions between RESI and MDE and the head of Pennsylvania's mining program, Jim Fuller, determined these assumptions to be relatively inaccurate depending on the intensity of drilling in an area. RESI's analysis determined 410 heavy truck trips per well pad and 1,438 heavy truck trips per well in the early development phase. A total of 365 light truck trips per well pad and 466 light truck trips per well were determined for the early development phase of drilling in Western Maryland. The number of truck trips are one-way, loaded trips based on assumptions for horizontal drilling.

The estimates of average heavy and light truck trips per well or well pad were inputted into RESI's analysis of the number of truck trips per year in each drilling scenario.

- For Scenario 1, the increase in truck activity for Western Maryland amounts to an average annual addition of 22,595 truck trips for heavy-duty trucks and 7,903 for light-duty trucks.
- For Scenario 2, the increase in truck activity for Western Maryland amounts to an average annual addition of 67,785 truck trips for heavy-duty trucks and 23,708 for light-duty trucks.

Most of the increase in truck activity can be attributed to the hauling of water to and from well sites. Increased noise, pollution, and damage to local roads are all concerns that have been widely documented in previous literature and during RESI's stakeholder interviews. Although these impacts may not be present for the total lifecycle of each well pad, increased volume during well pad development and drilling is significant enough to warrant further investigation into the impacts to communities and costs to those responsible for the maintenance of impacted roadways. Additional research is being conducted as part of a separate report for Maryland's Marcellus Shale Safe Drilling Initiative.

Other Community Impacts

RESI's discussions with community members and local representatives revealed several major areas of concerns regarding the impact drilling will have on Western Maryland's prominent industries, its school system, housing availability and affordability, local infrastructure and investment, and its overarching rural character. Stakeholders interviewed from Allegany County appeared more supportive of drilling compared to interviewees from Garrett County, likely due to the fact that the Marcellus Shale play underlies nearly all of Garrett County and only a small western section of Allegany County. Though many studies describe potentially severe direct and indirect impacts to rural communities such as Western Maryland, the existing literature also

notes the concurrence of the natural gas "boom" with the recent recession and the difficulty in separating the impacts of each event.

Conclusion

Extensive research indicates that the potential community, tourism-related, and economic and fiscal impacts—including but not limited to impacts to agriculture, schools, environmental amenities, health and safety, housing, traffic and roads, tourism and recreation—of shale gas drilling vary depending on numerous factors, ranging from well pad build out to royalty payments. Although RESI's literature review revealed that natural gas extraction activities typically follow a "boom and bust" cycle, most other states that are considering or currently allow shale gas drilling expect that such activity will generate positive economic impacts, at least during peak drilling activity.

10.0 References

Allegany County Department of Community Services and Allegany County Department of Public Works. "Allegany County Water and Sewerage Plan 2011." November 29, 2012. Accessed February 21, 2014. http://gov.allconet.org/utilities/docs/2011_WaterandSewerPlan_AMENDED_20121129.pdf.

Anderson, Paige. "Reasonable Accommodation: Split Estates, Conservation Easements, and Drilling in the Marcellus Shale." *Virginia Environmental Law Journal* 31 (2013): 136–167. Accessed August 29, 2014. http://lib.law.virginia.edu/lawjournals/sites/lawjournals/files/Reasonable%20Accommodation.pdf.

Bamberger, Michelle, and Robert E. Oswald. "Impacts of Gas Drilling on Human and Animal Health." *New Solutions* 22 (2012): 51–77. Accessed February 17, 2014. http://www.psehealthyenergy.org/data/Bamberger_Oswald_NS22_in_press.pdf.

Barta, Suzette and Mike D. Woods. "Constructing a Community Housing Profile: Estimating Supply and Demand in Your Local Housing Market." Oklahoma State University–Division of Agricultural Sciences and Natural Resources, Oklahoma Cooperative Extension Service AGEC-919. Accessed September 11, 2013. http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2185/F-919web.pdf.

Bernstein, Paula, Thomas C. Kinnaman, and Mengqi Wu. "Estimating Willingness to Pay for River Amenities and Safety Measures Associated with Shale Gas Extraction." Bucknell University (September 16, 2010). Accessed July 10, 2013. http://digitalcommons.bucknell.edu/cgi/viewcontent.cgi?article=1001&context=fac_pubs.

Bevins, Evan. "Is upswing in hotel/motel tax tourism or oil and gas?" *Parkersburg News and Sentinel*, January 5, 2014. Accessed February 23, 2014. http://www.newsandsentinel.com/page/content.detail/id/581858/Is-upswing-in-hotel-motel-tax-tourism-or-oil-and-gas-.html?nav=5054.

Bockstael, Nancy E. and Kenneth E. McConnell. *Environmental and Resource Valuation with Revealed Preferences: A Theoretical Guide to Empirical Models.* Netherlands: Springer, 2007. http://www.springer.com/economics/environmental/book/978-0-7923-6501-3.

Bowker, J.M., David H. Newman, Robert J. Warren, and David W. Henderson. "Estimating the Economic Value of Lethal Versus Nonlethal Deer Control in Suburban Communities." *Society and Natural Resources* 16 (2003): 143–158. DOI: 10.1080/08941920390174256.

Brasier, Kathryn J., Matthew R. Filteau, Diane K. McLaughlin, Jeffrey Jacquet, Richard C. Stedman, Timothy W. Kelsey, and Stephan J. Goetz. "Residents' Perceptions of Community and Environmental Impacts." *Journal of Rural Social Science* 26 No.1 (2011): 32–61. Accessed July 11, 2013. http://www.ag.auburn.edu/auxiliary/srsa/pages/Articles/JRSS%202011%2026%201%2032-61.pdf.

Bureau of Labor Statistics. "Quarterly Census of Employment and Wages." Accessed February 5, 2014. http://www.bls.gov/cew/.

Campoy, Ana. "Drilling Strains Rural Roads." *The Wall Street Journal*, July 26, 2012. Accessed February 28, 2014. http://online.wsj.com/news/articles/SB10000872396390444840104577551223860569402.

Carson, Richard T. *Valuing Oil Spill Prevention: A Case Study of California's Central Coast* Netherlands: Kluwer Academic Publishers, 2004.

Carson, Richard T., Robert C. Mitchell, Michael Hanemann, Raymond J. Kopp, Stanley Presser, and Paul A. Ruud. "Contingent Valuation and Lost Passive Use: Damages from the Exxon Valdez Oil Spill." *Environmental and Resource Economics* 25 (March 31, 2003): 257–286. Accessed July 10, 2013. http://are.berkeley.edu/~gh082644/Exxon%20Valdez%20Oil%20Spill.pdf.

Cebula, Richard C. "The Hedonic Pricing Model Applied to the Housing Market of the City of Savannah and Its Savannah Historic Landmark District." *The Review of Regional Studies* 39 (2009): 9–22. http:// journal.srsa.org/ojs/index.php/RRS/article/download/182/137.

Center for Workforce Information & Analysis–Pennsylvania Department of Labor and Industry. "Marcellus Shale Fast Facts: July 2012 Edition." August 7, 2012. Accessed August 28, 2014. http://www.marcellus.psu.edu/resources/PDFs/July2012_FastFacts.pdf.

Christopherson, Susan, and Ned Rightor. "The Boom-Bust Cycle of Shale Gas Extraction Economies." Cardi Reports No. 14 (September 2011). Accessed June 4, 2013.

Coleman, James L., Robert C. Milici, Troy A. Cook, Ronald R. Charpentier, Mark Kirschbaum, Timothy R. Klett, Richard M. Pollastro, and Christopher J. Schenk. "Assessment of Undiscovered Oil and Gas Resources of the Devonian Marcellus Shale of the Appalachian Basin." U.S. Geological Survey (2011). Accessed September 18, 2013. http://pubs.usgs.gov/fs/2011/3092/pdf/fs2011-3092.pdf.

Commonwealth of Pennsylvania Legislature. "Oil and Gas – Lease to Remove or Recover Act of July 20, 1979." P.L. 183, No. 60. (1979). http://www.legis.state.pa.us/WU01/LI/LI/US/HTM/1979/0/0060..HTM.

Considine, Timothy J., Robert Watson, and Seth Blumsack. "The Economic Impacts of the Pennsylvania Marcellus Shale Natural Gas Play: An Update." Pennsylvania State University (May 24, 2010). Accessed February 12, 2014. http://marcelluscoalition.org/wp-content/uploads/2010/05/PA-Marcellus-Updated-Economic-Impacts-5.24.10.3.pdf.

Cooley, Heather, and Kristina Donnelly. "Hydraulic Fracturing and Water Resources: Separating the Frack from the Fiction." Pacific Institute (June 2012). Accessed March 4, 2014. http://pacinst.org/wp-content/uploads/sites/21/2014/04/fracking-water-sources.pdf.

Deep Creek Hydro. "Station Statistics." Accessed February 26, 2014. http://www.deepcreekhydro.com/StationStatistics.html.

Deng, Jinyang, Steve Selin, and Kathryn Arano. "Travel/Tourism Related Economic Analysis for Garrett County, Maryland." Appalachian Regional Commission (January 30, 2010). Accessed February 28, 2014. http://www.deepcreekanswers.com/info/studies/Travel_Tourism_Related_Economic_Impact_Analysis.pdf.

Department of Business and Economic Development. "Cost of Living." Accessed April 17, 2014. http://www.choosemaryland.org/live/pages/costofliving.aspx.

Diaz, Vera Bartolome, Tom Knipe, Christopher Smith, Greg Waldman, Ethan Warsh, David West, and Austin Zwick. "Economic Implications of Marcellus Shale Natural Gas Development: Understanding Potential Impacts on Tourism, Agriculture and Housing." Presentation, May 9, 2011. http://cardi.cornell.edu/cals/devsoc/outreach/cardi/training/economic-implications-of-marcellus-shale-natural-gas-development.cfm.

Dix, Manfred, and Greg Albrecht. "An Economic Impact Analysis of the Haynesville Shale Natural Gas Exploration, Drilling and Production: Some Preliminary Results." August 28, 2008. Accessed February 12, 2014. http://dnr.louisiana.gov/assets/docs/mineral/haynesvilleshale/manfred-dix-impact-analysis.pdf.

Drajem, Mark. "EPA official links fracking and drinking water issues in Dimock, Pa." *The Washington Post*, July 29, 2013. Accessed April 16, 2014. http://www.washingtonpost.com/politics/epa-official-links-fracking-and-drinking-water-issues-in-dimock-pa/2013/07/29/7d8b34b2-f8a1-11e2-afc1-c850c6ee5af8_story.html.

Engelder, Terry. "Marcellus Reserves and Estimates Substantiated by Production Data." Research presented online through Penn State Extension Webinar on the Marcellus Shale. September 30, 2013. http://extension.psu.edu/natural-resources/natural-gas/webinars/marcellus-reserves-and-estimates-substantiated-by-production-data/marcellus-reserves-and-estimates-substantiated-by-production-data-powerpoint-september-19-2013.

Eshleman, Keith N., and Andrew Elmore. "Recommended Best Management Practices for Marcellus Shale Gas Development in Maryland." Appalachian Laboratory–University of Maryland Center for Environmental Science (February 18, 2013). Accessed August 28, 2014. http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Eshleman_Elmore_Final_BMP_Report_22113_Red.pdf.

Ferrari, Katherine D. "Rural Communities: How Do Individuals Perceive Change When Industry Enters the Area?" Dissertation, University of South Florida School of Social Work (October 15, 2013). Accessed May 21, 2014. http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=6009&context=etd.

Freudenburg, William R. "Addictive Economies: Extractive Industries and Vulnerable Localities in a Changing World Economy." *Rural Sociology* 57 no. 3 (1992): 305–332. Accessed February 18, 2013. DOI: 10.1111/j.1549-0831.1992.tb00467.x.

Fuller, Jim. Discussion with Ed Larrimore of MDE. April 3, 2014.

Furchtgott-Roth, Diana, and Andrew Gray. "The Economic Effects of Hydrofracturing on Local Economies: A Comparison of New York and Pennsylvania." *Growth and Prosperity Report* 1 (May 2013). Accessed February 12, 2014. http://www.manhattan-institute.org/pdf/gpr_1.pdf.

Gopalakrishnan, Sathya, and H. Allen Klaiber. "Is the Shale Boom a Bust for Nearby Residents? Evidence from Housing Values in Pennsylvania." *American Journal of Agricultural Economics* 96 (2014): 43–66. DOI: 10.1093/ajae/aat065.

Greene, William H. *Econometric Analysis*. New York: Pearson, 2008.

Haefele, Michelle, and Pete Morton. "The Influence of the Pace and Scale of Energy Development on Communities: Lessons from the Natural Gas Drilling Boom in the Rocky Mountains." *Western Economics Forum* 8 No. 2 (Fall 2009): 1–13. Accessed July 23, 2013. http://purl.umn.edu/92810.

Haefele, Michelle, Thomas P. Holmes, and Randall A. Kramer. "Using Contingent Valuation to Estimate the Value of Forest Ecosystem Protection." Accessed July 10, 2013. http://fds.duke.edu/db/attachment/405.

Halstead, John M., A.E. Luloff, and Thomas H. Stevens. "Protest Bidders in Contingent Valuation." *Northeastern Journal of Agricultural and Resource Economics* 2 (1992): 160–169. http://purl.umn.edu/29000.

Hamilton, Tracey Idell. "Drought spurring fracking concerns." *mySA*, July 2, 2011. Accessed February 17, 2014. http://www.mysanantonio.com/news/energy/article/Droughtspurringfrackingconcerns-1450808.php.

Herzenberg, Stephen, Diana Polson, and Mark Price. "Measuring the Costs and Benefits of Natural Gas Development in Greene County, Pennsylvania: A Case Study." Multistate Shale Research Collaborative (April 2014). Accessed April 18, 2014. https://pennbpc.org/sites/pennbpc.org/files/greeneCASESTUDY.pdf.

Higginbotham, Amy, Adam Pellillo, Tami Gurley-Calvez, and Tom S. Witt. "The Economic Impact of the Natural Gas Industry and the Marcellus Shale Development in West Virginia in 2009." West Virginia University (December 2010). Accessed February 12, 2014. http://www.be.wvu.edu/bber/pdfs/BBEr-2010-22.pdf.

Holoviak, Paula A. Duda. "An Evaluation of Strategies and Finances of the Rural Tourism Industry." The Center for Rural Pennsylvania (April 2012). Accessed October 7, 2013. http://www.rural.palegislature.us/documents/reports/Evaluation_Rural_Tourism_Industry.pdf.

Hughes, J. David. "Drill, Baby, Drill: Can Unconventional Fuels Usher in a New Era of Energy Abundance?," *Post Carbon Institute* (February 2013). http://www.postcarbon.org/reports/DBD-report-FINAL.pdf.

Institute for Public Policy & Economic Development, The. "Impact on Housing in Appalachian Pennsylvania as a Result of Marcellus Shale." November 2011. Accessed February 28, 2014. http://www.institutepa.org/PDF/Marcellus/housing11.pdf.

Jacquet, Jeffrey B. "Energy Boomtowns & Natural Gas: Implications for Marcellus Shale Local Governments & Rural Communities." Pennsylvania State University–The Northeast Regional Center for Rural Development, Paper No. 43 (January 2009). Accessed July 11, 2013. http://aese.psu.edu/nercrd/publications/rdp/rdp43/view.

Jacquet, Jeffrey B. "Landowner Attitudes toward Natural Gas and Wind Farm Development in Northern Pennsylvania." *Energy Policy* 50 (2012): 677–688. Accessed July 25, 2013. http://dx.doi.org/10.1016/j.enpol.2012.08.011.

Jacquet, Jeffrey B. "Risk to Communities from Shale Gas Development." South Dakota University. Presentation at the National Research Council Workshop on Risks from Shale Gas Development, May 31, 2013. http://sites.nationalacademies.org/DBASSE/BECS/DBASSE_083187.

Kelsey, Timothy W., Martin Shields, James R. Ladlee, and Melissa Ward. "Economic Impacts of Marcellus Shale in Pennsylvania: Employment and Income in 2009." Marcellus Shale Education & Training Center (August 2011). Accessed October 7, 2013. http://www.shaletec.org/docs/economicimpactfinalaugust28.pdf.

Kenney, Brigid. Email message to author. February 4, 2014.

Kinnaman, Thomas C. "The Economic Impact of Shale Gas Extraction: A Review of Existing Studies." Bucknell University (January 1, 2010). Accessed February 12, 2014. http://digitalcommons.bucknell.edu/cgi/viewcontent.cgi?article=1004&context=fac_pubs.

Maryland Attorney General's Office. "Landlords and Tenants: Tips on Avoiding Disputes." Accessed April 16, 2014. http://www.oag.state.md.us/Consumer/landlords.htm#renewals.

Legere, Laura. "Hazards posed by natural gas drilling not always underground." *thetimes-tribune.com*, June 21, 2010. http://thetimes-tribune.com/news/hazards-posed-by-natural-gas-drilling-not-always-underground-1.857452.

Leggett, Christopher G., Naomi S. Kleckner, Kevin J. Boyle, John W. Duffield, and Robert Cameron Mitchell. "Social Desirability Bias in Contingent Valuation Surveys Administered through In-Person Interviews." *Land Economics* 79 (2003): 561–575. DOI: 10.2307/3147300.

Maryland Department of the Environment. "Marcellus Shale Safe Drilling Initiative." Accessed February 10, 2014. http://www.mde.state.md.us/programs/land/mining/marcellus/pages/index.aspx.

Maryland Department of the Environment. "Stakeholder Meetings—Summary Notes." In *Impact Study of Marcellus Shale Safe Drilling Initiative—Stakeholder Interview Notes* (September 3, 2013). http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/economicStudy_Stakeholder_Interview_Summary_Notes_9_3_2013.pdf.

Maryland Department of Labor, Licensing and Regulation. "Brief Economic Facts: Garrett County, Maryland." 2013. Accessed May 22, 2014. http://www.choosemaryland.org/factsstats/Documents/briefeconomicfacts/GarrettBef.pdf.

Maryland Department of Labor, Licensing and Regulation. "County Industry Series." In *Employment and Wages by County*. 2012. Accessed February 10, 2014. http://www.dllr.state.md.us/lmi/emppay/.

Maryland Division of State Documents. "26.17.06.02." COMAR Online. Accessed February 21, 2014. http://www.dsd.state.md.us/comar/.

Maryland Energy Administration. "Smart Energy Investment Map." Accessed February 26, 2014. http://energy.maryland.gov/map/index.html.

Maryland State Education Association. "School Funding." Accessed March 13, 2014. http://www.marylandeducators.org/hot-issues/school-funding.

McKenzie, Lisa M., Roxana Z. Witter, Lee S. Newman, and John L. Adgate. "Human health risk assessment of air emissions from development of unconventional natural gas resources." *Science of the Total Environment* (2012). Accessed February 17, 2014. DOI: 10.1016/j.scitotenv.2012.02.018.

"Methods, Section 6: Contingent Valuation Method." In *Ecosystem Valuation*. Accessed February 13, 2014. http://www.ecosystemvaluation.org/contingent_valuation.htm.

Mitchell, Robert Cameron and Richard T. Carson. "Using Surveys to Value Public Goods: The Contingent Value Method." *Resources for the Future* (1989). Accessed July 10, 2013. http://econweb.ucsd.edu/~rcarson/papers/UsingSurveysToValuePublicGoods.pdf.

Muehlenbachs, Lucija, Elisheba Spiller, and Christopher Timmins. "Shale Gas Development and the Costs of Groundwater Contamination Risk." *Resources for the Future Discussion Paper* (2013): 12–40. http://www.rff.org/RFF/Documents/RFF-DP-12-40-REV.pdf.

National Bureau of Economic Research, The. "US Business Cycle Expansions and Contractions." Accessed May 19, 2014. http://www.nber.org/cycles/cyclesmain.html.

National Center for Smart Growth Research and Education–University of Maryland. "Sustainable Transformation of the Appalachian Region Data Brief: Transportation and Infrastructure." August 9, 2012. Accessed February 26, 2014. http://www.smartgrowth.umd.edu/assets/documents/star/star_brief_transportation_and_infrastructure.pdf.

National Motorists Association. "State Speed Limit Chart." Last updated January 29, 2014. Accessed May 20, 2014. http://www.motorists.org/speed-limits/state-chart.

Nedved, David K. Personal communication. October 18, 2013.

New York Municipal Insurance Reciprocal. "Protecting Our Local Roads." Accessed February 26, 2014. http://www.nymir.org/pdf/NYMIR%20Marcellus%20Roads%20FINAL.pdf.

"New York State Assembly votes to block fracking until 2015." *Reuters,* March 6, 2013. Accessed March 5, 2014. http://www.reuters.com/article/2013/03/06/energy-fracking-newyork-idUSL1N0BYFK320130306.

New York State Department of Environmental Conservation. "Supplemental Generic Environmental Impact Statement." September 7, 2011. Accessed February, 14 2014. http://www.dec.ny.gov/data/dmn/rdsgeisfull0911.pdf.

NTC Consultants. "Impacts on Community Character of Horizontal Drilling and High Volume Hydraulic Fracturing in Marcellus Shale and Other Low- Permeability Gas Reservoirs." Prepared for NYSERDA, Albany, NY (February 18, 2011). Accessed May 22, 2014. http://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/ng/NTC-Report.pdf.

ODNR Division of Oil & Gas Resources. "Oil & Gas Well Production." Accessed February 13, 2014. http://oilandgas.ohiodnr.gov/production.

Ohio Oil and Gas Association. "Summary of Ohio and Gas Activities (ODNR)." In *Downloadable Resources, 2004–2012*. Accessed February 24, 2014. http://ooga.org/our-industry/ohio-oil-gas-activity/.

Palma, Jim. "Baltimore's cost of living stacks up well." *MDBIZNews*, August 21, 2012. Accessed May 19, 2014. http://mdbiznews.choosemaryland.org/2012/08/21/baltimores-cost-of-living-stacks-up-well/.

Partridge, Mark D., Michael Farren, Amanda Weinstein, and Michael Betz. "Final Report: Assessing the Impact of Shale Energy Boom on Ohio Local Housing Markets." Ohio State University (2013). Accessed October 15, 2013. https://www.ohiohome.org/research/documents/OhioStateReport-Mar12.pdf.

PATT/PRLA Room Tax Task Force. "Statewide Policy Recommendations 2013." Presentation. Accessed February 7, 2014. https://www.patravelandtourism.org/sites/default/files/Hotel%20Tax%20Taskforce%20-%20Statewide%20Policy%20Recommendations%202013.pptx.

Penn State Cooperative Extension. "Marcellus Shale Gas Development: What Does It Mean for Pennsylvania Schools?" *Marcellus Education Fact Sheet* (2012). Accessed February 28, 2014. http://pubs.cas.psu.edu/freepubs/pdfs/ee0019.pdf.

Perryman Group, The. "A Decade of Drilling: The Impact of the Barnett Shale on Business Activity in the Surrounding Region and Texas." August 2011. Accessed February 12, 2014. http://barnettprogress.com/media/BarnettShaleStudy11.pdf.

Ramada Inn Cumberland-Downtown. "Marcellus Shale Region of PA Hotel Accommodations." Accessed February 14, 2014. http://www.hicumberland.com/lp-marcellus-shale-region-pa/.

Randall, CJ. "Hammer Down: A Guide to Protecting Local Roads Impacted by Shale Gas Drilling." *Working Paper Series: A Comprehensive Economic Impact Analysis of Natural Gas Extraction in the Marcellus* Shale (December 2010). Accessed February 28, 2014. http://www.greenchoices.cornell.edu/downloads/development/shale/Protecting_Local_Roads.pdf.

Richards, Chris, Executive Director of Lewis County Convention and Visitors Bureau. Personal communication. October 16, 2013.

Rosen, Sherwin. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *The Journal of Political Economy* 82 (1974): 34–55. http://www.jstor.org/stable/1830899.

Rumbach, Andrew. "Natural Gas Drilling in the Marcellus Shale: Potential Impacts on the Tourism Economy of the Southern Tier." Cornell University. Accessed February 12, 2014. http://www.greenchoices.cornell.edu/downloads/development/shale/Impacts_on_Tourism_Economy.pdf.

Sage Policy Group. "The Potential Economic & Fiscal Impacts of Natural Gas Production in Western Maryland." March 2012. Accessed May 16, 2014. http://marcelluscoalition.org/wp-content/uploads/2012/03/MD-Marcellus-Study.pdf.

Samson Energy. "Estimated Marcellus Shale Natural Gas Value." Accessed May 16, 2014. http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Economic_Value_Estimates.pdf.

Schwarzmann, Danielle Nicole. "The Environmental and Economic Benefits of Stream Restoration: An Application to Stream Restoration in Maryland." Dissertation, University of Maryland (2013). Accessed July 10, 2013. http://gradworks.umi.com/35/63/3563371.html.

Shaner Hotel Group, The. "Marcellus Shale Hotels." Accessed March 10, 2014. www.marcellusshalehotels.com.

Shen, Y., S. Wang, and S. He. "Improving Decline-curve Analysis of Low-permeability Gas Wells Using Type Curves." *Petroleum Science and Technology* 31 (2013): 912–920. http://dx.doi.org/10.2118/108176-PA.

Slonecker, E.T., L.E. Milheim, C.M. Roig-Silva, A.R. Malizia, D.A. Marr, and G.B. Fisher. "Landscape Consequences of Natural Gas Extraction in Bradford and Washington Counties, Pennsylvania, 2004–2010." U.S. Geological Survey (2012). Accessed August 28, 2014. http://pubs.usgs.gov/of/2012/1154/of2012-1154.pdf.

Stuart, Hunter. "Ohio Fracking Operations Halted Following Area Earthquakes." *Huffington Post*, March 12, 2014. Accessed April 16, 2014. http://www.huffingtonpost.com/2014/03/12/fracking-earthquakes-ohio-hilcorp_n_4950768.html.

Thomas, Andrew R., Iryna Lendel, Edward W. Hill, Douglas Southgate, and Robert Chase. "An Analysis of the Economic Potential for Shale Formations in Ohio." Ohio Shale Coalition (2012). Accessed February 13, 2014. http://urban.csuohio.edu/publications/center/center_for_economic_development/Ec_Impact_Ohio_Utica_Shale_2012.pdf.

Tse, Raymond Y.C. "Estimating Neighbourhood Effects in House Prices Towards a New Hedonic Model Approach," *Urban Studies* 39 (2002): 1165–1180. DOI: 10.1080/00420980220135545.

U.S. Bureau of Labor Statistics. "Occupation: Heavy and Tractor-Trailer Truck Drivers (SOC Code 533032)." From *Occupational Employment Statistics Query System*, May 2012. Accessed February 12, 2014. http://data.bls.gov/oes/.

U.S. Bureau of Labor Statistics. "Quarterly Census of Employment and Wages." 2012. Accessed February 7, 2014. http://www.bls.gov/qcew/.

U.S. Census Bureau. "American Community Survey and Puerto Rico Community Survey 2012 Subject Definitions." Accessed May 14, 2014. http://www.census.gov/acs/www/Downloads/data_documentation/SubjectDefinitions/2012_ACSSubjectDefinitions.pdf.

U.S. Census Bureau. "DEMOGRAPHIC AND HOUSING ESTIMATES." In *2012 American Community Survey 1-year Estimates*. Accessed May 12, 2014. http://factfinder2.census.gov/.

U.S. Census Bureau. "HOUSING CHARACTERISTICS." In *2010–2012 American Community Survey 3–Year Estimates*. Accessed May 12, 2014. http://factfinder2.census.gov/.

U.S. Census Bureau. "New Residential Construction: Length of Time, 1976–2012." Accessed February 7, 2014. https://www.census.gov/construction/nrc/lengthoftime.html.

U.S. Census Bureau. OnTheMap. From *2011 Longitudinal Employer-Household Dynamics 1-year Estimates*. Accessed September 12, 2014. http://onthemap.ces.census.gov/.

U.S. Census Bureau. "SELECTED ECONOMIC CHARACTERISTICS." In *2008-2012 American Community Survey 5-Year Estimates*. Accessed February 7, 2014. http://factfinder2.census.gov/.

U.S. Census Bureau. "SELECTED SOCIAL CHARACTERISTICS." In *2008-2012 American Community Survey 5-Year Estimates*. Accessed February 7, 2014. http://factfinder2.census.gov/.

U.S. Census Bureau. "VACANCY STATUS." In *2008–2012 American Community Survey 5–Year Estimates*. Accessed February 7, 2014. http://factfinder2.census.gov/.

U.S. Census Bureau. "VACANCY STATUS." In *2010–2012 American Community Survey 3–Year Estimates*. Accessed May 12, 2014. http://factfinder2.census.gov/.

U.S. Department of Agriculture. "2013 Rural-Urban Continuum Codes." Updated May 5, 2013. http://www.ers.usda.gov/datafiles/RuralUrban_Continuum_Codes/ruralurbancodes2013.xls.

U.S. Department of Agriculture, National Agricultural Statistics Service. "Table 8. Farms, Land in Farms, Value of Land and Buildings, and Land Use: 2012 and 2007," in *2012 Census of Agriculture - County Data*. Accessed August 28, 2014. http://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Maryland/st24_2_008_008.pdf.

U.S. Energy Information Administration. "Annual Energy Outlook 2013 with Projections to 2040." April 2013. Accessed September 18, 2013. http://www.eia.gov/forecasts/aeo/pdf/0383%282013%29.pdf.

U.S. Energy Information Administration. "Technically Recoverable Shale Oil and Shale Gas Reserves: An Assessment of 137 Shale Formations in 41 Countries Outside of the United States." June 2013. Accessed February 20, 2014. http://www.eia.gov/analysis/studies/worldshalegas/pdf/overview.pdf.

U.S. Geological Survey. "Estimated Use of Water in the United States: County-Level Data for 2005." National Water Information Service. Last modified February 24, 2014. Accessed March 10, 2014. http://water.usgs.gov/watuse/data/2005/.

U.S. Geological Survey. "Industrial Water Use." The USGS Water Science School (March 17, 2014). Accessed April 30, 2014. http://water.usgs.gov/edu/wuin.html.

U.S. Geological Survey. Presentation on percentage estimates of natural gas share by state. October 18, 2013. Email attachment from Brigid Kenney.

U.S. Geological Survey Oil and Gas Assessment Team. "Variability of Distributions of Well-Scale Estimated Ultimate Recovery for Continuous (Unconventional) Oil and Gas Resources in the United States." 2012. Accessed September 18, 2013. http://pubs.usgs.gov/of/2012/1118/OF12-1118.pdf.

University of Maryland Center for Agricultural and Natural Resource Policy. "State Review of Environmental Impacts Could Result in Mineral Leasing Opportunities in Maryland." (May 2014). Accessed September 9, 2014. http://drum.lib.umd.edu/bitstream/1903/15075/1/EB%20418%20Natural%20Gas.pdf.

Weber, Jeremy G. "The Effects of a Natural Gas Boom on Employment and Income in Colorado, Texas, and Wyoming." *Energy Economics* 34 (2012): 1580–1588. http://dx.doi.org/10.1016/j.eneco.2011.11.013.

Weinstein, Bernard L. and Terry L. Clower. "Potential Economic and Fiscal Impacts from Natural Gas Production in Broome County, New York." July 2009. Accessed February 12, 2014. http://www.gobroomecounty.com/files/countyexec/Marcellus-Broome%20County-Preliminary%20Report%20for%20distribution%207-27-09.pdf.

White, Mark, Deb Markley, Erik Pages, and Ken Poole, "Economic Diversity in Appalachia: Case Studies in Economic Diversification." University of Illinois at Urbana-Champaign's Regional Economics Applications Laboratory and the Center for Regional Economic Competitiveness (February 2014). Accessed August 27, 2014. http://www.arc.gov/assets/research_reports/EconomicDiversityinAppalachia-CaseStudiesinEconomicDiversification.pdf.

Wieder, Ben. "Schools Fill Budget Holes With Fracking Revenues." *STATELINE*, August 30, 2011. Accessed February 28, 2014. http://www.pewstates.org/projects/stateline/headlines/schools-fill-budget-holes-with-fracking-revenues-85899375145.

Williamson, Jonathan, and Bonita Kolb. "Marcellus Natural Gas Development's Effect on Housing in Pennsylvania." Center for the Study of Community and the Economy–Lycoming College (September 31, 2011). Accessed February 28, 2014. http://www.cohhio.org/files/HOUSING%20PHFA%20Marcellus_report.pdf.

Wilson, Janet. "Dr. Wilson's Facility Presentation." Presentation, October 28, 2013. Accessed February 28, 2014. http://www.garrettcountyschools.org/resources/public-information/pdf/Garrett-County-Schools---Dr.-Wilsons-Facility-Presentation-10-28-13.pdf.

Wisp Resort. "Mountain Information." Accessed February 21, 2014. http://www.wispresort.com/mountain-information.php.

Yanarella, Nadine, Vice President and Chief Financial Officer of Laurel Highlands Visitors Bureau. Personal communication. October 7, 2013.

Zoback, Mark, Saya Kitasei, and Brad Copithorne. "Addressing the Environmental Risks from Shale Gas Development." *Worldwatch Institute* (July 2010). Accessed February 17, 2014. http://www.worldwatch.org/files/pdf/Hydraulic%20Fracturing%20Paper.pdf.

Appendix A—Model Development

A.1 Industry Variables

A.1.1 Industry Sales

This section outlines the natural gas sales for each county under Scenarios 1 and 2. Natural gas sales were calculated using the projected EIA AEO 2013 natural gas prices and the thousands of cubic feet of natural gas that would be extracted each year from the total wells in production.[208] Scenario 1 represents a case where 25 percent of the total EUR are extracted. Scenario 2 represents a case where 75 percent of the total EURs are extracted. The timeframe of the study is 2017 through 2036.

Allegany County

Under Scenario 1, Allegany County would see minimal impact from natural gas drilling. Under this assumption, between 2017 through 2036, 18 wells would be drilled across 3 well pads. The annual industry sales are reported in Figure 45 below. Prices and volume produced are recorded in mcf.

[208] U.S. Energy Information Administration, "Annual Energy Outlook 2013 with Projections to 2040."

Figure 45: Industry Sales for Allegany County—Scenario 1, 25% Extraction

Year	Number of New Wells	AEO Price per mcf	Total Produced in mcf	Total Revenue
2017	2	$3.70	1,240,001.0	$4,588,004
2018	3	$3.96	2,345,503.7	$9,288,195
2019	3	$4.05	2,831,298.8	$11,466,760
2020	3	$4.13	3,079,501.6	$12,718,342
2021	3	$4.26	3,211,520.4	$13,681,077
2022	3	$4.48	3,283,902.4	$14,711,883
2023	1	$4.67	2,083,995.8	$9,732,260
2024	0	$4.79	1,000,702.6	$4,793,365
2025	0	$4.87	527,210.0	$2,567,513
2026	0	$5.02	285,821.8	$1,434,825
2027	0	$5.09	155,593.8	$791,972
2028	0	$5.22	83,211.8	$434,366
2029	0	$5.30	43,117.4	$228,522
2030	0	$5.40	20,907.9	$112,903
2031	0	$5.53	8,605.4	$47,588
2032	0	$5.63	1,790.8	$10,082
2033	0	$5.77	0.0	$0
2034	0	$6.04	0.0	$0
2035	0	$6.32	0.0	$0
2036	0	$6.69	0.0	$0

Sources: EIA, RESI

Under Scenario 2, Allegany County would see more impact from natural gas drilling than under Scenario 1. Under this assumption, between 2017 through 2036, a total of 60 wells would be drilled across 10 well pads. The annual industry sales are reported in Figure 46 below. Prices and volume produced are recorded in mcf.

Figure 46: Industry Sales for Allegany County—Scenario 2, 75% Extraction

Year	Number of New Wells	AEO Price per mcf	Total Produced in mcf	Total Revenue
2017	6	$3.70	3,720,003.0	$13,764,011
2018	12	$3.96	8,896,512.6	$35,230,190
2019	9	$4.05	9,222,149.7	$37,349,706
2020	6	$4.13	7,743,069.3	$31,978,876
2021	7	$4.26	7,856,328.1	$33,467,958
2022	6	$4.48	7,244,655.1	$32,456,055
2023	6	$4.67	7,007,734.6	$32,726,121
2024	6	$4.79	6,887,709.2	$32,992,127
2025	2	$4.87	4,344,449.3	$21,157,468
2026	0	$5.02	2,099,149.9	$10,537,732
2027	0	$5.09	1,102,611.1	$5,612,290
2028	0	$5.22	586,434.1	$3,061,186
2029	0	$5.30	314,420.6	$1,666,429
2030	0	$5.40	168,214.4	$908,358
2031	0	$5.53	86,234.8	$476,878
2032	0	$5.63	41,815.8	$235,423
2033	0	$5.77	17,210.8	$99,306
2034	0	$6.04	3,581.6	$21,633
2035	0	$6.32	0.0	$0
2036	0	$6.69	0.0	$0

Sources: EIA, RESI

Garrett County

Under Scenario 1, Garrett County would experience moderate impact from natural gas drilling. Under this assumption, between 2017 through 2036, 132 wells would be drilled across 22 well pads. The annual industry sales are reported in Figure 47 below. Prices and volume produced are recorded in mcf.

Figure 47: Industry Sales for Garrett County—Scenario 1, 25% Extraction

Year	Number of New Wells	AEO Price per mcf	Total Produced in mcf	Total Revenue
2017	6	$3.70	3,720,003.0	$13,764,011
2018	13	$3.96	9,516,513.1	$37,685,392
2019	26	$4.05	20,004,909.3	$81,019,883
2020	19	$4.13	20,051,366.5	$82,812,144
2021	15	$4.26	18,101,310.8	$77,111,584
2022	12	$4.48	15,597,578.9	$69,877,153
2023	11	$4.67	13,962,632.7	$65,205,495
2024	12	$4.79	13,837,632.8	$66,282,261
2025	12	$4.87	13,695,562.1	$66,697,387
2026	6	$5.02	9,890,132.3	$49,648,464
2027	0	$5.09	4,657,122.8	$23,704,755
2028	0	$5.22	2,432,495.9	$12,697,629
2029	0	$5.30	1,288,829.3	$6,830,795
2030	0	$5.40	690,589.5	$3,729,183
2031	0	$5.53	367,657.0	$2,033,143
2032	0	$5.63	191,751.8	$1,079,563
2033	0	$5.77	95,304.6	$549,908
2034	0	$6.04	40,887.6	$246,961
2035	0	$6.32	10,744.8	$67,907
2036	0	$6.69	0.0	$0

Sources: EIA, RESI

Under Scenario 2, Garrett County would see more impact from natural gas drilling than under Scenario 1. Under this assumption, between 2017 through 2036, a total of 390 wells would be drilled across 65 well pads. The annual industry sales are reported in Figure 48. Prices and volume produced are recorded in mcf.

Figure 48: Industry Sales for Garrett County—Scenario 2, 75% Extraction

Year	Number of New Wells	AEO Price per mcf	Total Produced in mcf	Total Revenue
2017	30	$3.70	18,600,015.0	$68,820,056
2018	60	$3.96	44,482,563.0	$176,150,949
2019	54	$4.05	51,690,753.0	$209,347,550
2020	48	$4.13	52,060,115.4	$215,008,277
2021	56	$4.26	57,764,868.8	$246,078,341
2022	36	$4.48	47,798,511.2	$214,137,330
2023	30	$4.67	40,496,321.6	$189,117,822
2024	30	$4.79	37,287,124.6	$178,605,327
2025	34	$4.87	38,140,637.8	$185,744,906
2026	12	$5.02	24,609,452.0	$123,539,449
2027	0	$5.09	11,812,145.6	$60,123,821
2028	0	$5.22	6,170,700.8	$32,211,058
2029	0	$5.30	3,291,475.0	$17,444,818
2030	0	$5.40	1,766,660.8	$9,539,968
2031	0	$5.53	923,051.6	$5,104,475
2032	0	$5.63	475,593.0	$2,677,589
2033	0	$5.77	233,684.0	$1,348,357
2034	0	$6.04	99,683.2	$602,087
2035	0	$6.32	21,489.6	$135,814
2036	0	$6.69	0.0	$0

Sources: EIA, RESI

A.1.2 Royalty Payments

Royalty payments are likely to negatively impact companies operating within the area as they are increased costs toward production. However, households would benefit from increased income if they held the mineral rights to the natural gas under their land.[209] As discussed in Section 2.4 of the report, it is unclear in some cases in Maryland if a single individual holds both the surface and mineral rights. The "split" estates within the region make it challenging to determine if there will be any increase disposable income paid to residents in the region. Therefore, RESI did not include royalty payments as increased disposable income for households in Garrett or Allegany Counties.

[209] Muehlenbachs, Spiller, and Timmins, "Shale Gas Development and the Costs of Groundwater Contamination Risk," 30.

However, this omission of increased income within the region does not discount producers from still being legally obligated to pay for leasing the land and minerals. Therefore, RESI kept royalty payments within its model, but only as an increased production cost. To date, the minimum recorded percentage a lease holder can be paid in a royalty for shale drilling is mandated by Pennsylvania at 12.5 percent of the production value.[210] RESI applied this percentage to the production revenues previously calculated and concluded the value in annual royalties that lease holders would receive from producers.

For Allegany County, RESI used the production amounts calculated in Figures 45 and 46 to determine the potential royalties paid by producers for drilling in Allegany County under Scenarios 1 and 2, respectively. The royalty payment amounts are reported for each scenario in Figure 49.

Figure 49: Estimated Royalty Payments Made by Firms Drilling in Allegany County

Year	Scenario 1	Scenario 2
2017	$573,500	$1,720,501
2018	$1,161,024	$4,403,774
2019	$1,433,345	$4,668,713
2020	$1,589,793	$3,997,360
2021	$1,710,135	$4,183,495
2022	$1,838,985	$4,057,007
2023	$1,216,533	$4,090,765
2024	$599,171	$4,124,016
2025	$320,939	$2,644,684
2026	$179,353	$1,317,217
2027	$98,997	$701,536
2028	$54,296	$382,648
2029	$28,565	$208,304
2030	$14,113	$113,545
2031	$5,948	$59,610
2032	$1,260	$29,428
2033	$0	$12,413
2034	$0	$2,704
2035	$0	$0
2036	$0	$0

Sources: EIA, RESI

[210] Commonwealth of Pennsylvania Legislature, "Oil and Gas – Lease to Remove or Recover Act of July 20, 1979," 2.

For Garrett County, RESI used the production amounts calculated in Figures 47 and 48 to determine the potential royalties paid by producers for drilling in Garrett County under Scenarios 1 and 2, respectively. The royalty payment amounts are reported for each scenario in Figure 50.

Figure 50: Estimated Royalty Payments Made by Firms Drilling in Garrett County

Year	Scenario 1	Scenario 2
2017	$1,720,501	$8,602,507
2018	$4,710,674	$22,018,869
2019	$10,127,485	$26,168,444
2020	$10,351,518	$26,876,035
2021	$9,638,948	$30,759,793
2022	$8,734,644	$26,767,166
2023	$8,150,687	$23,639,728
2024	$8,285,283	$22,325,666
2025	$8,337,173	$23,218,113
2026	$6,206,058	$15,442,431
2027	$2,963,094	$7,515,478
2028	$1,587,204	$4,026,382
2029	$853,849	$2,180,602
2030	$466,148	$1,192,496
2031	$254,143	$638,059
2032	$134,945	$334,699
2033	$68,738	$168,545
2034	$30,870	$75,261
2035	$8,488	$16,977
2036	$0	$0

Sources: EIA, RESI

Despite the potential for royalty payments, it is unclear as to whom may receive royalty payments. Since mineral and surface rights are decoupled from land ownership in Maryland, it is feasible that a resident may own the surface rights, but a nonresident may own the mineral rights. Therefore, RESI didn't include royalty payments in the model as an increase to household income but did keep them in as part of the producer's costs for extraction.

A.2 Household Variables

Indirect methodology is often used to measure individuals' desire for economic change. Methods such as hedonic pricing analysis are often employed to seek out the underlying preference of buyers within a region for certain items given particular attributes. The following subsection outlines the use of hedonic pricing analysis in previous shale studies and the incorporation of data used in RESI's analysis.

Hedonic pricing analysis methodology was first employed by Rosen in 1974, where research looked at the potential implicit product differentiation in purely competitive markets.[211] A hedonic model assists in determining the implicit price associated with a good when an equation is created to determine the association of the good's price and corresponding attributes of the good.[212] With respect to home prices, a market considered to be competitive but highly differentiated, some researchers have established that hedonic models often yield more accurate reflections of the values associated with home attributes over the traditional OLS models.[213]

OLS models seek to draw direct relationships between home prices and tangible characteristics such as the number of bedrooms and bathrooms, for example. Hedonic pricing analyses seek to build on the OLS relationship by incorporating the valuations of individuals' tastes and preferences. These methods attempt to quantify a preference for a homebuyer to live close to work, or away from railroad tracks. These attributes may not be as easily quantifiable and require, in some instances, the use of spatial data analysis. Attributes may include quieter neighborhoods, better air quality, and/or better school districts.[214] These locational attributes have been noted to affect home prices, a phenomenon which may not be easily captured in property data or assessor records.[215]

Recent research in natural gas drilling has begun to bring focus to these underlying impacts through the use of hedonic pricing analysis. For example, Gopalakrishnan and Klaiber completed a study of home values in Washington County, Pennsylvania, and the effects attributed to drilling. In the study, Gopalakrishnan and Klaiber found that, using a locational variable such as distance from a well pad, home values declined by nearly 22 percent.[216] The researchers indicated that the valuation decline occurred when homes were located within three-quarters of a mile of an existing active well location and these homes were reliant upon

---

[211] Sherwin Rosen, "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition," *The Journal of Political Economy* 82 (1974): 1, http://www.jstor.org/stable/1830899.
[212] Ibid.
[213] Raymond Y.C. Tse, "Estimating Neighborhood Effects in House Prices: Towards a New Hedonic Model Approach," *Urban Studies* 39 (2002): 1165, DOI: 10.1080/00420980220135545.
[214] Ibid, 1166.
[215] Richard J. Cebula, "The Hedonic Pricing Model Applied to the Housing Market of the City of Savannah and Its Savannah Historic Landmark District," *The Review of Regional Studies* 39 (2009): 20, http://journal.srsa.org/ojs/index.php/RRS/article/download/182/137.
[216] Sathya Gopalakrishnan and H. Allen Klaiber, "Is the Shale Boom a Bust for Nearby Residents? Evidence from Housing Values in Pennsylvania," *American Journal of Agricultural Economics* 96 (2014): 4, DOI: 10.1093/ajae/aat065.

well water for their main water source.[217] However, the farther the distance a home was from the well pad, the less significant the impact became on home values.[218]

A 2012 study by Muehlenbachs, Spiller, and Timmins of the same county found home values for homes located near well sites and reliant on well water declined by 26.6 percent.[219] In a 2013 study, the authors analyzed property transactions from 36 counties in Pennsylvania and 7 counties in New York.[220] Similar to the findings from their study of one county, their findings indicated that properties relying on private drinking water wells were negatively affected by nearby shale gas wells whereas those properties that had access to piped water were positively affected. However, distance to the well matters—the negative effect for groundwater-dependent homes became greater the closer the well, and the positive effect for piped-water homes became smaller. For properties not in very close proximity to a well but in the general vicinity of a well (i.e., within 12 miles), property values are seen to increase.[221] Spatial parameters, such as distance from historical well locations, and other variables indicated to be statistically significant by current literature were the primary guides in data that RESI analyzed.

To create a hedonic model associated with the markup, or perceived change in home values associated with Marcellus Shale drilling, RESI used a combination of historical data and spatial analysis. Variables regarding housing attributes included the following:

- Number of stories,
- Number of bathrooms,
- Square footage of building,
- Construction quality of property,
- Year property was built,
- Finished square feet of the property,
- Presence of a garage on property, and
- Housing market value.

These data were collected from DataQuick Property Data. The dataset is a combination of historical assessor and recordation data for each county. RESI used the “housing market price”

[217] Gopalakrishnan and Klaiber, “Is the Shale Boom a Bust for Nearby Residents?,” 4.
[218] Ibid.
[219] Lucija Muehlenbachs, Elisheba Spiller, and Christopher Timmins, "Shale Gas Development and the Costs of Groundwater Contamination Risk," *Resources for the Future Discussion Paper* (2013): 29, http://www.rff.org/RFF/Documents/RFF-DP-12-40-REV.pdf.
[220] Ibid, 39.
[221] Ibid, 29.

variable as a dependent variable in the model. All of the remaining attributes were included as independent variables.

Using DataQuick Property Data and historical well locations, RESI extrapolated the current impacts associated with the wells in the region to determine the potential impacts of new well pads being constructed. In addition to the current and historical market values of the homes, RESI received data from the counties regarding public and well water services in each region.

The inclusion of well and public water service data acted as a variable to capture concerns regarding well water contamination from drilling activities among residents to determine if RESI's findings are consistent with those of prior research. [222]

Using GIS and the DataQuick Property Data, RESI established three dummy variables for homes located within a half mile, a mile, or two miles of a current well. These variables equal one (1) for homes located within a given distance of a current well and zero (0) otherwise.

RESI used the public and well water data to assist in the analysis, a dummy variable was created for this purpose. Under this dummy variable, the value would equal one (1) if the home was on well water and zero otherwise (0). Well water or public water dummy variables have been a key factor in decreasing the potential rise in home values near shale drilling locations in previous research.[223] [224] According to the existing literature discussed in Appendix A, declines in home value are more noticeable in homes using well water than public water. Using the follow equation, RESI worked to determine the potential loss to home values in each county due to Marcellus Shale drilling:

$$\begin{aligned}\log(home\ market\ value)_i &= \alpha_i + \beta_{1i}\log(land\_sqft) + \beta_{2i}\log(numberbaths) \\ &+ \beta_{3i}\log(numberstories) + \beta_{4i}\log(constructionquality) \\ &+ \beta_{5i}\log(yearbuilt) + \beta_{6i}waterdummy + \beta_{7i}wellhalfdummy \\ &+ \beta_{8i}wellonemiledummy + \beta_{9i}welltwomiledummy \\ &+ \beta_{10i}\log(finishedsqfeet) + \beta_{11i}\log(garage)\end{aligned}$$

[222] Muehlenbachs, Spiller, and Timmins, "Shale Gas Development and the Costs of Groundwater Contamination Risk," 27.
[223] Gopalakrishnan and Klaiber, "Is the Shale Boom a Bust for Nearby Residents?," 3.
[224] Muehlenbachs, Spiller, and Timmins, "Shale Gas Development and the Costs of Groundwater Contamination Risk," 29.

In the equation above, RESI uses the subscript i to represent the county where the home is located. Dummy variables are included within the regression to gauge the impacts from locational attributes, such as distance to an existing well or the home's water source, on the market value of the home in question, as shown below. The basis for comparison in the model above was whether or not homes were located more than two miles from a natural gas well and on well water.

$$waterdummy = 1\ if\ on\ public\ water, 0\ otherwise$$
$$wellhalfdummy = 1\ if\ well\ is\ located\ within\ a\ half\ mile, 0\ otherwise$$
$$welllonemiledummy = 1\ if\ well\ is\ located\ within\ a\ mile, 0\ otherwise$$
$$welltwomiledummy = 1\ if\ well\ is\ located\ within\ two\ miles, 0\ otherwise$$

The results of the above regression are reported in Figure 51.

Figure 51: Hedonic Housing Price Regression Analysis[225]

Variable	Allegany County		Garrett County	
	Beta Coefficient Estimate	Statistically Significant?[226]	Beta Coefficient Estimate	Statistically Significant?[227]
log(land_sqft)	0.32	Yes	0.37	Yes
log(numberbaths)	0.11	Yes	0.08	Yes
log(numberstories)	0.12	Yes	0.10	Yes
log(constructionquality)	0.87	Yes	0.83	Yes
log(yearbuilt)	6.50	Yes	5.84	Yes
Wellhalfdummy	-0.06	Yes	-0.03	Yes
Wellonemiledummy	-0.05	Yes	-0.02	Yes
Welltwomiledummy	0.04	Yes	0.03	Yes
log(finishedsqfeet)	0.29	Yes	0.27	Yes
log(garage)	0.11	Yes	0.08	Yes

Sources: Eviews, DataQuick, RESI, SAS

As indicated in **Error! Reference source not found.**3, nearly all the variables were statically significant at the 95 percent confidence level. **Error! Reference source not found.**3 indicates that those living

[225] The water dummy variable proved to be inconsistent with previous literature. After a review of the property data, RESI determined that the presence of public water homes near current well sites was few to none. Additionally, the data reported that there were more homes on well water near current or inactive well locations.
[226] Statistical significance is reported here at the 95 percent confidence level.
[227] Statistical significance is reported here at the 95 percent confidence level.

within a half mile to a mile of a current well experience some decline in property values—36 to 35 percent, respectively. Given the model's use of a log-log regression, the dummy impact multipliers are read as the following, where β is equal to the variables reported in Figure 51:

$$Difference\ between\ home\ values\ located\ within\ a\ half\ mile\ of\ a\ well\ and\ those\ not\ located\ within\ two\ miles\ of\ a\ well = 100 * e^{(\beta-1)}$$

Holding all other variables equal, the difference in valuation between a home that is more than two miles from a Marcellus well and one that is within a half-mile of a well can equal a loss of 7 to 9 percent. Meaning the home within a half-mile of the Marcellus well with the same attributes as the home located more than two miles away could have a property valuation eight percent less.

A.3 Willingness to Pay for Environment

Placing a dollar value on maintaining the status quo of scenic properties in an area is a difficult task. To determine stakeholder's WTP associated with conservation of such attractions, RESI conducted a survey, administered on site and on the web, in the region. RESI incorporated results from the survey within a contingent valuation analysis to determine the WTP to conserve the aesthetic beauty of the region.

The methodology of contingent valuation strives to determine a person's valuation of "goods" based on the attributes of the individual and his or her preferences. This method is often referred to as a "revealed preference method" since it takes information from an individual and assigns a dollar value based on a question such as "would you be willing to pay $X to offset this negative impact?" RESI assigned dollar values to nonmonetary attributes associated with environmental conservation based on characteristics and stated preferences obtained through its survey, as described in Appendix B, and determined the overall market's WTP for the environment of the counties.

In CV, a scenario indicating potentially negative impacts is described to the respondent, and users are then asked a series of questions regarding their preferred payment amounts and valuation of the region overall. Additional attributes about the individual, such as his or her age, sex, household income, preference for traveling, and use of the outdoor goods (parks, hiking trails, streams, lakes, etc.) are revealed through the survey portion of the methodology.

RESI's survey reached nearly 1,700 respondents. However, due to incomplete responses, this number was later revised down to 802 viable responses. More information regarding the procedures used to clean the data can be found in Appendix B.

To analyze the potential WTP to maintain the aesthetic beauty of the region, RESI then reviewed the data further for any discrepancies. This included exclusion of data points where

individuals stated that they were unemployed yet willing to pay a large sum into a conservation fund and where individuals reported an annual household income of fewer than $25,000. After further revision, RESI finalized its sample size to 641 surveys for the purpose of this analysis. The bid value frequencies are reported in Figure 52 below.

Figure 52: Willingness to Pay—Annual Bid Amount Frequencies

Annual Bid	Responses	Percentage
$10	73	11.4%
$40	75	11.7%
$70	16	2.5%
$100	115	17.9%
$140	9	1.4%
$160	56	8.7%
Not willing to pay	297	46.3%

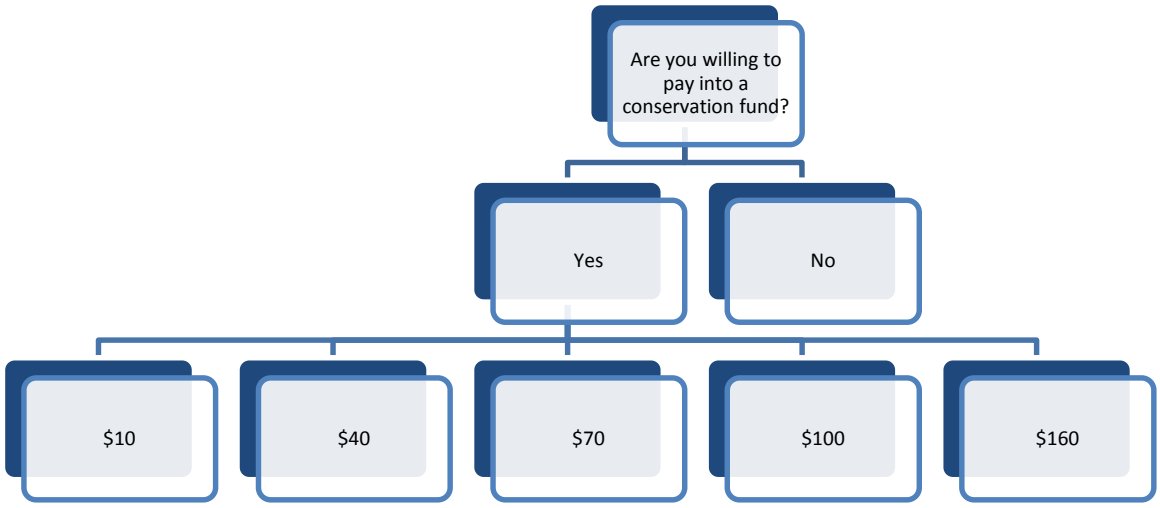
Sources: RESI, SAS

RESI found that approximately 46 percent of respondents stated that they were unwilling to pay into a conservation fund. Further analysis found that these individuals provided the following reasons:

- They were unable to pay that amount,
- They felt that the government should spend the funds elsewhere, or
- They felt that the production companies should pay the fees associated with offsetting the negative impacts from Marcellus Shale drilling.

Given the type of information gauged, the model can be viewed as a binary regression, or a nested model. A binary regression associates the variable being examined on only two responses, “yes” or “no,” and codes those responses as “1” or “0,” respectively. However, to gauge the revealed preference of maintain the scenic qualities in Western Maryland, RESI added a secondary level of analysis. The inclusion of a secondary level in the analysis changed the model into a nested Tobit model. A nested model means that the prior answer reflects the latter response. Figure 53 demonstrates the concept of a nested model.

Figure 53: Nesting within Economic Models



Source: RESI

Figure 53 demonstrates the nesting of the model through the question, "Are you willing to pay into a conservation fund?" RESI associated yes responses to those who gave a dollar value (where the values were randomly selected between $10 and $160 per year). A response of "no" or $0 was recorded and follow-up questions were asked to determine the reason an individual responded no.

To determine if the response of a survey participant was a true $0 bid, RESI conducted a series of follow-up questions. Using these questions, RESI examined potential protest bids associated with the scenario. Protest bids indicate individuals who may oppose the methodology through a nonresponse or a response of $0 despite having an underlying value for the object or policy in question.[228] Protest bids in the survey were considered to be those who felt the money should come from the drilling companies or respondents who felt the money should come from somewhere else. The remaining responses are classified for true $0 bids and examined as potential lower bounds within the analysis.

[228] Halstead, Luloff, and Stevens, "Protest Bidders in Contingent Valuation," *Northeastern Journal of Agricultural and Resource Economics* 2 (1992): 160–161.

To avoid potential self-selection bias, RESI treated protest bids using two methods: (1) dropping the bids based on additional survey responses/nonresponses and (2) keeping them in as true $0 bids for those who did not focus particularly on one extreme or another in other survey questions.[229] The inclusion of the $0 bid created the lower bound used in this analysis. Binary choice models, such as the one described in Figure 53, are often analyzed using a series of models such as Nested Logit, Multinomial Logit, and Tobit. These models allow the dependent variable—in this case WTP into a conservation fund—to take on a binary response of "0" or "1" to be analyzed. Furthermore, the secondary analysis will then take on a lower bound, often zero, and truncate the analysis to review only the results associated with those who stated that they were willing to pay into the fund.

RESI's model included independent variables such as the following:

- Age,
- Income,
- Educational attainment,
- Visits to parks/streams/lakes,
- Distance from Allegany or Garrett County,
- Place of residency,
- Whether respondents owned second homes in Western Maryland, and
- Whether the interview was conducted on-site or via the web.

This last variable was included because, according to researchers, the methodology of the delivery of the survey can alter the responses of interviewees.[230] Adding this variable was crucial in smoothing out any potential correlation within the data to the dependent variable. The value that the respondents were willing to pay was included within the model as well.

RESI used a variety of methods to determine results. RESI finally used a Tobit model and found that individuals' WTP for conservation of scenic areas in Western Maryland was $44.05 per year. More information regarding the results of additional analyses can be found in Appendix E of this report. The dollar value assignments based on the variables included within the model are reported in Figure 54. For more information on CVM or the survey, please refer to Appendix B of this report.

[229] Halstead, Luloff, and Stevens, "Protest Bidders in Contingent Valuation," 162.
[230] Christopher C. Leggett et al., "Social Desirability Bias in Contingent Valuation Surveys Administered Through In-Person Interviews," *Land Economics* 79 (2003): 574, DOI: 10.2307/3147300.

Figure 54: Willingness to Pay by Attribute

Bid	WTP
Distance	-$0.02
Frequency of Parks/Recreation	$4.87
Allegany Primary Residence	$2.87
Garrett Primary Residence	$8.19
In Person Interview	$6.41
Sex	-$1.98
Age (30-49 years old)	$4.89
Age (50-69 years old)	$3.88
Age (70 or older)	-$10.50
Education (high school diploma or less)	-$1.53
Education (Associate's Degree or some college)	$12.97
Education (Post Bachelor's Degree)	$17.99
Employed (full-time, part-time, or self)	-$11.56
Income (less than $50,000 per year)	-$5.86
Income (more than $75,001, less than $125,000)	$0.19
Income (greater than $125,000 per year)	$13.23

Sources: RESI, SAS

Using the WTP for conservation, housing price percentage changes from the hedonic model, the royalty payment estimates for increased household disposable income, and the industry sales calculated in this section, RESI calculated the impacts from Marcellus Shale drilling in Western Maryland at the 25 percent and 75 percent extraction levels. These impacts and a description of how all of the variables fit into the model can be found in Section 8.0 of this report.

A.3.1 Inclusion of Protest Bids

In response to Dr. Lipscomb as well as Dr. Schwarzmann from Maryland Department of the Environment, RESI addressed the decision regarding the inclusion of some protest bids. In the survey, RESI had two potential protest bid sections as follow-ups to the WTP question. If the participant indicated that they were unwilling to pay into a conservation fund, then they were provided with a set of reasons for why they did not wish to pay into the fund. One of the responses, "Conservation funding should be provided by the drilling and gas companies" was a choice. When analyzing the results, RESI found that nearly 72 percent of respondents had stated this reasoning when choosing zero as their WTP.

The inclusion of protest bids in contingent valuation has been highly debated. Halstead, Luloff, and Stevens concluded that the inclusion of protest bids may introduce some bias; however,

the exclusion of some bids may be more detrimental.[231] The exclusion of protest bids in cases where the respondent may have a valuation for the good but may also be strongly opinionated about the scenario may create a selection bias error. This error may pose a greater risk than the lesser bias introduced by inclusion.

Protest bidders can be included if, in some cases, discriminant analysis between the two groups for socioeconomic and demographic analysis fails to determine if a difference exists. RESI performed a similar analysis as Halstead, Luloff, and Stevens using a discriminant analysis function. The model produced the matrix shown in Figure 55.

Figure 55: Reclassification of Protest Bidders under Discriminate Analysis Function for WTP

Bidder	Protestor	Non-protestor
Protestor	169	98
Non-protestor	176	216

Sources: RESI, STATA

Under this analysis, the redistribution at the probability of .001 indicated to RESI that the difference between the two groups was potentially negligible. By not including the protest bidders, RESI would exclude 100 observations of protest bidders. The analysis indicates that, despite the respondents' answers, they do place a value on the resource and would wish to conserve it given the sociodemographic and economic characteristic similarities as those who responded as being willing to pay. Some protest bidders were then included within the model but valued as a "true zero." A "true zero" bid is someone who stated that they would not pay into a conservation fund for reasons ranging from not believing drilling would impact the environment to being unable to pay into the fund. The inclusion of the protest bidders in RESI's analysis may create a more conservative WTP estimate, but it captures those who most likely value the Western Maryland environment.

A.3.2 Turnbull Lower Bound Estimator

Upon reviewer suggestion, RESI dropped some estimates and reviewed the model using a Turnbull Lower Bound estimator. Using a Turnbull Lower Bound estimator, a researcher can run analysis with minor to no restrictive assumptions regarding preferences. Carson contests the use of Turnbull Lower Bound estimators due to the potential to be sensitive to the "choice of

[231] Halstead, Luloff, and Stevens, "Protest Bidders in Contingent Valuation," 155.

the dollar amounts used."[232] However, based on reviewer feedback, RESI ran a Turnbull Lower Bound estimator for the contingent valuation model described in Appendix C of this report.

Under this analysis, RESI's results yielded an approximately $12 decline in WTP for the conservation fund. Under the Turnbull Lower Bound Estimate, RESI estimated the WTP of individuals to be approximately $32. To determine the impact this dollar amount would have on the analysis, RESI reran the REMI PI+ model at the lower WTP amount. Under the trial runs, RESI found that the change in dollar amount yielded only a .1 change in employment on average during the twenty-year drilling period.

RESI reran the Turnbull Lower Bound Estimate for all scenarios within each county to determine if economic impacts did change. Changes in economic impacts were negligible, adding between -0.3 to 0.5 additional jobs and very minimal amounts to wages and output in some instances. Given the low change in economic impacts associated with the additional runs for each county, RESI determined that the Tobit-estimated WTP of $44.05 is a valid estimate for individuals' WTP to conserve.

[232] Richard T. Carson, *Valuing Oil Spill Prevention: A Case Study of California's Central Coast* (Netherlands: Kluwer Academic Publishers, 2004), 225.

A.4 Summary of Input Variables

Figure 56: Inputs for Allegany County—Scenario 1, 25% Extraction

Year	Industry Sales	Increased Production Cost from Royalty Payments	Total Housing Valuation Change[233]	Environmental Tax to Offset Drilling Impacts
2017	$4,588,004	$573,500	-$80,905,520	$3,234,924
2018	$9,288,195	$1,161,024	-$80,905,520	$3,234,924
2019	$11,466,760	$1,433,345	-$80,905,520	$3,234,924
2020	$12,718,342	$1,589,793	-$80,905,520	$3,234,924
2021	$13,681,077	$1,710,135	-$84,950,796	$3,234,924
2022	$14,711,883	$1,838,985	-$84,950,796	$3,234,924
2023	$9,732,260	$1,216,533	-$84,950,796	$3,234,924
2024	$4,793,365	$599,171	-$84,950,796	$3,234,924
2025	$2,567,513	$320,939	-$84,950,796	$3,234,924
2026	$1,434,825	$179,353	-$84,950,796	$3,234,924
2027	$791,972	$98,997	-$84,950,796	$3,234,924
2028	$434,366	$54,296	-$84,950,796	$3,234,924
2029	$228,522	$28,565	-$84,950,796	$3,234,924
2030	$112,903	$14,113	-$84,950,796	$3,234,924
2031	$47,588	$5,948	-$84,950,796	$3,234,924
2032	$10,082	$1,260	-$84,950,796	$3,234,924
2033	$0	$0	-$84,950,796	$0
2034	$0	$0	-$84,950,796	$0
2035	$0	$0	-$84,950,796	$0
2036	$0	$0	-$84,950,796	$0

Source: RESI

[233] The valuation used over time is an average percentage based on the total households impacted over the total households within the region proportional to the base stock of households.

Figure 57: Inputs for Allegany County—Scenario 2, 75% Extraction

Year	Industry Sales	Increased Production Cost from Royalty Payments	Total Housing Valuation Change[234]	Environmental Tax to Offset Drilling Impacts
2017	$13,764,011	$1,720,501	-$80,905,520	$3,234,924
2018	$35,230,190	$4,403,774	-$84,950,796	$3,234,924
2019	$37,349,706	$4,668,713	-$88,996,072	$3,234,924
2020	$31,978,876	$3,997,360	-$88,996,072	$3,234,924
2021	$33,467,958	$4,183,495	-$88,996,072	$3,234,924
2022	$32,456,055	$4,057,007	-$93,041,348	$3,234,924
2023	$32,726,121	$4,090,765	-$93,041,348	$3,234,924
2024	$32,992,127	$4,124,016	-$93,041,348	$3,234,924
2025	$21,157,468	$2,644,684	-$93,041,348	$3,234,924
2026	$10,537,732	$1,317,217	-$93,041,348	$3,234,924
2027	$5,612,290	$701,536	-$93,041,348	$3,234,924
2028	$3,061,186	$382,648	-$93,041,348	$3,234,924
2029	$1,666,429	$208,304	-$93,041,348	$3,234,924
2030	$908,358	$113,545	-$93,041,348	$3,234,924
2031	$476,878	$59,610	-$93,041,348	$3,234,924
2032	$235,423	$29,428	-$93,041,348	$3,234,924
2033	$99,306	$12,413	-$93,041,348	$3,234,924
2034	$21,633	$2,704	-$93,041,348	$3,234,924
2035	$0	$0	-$93,041,348	$0
2036	$0	$0	-$93,041,348	$0

Source: RESI

[234] The valuation used over time is an average percentage based on the total households impacted over the total households within the region proportional to the base stock of households.

Figure 58: Inputs for Garrett County—Scenario 1, 25% Extraction

Year	Industry Sales	Increased Production Cost from Royalty Payments	Total Housing Valuation Change[235]	Environmental Tax to Offset Drilling Impacts
2017	$13,764,011	$1,720,501	-$147,838,917	$1,324,268
2018	$37,685,392	$4,710,674	-$154,266,696	$1,324,268
2019	$81,019,883	$10,127,485	-$157,480,586	$1,324,268
2020	$82,812,144	$10,351,518	-$160,694,475	$1,324,268
2021	$77,111,584	$9,638,948	-$160,694,475	$1,324,268
2022	$69,877,153	$8,734,644	-$160,694,475	$1,324,268
2023	$65,205,495	$8,150,687	-$163,908,365	$1,324,268
2024	$66,282,261	$8,285,283	-$163,908,365	$1,324,268
2025	$66,697,387	$8,337,173	-$163,908,365	$1,324,268
2026	$49,648,464	$6,206,058	-$163,908,365	$1,324,268
2027	$23,704,755	$2,963,094	-$163,908,365	$1,324,268
2028	$12,697,629	$1,587,204	-$163,908,365	$1,324,268
2029	$6,830,795	$853,849	-$163,908,365	$1,324,268
2030	$3,729,183	$466,148	-$163,908,365	$1,324,268
2031	$2,033,143	$254,143	-$163,908,365	$1,324,268
2032	$1,079,563	$134,945	-$163,908,365	$1,324,268
2033	$549,908	$68,738	-$163,908,365	$1,324,268
2034	$246,961	$30,870	-$163,908,365	$1,324,268
2035	$67,907	$8,488	-$163,908,365	$1,324,268
2036	$0	$0	-$163,908,365	$0

Source: RESI

[235] The valuation used over time is an average percentage based on the total households impacted over the total households within the region proportional to the base stock of households.

Figure 59: Inputs for Garrett County—Scenario 2, 75% Extraction

Year	Industry Sales	Increased Production Cost from Royalty Payments	Total Housing Valuation Change[236]	Environmental Tax to Offset Drilling Impacts
2017	$68,820,056	$8,602,507	-$163,908,365	$1,324,268
2018	$176,150,949	$22,018,869	-$176,763,923	$1,324,268
2019	$209,347,550	$26,168,444	-$183,191,702	$1,324,268
2020	$215,008,277	$26,876,035	-$186,405,591	$1,324,268
2021	$246,078,341	$30,759,793	-$186,405,591	$1,324,268
2022	$214,137,330	$26,767,166	-$189,619,481	$1,324,268
2023	$189,117,822	$23,639,728	-$189,619,481	$1,324,268
2024	$178,605,327	$22,325,666	-$189,619,481	$1,324,268
2025	$185,744,906	$23,218,113	-$189,619,481	$1,324,268
2026	$123,539,449	$15,442,431	-$189,619,481	$1,324,268
2027	$60,123,821	$7,515,478	-$189,619,481	$1,324,268
2028	$32,211,058	$4,026,382	-$189,619,481	$1,324,268
2029	$17,444,818	$2,180,602	-$189,619,481	$1,324,268
2030	$9,539,968	$1,192,496	-$189,619,481	$1,324,268
2031	$5,104,475	$638,059	-$189,619,481	$1,324,268
2032	$2,677,589	$334,699	-$189,619,481	$1,324,268
2033	$1,348,357	$168,545	-$189,619,481	$1,324,268
2034	$602,087	$75,261	-$189,619,481	$1,324,268
2035	$135,814	$16,977	-$189,619,481	$1,324,268
2036	$0	$0	-$189,619,481	$0

Source: EIA, RESI

[236] The valuation used over time is an average percentage based on the total households impacted over the total households within the region proportional to the base stock of households.

Appendix B—Contingent Valuation Analysis

B.1 Survey Background

RESI employed two survey methods (on-site and web) to generate survey data. Both survey methods included the same questions; only the survey administration method varied. Survey participation was random through online and in-person interviews. This sample was not intended to be representative of the populations of Allegany or Garrett Counties or the state as responses were expected from outside Western Maryland.

On-site responses were collected at six locations in Allegany and Garrett Counties. RESI conducted surveys on Wednesday, August 14, 2013, and Thursday, August 15, 2013, at the following locations:

- Oakland Farmers Market,
- Cumberland Farmers Market,
- Wisp Outdoor Adventure Park,
- Garrett 8 Cinemas,
- SHOP 'n' SAVE Fresh in McHenry, and
- Swallows Falls State Park.

RESI gathered web data through the administration of an online survey. The web survey was available through the Garrett County Website[237] and promoted through the following:

- Garrett County's Twitter page;
- Garrett County's Facebook page;
- Garrett County Economic Development's Twitter page;
- GCED's Facebook page;
- GCED's LinkedIn page; and
- GCED's website, including
    - "News" page,
    - "Marcellus Shale" page, and
    - "Agriculture in the News" page.

The responses from the survey were organized according to residence status: Garrett County residents, Allegany County residents, and those residing in neither county (nonresidents). The survey had several aims:

1. To assist in engaging residents of Allegany and Garrett Counties in regard to the effects of natural gas drilling in their communities.

[237] The survey link, which is now closed, was http://resisurvey.resiusa.org/surveydata/ContingentValuation.htm.

2. To provide residents with an opportunity to voice their opinions on the ramifications of natural gas exploration.
3. To provide nonresidents with an opportunity to voice their opinions on natural gas drilling.
4. To help Maryland legislators make informed decisions about the future of natural gas exploration within the state, including current stakeholder perception of the region.

RESI analyzed survey responses to estimate the WTP for environmental protection. Responses relevant to the WTP for the purpose of conserving the aesthetic of the region from the survey respondents were used in a Tobit model to generate an estimate of the change in spending (elasticity) related to environmental amenities given the level of drilling in an area.

Survey findings are presented in figures in Appendix C. For each survey question and its corresponding figure, RESI discusses the findings and includes any conclusions that can be drawn from the data. RESI used the survey findings to complete a community impact analysis as well as an economic and fiscal impact analysis.

B.2 Survey Development

Prior to developing the survey, RESI performed extensive research on CVM and other survey development methods to best measure the perceived value of environmental goods.

B.2.1 Contingent Valuation Method

CVM is a proven scientific technique used to determine the WTP for a "public" good, or a good that is not bought and sold in the marketplace.[238] Environmental quality is one such good. CVM requires direct questioning of the public via survey on the value they are willing to pay in regard to specific environmental items; the amount is contingent on a hypothetical scenario.[239] Simply put, the CVM estimates the economic values that people place on the ecosystem and the environment.[240] It is also common for a CVM to ask people to identify the compensation, or willingness to accept pricing, that would be necessary for them to "give up specific environmental services." [241]

---

[238] Robert Cameron Mitchell and Richard T. Carson, "Using Surveys to Value Public Goods: The Contingent Value Method," *Resources for the Future* (1989): 2, accessed July 10, 2013, http://econweb.ucsd.edu/~rcarson/papers/UsingSurveysToValuePublicGoods.pdf.
[239] "Methods, Section 6: Contingent Valuation Method," in *Ecosystem Valuation*, accessed February 13, 2014, http://www.ecosystemvaluation.org/contingent_valuation.htm.
[240] Ibid.
[241] Ibid.

RESI sought to measure the value residents and nonresidents of Allegany and Garrett Counties are willing to pay to avoid potential environmental damage associated with shale-based oil exploration and extraction. Responses provided inputs for the valuation of streams, parks, scenic viewsheds, rental rates, and individuals' expectations should drilling take place.

B.2.2 Developing Survey Questions

To develop questions specific to its needs, RESI conducted a review of existing surveys for contingent valuation. RESI researched and reviewed several studies to design a survey that elicited responses to questions relevant to the current trends associated with environmental and recreational amenity enjoyment in Allegany and Garrett Counties.

CVM contains two parts: surveying and analysis. The use of surveying for contingent valuation has been employed by many researchers to determine the WTP for other environmental recreation or goods. Through the review of the methods used by other researchers, RESI determined the appropriate measures for WTP in the hypothetical scenario.

A Duke University study, "CV to Estimate the Value of Forest Ecosystem Protection," determined that respondents' WTP for forest ecosystem protection ranged from $8 to $120 per year in higher taxes.[242] Respondents to a survey developed by University of Maryland doctoral candidate Danielle Schwarzmann were given two annual values, $40 and $60, to determine WTP for stream restoration in the Chesapeake Bay Watershed.[243] In another study, on damages related to the Exxon Valdez Oil Spill, participants were asked to pay a one-time federal tax to protect another oil spill from occurring, and the WTP dollar amount ranged from $10 to $120.[244] A Bucknell University study estimated individuals' WTP at $10.46 per month (or approximately $125 per year) to eliminate environmental damages associated with Marcellus Shale drilling.[245]

---

[242] Michelle Haefele, Thomas P. Holmes, and Randall A. Kramer, "Using Contingent Valuation to Estimate the Value of Forest Ecosystem Protection," 5, accessed July 10, 2013, http://fds.duke.edu/db/attachment/405.
[243] Danielle Nicole Schwarzmann, "The Environmental and Economic Benefits of Stream Restoration: An Application to Stream Restoration in Maryland," Dissertation, University of Maryland (2013): 221–222, accessed July 10, 2013, http://gradworks.umi.com/35/63/3563371.html.
[244] Richard T. Carson et al., "Contingent Valuation and Lost Passive Use: Damages from the Exxon Valdez Oil Spill," *Environmental and Resource Economics* 25 (March 31, 2003): 269, accessed July 10, 2013, http://are.berkeley.edu/~gh082644/Exxon%20Valdez%20Oil%20Spill.pdf.
[245] Paula Bernstein, Thomas C. Kinnaman, and Mengqi Wu, "Estimating Willingness to Pay for River Amenities and Safety Measures Associated with Shale Gas Extraction," Bucknell University (September 16, 2010): 29, accessed July 10, 2013, http://digitalcommons.bucknell.edu/cgi/viewcontent.cgi?article=1001&context=fac_pubs.

Following a thorough literature review process, RESI developed questions to determine residents' and nonresidents' WTP to protect environmental amenities and recreational attractions from potential Marcellus Shale drilling. RESI enhanced the survey questions through evaluation by a sample respondent group comprising other team members.

To ensure that the survey questions and design were rigorously reviewed, RESI expanded its review process before releasing the survey to the public. The proposed survey was reviewed by Dr. Danielle Schwarzmann, an economist with experience with contingent valuation surveys as well as members of the Marcellus Shale Safe Drilling Initiative Advisory Commission. RESI sought feedback regarding clarity, logic, and format. All comments and edits deemed to be relevant and that maintained the contigent valuation methodology and scope of the project were incorporated, and the survey was finalized. The survey question as well as the survey results can be found in Appendix D of this report.

Appendix C—Survey Questions and Results

This appendix details the results from the 2013 Marcellus Shale Survey.

C.1 Survey Questions

Part A: Background

Numerous state parks and other outdoor activities have led to a strong tourism industry in Western Maryland, which includes Garrett and Allegany Counties. Specifically, Garrett County contains over 76,000 acres of parks, lakes, waterfalls, and publicly accessible forestland.

1. How often do you participate in outdoor recreation activities in parks and other major outdoor attractions in Garrett and Allegany Counties such as Deep Creek, Swallow Falls State Park, Rocky Gap State Park, and Wisp Mountain Resort? *Please choose one answer from the following:*
    a. Nearly everyday
    b. Once a week
    c. Once a month
    d. A few times a year
    e. Once a year
    f. Never
    g. Other Amount_____

2. How often do you recreate in local trails, streams, and woodlands in Garrett and Allegany Counties? *Please choose one answer from the following:*
    a. Nearly everyday
    b. Once a week
    c. Once a month
    d. A few times a year
    e. Once a year
    f. Never
    g. Other Amount_____

3. What is the main activity you participate in at the above locations? Please choose one answer from the following: *(If answered "Never" to **both** questions #1 and #2 skip to question #5)* Camping
    a. Hiking
    b. Hunting
    c. Swimming
    d. Boating
    e. Fishing
    f. Bird watching
    g. Winter sports

h. Other_____

4. When planning a day trip, what is the furthest distance **one way** (in miles) that you are willing to drive to participate in the previous activities? *Please give a value.*

   _____

5. Please rank the following from most to least important. (From 1= most important, 2= moderately important, 3 = least important)
   a. Scenic quality_____
   b. Abundant wildlife_____
   c. Clean lakes and waterways_____

Part B: Residence

6. What is the zip-code of your home? _____

7. Do you live in…
   a. Allegany County
   b. Garrett County
   c. Neither (*If selected "Neither," skip to question #11*)

8. Would you describe the location of your home as…?
   _____Urban, _____Suburban, or _____Rural

9. Do you rent or own your home?
   a. Rent
   b. Own *(If selected "Own," skip to question #11)*
   c. Other *(If selected "Other," skip to question #11*
      (Explain_____)

10. If you answered "Rent" to **question #9**, is it considered a(n)…
    a. Apartment or Condo
       i. What is your rent per month?
          1. $0-$500
          2. $500-$1,000
          3. $1,001-$1,500
          4. $1,501-$2,000
          5. $2,001+
    b. Single-family house
       i. What is your rent per month?
          1. $0-$500
          2. $500-$1,000

3. $1,001-$1,500
4. $1,501-$2,000
5. $2,001+

11. If you have a **second home**, what is the zip-code? *(If respondent does not have a second home, skip to Part C on page 4)* _____

12. Is your **second home** in…
    a. Allegany County
    b. Garrett County
    c. Neither *(If selected "Neither" skip to Part C on page 4)*

13. Would you describe the location of your **second home** as…?
    _____Urban, _____Suburban, or _____Rural

14. Do you rent or own your **second home**?
    a. Rent
    b. Own *(If selected "Own," skip to Part C on page 4)*
    c. Other *(If selected "Other," skip to Part C on page 4)*
    (Explain_____)

15. If you rent your second home, is it considered a(n)…
    a. Vacation rental
    b. Apartment or Condo
        i. What is your rent per month?
            1. $0-$500
            2. $500-$1,000
            3. $1,001-$1,500
            4. $1,501-$2,000
            5. Over $2,000
    c. Single-Family House
        i. What is your rent per month?
            1. $0-$500
            2. $500-$1,000
            3. $1,001-$1,500
            4. $1,501-$2,000
            5. Over $2,000

Part C: Hypothetical Scenario

In Pennsylvania and West Virginia, Marcellus Shale drilling has become a source of natural gas and contributed to economic growth and new jobs in those regions. If exploration of the

Marcellus Shale is permitted in Maryland, the same could occur here. However, exploring for natural gas may cause negative impacts to the environment, including effects on the scenic, wildlife and water quality.

Suppose Maryland were considering creating a conservation fund, paid by all households through additional annual property taxes, to protect against potential environmental damages from shale natural gas drilling in Allegany and Garrett Counties.

16. How much would you be willing to pay annually into the conservation fund to protect against potential environmental damages from drilling? *Please choose one answer from the following:*
    a. $10 per year *(Skip to question #18)*
    b. $40 per year *(Skip to question #18)*
    c. $70 per year *(Skip to question #18)*
    d. $100 per year *(Skip to question #18)*
    e. $130 per year *(Skip to question #18)*
    f. $160 per year *(Skip to question #18)*
    g. Nothing at all *(If selected "Nothing at all," answer question #17)*

17. *If you answered "Nothing at all" to the previous question, please indicate why you would not support this conservation fund.*
    a. I don't believe drilling will have any substantial effect on the environment
    b. I can't afford to pay any additional taxes
    c. Funding should be on a voluntary basis or through charities
    d. Conservation funding should be provided by the drilling and gas companies
    e. Conservation funding should come from existing government tax revenues
    f. There are more important uses of public funds

18. How important to you is the preservation of the environmental quality of parks, lakes, streams, and forestland. (From 1 to 5 with 1 = not at all important, 2 = slightly important, 3 = moderately important, 4 = very important, 5 = extremely important)
    a. 1 2 3 4 5

19. Rank the following three at-risk environmental resources by how threatened you believed them to be from drilling activity, if it occurred? (1 = most threatened, 2 = moderately threatened, 3 = threatened)
    a. Scenic quality_____
    b. Abundant wildlife _____
    c. Clean lakes and waterways_____

20. Do you own **land** in Garrett or Allegany Counties?
    _____Yes _____No *(If selected "No," skip to question #24)*

21. What is the approximate acreage of land your own in Garrett or Allegany Counties?
    _____acre(s)

22. Suppose you could lease your land for natural gas drilling. What would you do?
    a. Definitely lease it
    b. Probably lease it
    c. Not sure
    d. Probably not lease it
    e. Definitely not lease it (*If selected "Definitely not lease it," skip to question #24*)

23. What is the minimum value you would accept for a lease of your land per acre/year?
    a. Below $100 per year
    b. At least $100 per year
    c. At least $500 per year
    d. At least $1,000 per year
    e. At least $3,000 per year
    f. At least $5,000 per year

24. How informed are you on the benefits and concerns of natural gas exploration in shale formations?
    From 1 to 5 with 1 = not at all informed, 2 = slightly informed, 3 = moderately informed, 4 = very informed, 5 = extremely informed)
    a. 1 2 3 4 5

25. Suppose you were considering moving to a new home within the next 12 months. Would the presence of natural gas deter you from moving to a residence within Allegany or Garrett County?
    a. Yes
    b. No

Part D: Demographics

26. Gender
    _____Male _____Female

27. What is your age? *(Show respondent ranges)*
    a. 18–29 years old
    b. 30–39 years old

c. 40–49 years old
d. 50–59 years old
e. 60–69 years old
f. 70–79 years old
g. 80 years or older

28. What is the highest level of education you have completed?
    a. _____Some high school
    b. _____High school diploma or GED
    c. _____Some College
    d. _____Associate's degree
    e. _____Bachelor's degree
    f. _____Post-Baccalaureate degree

29. Which best describes your employment situation in the past 12 months?
    a. _____Employed, full-time
    b. _____Employed, part-time
    c. _____Self-employed
    d. _____Unemployed
    e. _____Retired
    f. _____Student
    g. _____Stay at home parental guardian
30. Which best fits your household income for the past 12 months?
    a. _____Under $10,000
    b. _____$10,001–$25,000
    c. _____$25,001–$50,000
    d. _____$50,001–$75,000
    e. _____$75,001–$100,000
    f. _____$100,001–$125,000
    g. _____$125,001–$150,000
    h. _____$150,001–$200,000
    i. _____Over $200,000

C.2 Survey Analysis

C.2.1 Quality Control

A total of 1,699 surveys (1,541 web surveys and 158 on-site surveys) were submitted. Over half of the responses that were submitted via the web survey, or 896 surveys, were either answered incompletely or did not contain responses to any of the thirty-questions. A total of 865 surveys were completely unanswered, while 31 were incomplete beyond analysis. As a result, RESI analyzed a total of 802 viable surveys.

Surveys that did not contain a single a response were eliminated and not incorporated into RESI's analysis. Surveys that were incomplete were assessed to determine whether or not they could be utilized for the analysis. Incomplete surveys were deemed viable if they contained information on the respondent's place of residence and/or demographics and if they included responses to the majority of the questions in "Part C: Hypothetical Scenario."

In some cases, the surveys contained responses that were converted into numerical values for analysis purposes. Survey responses that could be extrapolated were kept and included within the initial viable response records. For example, question four (4) asked for the total mileage that the respondent was willing to drive for a day trip. Some respondents provided the number of hours that they were willing to travel rather than the number of miles.[246]

RESI also reviewed the zip codes provided for place of residence and cross-referenced with whether the respondent indicated that they resided in Allegany or Garrett Counties. There were several instances where residents of Allegheny County, Pennsylvania, indicated that they were residents of Allegany County in response to question seven (7), which asked respondents to indicate whether they resided in Allegany County, Garrett County, or neither. RESI adjusted for this based on the provided zip codes.

C.2.2 Additional Cleaning for Contingent Valuation Analysis

RESI used the CVM to determine the WTP of individuals to preserve the environment of Allegany and Garrett Counties. Prior to running the nested model used for the analysis, RESI first determined the level of potential bias within the data.[247] First, RESI determined the independent and dependent variables. Question 16 in the survey was used as the dependent variable, and additional questions created the list of independent variables or attributes. The following questions were included into the model as independent variables:

- Question 1, respondent's participation in outdoor activities;
- Question 4, farthest distance respondent was willing to drive to participate in outdoor activities;
- Question 7, respondent's residency;
- Question 11, whether or not respondent owned a second home;
- Question 12, location of respondent's second home, if applicable;
- Question 18, importance of preservation;

[246] RESI assumed travel at 65 miles per hour to convert the number of hours provided into mileage.
[247] Nancy E. Bockstael and Kenneth E. McConnell, *Environmental and Resource Valuation with Revealed Preferences: A Theoretical Guide to Empirical Models.* (Netherlands: Springer, 2007), 118–119.

- Question 24, whether or not respondent was informed on the benefits and concerns associated with natural gas drilling;
- Question 26, gender of respondent;
- Question 27, age range of respondent;
- Question 28, highest educational attainment of respondent;
- Question 29, employment status of respondent; and
- Question 30, household income of respondent.

To determine the level of potential bias, RESI ran a correlation analysis to determine if any of the variables in the model were highly correlated with the dependent variable as well as if there may have been any potential for variables correlated with one another, which could present additional bias. RESI found a significant bias in WTP with those who stated that they were informed (Question 24) and those who owned a second home in either Allegany County or Garrett County.

To correct for this bias, RESI reviewed the data for a few factors. RESI looked at the WTP versus employment status. Individuals who were unemployed and willing to pay $160 into a conservation fund were considered potentially biased. RESI reviewed these respondents for their age ranges to determine if these respondents were possibly retired or if they were married and therefore possibly had a higher household income. RESI used factors such as these to determine if the responses were biased. RESI reviewed other questions including residency and participation in outdoor recreation. RESI dropped responses that appeared biased (26 responses) from the overall sample. Additionally, those who stated that they were very informed and responded to Question 24 with a WTP of $0 were reviewed for a potential protest bid.

Protest bids are reported WTPs that are not necessarily zero. These individuals may state that they have a WTP of zero because they do not agree with the methodology or the survey instrument.[248] There are typically a few methods to resolve this, including either dropping the protest bids or including them but creating more conservative estimates within the analysis. Question 17 of the survey was used to determine the potential protest bids. If individuals answered that "Conservation funding should come from existing government revenues," then RESI dropped these individuals from the sample as they exhibited disagreement with the method of payment for offsetting potential externalities associated with drilling.

[248] John M. Halstead, A.E. Luloff, and Thomas H. Stevens, "Protest Bidders in Contingent Valuation," *Northeast Journal of Agricultural Economics* 2 (1992): 163, http://purl.umn.edu/29000.

However, in some cases, there was reason for the inclusion of the protest bids associated with those respondents who indicated that "Conservation funding should be provided by the drilling and gas companies," which allowed for some minimal bias. Traditionally, these bids would be dropped from the analysis, but recent literature has suggested that the exclusion of these bids may introduce significant selection bias within the model.[249] However, if a discriminant analysis for demographics regarding the groups protesting versus those who are willing to pay is conducted, it is possible to determine a set that can be included within the sample with minimal bias.[250] When running the two groups together, if analysis cannot differentiate statistically between the two groups, it is possible that the protest bidders may not be adequately registering a true "zero" bid and therefore may value the resource.[251]

Using additional econometric techniques such as treating some protest bids as "true zero bids" and dropping only those that could be classified as "true protest bids", some of the potential bias may be mitigated.[252] Protest bidders have been included in analysis by agencies such as the USDA Forest Service.[253] The inclusion of the protest bids did produce a more conservative estimate in the study.[254]

Econometricians have used techniques to mitigate and minimize the potential for bias within a model for several decades. When there is a potential for bias within a model, economists will often look for additional instrument variables that are not correlated with the dependent variable but are correlated with some of the omitted variables or those who are protest bidders.[255] RESI decided to include the variables *second_home* and *in-person* to smooth some of the bias out of the model. In-person interviews are a known method of mitigating the potential bias within a sample set since literature in sociology has suggested respondents answer differently in person than online.[256]

After RESI further cleaned the variables for bias, a sample size of 641 responses remained within the analysis. RESI ran another correlation analysis, and the results determined that there was no serial correlation within the model.

---

[249] Halstead, Luloff, and Stevens, "Protest Bidders in Contingent Valuation," 162.
[250] Ibid, 164.
[251] Ibid, 167.
[252] Ibid, 168.
[253] J.M. Bowker et al., "Estimating the Economic Value of Lethal Versus Nonlethal Deer Control in Suburban Communities," *Society and Natural Resources* 16 (2003): 143–158, DOI: 10.1080/08941920390174256.
[254] Ibid, 155.
[255] William H. Greene, *Econometric Analysis* (New York: Pearson, 2008), 245.
[256] Halstead, Luloff, and Stevens, "Protest Bidders in Contingent Valuation," 161.

C.3 Survey Responses

Of the 802 viable surveys, 645 surveys were completed via the web survey, while 157 were completed on site at locations in Garrett and Allegany Counties.[257] Of the 802 viable surveys, 139 were completed by Allegany County residents, 279 were completed by Garrett County residents, and 379 were completed by respondents who indicated that they reside in neither Allegany County nor Garrett County. Several respondents provided neither their place of residence nor their zip code. Therefore, totals throughout the report may not add up exactly.

Figure 60: How often do you participate in outdoor recreation activities in parks and other major outdoor attractions in Garrett and Allegany Counties such as Deep Creek Lake, Swallow Falls State Park, Rocky Gap State Park, and Wisp Mountain Resort?

	All		Allegany		Garrett		Neither[258]	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Nearly everyday	127	16%	20	14%	87	31%	18	5%
Once a week	173	22%	38	27%	74	27%	60	16%
Once a month	145	18%	28	20%	51	18%	66	17%
A few times a year	201	25%	29	21%	49	18%	121	32%
Once a year	81	10%	11	8%	8	3%	62	16%
Never	52	6%	9	6%	7	3%	36	9%
Other amount	23	3%	4	3%	3	1%	16	4%
Total	**802**		**139**		**279**		**379**	

Source: RESI

The plurality of all survey respondents, or 25 percent, stated that they participated in outdoor recreational activities in Garrett and Allegany Counties a few times a year. Most often, respondents from Allegany County, 27 percent, indicated that they participate in outdoor activities once a week, while respondents from Garrett County, 31 percent, most often indicated that they participate in outdoor recreational activities nearly every day. Those respondents who reside in neither county, 32 percent, most frequently indicated that they participate in outdoor activities only a few times a year. Garrett County residents were more likely to participate in outdoor activities at a higher regularity than Allegany County residents or those respondents who reside in neither of the two counties.

[257] More surveys were received via the web survey. However, upon review, RESI found that they were mostly incomplete and unusable in the analysis.

[258] "Neither" refers to nonresidents of both Allegany and Garrett Counties.

A small portion of respondents indicated that they participate in outdoor recreational activities some "other amount." Those respondents who indicated that they participate in outdoor recreation with "other amount," provided responses such as the following:

- "As often as possible,"
- "Only occasionally,"
- "Not in recent years," and
- "I am a resident."

Figure 61: How often do you recreate in local trails, streams, and woodlands in Garrett and Allegany Counties?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Nearly everyday	151	19%	36	26%	92	33%	21	6%
Once a week	186	23%	41	29%	81	29%	63	17%
Once a month	127	16%	22	16%	34	12%	71	19%
A few times a year	185	23%	18	13%	56	20%	110	29%
Once a year	65	8%	9	6%	7	3%	48	13%
Never	69	9%	12	9%	7	3%	50	13%
Other amount	19	2%	1	1%	2	1%	16	4%
Total	**802**		**139**		**279**		**379**	

Source: RESI

A plurality of respondents, or 23 percent, indicated that they recreated in local trails, streams, and woodlands in Garrett and Allegany Counties either once a week or only a few times a year. Respondents residing in Allegany County most often indicated, at 29 percent, that they recreate in the outdoors once a week, while respondents residing in Garrett County most often, at 33 percent, indicated that they recreate in the outdoors nearly every day. Those respondents residing in neither county most often, at 29 percent, indicated that they recreate in local trails, streams, and woodlands only a few times a year.

Those respondents who indicated that they recreate in local trails, streams, and woodlands with "other amount," provided responses such as the following:

- "As often as possible,"
- "Every few years,"
- "Not in recent years," and
- "I am a resident."

Figure 62: What is the main activity you participate in at the above locations?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
I don't visit any of the above locations	38	5%	2	1%	4	1%	32	8%
Camping	34	4%	7	5%	4	1%	23	6%
Hiking	320	40%	69	51%	125	45%	125	33%
Hunting	26	3%	4	3%	15	5%	6	2%
Swimming	45	6%	10	7%	15	5%	20	5%
Boating	139	17%	7	5%	41	15%	88	23%
Fishing	43	5%	10	7%	16	6%	17	5%
Bird Watching	18	2%	2	1%	11	4%	5	1%
Winter sports	36	5%	1	1%	15	5%	20	5%
Other	98	12%	24	18%	33	12%	41	11%
Total	**797**		**136**		**279**		**377**	

Source: RESI

Of all the respondents, 40 percent indicated that hiking is the main activity in which they participated at the listed locations. Hiking also received the most responses from respondents residing in Garrett County, Allegany County, and neither county. Most often, those respondents who indicated a response of "Other" participated in kayaking, biking, walking, or golfing at the listed locations.

Figure 63: When planning a day trip, what is the farthest distance one way (in miles) that you are willing to drive to participate in the previous activities?[259]

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Less than 30 miles	177	23%	36	28%	104	38%	36	10%
31–60 miles	226	30%	50	38%	92	34%	83	23%
61–120 miles	188	25%	31	24%	47	17%	109	31%
121–250 miles	149	20%	12	9%	26	10%	110	31%
More than 250 miles	23	3%	1	1%	3	1%	19	5%
Average	**99 miles**							

Source: RESI

The plurality of respondents, 30 percent, indicated that they would travel between 31 and 60 miles one way to participate in outdoor activities. The plurality of respondents residing in Allegany County, 38 percent, also indicated that they would be willing to travel between 31 and 60 miles one way to participate in outdoor activities. Respondents residing in Garrett County most often, 38 percent of respondents, indicated that they would be willing to drive less than 30 miles. Respondents not residing in Allegany or Garrett Counties most often, 31 percent each, indicated that they would be willing to travel 61 to 120 miles or 121 to 250 miles.

[259] For those respondents who answered in hours rather than miles, RESI assumed an average of 65 miles per hour. RESI based this assumption on data regarding the speed limit for rural interstates in Maryland as provided by the National Motorists Association using data from the Governors Highway Safety Association. Please refer to Section 10.0 of this report for more information on this resource.

Figure 64: Please rank the following from most to least important

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Scenic Quality								
Most Important	190	24%	38	27%	63	23%	89	23%
Moderately Important	297	37%	49	35%	120	43%	126	33%
Least Important	315	39%	52	37%	96	34%	164	43%
Abundant Wildlife								
Most Important	82	10%	16	12%	33	12%	33	9%
Moderately Important	328	41%	54	39%	102	37%	169	45%
Least Important	391	49%	69	50%	143	51%	177	47%
Clean Lakes and Waterways								
Most Important	577	72%	97	70%	199	71%	276	73%
Moderately Important	170	21%	33	24%	55	20%	82	22%
Least Important	55	7%	9	6%	25	9%	21	6%

Source: RESI

The majority of respondents valued clean lakes and waterways as the most important outdoor quality. Only 7 percent of all respondents valued clean lakes and waterways as the least important outdoor quality. Residents in Allegany County, Garrett County, and neither county believe clean lakes and waterways are most important compared to abundant wildlife and scenic quality.

Figure 65: Where do you reside?[260]

	Respondents			Respondents	
Response	**Count**	**Percent**	**Response**	**Count**	**Percent**
California	**5**	**0.60%**	Buncombe	1	
Los Angeles	1		Durham	1	
San Diego	1		Wake	2	
San Francisco	1		**Ohio**	**2**	**0.30%**
San Mateo	1		Cuyahoga	1	
Santa Barbara	1		Guernsey	1	

[260] Findings in this figure are based on responses of the zip code in which the respondents' home is.

Response	Respondents Count	Percent	Response	Respondents Count	Percent
Colorado	**2**	**0.30%**	**Oregon**	**1**	**0.10%**
Denver	1		Clackamas	1	
Larimer	1		**Pennsylvania**	**54**	**6.80%**
Delaware	**1**	**0.10%**	Allegheny	10	
District of Columbia	**5**	**0.60%**	Bedford	5	
New Castle	1		Blair	2	
Florida	**5**	**0.60%**	Bucks	2	
Brevard	1		Cambria	2	
Lee	1		Carbon	1	
Nassau	2		Centre	3	
Palm Beach	1		Delaware	1	
Hawaii	**2**	**0.30%**	Fayette	7	
Hawaii	1		Lawrence	1	
Honolulu	1		Lehigh	2	
Idaho	**1**	**0.10%**	Montgomery	1	
Latah	1		Snyder	1	
Illinois	**3**	**0.40%**	Somerset	3	
Kane	1		Washington	1	
Madison	1		Wayne	1	
McHenry	1		Westmoreland	9	
Kentucky	**3**	**0.40%**	York	2	
Jefferson	1		**Rhode Island**	**1**	**0.10%**
Oldham	1		Washington	1	
Webster	1		**Tennessee**	**1**	**0.10%**
Maryland	**611**	**76.90%**	Williamson	1	
Allegany	139		**Virginia**	**27**	**3.40%**
Anne Arundel	18		Albemarle	1	
Baltimore	17		Arlington	4	
Baltimore City	33		Chesterfield	1	
Calvert	1		Fairfax	11	
Carroll	9		Falls Church City	3	
Cecil	2		Harrisonburg City	1	
Charles	1		Loudoun	3	
Frederick	17		Prince William	1	
Garrett	279		Rockingham	1	
Harford	3		York	1	

Response	Respondents Count	Percent	Response	Respondents Count	Percent
Howard	21		**Washington**	**1**	**0.10%**
Montgomery	40		Island	1	
Prince George's	16		**West Virginia**	**50**	**6.30%**
Somerset	1		Berkeley	1	
St. Mary's	2		Jefferson	2	
Talbot	4		Kanawha	2	
Washington	6		Lewis	1	
Wicomico	2		Mineral	5	
Michigan	**3**	**0.40%**	Monongalia	16	
Washtenaw	1		Morgan	2	
Wayne	2		Preston	15	
Mississippi	**1**	**0.10%**	Randolph	1	
Warren	1		Taylor	1	
New York	**7**	**0.90%**	Tucker	4	
Chenango	2		**International**	**6**	**0.80%**
Livingston	1		Australia	1	
Oneida	1		Austria	1	
New York	2		England	1	
Ulster	1		Sweden	1	
North Carolina	**4**	**0.50%**	Switzerland	2	

Source: RESI

The majority of respondents, 77 percent, reside in Maryland. Many nonresident respondents indicated that they reside in Pennsylvania, 7 percent, or West Virginia, 6 percent. Of all respondents, 3 percent indicated that they reside in Virginia. The remaining states of residence are each home to one percent or fewer of the remaining respondents.

Of Maryland resident respondents, 68 percent indicated that they reside in Allegany or Garrett Counties. The next two top counties of residence were Montgomery County and Baltimore City, with 7 and 5 percent, respectively.

Figure 66: Do you live in Allegany County or Garrett County?

	Respondents	
Response	**Count**	**Percent**
Allegany County	139	17%
Garrett County	279	35%
Neither	379	48%
Total	**797**	

Source: RESI

More than half of the survey respondents, 52 percent, indicated their place of residence as Allegany or Garrett Counties. Many respondents, 35 percent, reside in Garrett County. The remaining 48 percent reside outside Garrett and Allegany Counties. However, as seen in Figure 65, many reside within Maryland.

Figure 67: How would you describe the location of your home?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Urban	45	10%	35	26%	8	3%	2	6%
Suburban	100	22%	54	39%	31	11%	15	42%
Rural	308	68%	48	35%	238	86%	19	53%
Total	**453**		**137**		**277**		**36**	

Source: RESI

The majority of all survey respondents, 68 percent, described the location of their home as a rural setting. Many respondents in Allegany County, or 39 percent, described the location of their home as a suburban setting with rural close behind, at 35 percent. Meanwhile, 86 percent of residents in Garrett County listed their home location as a rural setting. Among all respondents, 10 percent described their home as being located in an urban area.

Figure 68: Do you rent or own your home?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Rent	47	10%	24	18%	22	8%	1	3%
Own	383	85%	101	74%	246	89%	33	94%
Other	20	4%	12	9%	7	3%	1	3%
Total	**450**		**137**		**275**		**35**	

Source: RESI

Among all respondents, 85 percent stated that they own their homes. Of those residents residing in Allegany or Garrett Counties, most own their home—74 percent and 89 percent,

respectively. Of those respondents residing in neither county, 94 percent stated that they own their home. When compared to respondents residing in Garrett County or neither county, more respondents residing in Allegany County, or 18 percent, indicated that they rent.

Figure 69: What type of dwelling is your rented home considered?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Apartment or Condo	15	35%	11	48%	4	21%	0	0%
Single Family	23	53%	11	48%	11	58%	1	100%
Neither	5	12%	1	4%	4	21%	0	0%
Total	**43**		**23**		**19**		**1**	

Source: RESI

Over half of all survey respondents, or 53 percent, listed their rented property as being a single-family home, while 35 percent described their rented property as an apartment or condo. Twelve percent of all respondents described their rented property as being neither an apartment nor condo nor a single-family home.

Allegany County respondents who indicated that they rent their home were equally likely to indicate that their rented property was an apartment or condo as a single-family home, at 48 percent each. Over half of those respondents who reside in rented homes in Garrett County, or 58 percent, indicated that their rented home is considered a single-family dwelling.

Figure 70: What is your rent per month?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
$0–$500	14	35%	10	50%	3	16%	1	100%
$500–$1,000	22	55%	9	45%	13	68%	0	0%
$1,001–$1,500	4	10%	1	5%	3	16%	0	0%
$1,501–$2,000	0	0%	0	0%	0	0%	0	0%
$2,001+	0	0%	0	0%	0	0%	0	0%
Total	**40**		**20**		**19**		**1**	

Source: RESI

The majority of all respondents, or 55 percent, stated that their rent is between $500 and $1,000 per month. Among all respondents, no one indicated that they pay over $1,500 in rent per month. Residents of Allegany County indicated the lowest rent—50 percent indicated that their monthly rent was fewer than $500, while 45 percent indicated a monthly rent of $500 to $1,000.

Residents of Garrett County, on the other hand, indicated that they pay the most money for rent. While 68 percent of Garrett County residents indicated that their monthly rent is between $500 and $1,000, 16 percent of respondents from Garrett County, as opposed to only 5 percent of respondents from Allegany County, indicated that they pay between $1,001 and $1,500 for rent per month.

Figure 71: Do you have a second home?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Yes	211	29%	26	19%	69	25%	115	30%
No	590	74%	113	81%	210	75%	264	70%
Total	**801**		**139**		**279**		**379**	

Source: RESI

Most respondents, or 74 percent, stated that they do not own a second home. At 70 percent, residents from neither county had the largest percentage of second homes.

Figure 72: Is your second home in Allegany or Garrett County?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Allegany County	6	3%	6	25%	0	0%	0	0%
Garrett County	95	46%	6	25%	19	28%	70	61%
Neither	107	51%	12	50%	50	72%	44	39%
Total	**208**		**24**		**69**		**114**	

Source: RESI

Of all the respondents who indicated that they own second homes, 51 percent were located in neither Allegany County nor Garrett County.

Figure 73: What is the zip code of your second home?

	Respondents	
Response	**Count**	**Percent**
Delaware	**1**	**0.9%**
Kent	1	
Florida	**3**	**2.7%**
Broward	1	
Manatee	2	
Georgia	**1**	**0.9%**
Glynn	1	
Maryland	**96**	**87.3%**
Allegany	7	
Baltimore	1	
Baltimore City	1	
Garrett	87	
North Carolina	**2**	**1.8%**
Buncombe	1	
Hanover	1	
Pennsylvania	**1**	**0.9%**
Montgomery	1	
Virginia	**2**	**1.8%**
Fairfax	1	
Loudoun	1	
West Virginia	**2**	**1.8%**
Mineral	1	
Preston	1	
International	**2**	**1.8%**

Source: RESI

According to the provided zip codes, 87 percent of second homes owned by respondents were located within Maryland. A large portion of these second homes located in Maryland, 87 of 96 second homes, were located in Garrett County.

Figure 74: How would you describe the location of your second home?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Urban	5	5%	4	33%	0	0%	1	1%
Suburban	16	16%	1	8%	4	20%	11	16%
Rural	81	79%	7	58%	16	80%	58	83%
Total	**102**		**12**		**20**		**70**	

Source: RESI

The majority of all survey respondents who indicated that they had a second home, or 79 percent, described the location of their second home as being in a rural environment. This was the most popular choice for each respondent subcategory.

Figure 75: Do you rent or own your second home?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Rent	3	3%	1	8%	1	5%	1	1%
Own	98	95%	12	92%	19	95%	67	96%
Other	2	2%	0	0%	0	0%	2	3%
Total	**103**		**13**		**20**		**70**	

Source: RESI

Of all the respondents with second homes, 95 percent indicated that they own their second home. Only 3 percent of all respondents with a second home indicated that they rent their homes, while 2 percent listed doing "other" things with their second home.

Figure 76: If you rent your second home, what type of dwelling is it considered?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Vacation Rental	0	0%	0	0%	0	0%	0	0%
Apartment or Condo	0	0%	0	0%	0	0%	0	0%
Single Family	3	100%	1	100%	1	100%	1	100%
Total	**3**		**1**		**1**		**1**	

Source: RESI

Only three respondents, all of whom listed their second home as a single family dwelling, indicated that they rent their second homes.

Figure 77: What is your rent per month?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
$0-$500	2	67%	1	100%	0	0%	1	100%
$500–$1,000	1	33%	0	0%	1	100%	0	0%
$1,001–$1,500	0	0%	0	0%	0	0%	0	0%
$1,501–$2,000	0	0%	0	0%	0	0%	0	0%
$2,001+	0	0%	0	0%	0	0%	0	0%
Total	**3**		**1**		**1**		**1**	

Source: RESI

Of all respondents who indicated that they rent their second home, 67 percent, stated that their rent is between $0 and $500 per month. The dollar values below were presented in a payment card method, where respondents were given a selection of values from which to choose.

Figure 78: How much would you be willing to pay annually into the conservation fund to protect against potential environmental damages from drilling?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
$10 per year	86	11%	15	11%	24	9%	47	12%
$40 per year	83	10%	18	13%	19	7%	46	12%
$70 per year	20	3%	6	4%	4	1%	10	3%
$100 per year	133	17%	15	11%	50	18%	67	18%
$130 per year	9	1%	2	1%	2	1%	5	1%
$160 per year	87	11%	13	9%	26	9%	48	13%
Nothing at all	380	48%	69	50%	153	55%	155	41%
Total	**798**		**138**		**278**		**378**	

Source: RESI

Nearly half of all respondents, or 48 percent, stated that they were willing to pay “nothing at all” into an annual conservation fund that would protect against environmental damages from drilling. Respondents residing in Garrett County were the least likely, at 55 percent, to be willing to pay into the fund. Respondents residing in Allegany County were not far behind; 50 percent indicated they would be willing to contribute nothing at all to the conservation fund. Respondents residing in neither Allegany County nor Garrett County were most likely, at 59 percent, to indicate a willingness to contribute some amount to the conservation fund.

Figure 79: If you answered "Nothing at all" to the previous question, please indicate why you would not support this conservation fund.

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
I don't believe drilling will have any substantial effect on the environment	38	10%	6	8%	23	15%	9	6%
I can't afford to pay any additional taxes	27	7%	10	14%	9	6%	8	5%
Funding should be on a voluntary basis or through charities	7	2%	4	6%	0	0%	3	2%
Conservation funding should be provided by the drilling and gas companies	273	72%	42	59%	107	70%	122	79%
Conservation funding should come from existing government tax revenues	22	6%	6	8%	7	5%	9	6%
There are more important uses of public funds	13	3%	3	4%	6	4%	3	2%
Total	**380**		**71**		**152**		**154**	

Source: RESI

The majority of respondents who indicated they would be willing to contribute "nothing at all" to the conservation fund, 72 percent, agree that conservation funding should be provided by the drilling and gas companies.

Figure 80: How important to you is the preservation of the environmental quality of parks, lakes, streams, and forestland?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Not at all important	12	2%	2	1%	4	1%	6	2%
Slightly important	8	1%	1	1%	5	2%	2	1%
Moderately important	32	4%	4	3%	15	5%	13	3%
Very important	88	11%	16	12%	36	13%	36	10%
Extremely important	658	82%	115	83%	218	78%	321	85%
Total	**798**		**138**		**278**		**378**	

Source: RESI

Among all respondents, 82 percent believe that the preservation of the environmental quality of parks, lakes, streams, and forestland is extremely important. Of 798 respondents, 12 respondents, or 2 percent, stated that the preservation of the environmental quality of parks, lakes, streams, and forestland was not at all important.

Figure 81: Please rank the following three at risk environmental resources by how threatened you believe them to be from drilling activity.

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Scenic Quality								
Most Threatened	107	13%	22	16%	42	15%	43	11%
Moderately Threatened	273	34%	43	31%	121	44%	107	28%
Threatened	415	52%	73	53%	114	41%	226	60%
Abundant Wildlife								
Most Threatened	82	10%	16	12%	22	8%	44	12%
Moderately Threatened	408	51%	76	55%	113	41%	217	58%
Threatened	304	38%	45	33%	142	51%	115	31%
Clean Lakes and Waterways								
Most Threatened	643	81%	112	81%	218	79%	309	82%
Moderately Threatened	77	10%	12	9%	26	9%	39	10%
Threatened	75	9%	14	10%	33	12%	28	7%

Source: RESI

Most often, clean lakes and waterways were ranked as being the environmental resource most threatened by drilling activity. Among all respondents, 81 percent believe clean lakes and waterways are the most threatened environmental resource from drilling activity. At 10 percent, respondents were least likely to indicate that abundant wildlife was most threatened.

Figure 82: Do you own land in Garrett or Allegany Counties?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Yes	388	49%	79	57%	233	84%	74	20%
No	410	51%	59	43%	45	16%	304	80%
Total	**798**		**138**		**278**		**378**	

Source: RESI

Among all respondents, 51 percent indicated that they do not own land in Garrett or Allegany Counties. Of those respondents residing in Garrett County, 84 percent indicated that they own land in Garrett or Allegany Counties, while 57 percent of respondents residing in Allegany County indicated that they own land in one of the two counties.

Figure 83: What is the approximate acreage of land that you own in Garrett or Allegany Counties?

Response	Count	Percent
Less than 1 acre	46	12%
1–10 acres	221	57%
11–25 acres	32	8%
26–50 acres	33	9%
51–100 acres	20	5%
More than 100 acres	36	9%

Source: RESI

The majority, 57 percent, of respondents who indicated that they own land in Garrett or Allegany Counties own between 1 and 10 acres of land in Garrett or Allegany Counties.

Figure 84: Suppose you could lease your land for natural gas drilling. What would you do?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Definitely lease it	50	13%	13	15%	32	14%	4	5%
Probably lease it	35	9%	8	10%	20	8%	7	9%
Not sure	27	7%	6	7%	16	7%	5	7%
Probably not lease it	26	7%	9	11%	14	6%	3	4%
Definitely not lease it	261	65%	48	57%	155	65%	57	75%
Total	**399**		**84**		**237**		**76**	

Source: RESI

Of all respondents, 65 percent stated they would definitely not lease their land for natural gas drilling, while 13 percent agreed that they would definitely lease their land for natural gas drilling. Respondents who reside outside the two counties were more likely, at 75 percent, to indicate that they would not lease their land compared to residents in Garrett and Allegany Counties, at 57 percent and 65 percent, respectively.

Figure 85: **What is the minimum value you would accept for a lease (per acre/year) to drill for natural gas on your land?**

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Fewer than $100 per year	3	2%	0	0%	3	4%	0	0%
At least $100 per year	3	2%	0	0%	3	4%	0	0%
At least $500 per year	16	12%	3	9%	10	13%	3	16%
At least $1,000 per year	39	30%	10	29%	23	31%	5	26%
At least $3,000 per year	21	16%	2	6%	16	21%	3	16%
At least $5,000 per year	48	37%	20	57%	20	27%	8	42%
Market Value	0	0%	0	0%	0	0%	0	0%
Total	**130**		**35**		**75**		**19**	

Source: RESI

Of respondents who would lease their land for natural gas drilling, 37 percent stated that they would lease their land for a minimum value of at least $5,000 an acre per year. Another 4 percent of all respondents stated that they would lease their land for some value below $500 per year. Respondents residing in Allegany County would accept no fewer than $500 per year to lease their land, while 8 percent of respondents residing in Garrett County would lease their land for under $100 per year or at least $100 per year.

Figure 86: How informed are you on the benefits and concerns of natural gas exploration in shale formations?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Not at all informed	23	3%	6	4%	5	2%	12	3%
Slightly informed	30	4%	7	5%	9	3%	14	4%
Moderately informed	159	20%	38	28%	54	19%	67	18%
Very informed	276	35%	47	34%	85	31%	142	38%
Extremely informed	309	39%	40	29%	125	45%	142	38%
Total	**797**		**138**		**278**		**377**	

Source: RESI

The plurality of respondents, or 39 percent, indicated that they were extremely informed on the benefits and concerns of natural gas exploration in shale formations, while an additional 35 percent indicated that they were very informed. Of those respondents residing in Garrett and Allegany Counties, most indicated that they were very or extremely informed on the benefits and concerns of natural gas exploration, at 63 percent and 76 percent, respectively. In all cases, fewer than 5 percent of respondents indicated that they were not at all informed on the benefits and concerns of natural gas explorations.

Figure 87: Suppose you were considering moving to a new home within the next 12 months. Would the presence of natural gas drilling deter you from moving to a residence within Allegany or Garrett County?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Yes	603	76%	96	70%	200	72%	304	81%
No	194	24%	42	30%	78	28%	73	19%
Total	**797**		**138**		**278**		**377**	

Source: RESI

Approximately 76 percent of all respondents indicated that the presence of natural gas drilling would deter them from moving to a residence within Allegany or Garrett Counties. Of respondents residing in neither county, 81 percent would be deterred from moving into a new residence due to the presence of natural gas drilling, while 19 percent indicated that they would not let the presence of natural gas drilling deter them from moving to a residence within Allegany or Garrett Counties.

Figure 88: What is your gender?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Male	425	54%	72	53%	143	52%	206	56%
Female	357	46%	63	47%	130	48%	164	44%
Total	**782**		**135**		**273**		**370**	

Source: RESI

The majority of all respondents, or 54 percent, were male. There were more male than female residents from all areas of interest who completed the survey.

Figure 89: What is your age?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
18–29 year old	92	12%	24	18%	20	7%	48	13%
30–39 years old	118	15%	36	27%	26	9%	56	15%
40–49 years old	133	17%	17	13%	43	16%	72	19%
50–59 years old	198	25%	23	17%	79	29%	96	26%
60–69 years old	180	23%	23	17%	86	31%	69	18%
70–79 years old	62	8%	11	8%	19	7%	31	8%
80 years or older	3	0%	0	0%	1	0%	2	1%
Total	**786**		**134**		**274**		**374**	

Source: RESI

A quarter of all survey respondents indicated that they were between the ages of 50 and 59 years old, followed by those between the ages of 60 and 69 years, at 23 percent. Allegany County respondents represented a slightly younger age group. Of those respondents residing in Allegany County, 27 percent were between 30 and 39 years old, compared to only 9 percent the respondents residing in Garrett County. The survey respondents residing in Garrett County were most likely, at 31 percent, to fall between 60 and 69 years of age.

Figure 90: What is the highest level of education you have completed?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Some high school	4	1%	3	2%	1	0%	0	0%
High school diploma or GED	39	5%	15	11%	14	5%	10	3%
Some college	131	17%	32	24%	47	17%	51	14%
Associate's degree	71	9%	16	12%	28	10%	27	7%
Bachelor's degree	260	33%	41	30%	87	32%	131	35%
Post-baccalaureate degree	281	36%	29	21%	96	35%	154	41%
Total	**786**		**136**		**273**		**373**	

Source: RESI

Most respondents, a combined 69 percent, indicated that they had either a Bachelor's or post-baccalaureate degree. The same was true of respondents residing in Garrett and Allegany Counties. Of the respondents residing in Allegany County, 51 percent indicated that they hold at least a Bachelor's degree, while 67 percent of those residing in Garrett County indicated that they hold at least a Bachelor's degree.

Figure 91: **Which best describes your employment situation in the past 12 months?**

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Employed full time	398	51%	64	47%	133	49%	200	54%
Employed part time	67	9%	14	10%	19	7%	34	9%
Self-employed	103	13%	11	8%	41	15%	51	14%
Unemployed	15	2%	3	2%	4	1%	8	2%
Retired	160	20%	30	22%	68	25%	59	16%
Student	17	2%	8	6%	3	1%	6	2%
Stay-at-home parental guardian	25	3%	6	4%	5	2%	14	4%
Total	**785**		**136**		**273**		**372**	

Source: RESI

Of all survey respondents, 51 percent indicated that they are employed full time. Full-time employment status was most frequently indicated by those respondents residing in Garrett and Allegany Counties as well, with frequencies of 49 percent and 47 percent, respectively. Respondents were least likely to indicate that they were unemployed—2 percent or fewer of each subcategory indicated that they were unemployed.

Figure 92: Which best fits your household income for the past 12 months?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Under $10,000	25	3%	13	10%	2	1%		3%
$10,001–$25,000	53	7%	21	16%	19	7%	13	4%
$25,001–$50,000	126	17%	29	22%	50	19%	46	13%
$50,001–$75,000	143	19%	25	19%	55	21%	62	18%
$75,001–$100,000	121	16%	15	12%	40	15%	65	19%
$100,001–$125,000	88	12%	11	9%	35	13%	41	12%
$125,001–$150,000	62	8%	9	7%	22	8%	31	9%
$150,001–$200,000	69	9%	4	3%	20	8%	45	13%
Over $200,000	60	8%	2	2%	21	8%	37	11%
Total	**747**		**129**		**264**		**350**	

Source: RESI

Among all respondents, 19 percent indicated that their household income was between $50,001 and $75,000 for the previous twelve months. Most respondents, or 52 percent, indicated that their household income was between $25,001 and $100,000 for the previous twelve months.

Respondents residing in Allegany County most often, at 22 percent, indicated that their household income was between $25,001 and $50,000. This was followed closely by an income range of between $50,001 and $75,000, at 19 percent of Allegany County respondents. Respondents residing in Garrett County indicated similar household income patterns—21 percent of Garrett County respondents indicated that their household income was between $50,001 and $75,000, while 19 percent of Garrett County respondents indicated that their household income was between $25,001 and $50,000. Respondents residing in neither county indicated the highest level of household income. Of those respondents residing outside Garrett and Allegany Counties, 19 percent indicated a household income between $75,001 and $100,000.

Appendix D—Additional Economic and Fiscal Impacts

This appendix reports the detail impacts associated with Marcellus Shale drilling for Scenarios 1 and 2 for each county.

D.1 Detailed Baseline Results—Allegany County

To determine the economic impacts associated with Marcellus Shale drilling in Allegany County, RESI first assessed the baseline forecast for the region under the status quo. The baseline results can be found for employment, output, and wages in Figure 93.

Figure 93: Detailed Economic Forecast—Allegany County, Baseline

Year	Employment	Output	Wages
2017	29,668	$3,841,487,975	$1,003,450,532
2018	29,767	$3,863,299,620	$1,012,837,609
2019	29,818	$3,877,646,744	$1,020,585,720
2020	29,870	$3,891,879,838	$1,028,488,805
2021	29,918	$3,905,631,933	$1,036,533,974
2022	29,966	$3,919,161,296	$1,044,708,914
2023	30,013	$3,932,683,574	$1,052,859,568
2024	30,060	$3,946,141,864	$1,061,073,227
2025	30,105	$3,959,745,271	$1,069,368,615
2026	30,151	$3,973,869,178	$1,077,709,209
2027	30,196	$3,988,288,278	$1,086,131,118
2028	30,242	$4,003,191,135	$1,094,554,677
2029	30,289	$4,018,551,996	$1,103,095,417
2030	30,336	$4,034,401,379	$1,111,740,539
2031	30,377	$4,048,326,243	$1,119,879,075
2032	30,414	$4,062,311,827	$1,127,981,758
2033	30,452	$4,076,290,414	$1,136,169,026
2034	30,489	$4,090,238,066	$1,144,418,662
2035	30,527	$4,104,218,807	$1,152,627,217
2036	30,564	$4,118,171,742	$1,160,933,378

Sources: RESI, REMI PI+

D.2 Economic Impacts—Allegany County

The economic impacts for employment, output, and wages for Scenario 1 for Allegany County are reported in Figures 94 through 96. The economic impacts for employment, output, and wages for Scenario 2 for Allegany County are reported in Figures 97 through 99.

Figure 94: Detailed Employment Impacts—Allegany County, Scenario 1

Year	Direct	Spinoff	Total
2017	139.8	146.1	286.0
2018	60.4	64.5	124.9
2019	201.9	211.4	413.2
2020	107.1	113.5	220.6
2021	240.5	251.8	492.3
2022	135.8	143.9	279.7
2023	95.9	102.3	198.2
2024	58.8	63.3	122.2
2025	32.7	36.3	69.0
2026	15.2	17.7	32.9
2027	4.1	6.1	10.2
2028	-2.3	-0.5	-2.8
2029	-4.7	-3.4	-8.1
2030	-5.0	-4.1	-9.2
2031	-5.6	-4.5	-10.1
2032	-4.4	-3.5	-7.9
2033	10.3	11.3	21.6
2034	12.4	13.5	25.9
2035	15.1	16.0	31.2
2036	16.4	17.5	33.8

Sources: RESI, REMI PI+

Figure 95: Detailed Output Impacts—Allegany County, Scenario 1

Year	Direct	Spinoff	Total
2017	$13,005,474	$11,378,071	$24,383,545
2018	$9,522,156	$8,330,627	$17,852,783
2019	$21,550,999	$18,854,275	$40,405,273
2020	$15,316,835	$13,400,206	$28,717,041
2021	$26,499,264	$23,183,353	$49,682,617
2022	$19,174,529	$16,775,178	$35,949,707
2023	$13,770,502	$12,047,369	$25,817,871
2024	$8,594,356	$7,518,925	$16,113,281
2025	$5,404,027	$4,727,809	$10,131,836
2026	$3,287,992	$2,876,559	$6,164,551
2027	$1,920,708	$1,680,366	$3,601,074
2028	$1,106,849	$968,346	$2,075,195
2029	$651,088	$569,616	$1,220,703
2030	$455,761	$398,731	$854,492
2031	$227,881	$199,365	$427,246
2032	$195,326	$170,885	$366,211
2033	$1,106,849	$968,346	$2,075,195
2034	$1,237,066	$1,082,270	$2,319,336
2035	$1,399,838	$1,224,673	$2,624,512
2036	$1,432,393	$1,253,154	$2,685,547

Sources: RESI, REMI PI+

Figure 96: Detailed Wages Impacts—Allegany County, Scenario 1

Year	Direct	Spinoff	Total
2017	$3,042,690	$3,228,610	$6,271,300
2018	$1,736,060	$1,842,140	$3,578,200
2019	$4,795,440	$5,088,460	$9,883,900
2020	$3,068,647	$3,256,153	$6,324,800
2021	$6,118,760	$6,492,640	$12,611,400
2022	$4,032,888	$4,279,312	$8,312,200
2023	$2,913,148	$3,091,152	$6,004,300
2024	$1,763,812	$1,871,588	$3,635,400
2025	$912,472	$968,228	$1,880,700
2026	$288,729	$306,371	$595,100
2027	-$151,763	-$161,037	-$312,800
2028	-$427,538	-$453,662	-$881,200
2029	-$581,145	-$616,655	-$1,197,800
2030	-$634,854	-$673,646	-$1,308,500
2031	-$662,606	-$703,094	-$1,365,700
2032	-$627,431	-$665,769	-$1,293,200
2033	-$129,542	-$137,458	-$267,000
2034	$0	$0	$0
2035	$144,389	$153,211	$297,600
2036	$18,485	$19,615	$38,100

Sources: RESI, REMI PI+

Figure 97: Detailed Employment Impacts—Allegany County, Scenario 2

Year	Direct	Spinoff	Total
2017	169.3	177.1	346.4
2018	293.2	307.5	600.6
2019	355.1	372.4	727.6
2020	379.3	397.7	777.0
2021	407.8	428.3	836.1
2022	421.6	442.8	864.4
2023	433.8	456.0	889.7
2024	442.5	465.5	908.0
2025	258.1	274.5	532.6
2026	161.1	173.1	334.1
2027	94.1	103.6	197.7
2028	52.0	59.4	111.5
2029	26.1	31.9	58.0
2030	13.0	17.7	30.7
2031	5.5	9.7	15.1
2032	3.7	7.4	11.1
2033	23.0	26.7	49.7
2034	27.5	31.0	58.5
2035	31.9	35.0	66.8
2036	35.7	38.9	74.6

Sources: RESI, REMI PI+

Figure 98: Detailed Output Impacts—Allegany County, Scenario 2

Year	Direct	Spinoff	Total
2017	$16,939,996	$17,941,604	$34,881,600
2018	$33,805,884	$35,804,716	$69,610,600
2019	$39,852,719	$42,209,081	$82,061,800
2020	$40,697,494	$43,103,806	$83,801,300
2021	$44,284,063	$46,902,437	$91,186,500
2022	$45,914,366	$48,629,134	$94,543,500
2023	$47,870,681	$50,701,119	$98,571,800
2024	$49,441,638	$52,364,962	$101,806,600
2025	$31,716,163	$33,591,437	$65,307,600
2026	$20,067,147	$21,253,653	$41,320,800
2027	$12,775,415	$13,530,785	$26,306,200
2028	$8,180,992	$8,664,708	$16,845,700
2029	$5,187,247	$5,493,953	$10,681,200
2030	$3,497,648	$3,704,452	$7,202,100
2031	$2,341,672	$2,480,128	$4,821,800
2032	$1,748,848	$1,852,252	$3,601,100
2033	$2,638,060	$2,794,040	$5,432,100
2034	$2,667,733	$2,825,467	$5,493,200
2035	$2,756,654	$2,919,646	$5,676,300
2036	$2,875,199	$3,045,201	$5,920,400

Sources: RESI, REMI PI+

Figure 99: Detailed Wages Impact—Allegany County, Scenario 2

Year	Direct	Spinoff	Total
2017	$3,897,827	$4,135,873	$8,033,700
2018	$7,295,962	$7,741,538	$15,037,500
2019	$9,113,512	$9,670,088	$18,783,600
2020	$9,957,442	$10,565,558	$20,523,000
2021	$11,029,117	$11,702,683	$22,731,800
2022	$11,673,200	$12,386,100	$24,059,300
2023	$12,289,529	$13,040,071	$25,329,600
2024	$12,791,065	$13,572,235	$26,363,300
2025	$7,904,917	$8,387,683	$16,292,600
2026	$4,712,209	$4,999,991	$9,712,200
2027	$2,341,306	$2,484,294	$4,825,600
2028	$688,477	$730,523	$1,419,000
2029	-$451,561	-$479,139	-$930,700
2030	-$1,104,911	-$1,172,389	-$2,277,300
2031	-$1,508,439	-$1,600,561	-$3,109,000
2032	-$1,654,625	-$1,755,675	-$3,410,300
2033	-$1,034,607	-$1,097,793	-$2,132,400
2034	-$812,538	-$862,162	-$1,674,700
2035	-$551,558	-$585,242	-$1,136,800
2036	-$299,844	-$318,156	-$618,000

Sources: RESI, REMI PI+

D.3 Fiscal Impacts—Allegany County

The fiscal impacts for state and local tax revenues for Scenario 1 for Allegany County are reported in Figures 100 and 101. The fiscal impacts for state and local tax revenues for Scenario 2 for Allegany County are reported in Figures 102 and 103.

Figure 100: Fiscal Impacts Associated with Drilling in Allegany County—Scenario 1, 25% Extraction

Year	Property	Income	Sales	Payroll	Other[261]	Total
2017	$34,401	$24,181	$51,829	$1,044	$34,211	$145,666
2018	$178,985	$125,808	$269,697	$5,432	$178,018	$757,940
2019	$72,934	$51,265	$109,822	$2,212	$72,490	$308,723
2020	$221,654	$155,801	$333,934	$6,726	$220,419	$938,534
2021	$106,273	$74,699	$160,062	$3,224	$105,652	$449,910
2022	$88,291	$62,059	$133,014	$2,679	$87,798	$373,841
2023	$67,018	$47,107	$100,981	$2,034	$66,654	$283,794
2024	$51,279	$36,044	$77,345	$1,558	$51,053	$217,279
2025	$39,232	$27,576	$59,167	$1,192	$39,055	$166,222
2026	$30,249	$21,262	$45,669	$920	$30,145	$128,245
2027	$23,723	$16,675	$36,013	$725	$23,771	$100,907
2028	$21,501	$15,113	$31,433	$633	$20,748	$89,428
2029	$18,944	$13,316	$28,297	$570	$18,678	$79,805
2030	$16,298	$11,456	$24,680	$497	$16,291	$69,222
2031	$16,714	$11,748	$25,024	$504	$16,517	$70,507
2032	$30,758	$21,620	$46,039	$927	$30,389	$129,733
2033	$33,228	$23,356	$50,099	$1,009	$33,069	$140,761
2034	$36,473	$25,637	$54,982	$1,107	$36,292	$154,491
2035	$38,850	$27,308	$58,718	$1,183	$38,758	$164,817
2036	$39,873	$28,027	$59,903	$1,207	$39,540	$168,550

Sources: REMI PI+, RESI

[261] Other taxes include other forms of fees and taxes such as licenses, permits, etc.

Figure 101: Local Income and Property Fiscal Impacts Associated with Drilling in Allegany County—Scenario 1, 25% Extraction

Year	Total Income Tax	State Share	Local Share	Total Property Tax	State Share	Local Share
2017	$24,181	$14,815	$9,366	$34,401	$3,528	$30,873
2018	$125,808	$77,079	$48,729	$178,985	$18,357	$160,627
2019	$51,265	$31,409	$19,856	$72,934	$7,480	$65,454
2020	$155,801	$95,455	$60,346	$221,654	$22,734	$198,920
2021	$74,699	$45,766	$28,933	$106,273	$10,900	$95,373
2022	$62,059	$38,022	$24,037	$88,291	$9,055	$79,235
2023	$47,107	$28,861	$18,246	$67,018	$6,874	$60,144
2024	$36,044	$22,083	$13,961	$51,279	$5,259	$46,019
2025	$27,576	$16,895	$10,681	$39,232	$4,024	$35,208
2026	$21,262	$13,027	$8,235	$30,249	$3,102	$27,147
2027	$16,675	$10,216	$6,459	$23,723	$2,433	$21,290
2028	$15,113	$9,259	$5,854	$21,501	$2,205	$19,296
2029	$13,316	$8,158	$5,158	$18,944	$1,943	$17,001
2030	$11,456	$7,019	$4,437	$16,298	$1,672	$14,626
2031	$11,748	$7,198	$4,550	$16,714	$1,714	$15,000
2032	$21,620	$13,246	$8,374	$30,758	$3,155	$27,603
2033	$23,356	$14,310	$9,046	$33,228	$3,408	$29,820
2034	$25,637	$15,707	$9,930	$36,473	$3,741	$32,732
2035	$27,308	$16,731	$10,577	$38,850	$3,985	$34,866
2036	$28,027	$17,171	$10,855	$39,873	$4,090	$35,783

Sources: REMI PI+, RESI

With the increased activity under Scenario 2, Allegany County will experience an increase to total State tax revenues over the twenty-year period.[262] These results can be found in Figure 102.

[262] These tax revenues do not include additional severance tax revenues potentially collected at the county level.

Figure 102: Fiscal Impacts Associated with Drilling in Allegany County—Scenario 2, 75% Extraction

Year	Property	Income	Sales	Payroll	Other[263]	Total
2017	$226,250	$159,030	$340,756	$6,863	$224,922	$957,821
2018	$276,303	$194,213	$416,098	$8,381	$274,653	$1,169,648
2019	$308,898	$217,124	$465,325	$9,372	$307,146	$1,307,865
2020	$347,079	$243,961	$522,766	$10,529	$345,061	$1,469,396
2021	$375,223	$263,744	$565,178	$11,384	$373,056	$1,588,585
2022	$405,242	$284,844	$610,395	$12,294	$402,902	$1,715,677
2023	$432,731	$304,166	$651,739	$13,127	$430,192	$1,831,955
2024	$263,173	$184,984	$396,418	$7,984	$261,662	$1,114,221
2025	$205,147	$144,198	$309,091	$6,226	$204,021	$868,683
2026	$160,636	$112,911	$242,010	$4,874	$159,743	$680,174
2027	$129,361	$90,927	$195,057	$3,929	$128,751	$548,025
2028	$106,143	$74,608	$160,326	$3,229	$105,826	$450,132
2029	$91,977	$64,651	$139,017	$2,800	$91,761	$390,206
2030	$80,535	$56,608	$122,019	$2,458	$80,541	$342,161
2031	$74,763	$52,551	$113,166	$2,279	$74,697	$317,456
2032	$91,922	$64,612	$140,427	$2,828	$92,691	$392,480
2033	$94,631	$66,516	$142,861	$2,877	$94,298	$401,183
2034	$98,043	$68,914	$147,914	$2,979	$97,633	$415,483
2035	$102,741	$72,217	$154,675	$3,115	$102,096	$434,844
2036	$105,659	$74,267	$159,281	$3,208	$105,136	$447,551

Sources: REMI PI+, RESI

During the height of drilling activity, RESI estimates that tax revenues will increase annually by $1.3 million on average. During the ten-year period after active drilling, tax revenues will increase by $0.4 million annually. The results shown here are additional state tax revenues associated with drilling in Allegany County only. Figure 103 reports the total, state, and local share of property and income taxes attributable to the drilling period for Scenario 2 in Allegany County.

[263] Other taxes include other forms of fees and taxes such as licenses, permits, etc.

Figure 103: Local Income and Property Fiscal Impacts Associated with Drilling in Allegany County—Scenario 2, 75% Extraction

Year	Total Income Tax	State Share	Local Share	Total Property Tax	State Share	Local Share
2017	$159,030	$97,434	$61,597	$226,250	$23,205	$203,044
2018	$194,213	$118,989	$75,224	$276,303	$28,339	$247,964
2019	$217,124	$133,026	$84,098	$308,898	$31,682	$277,216
2020	$243,961	$149,469	$94,493	$347,079	$35,598	$311,481
2021	$263,744	$161,589	$102,155	$375,223	$38,484	$336,738
2022	$284,844	$174,517	$110,328	$405,242	$41,563	$363,679
2023	$304,166	$186,355	$117,812	$432,731	$44,383	$388,348
2024	$184,984	$113,335	$71,649	$263,173	$26,992	$236,181
2025	$144,198	$88,346	$55,852	$205,147	$21,041	$184,107
2026	$112,911	$69,178	$43,733	$160,636	$16,475	$144,161
2027	$90,927	$55,709	$35,219	$129,361	$13,268	$116,093
2028	$74,608	$45,710	$28,898	$106,143	$10,886	$95,257
2029	$64,651	$39,610	$25,041	$91,977	$9,434	$82,544
2030	$56,608	$34,682	$21,926	$80,535	$8,260	$72,275
2031	$52,551	$32,197	$20,354	$74,763	$7,668	$67,095
2032	$64,612	$39,586	$25,026	$91,922	$9,428	$82,494
2033	$66,516	$40,752	$25,763	$94,631	$9,706	$84,925
2034	$68,914	$42,222	$26,692	$98,043	$10,056	$87,987
2035	$72,217	$44,245	$27,971	$102,741	$10,538	$92,203
2036	$74,267	$45,502	$28,766	$105,659	$10,837	$94,822

Sources: REMI PI+, RESI

Under Scenario 2 for Allegany County, RESI found similar impacts to those for Scenario 1 over the drilling period. RESI expects that there will be increased tax revenues during the drilling period.

D.4 Detailed Baseline Results—Garrett County

To determine the economic impacts associated with Marcellus Shale drilling in Garrett County, RESI first assessed the baseline forecast for the region under the status quo. The baseline results can be found for employment, output, and wages in Figure 104.

Figure 104: Detailed Employment Forecast—Garrett County, Baseline

Year	Employment	Output	Wages
2017	10,608	$1,366,803,593	$266,880,090
2018	10,645	$1,375,338,068	$269,488,249
2019	10,663	$1,380,849,401	$271,532,364
2020	10,679	$1,386,059,883	$273,496,274
2021	10,693	$1,391,079,225	$275,484,989
2022	10,706	$1,395,988,824	$277,454,018
2023	10,719	$1,400,862,189	$279,430,612
2024	10,732	$1,405,697,988	$281,372,544
2025	10,744	$1,410,559,652	$283,348,387
2026	10,755	$1,415,586,238	$285,321,872
2027	10,766	$1,420,706,091	$287,294,611
2028	10,777	$1,425,973,911	$289,221,698
2029	10,787	$1,431,408,517	$291,193,642
2030	10,797	$1,436,997,332	$293,170,011
2031	10,806	$1,441,904,952	$295,019,941
2032	10,819	$1,446,817,878	$296,825,786
2033	10,825	$1,451,743,391	$298,691,980
2034	10,819	$1,456,646,281	$300,559,814
2035	10,825	$1,461,547,408	$302,404,451
2036	10,838	$1,466,452,944	$304,260,557

Sources: RESI, REMI PI+

D.5 Economic Impacts—Garrett County

The economic impacts for employment, output, and wages for Scenario 1 for Garrett County are reported in Figures 105 through 107. The economic impacts for employment, output, and wages for Scenario 2 for Garrett County are reported in Figures 108 through 110.

Figure 105: Detailed Employment Impacts—Garrett County, Scenario 1

Year	Direct	Spinoff	Total
2017	181.8	190.0	371.8
2018	314.9	329.9	644.7
2019	507.7	532.3	1,040.1
2020	582.0	609.4	1,191.4
2021	605.7	634.4	1,240.1
2022	602.7	631.4	1,234.1
2023	594.2	623.4	1,217.6
2024	596.2	626.0	1,222.2
2025	596.3	626.5	1,222.7
2026	387.6	410.3	797.9
2027	246.3	262.7	509.0
2028	147.8	160.4	308.1
2029	83.8	93.5	177.3
2030	41.7	49.2	90.9
2031	21.1	27.6	48.8
2032	14.1	19.5	33.6
2033	14.1	19.0	33.1
2034	17.8	22.4	40.3
2035	24.1	28.2	52.3
2036	30.7	34.9	65.5

Sources: RESI, REMI PI+

Figure 106: Detailed Output Impacts—Garrett County, Scenario 1

Year	Direct	Spinoff	Total
2017	$17,617,074	$18,607,296	$36,224,370
2018	$35,946,543	$37,967,027	$73,913,570
2019	$65,006,550	$68,660,440	$133,666,990
2020	$71,551,729	$75,573,511	$147,125,240
2021	$72,189,923	$76,247,577	$148,437,500
2022	$70,468,288	$74,429,172	$144,897,460
2023	$69,340,324	$73,237,806	$142,578,130
2024	$70,765,121	$74,742,689	$145,507,810
2025	$71,833,724	$75,871,356	$147,705,080
2026	$50,402,342	$53,235,358	$103,637,700
2027	$30,069,239	$31,759,371	$61,828,610
2028	$18,373,997	$19,406,763	$37,780,760
2029	$11,042,210	$11,662,870	$22,705,080
2030	$5,758,571	$6,082,249	$11,840,820
2031	$3,443,270	$3,636,810	$7,080,080
2032	$2,285,620	$2,414,090	$4,699,710
2033	$1,810,683	$1,912,457	$3,723,140
2034	$1,781,002	$1,881,108	$3,662,110
2035	$1,988,787	$2,100,573	$4,089,360
2036	$2,255,934	$2,382,736	$4,638,670

Sources: RESI, REMI PI+

Figure 107: Detailed Wages Impacts—Garrett County, Scenario 1

Year	Direct	Spinoff	Total
2017	$4,145,692	$4,380,158	$8,525,850
2018	$7,807,254	$8,248,806	$16,056,060
2019	$13,527,753	$14,292,837	$27,820,590
2020	$16,035,571	$16,942,489	$32,978,060
2021	$17,233,831	$18,208,519	$35,442,350
2022	$17,638,202	$18,635,758	$36,273,960
2023	$17,857,077	$18,867,013	$36,724,090
2024	$18,343,059	$19,380,481	$37,723,540
2025	$18,730,736	$19,790,084	$38,520,820
2026	$12,967,574	$13,700,976	$26,668,550
2027	$7,966,778	$8,417,352	$16,384,130
2028	$4,295,938	$4,538,902	$8,834,840
2029	$1,624,891	$1,716,789	$3,341,680
2030	-$328,316	-$346,884	-$675,200
2031	-$1,431,981	-$1,512,969	-$2,944,950
2032	-$1,975,467	-$2,087,193	-$4,062,660
2033	-$2,147,969	-$2,269,451	-$4,417,420
2034	-$2,092,323	-$2,210,657	-$4,302,980
2035	-$1,840,056	-$1,944,124	-$3,784,180
2036	-$1,487,627	-$1,571,763	-$3,059,390

Sources: RESI, REMI PI+

Figure 108: Detailed Employment Impacts—Garrett County, Scenario 2

Year	Direct	Spinoff	Total
2017	283.7	298.8	582.5
2018	705.6	741.2	1,446.8
2019	929.6	974.2	1,903.9
2020	1,039.8	1,088.2	2,128.0
2021	1,185.0	1,239.7	2,424.7
2022	1,128.3	1,179.7	2,308.1
2023	1,044.1	1,092.5	2,136.5
2024	978.5	1,024.8	2,003.3
2025	965.7	1,012.8	1,978.5
2026	763.0	801.2	1,564.2
2027	363.4	386.7	750.1
2028	145.6	160.9	306.5
2029	4.2	13.7	17.9
2030	-77.9	-71.9	-149.8
2031	-122.4	-118.4	-240.8
2032	-139.7	-137.2	-276.9
2033	-140.8	-139.4	-280.2
2034	-133.0	-131.9	-265.0
2035	-118.8	-118.3	-237.1
2036	-33.7	-31.6	-65.3

Sources: RESI, REMI PI+

Figure 109: Detailed Output Impacts—Garrett County, Scenario 2

Year	Direct	Spinoff	Total
2017	$44,233,885	$46,739,015	$90,972,900
2018	$110,265,673	$116,510,427	$226,776,100
2019	$137,524,197	$145,312,703	$282,836,900
2020	$147,747,991	$156,115,509	$303,863,500
2021	$169,486,573	$179,085,227	$348,571,800
2022	$155,389,896	$164,190,204	$319,580,100
2023	$142,153,850	$150,204,550	$292,358,400
2024	$135,268,715	$142,929,485	$278,198,200
2025	$138,295,797	$146,128,003	$284,423,800
2026	$103,247,019	$109,094,281	$212,341,300
2027	$52,261,567	$55,221,333	$107,482,900
2028	$26,412,725	$27,908,575	$54,321,300
2029	$10,624,449	$11,226,151	$21,850,600
2030	$1,602,570	$1,693,330	$3,295,900
2031	-$3,590,965	-$3,794,335	-$7,385,300
2032	-$6,054,165	-$6,397,035	-$12,451,200
2033	-$6,914,795	-$7,306,405	-$14,221,200
2034	-$6,825,766	-$7,212,334	-$14,038,100
2035	-$6,202,514	-$6,553,786	-$12,756,300
2036	-$712,232	-$752,568	-$1,464,800

Sources: RESI, REMI PI+

Figure 110: Detailed Wages Impact—Garrett County, Scenario 2

Year	Direct	Spinoff	Total
2017	$7,845,928	$8,290,272	$16,136,200
2018	$20,002,444	$21,135,256	$41,137,700
2019	$27,106,431	$28,641,569	$55,748,000
2020	$31,441,136	$33,221,764	$64,662,900
2021	$37,289,430	$39,401,270	$76,690,700
2022	$36,957,383	$39,050,417	$76,007,800
2023	$35,642,321	$37,660,879	$73,303,200
2024	$34,616,616	$36,577,084	$71,193,700
2025	$35,197,177	$37,190,523	$72,387,700
2026	$28,634,802	$30,256,498	$58,891,300
2027	$15,580,558	$16,462,942	$32,043,500
2028	$7,322,840	$7,737,560	$15,060,400
2029	$1,311,366	$1,385,634	$2,697,000
2030	-$2,711,761	-$2,865,339	-$5,577,100
2031	-$5,314,072	-$5,615,028	-$10,929,100
2032	-$6,783,123	-$7,167,277	-$13,950,400
2033	-$7,426,748	-$7,847,352	-$15,274,100
2034	-$7,532,455	-$7,959,045	-$15,491,500
2035	-$7,200,456	-$7,608,244	-$14,808,700
2036	-$4,106,565	-$4,339,135	-$8,445,700

Sources: RESI, REMI PI+

D.6 Fiscal Impacts—Garrett County

The fiscal impacts for state and local tax revenues for Scenario 1 for Garrett County are reported in Figures 111 and 112. The fiscal impacts for state and local tax revenues for Scenario 2 for Garrett County are reported in Figures 113 and 114.

Figure 111: Fiscal Impacts Associated with Drilling in Garrett County—Scenario 1, 25% Extraction

Year	Property	Income	Sales	Payroll	Other[264]	Total
2017	$248,380	$174,586	$366,484	$7,382	$241,904	$1,038,736
2018	$376,336	$264,526	$555,212	$11,183	$366,478	$1,573,735
2019	$441,636	$310,426	$651,720	$13,127	$430,179	$1,847,088
2020	$483,115	$339,581	$712,850	$14,358	$470,529	$2,020,433
2021	$509,644	$358,228	$751,998	$15,146	$496,369	$2,131,385
2022	$535,155	$376,160	$789,643	$15,905	$521,218	$2,238,081
2023	$564,530	$396,807	$833,001	$16,778	$549,837	$2,360,953
2024	$591,853	$416,013	$873,327	$17,590	$576,455	$2,475,238
2025	$401,904	$282,498	$592,998	$11,944	$391,419	$1,680,763
2026	$316,852	$222,715	$467,587	$9,418	$308,639	$1,325,211
2027	$250,850	$176,322	$370,221	$7,457	$244,371	$1,049,221
2028	$201,985	$141,975	$298,069	$6,004	$196,746	$844,779
2029	$165,990	$116,674	$245,114	$4,937	$161,792	$694,507
2030	$142,262	$99,996	$210,220	$4,234	$138,760	$595,472
2031	$128,956	$90,643	$191,189	$3,851	$126,198	$540,837
2032	$122,923	$86,403	$181,994	$3,666	$120,129	$515,115
2033	$119,030	$83,666	$176,174	$3,548	$116,287	$498,705
2034	$120,907	$84,986	$179,250	$3,610	$118,317	$507,070
2035	$124,727	$87,671	$184,290	$3,712	$121,644	$522,044
2036	$128,640	$90,421	$189,715	$3,821	$125,225	$537,822

Sources: REMI PI+, RESI

During the height of drilling activity, RESI estimates that tax revenues will increase annually by $1.9 million on average. During the ten-year period after active drilling, tax revenues will increase by $0.6 million annually. The results shown here are additional state tax revenues associated with drilling in Garrett County only. Figure 112 reports the total, state, and local share of property and income taxes attributable to the drilling period for Scenario 1 in Garrett County.

[264] Other taxes include other forms of fees and taxes such as licenses, permits, etc.

Figure 112: Local Income and Property Fiscal Impacts Associated with Drilling in Garrett County—Scenario 1, 25% Extraction

Year	Total Income Tax	State Share	Local Share	Total Property Tax	State Share	Local Share
2017	$174,586	$112,784	$61,802	$248,380	$25,244	$223,136
2018	$264,526	$170,885	$93,641	$376,336	$38,248	$338,088
2019	$310,426	$200,537	$109,889	$441,636	$44,885	$396,751
2020	$339,581	$219,371	$120,210	$483,115	$49,101	$434,014
2021	$358,228	$231,418	$126,811	$509,644	$51,797	$457,847
2022	$376,160	$243,002	$133,159	$535,155	$54,390	$480,766
2023	$396,807	$256,340	$140,467	$564,530	$57,375	$507,155
2024	$416,013	$268,747	$147,266	$591,853	$60,152	$531,701
2025	$282,498	$182,495	$100,003	$401,904	$40,847	$361,057
2026	$222,715	$143,875	$78,840	$316,852	$32,203	$284,649
2027	$176,322	$113,905	$62,417	$250,850	$25,495	$225,355
2028	$141,975	$91,717	$50,258	$201,985	$20,528	$181,456
2029	$116,674	$75,372	$41,302	$165,990	$16,870	$149,120
2030	$99,996	$64,598	$35,398	$142,262	$14,459	$127,803
2031	$90,643	$58,556	$32,087	$128,956	$13,106	$115,849
2032	$86,403	$55,817	$30,586	$122,923	$12,493	$110,430
2033	$83,666	$54,049	$29,617	$119,030	$12,097	$106,932
2034	$84,986	$54,901	$30,084	$120,907	$12,288	$108,619
2035	$87,671	$56,636	$31,035	$124,727	$12,676	$112,051
2036	$90,421	$58,413	$32,009	$128,640	$13,074	$115,566

Sources: REMI PI+, RESI

Finally, RESI reviewed the potential fiscal impacts associated with Shale drilling in Garrett County for Scenario 2. The increased drilling activity would result in increased additional tax revenues over the twenty-year period, as reported in Figure 113.

Figure 113: Fiscal Impacts Associated with Drilling in Garrett County—Scenario 2, 75% Extraction

Year	Property	Income	Sales	Payroll	Other[265]	Total
2017	$443,221	$311,540	$654,033	$13,173	$431,706	$1,853,673
2018	$589,901	$414,641	$870,451	$17,532	$574,556	$2,467,081
2019	$686,073	$482,240	$1,012,385	$20,391	$668,243	$2,869,332
2020	$813,710	$571,956	$1,200,646	$24,183	$792,508	$3,403,003
2021	$822,411	$578,072	$1,213,479	$24,441	$800,978	$3,439,381
2022	$817,240	$574,437	$1,205,893	$24,289	$795,971	$3,417,830
2023	$817,914	$574,911	$1,206,790	$24,307	$796,563	$3,420,485
2024	$849,374	$597,024	$1,253,280	$25,243	$827,250	$3,552,171
2025	$748,309	$525,986	$1,104,174	$22,240	$728,830	$3,129,539
2026	$426,625	$299,874	$629,520	$12,680	$415,526	$1,784,225
2027	$280,363	$197,067	$413,766	$8,334	$273,114	$1,172,644
2028	$170,180	$119,619	$251,273	$5,061	$165,857	$711,990
2029	$94,422	$66,369	$141,087	$2,842	$93,127	$397,847
2030	$41,565	$29,216	$61,235	$1,233	$40,419	$173,668
2031	$6,462	$4,542	$9,525	$192	$6,287	$27,008
2032	-$14,982	-$10,531	-$22,089	-$445	-$14,580	-$62,627
2033	-$29,169	-$20,503	-$43,010	-$866	-$28,389	-$121,937
2034	-$30,911	-$21,728	-$45,597	-$918	-$30,097	-$129,251
2035	$54,743	$38,479	$80,725	$1,626	$53,284	$228,857
2036	$73,089	$51,374	$107,699	$2,169	$71,089	$305,420

Sources: REMI PI+, RESI

During the height of drilling activity, RESI estimates that tax revenues will increase annually by $2.9 million on average. During the ten-year period after active drilling, tax revenues will increase by $0.3 million annually. The results shown here are additional state tax revenues associated with drilling in Garrett County only.

Figure 114 reports the total, state, and local share of property and income taxes attributable to the drilling period for Scenario 2 in Garrett County.

[265] Other taxes include other forms of fees and taxes such as licenses, permits, etc.

Figure 114: Local Income and Property Fiscal Impacts Associated with Drilling in Garrett County—Scenario 2, 75% Extraction

Year	Total Income Tax	State Share	Local Share	Total Property Tax	State Share	Local Share
2017	$311,540	$201,257	$110,283	$443,221	$45,046	$398,175
2018	$414,641	$267,860	$146,780	$589,901	$59,954	$529,947
2019	$482,240	$311,530	$170,710	$686,073	$69,728	$616,345
2020	$571,956	$369,487	$202,469	$813,710	$82,700	$731,010
2021	$578,072	$373,438	$204,634	$822,411	$83,584	$738,827
2022	$574,437	$371,090	$203,347	$817,240	$83,059	$734,181
2023	$574,911	$371,396	$203,515	$817,914	$83,127	$734,787
2024	$597,024	$385,681	$211,343	$849,374	$86,325	$763,049
2025	$525,986	$339,790	$186,196	$748,309	$76,053	$672,256
2026	$299,874	$193,720	$106,154	$426,625	$43,359	$383,265
2027	$197,067	$127,306	$69,761	$280,363	$28,494	$251,869
2028	$119,619	$77,275	$42,345	$170,180	$17,296	$152,884
2029	$66,369	$42,875	$23,494	$94,422	$9,596	$84,825
2030	$29,216	$18,874	$10,342	$41,565	$4,224	$37,340
2031	$4,542	$2,934	$1,608	$6,462	$657	$5,805
2032	-$10,531	-$6,803	-$3,728	-$14,982	-$1,523	-$13,459
2033	-$20,503	-$13,245	-$7,258	-$29,169	-$2,965	-$26,204
2034	-$21,728	-$14,036	-$7,691	-$30,911	-$3,142	-$27,770
2035	$38,479	$24,858	$13,621	$54,743	$5,564	$49,179
2036	$51,374	$33,188	$18,186	$73,089	$7,428	$65,661

Sources: REMI PI+, RESI

Appendix E—Economic and Fiscal Impacts in Other States

A number of analyses have sought to estimate the traditional economic and fiscal impacts of shale drilling in other states. The following subsections detail the findings of similar studies for New York, West Virginia, Pennsylvania, Louisiana, Texas, and Ohio.

E.1 New York

The Marcellus Shale in New York makes up 10 to 20 percent of the total Marcellus Shale Formation—most of the formation in New York is found beneath the Southern Tier of the state. In recent years, every county in southern New York has undergone exploratory drilling.[266] However, a 2013 moratorium on any additional exploration was extended until May 2015.[267] A 2009 impact analysis of natural gas production on Broome County, New York, estimated an employment impact ranging from 8,136 to 16,272 jobs, an output impact ranging from $764.9 million to $1.53 billion, and a tax revenue impact ranging from $4.3 million to $8.6 million, depending on production levels.[268]

A 2011 report analyzed the potential economic and tourism impacts of shale development in the New York Southern Tier Central Region. As visitor spending in the Southern Tier surpassed $239 million, and the tourism industry accounted for 4,691 jobs, $113.5 million in income, and nearly $31 million in state and local tax revenues in 2008, the potential negative impacts to the industry resulting from shale development are of significant concern.[269]

E.2 West Virginia

In the past decade, activity in West Virginia's Marcellus Shale play has become integral to the state's natural gas industry. In 2009 alone, more than 500 permits for shale development were issued. That same year, the entire industry—not just activity directly associated with the Marcellus Shale play—"employed 9,869 individuals and paid over $551.9 million in wages" and "paid approximately $88.4 million in property taxes to the state."[270] Analysis of the Marcellus Shale play in particular projected impacts of 7,600 jobs, $2.4 billion in output, and $14.5 million

[266] Weinstein and Clower, "Potential Economic and Fiscal Impacts from Natural Gas Production in Broome County, New York," 1.
[267] "New York State Assembly votes to block fracking until 2015," *Reuters,* March 6, 2013, accessed March 5, 2014, http://www.reuters.com/article/2013/03/06/energy-fracking-newyork-idUSL1N0BYFK320130306.
[268] Weinstein and Clower, "Potential Economic and Fiscal Impacts from Natural Gas Production in Broome County, New York," 10.
[269] Rumbach, "Natural Gas Drilling in the Marcellus Shale," 6–8.
[270] Higginbotham et al., "The Economic Impact of the Natural Gas Industry and the Marcellus Shale Development in West Virginia in 2009," 1.

in tax revenues.[271]

Drilling operations in the shale play raised new policy questions. Some key policy questions cover tax, legal, and environmental issues such as the following:

- The utilization of roads,
- The relationship between property ownership and mineral ownership, and
- The size of the local labor pool.[272]

E.3 Pennsylvania

An analysis conducted by Pennsylvania State University in 2010 estimated the Marcellus gas industry's economic impact in 2008 and projected its impact for 2009 and beyond. The study cited economic impacts for 2008 and 2009 at 29,000 and 48,000 jobs and $2.3 billion to $3.8 billion in economic activity, respectively. Fiscal impacts were estimated at $240.0 million and $400.0 million for 2008 and 2009, respectively. The study also projected impacts to 2020—175,000 jobs, $13.0 billion in economic activity, and $12.0 billion in tax revenues.[273]

Penn State's analysis showed a positive trajectory for the gas industry's impacts, with the assumption that the industry was just emerging as of 2010. According to the report, the majority of these positive impacts can primarily be attributed to the indirect impact of the gas industry requiring inputs from other sectors of the economy and the induced impact of "lease and royalty payments to land owners, who also spend and pay taxes on this income."[274]

Although the Penn State report shows significant positive economic impacts, there is much debate regarding the best methods for estimating the economic impacts of shale drilling. A 2010 Bucknell University report that assessed Penn State's analysis (as well as an earlier analysis from the same Penn State research team) discussed a number of weaknesses in the assumptions, specifically those relating to household spending patterns. The report suggests that the following additions would strengthen the Penn State analyses:

> (1) including better assumptions of when and where households spend windfall gains, (2) clarifying the process used to determine where suppliers to the industry and royalty earnings households are located (in Pennsylvania or not),

---

[271] Higginbotham et al., "The Economic Impact of the Natural Gas Industry and the Marcellus Shale Development in West Virginia in 2009," 24.
[272] Ibid, 1.
[273] The estimated tax revenues reflect the net present value over a ten-year period.
[274] Considine, Watson, and Blumsack, "The Economic Impacts of the Pennsylvania Marcellus Shale Natural Gas Play: An Update," iv.

and (3) developing a more appropriate econometric model to estimate well drilling as a function of current price and other relevant variables.[275]

Much of the analysis focusing on the economic impacts of shale drilling in northeast states cites the example of Pennsylvania. An analysis of New York drilling based on the model of Pennsylvania found that there could be a link between the presence of gas wells and better economic performance. The results suggest that gas wells correlated with higher per-capita income and job growth rates. According to the report, "These results could equally well be applied to counties in New York and other states, from California to West Virginia, that have the potential to drill for oil and natural gas."[276] For New York, the potential impact for total income could reach as high as $8 billion.[277]

E.4 Louisiana

The Haynesville shale play is located beneath northern Louisiana. As a result of relatively recent technological advancements, the shale play has begun to be explored and drilled as of the mid-2000s.[278] Much information regarding the Haynesville shale is currently unknown—however, the shale play is expected to provide significant positive impacts.[279]

A 2008 report led by the Louisiana Department of Natural Resources estimated the employment impact at 40,000 jobs over the first five years and 25,000 jobs annually thereafter.[280] Estimated impacts also include approximately $150 million in annual state tax revenues and between $2.0 billion and $3.0 billion in gross regional product from 2007 and 2023, according to the report. It should be noted, however, that the authors of the report stated that "so little is actually known of the Haynesville Shale" that they "had to make many…assumptions."[281] As a result, these impacts should be considered preliminary in nature.

---

[275] Thomas C. Kinnaman, "The Economic Impact of Shale Gas Extraction: A Review of Existing Studies," Bucknell University (January 1, 2010): 18, accessed February 12, 2014, http://digitalcommons.bucknell.edu/cgi/viewcontent.cgi?article=1004&context=fac_pubs.
[276] Diana Furchtgott-Roth and Andrew Gray, "The Economic Effects of Hydrofracturing on Local Economies: A Comparison of New York and Pennsylvania," *Growth and Prosperity Report* 1 (May 2013): 9, accessed February 12, 2014, http://www.manhattan-institute.org/pdf/gpr_1.pdf.
[277] Ibid.
[278] Dix and Albrecht, "An Economic Impact Analysis of the Haynesville Shale Natural Gas Exploration, Drilling and Production," 2.
[279] Ibid.
[280] Ibid, 8.
[281] Ibid, 4.

E.5 Texas

The Barnett Shale in north central Texas is currently the largest producer of natural gas in the continental U.S. Since drilling began, it is estimated that natural gas production has exceeded 9 trillion cubic feet.[282] Researchers found that these activities resulted in increased population, employment, income and local tax revenues.

A 2011 report investigated the benefits of investment in and production of Barnett Shale to north central Texas. The cumulative economic benefits from 2001 to 2011 "stemming from activity associated with the Barnett Shale include $65.4 billion in output (gross product) and 596,648 person-years of employment in the region, with even larger gains for the state as a whole ($80.7 billion in output and 710,319 person-years of employment)" and $5.8 billion in state and local tax revenues.[283] The Perryman Group estimated that shale activity in 2011 alone generated $13.7 billion in annual output and more than 100,000 jobs for Texas, as well as $1.6 billion in state and local tax revenues.[284]

In addition to serving as a significant fuel source for the nation, Barnett Shale activity is a substantial source of economic stimulus for Texas. The effect due to Barnett Shale activity surpasses that of aircraft manufacturing, air transportation, and motor vehicles in the state.[285] The report notes that, while "the production and development at the Barnett Shale will continue to fluctuate over time….the Barnett Shale is expected to continue to generate economic stimulus for local area and state economies for decades to come."[286]

E.6 Ohio

In 2012 the Ohio Department of Natural Resources reported that nearly 90 wells were currently producing close to 636,000 barrels and more than 12.8 billion cubic feet of natural gas from the Utica Shale formation.[287] To determine the resulting impacts of development of the Utica Shale, a study team conducted an economic development impact analysis for 2011 through 2014.

By 2014 investment in shale development is expected to generate more than $9.6 billion in output and more than $433.5 million in state and local tax revenues while supporting

---

[282] The Perryman Group, "A Decade of Drilling," 3.
[283] Ibid, 30, 5.
[284] Ibid, 18.
[285] Ibid, 25–26.
[286] Ibid, 30.
[287] "Oil & Gas Well Production," ODNR Division of Oil & Gas Resources, accessed February 13, 2014, http://oilandgas.ohiodnr.gov/production.

approximately 65,700 jobs and nearly $3.3 billion in labor income.[288] The study team concluded that, in addition to positive economic impacts (increased employment, output, labor income, and tax revenues), Ohio will also likely see "increased land and property values throughout the region."[289]

According to the research team, new drilling technologies have placed Ohio in a position to extract both oil and gas from Utica Shale plays. Utica Shale, unlike Marcellus Shale, produces both liquids and natural gas—the liquids "are valuable and can be separated from the "dry" gas (methane) through processing and fractionation procedures."[290] However, to implement horizontal drilling and hydraulic fracturing in Ohio, considerable investments will be required, including the following:

- Acquisition of mineral rights,
- Road and bridge upgrades,
- Drilling and completing wells, and
- Post-production development.[291]

END OF DOCUMENT

[288] Thomas et al., "An Analysis of the Economic Potential for Shale Formations in Ohio," 2.
[289] Ibid, 3.
[290] Ibid, 2.
[291] Ibid, 1–2.