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The Socioeconomic Impact of Uranium Mining and Milling in the Chatham Labor Shed, Virginia

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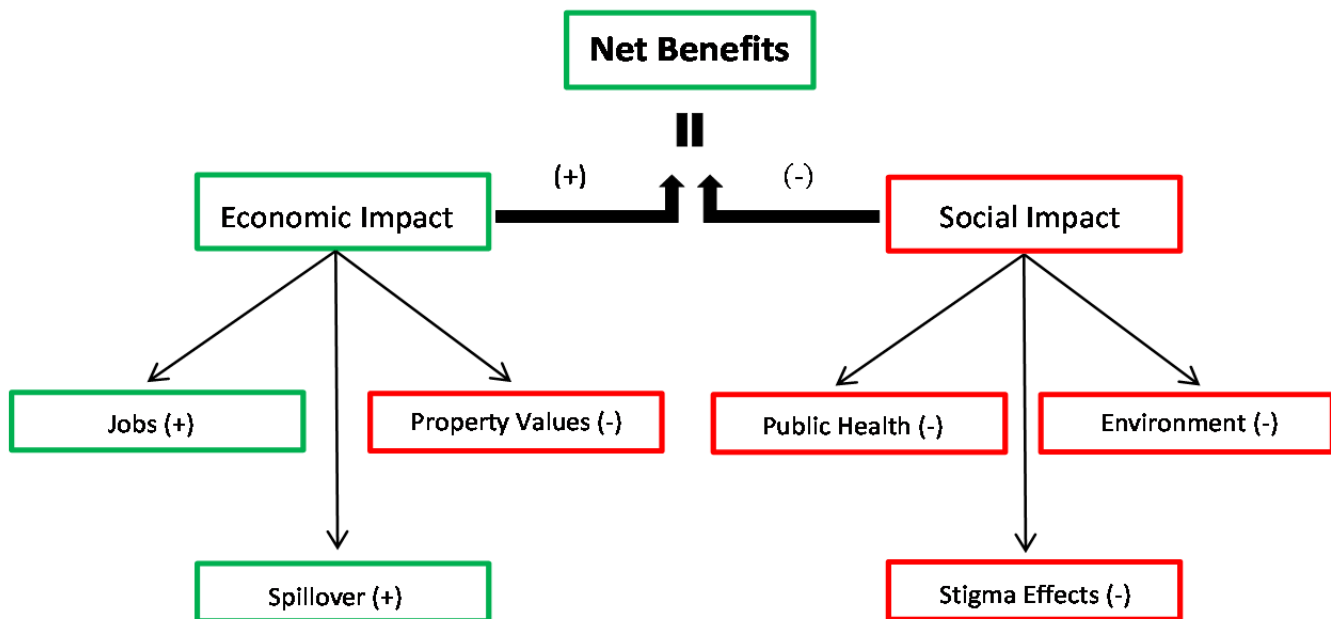
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1. Executive Summary

Virginia Uranium Incorporated (VUI) asked the Virginia legislature to lift the statewide moratorium on uranium mining and milling imposed in the 1980s so VUI can begin the permitting process for a uranium mining and milling operation at the Coles Hill site in Pittsylvania County. Chmura Economics & Analytics (Chmura) was charged by the Virginia Coal and Energy Commission with producing a socioeconomic study to broadly consider the net benefits from a mining and milling operation in the Commonwealth. This report provides the facts and context to understand the magnitude of economic benefits and the socioeconomic costs stemming from a uranium mine and mill in Virginia. Chmura’s analysis provides a framework for Virginia legislators to assess and balance the health and environmental risks against the economic rewards inherent to this industry.

The conceptual framework shown below depicts the process and components that underlie our assessment of the net benefit to Virginia from a uranium mining and milling operation:



In the opinion of Chmura, the mining and milling operations would bring substantial and much needed economic benefits to Pittsylvania County, the immediately surrounding areas, and the state. During its projected 35 years of operations, the Coles Hill site is expected to support more than 1,000 jobs annually (direct, indirect, and induced)¹ and have an annual net positive economic impact of approximately \$135 million. This net benefit comes after subtracting for a broad array of potential socioeconomic costs (such as public health and the environment) and

¹ *Direct Impact*—economic activity generated by a project or operation; *Indirect Impact*—secondary economic activity that is generated by a project or operation; *Induced Impact*—economic activity generated by increased household income and spending resulting from direct and indirect impact.

negative “stigma” effects on some sectors (such as tourism and agriculture), which under specific circumstances, Chmura judges most likely to be minimal. Over the life of the operation, the Coles Hill site could generate almost \$5.0 billion in net accumulated economic revenue for Virginia firms.

These impressive figures, however, are predicated on the assumption that the Coles Hill site will be continuously operated and ultimately decommissioned within established federal guidelines, which, by law, reduce environmental and public health risks to the surrounding communities to near negligible levels.

Chmura cannot model or predict the likelihood that these assumptions will hold true for the entire time the Coles Hill site is in existence. Similarly, we cannot predict with certainty whether the site will be maintained for centuries after its closure in such a manner that the toxic and carcinogenic substances stored at the former Coles Hill location will not adversely impact the environment or health of the surrounding communities. With this in mind, Chmura defined and analyzed four scenarios that assume various levels of environmental contamination. Scenario 2 is the “baseline” scenario and the main focus of this report.

Scenario 1: Negligible environmental impact. The qualities of air, water, noise, and soil are not materially altered from today’s existing conditions.

Scenario 2: (BASELINE) Moderate environmental impact in terms of the qualities of air, water, noise, and soil—all contamination remains within limits set by current federal standards.

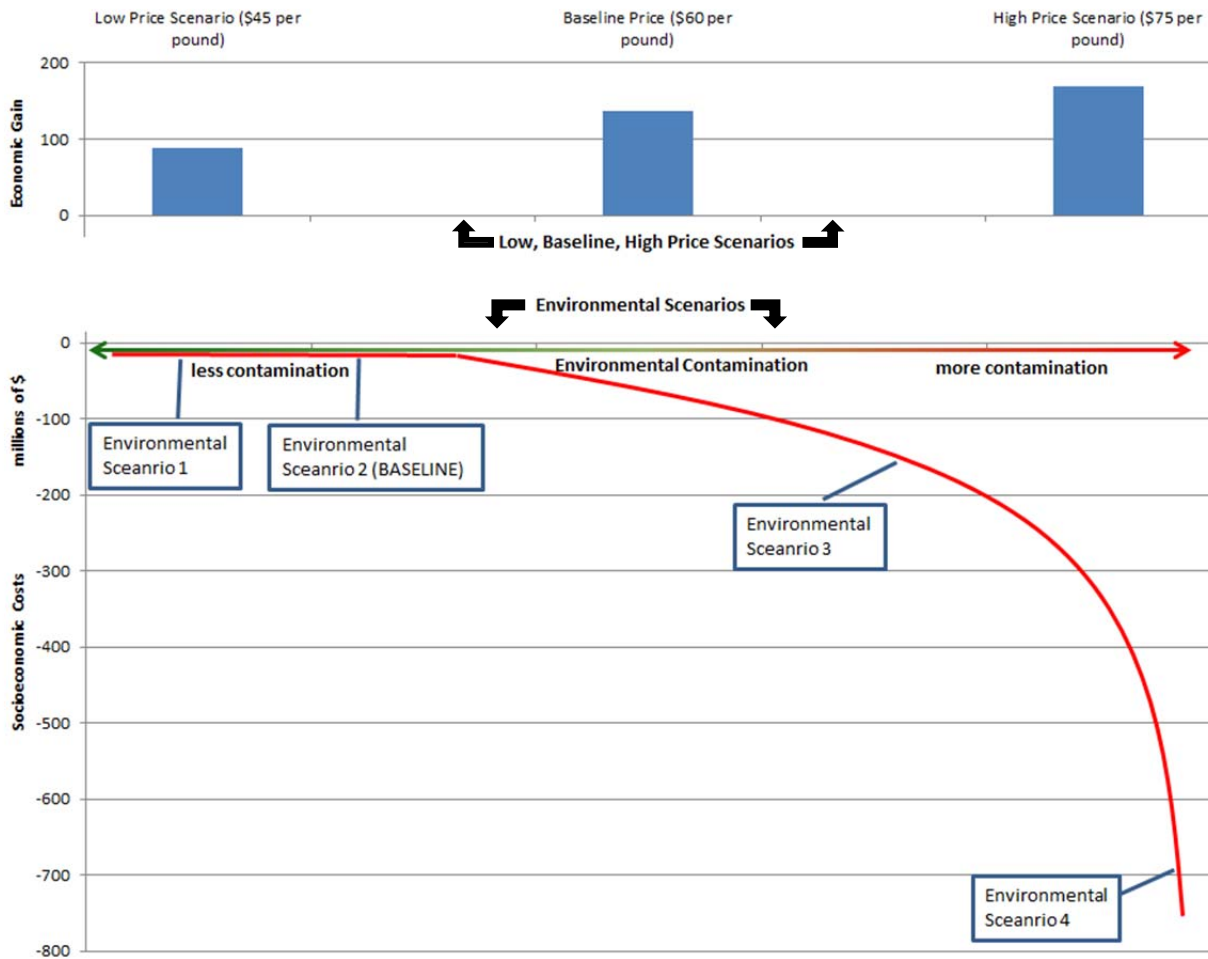
Scenario 3: Significant environmental impact in terms of the qualities of air, noise, or soil (but not water). At least in one of these three areas, (air, soil, or noise, but not water) contamination exceeds the limits set by current federal standards.

Scenario 4: Severe environmental impact in terms of the qualities of air, water, noise, and soil. Contamination of both water and at least one other area (air, soil, or noise) exceeds the limits set by current federal standards.

Chmura makes no determination as to the likelihood for each of these scenarios, save noting that Chmura believes that based on the extensive federal regulations within which VUI must operate, some advances in technology, and other reasons expressed in the report that the baseline scenario is more likely to occur than the other scenarios. Accordingly, Chmura utilizes these four scenarios to provide context and cost comparisons given these scenarios differing assumptions. Chmura assumes a \$60 price for uranium (yellowcake) in the baseline scenario, but also analyzes the economic impact of the Coles Hill site under a high (\$75) and a low (\$45) uranium price.

Chmura’s analysis concludes that under the first two scenarios, the net economic impact for Pittsylvania County as well as for Virginia is clearly substantial and positive. However, the risks and rewards are not balanced, and the adverse economic impact under the worst-case scenario is nearly twice as great as the corresponding positive impact in our best-case scenario. Under scenario 3, the Coles Hill operation would still provide a positive net economic impact over the long-term so long as the mine and mill operated for roughly 10 years before environmental contamination reached the levels assumed in this scenario. Under scenario 4, the Coles Hill site unambiguously has a negative net economic impact no matter how long the site operates before environmental contamination reached the levels assumed in this scenario. A key finding, however, is that the most significant driver of the socioeconomic costs is not the reclamation and remediation price-tag to clean-up the environment, but rather the potential negative stigma effects impacting agriculture, tourism, and possibly other industries. It may also be possible to mitigate some of these stigma effects to reduce the negative impact.

Summary Socioeconomic Benefit (Peak Year Impact)



The majority of the report analyzes and models the socioeconomic impact of the baseline scenario, which assumes underground mining techniques will be employed by VUI. Chmura finds that under the baseline scenario the Coles Hills site brings much needed jobs and investment to an area of Virginia that remains economically depressed. Alternative uranium price scenarios, as well as the socioeconomic impact of alternative environmental contamination scenarios and for VUI utilizing open pit mining techniques are analyzed and addressed fully in the appendix.

Key findings of Chmura’s analysis of the baseline scenario:

- The Chatham Labor Shed²—Pittsylvania County and a few adjacent localities—has lower income and education levels and higher unemployment and poverty rates than Virginia as a whole. The area badly needs investment and economic development opportunities.
- The Coles Hill site will generate jobs and a net economic benefit during all three phases—construction, operation, and decommissioning and reclamation.
- During the construction phase, the investments in the Coles Hill site would support 323 jobs annually (direct, indirect, and induced) in Virginia. Roughly 75 percent of these jobs would likely be filled by residents of the Chatham Labor Shed. The roughly 3-year construction phase would have a net economic impact of over \$35 million per year and would generate roughly \$2.5 million per year in state and local taxes.
- During the operational phase, the Coles Hill site will support 1,052 jobs (direct, indirect, and induced) in Virginia, and about half of these jobs are likely to be filled by the residents of the Chatham Labor Shed. The projected 35-year operational phase will generate \$135 million per year of net economic benefits to Virginia and produce approximately \$3.1 million per year in state and local taxes. Remediation spending will add a total of \$25 million in net economic impact and, assuming this money is largely spent in the final 20 years of the mine, it will generate an additional 13 jobs per year in Virginia over this period.
- This impressive positive economic impact is net of anticipated socioeconomic costs realized due to possible negative stigma effects, added costs of regulation, added use of public services, emergency planning, and risks to public health and the environment.
- Assuming the Commonwealth of Virginia becomes an agreement state for the purposes of regulating the mill tailings portion of the Coles Hill operation, Virginia will need to spend an additional \$2.5 million per year to monitor the industry.
- Given the assumptions of the baseline scenario, any negative stigma effects on real estate are likely to be localized, short-lived, and minimal. Chmura estimates that the approximately 175 residences located within a 2-mile radius are likely to see an impairment of their real estate values. Chmura estimates this loss to be 5 percent.
- Given the assumptions of the baseline scenario, prudent management, and transparent communication between VUI and the public, neither the tourism nor the agricultural sector are likely to experience any decline due to the Coles Hill operation. Chmura judges it unlikely that any private school in the area will be harmed by the Coles Hill operation.

² Pittsylvania County, Danville City, Campbell County, Halifax County, Henry County, Martinsville City, Franklin County, Bedford County, and Bedford City.

- Under the assumptions of the baseline scenario, the Coles Hill operation will not result in any increase in cancer rates or other fatal illnesses. A portion of the approximately 2,700 people living within five miles of the Coles Hill site who are already sensitive to air quality issues could experience increased asthma-related symptoms or other respiratory problems.
- Given the assumptions of the baseline scenario, the Coles Hill operation poses minimal risk to degrade the surrounding environment—air, soil, and water. Natural vistas and landscapes within a one-mile radius of the site are likely to be negatively altered.
- The Coles Hill operation will not induce a large in-migration of people to the region and thus there is little chance that the Coles Hill site will strain the resources of public services—schools, police, and fire—or other public and civic institutions.
- Addressing the issue of environmental justice, African Americans, the area’s predominant minority community, are unlikely to be disproportionality impacted—either positively or negatively—by the Coles Hill site relative to their peers. The Virginia chapter of the National Association for the Advancement of Colored People currently opposes uranium mining in Virginia.
- Chmura judges the Coles Hill site will not adversely affect the image of the region nor erode the quality of life for the residents of Pittsylvania County. Conversely, given the assumptions of the baseline scenario, the added economic benefit will likely improve the quality of life via increased economic opportunities.

Overall, Chmura found that residents of the Chatham Labor Shed were of mixed opinion as to whether the benefits of the Coles Hill operation would outweigh the costs and risks to public health and the environment. Most citizens of the region were aware of the poor track record of the uranium industry as a steward of the environment, and many were correspondingly skeptical of VUI’s ability to be a good steward of the environment. A vast majority were skeptical of state or federal authorities to safeguard the environment or public health via an enhanced regulatory environment.

Chmura notes, however, that several steps could be taken to mitigate some of this skepticism and bolster the public’s confidence in VUI as well as in state and federal regulatory agencies. These steps include the signing of an “Impact-Benefit Agreement” between VUI and Pittsylvania County, the establishment of permanent Environmental Quality Committees, and the utilization of “adaptive management” practices by VUI.

About the authors:

This report was authored by Chmura Economics & Analytics, LLC (Chmura) with input from Issues Management Group, LLC (IMG) in sections 6-8. Chmura is an applied economic consulting firm headquartered in Richmond, Virginia. IMG is a management consulting firm based in Roanoke, Virginia. Chmura and IMG declare no conflicts of interest in the production of this report.

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2. Background

In the early 1980s, a significant deposit of uranium (the current estimate for the deposit is 119 million pounds) was found outside the town of Chatham, Virginia, which is located in Pittsylvania County. In 1982, the Virginia General Assembly placed a moratorium on uranium mining in the Commonwealth until both proper regulations and a formal permitting process were put in place. However, because of the decline of the nuclear industry in the early 1980s interest in mining Coles Hill (located about 5 miles northwest of the Town of Chatham) subsided, and the General Assembly never wrote the necessary regulations or lifted the moratorium.

With the growing international demand for uranium ore and its associated 'clean energy' generation, the significant deposits of uranium in Coles Hill, Virginia have become a heightened matter of legislative importance. The deposit on Coles Hill is estimated to be the largest undeveloped uranium deposit in the United States. In 2007, the families that own the uranium-rich land, along with dozens of local investors, formed Virginia Uranium Inc. (VUI) to utilize the vast resource. However, in order to develop the uranium sites in Coles Hill, the moratorium imposed by the Virginia General Assembly needs to be lifted.

In 2008, the Virginia Coal and Energy Commission ("the Commission") created the Uranium Mining Subcommittee (the "Subcommittee") whose efforts are aligned with the Virginia Center for Coal and Energy Research (VCCER) to oversee a technical study of uranium mining and milling operations by the National Academy of Sciences (NAS). NAS has been charged to examine the public health, safety, environmental impacts, and other technical aspects of uranium mining in Virginia and deliver a technical report including a review of other studies that support the full Commission in the area of policy development with regard to uranium mining. On a parallel track, the Virginia Coal and Energy Commission charged Chmura to produce a socioeconomic impact study to provide clarity around the major issues of safety, regulatory policies, public health and toxicity, overall quality of life, and the economic and fiscal impacts from uranium mining and milling on the region and the Commonwealth.

The Chmura report defines the geographical reach of the socioeconomic impacts within the Commonwealth and surrounding Coles Hill site of uranium mining and milling operations. The Chmura report quantifies and qualifies both the economic impact from the ore and the benefits to the Commonwealth and the localities. It also models the costs and benefits of mining the ore to the state and the regions assuming VUI utilizes current technologies as described in company documents. Use of the most updated technology is essential for preserving the quality of life for the individuals in both the Commonwealth and the localities surrounding the Coles Hill site. The following is a list of four major impact components that will drive the conversation and decision-making process within the Commission:

1. Economic impacts
2. Government services and regulatory impacts
3. Public health and environmental impacts
4. Societal impacts

3. Methodology

This section illustrates the methodology used by Chmura in studying the social economic impact of uranium mining and milling in Virginia. This section provides a brief review of the other social economic studies of uranium operations in both the United States and around the world. Also included are more details regarding economic impact methodology, social impact methodology, and data collection and analysis methods.

3.1. Literature Review

3.1.1. Prior Studies on Coles Hill

In August 1984, under contract with Virginia Coal and Energy Commission, the Tayloe Murphy Institute of the University of Virginia published “Cost-Benefit Analysis of Mining & Milling Uranium at the Swanson Site in Pittsylvania County, Virginia”. The study found that the benefits of uranium mining and milling in Virginia include employment and taxes from both the construction and the operation phase of the project. The study also quantified the cost of the project, including cost of approval, monitoring, and protection, as well as infrastructure needed. The study qualitatively discussed the environmental effects of the project on radiation and air and water quality, but did not make a formal estimate of those effects. The study concluded that the benefit to cost ratio is 26:1 for the project.

In 1984, SENSES Consultants Limited of Canada were retained by the Uranium Subcommittee to undertake an evaluation of potential radiological risks associated with uranium development in the Commonwealth of Virginia. This study concluded that uranium development in Virginia can be undertaken with minimal risks.

3.1.2. Other Social Economic Studies

Experiences from other parts of the country can shed light on the economic and social impacts that could be experienced in Virginia. In recent years, proposals for uranium mining and milling have been advanced in several states such as New Mexico, Texas, and Colorado. Social economic studies regarding those projects are summarized here.

In July 2007, Hicks & Company in Austin, Texas drafted the report “Socioeconomic and Ecological Assessment in Support of the License Application for the Goliad County ISR and Uranium Processing Facility, Goliad County, Texas”. This study examined the impact of in-situ leaching³ and uranium processing operations in Goliad County, Texas. Goliad is a small and rural county that lagged behind the state average in terms of income and educational attainment. The benefits of uranium mining and processing comes primarily from increased employment, better income, and business sales from the project. This study also discussed other impacts of the project such as transportation and ecological impacts.

In New Mexico, the state is exploring the option of new uranium mining and milling operations. In 2008, the Arrowhead Center of New Mexico State University published a report titled “The Economic Impact of Proposed

³ In-situ leaching (ISL) is also known as solution mining, or in situ recovery (ISR) in North America. This involves leaving the ore where it is in the ground, and recovering the minerals from it by dissolving them and pumping the loaded solution to the surface where the minerals can be recovered. Source: <http://www.world-nuclear.org/info/inf27.html>.

Uranium Mining and Milling Operations in the State of New Mexico”.⁴ This study assumes that the uranium (yellowcake) price will stay at \$90 per pound. The study estimated that in this scenario, a total of 315 million pounds of uranium will be produced in 30 years from 2012 to 2042. The researchers concluded that capital expenditures of \$2.1 billion would generate total economic impacts of \$3.1 billion and 12,586 jobs during the construction phase. The ongoing operation of uranium mining and milling in the state can generate \$0.9 billion per year and support 8,289 jobs in the state. The number of direct jobs in mining and milling is 3,265 per year in the state.

In October 2008, the New Mexico Environmental Law Center released a critical evaluation of the above Arrowhead report, titled “An Economic Evaluation of a Renewed Uranium Mining Boom in New Mexico”.⁵ This study stated that the Arrowhead report exaggerated the economic impacts by using a relatively high uranium price assumption, and low labor productivity assumptions. The study also stated that the Arrowhead report did not address the ongoing environmental and public health costs after the mining operation is shut down. This study also stated that uranium mining is subject to the boom/bust cycle of mining operations, and the region needs to diversify its economic base in preparation for the eventual termination of mining and milling operations.

In November 2009, The Louis Berger Group of Colorado prepared the study “Socioeconomics Baseline and Impact Analysis for the Proposed Piñon Ridge Uranium Mill, Montrose County, Colorado”. This study examined the impact in a region of 80 kilometers around the proposed uranium mill. The study provided a comprehensive description of both the social and economic backgrounds of the region, and also estimated the jobs and fiscal revenues resulting from the construction and operation of the proposed Piñon Ridge Mill. This study did not address the environmental and health effects of uranium milling in the region. An environmental watchdog group, the Sheep Mountain Alliance, published a separate socioeconomic study that challenged some of the findings of the Louis Berger Group study.⁶ The Sheep Mountain Alliance study posits the mill will create fewer jobs in the region than what was predicted by the Louis Berger Group and the long-term costs of the mill will be greater.

In February 2011 the U.S. Department of the Interior, Bureau of Land Management, Arizona Strip District received a socioeconomic study for the “Northern Arizona Proposed Withdrawal Environmental Impact Statement” prepared by SWCA Environmental Consultants.⁷ This study examined the socioeconomic impact of four separate scenarios allowing mining on public lands in northern Arizona, utilizing a uranium (yellowcake) price of \$40 per pound. It also addressed the public health and environmental implications for uranium mining operations in northern Arizona.

The American Clean Energy Resources Trust, a mining industry-affiliated non-governmental organization, received “Economic Impact of Uranium Mining on Coconino & Mohave Counties, Arizona”, a study conducted in 2009 by Tetra Tech.⁸ This study addressed the economic impact of uranium mining in northern Arizona, applying a uranium (yellowcake) price of \$50 per pound, but did not address any environmental or public health risks associated with the project.

⁴ Source: Office of Policy Analysis, Arrowhead Center, Inc. New Mexico State University, Las Cruces, New Mexico, August 1, 2008. Available at: <http://arrowheadcenter.nmsu.edu/policyanalysis/documents/uraniumreportaugust2008final.pdf>.

⁵ New Mexico Environmental Law Center, prepared by Thomas Power, Research Professor and Professor Emeritus, Economics Department, University of Montana.

⁶ “A Socioeconomic Analysis of the Impact of the Proposed Piñon Ridge Uranium Project on Western Mesa, Montrose, and San Miguel Counties, Colorado” Sheep Mountain Alliance, 2010.

⁷ “Northern Arizona Proposed Withdrawal Environmental Impact Statement” U.S. Department of the Interior, Bureau of Land Management. Available at: <http://www.blm.gov/pgdata/etc/medialib/blm/az/pdfs/withdraw.Par.15612.File.dat/Socio-Report.pdf>.

⁸ “Economic Impact of Uranium Mining on Coconino & Mohave Counties, Arizona” American Clean Energy Trust. Available at: http://acertgroup.com/Economic_Impact.pdf.

The Bureau of Land Management (BLM), Monticello Field Office conducted an environmental analysis in 2009 in conjunction with SWCA Environmental Consultants to assess the potential environmental impacts associated with the Daneros Mine Project, which addressed some socioeconomic issues.⁹ The Monticello Field Office evaluated two alternatives regarding the Daneros project, which was a proposal for a small underground uranium mine situated in Bullseye Canyon in San Juan County, Utah. The Daneros mine property comprises 65 unpatented mining claims located on public lands. The BLM ultimately concluded the Daneros mine project presented only minimal risks to both public health and the local environment, and allowed the mining project to go forward contingent on several conditions being implemented in terms of mine safety and additional measures aimed at augmenting existing environmental protections. A comprehensive socioeconomic study, however, was not conducted for the Daneros mining project.

These studies highlight the need for a socioeconomic impact study that will not only estimate the jobs and revenue benefits of a mining and milling operation, but also provide a comprehensive assessment of the long-term environmental and public health impact of the operation on the region.

3.2. Economic Development Method

In this report, Chmura has estimated the economic and fiscal impacts from uranium mining and milling in the following three phases:

- 1) Construction of the mine and milling plant
- 2) On-going operations of the mine and milling plant
- 3) Cessation of active mining and milling operations

The start-up phase will have a construction-intensive economic impact component. During this phase, local government revenue may be less than what it would be during the on-going operations of the mining and milling operations. At the conclusion of the construction phase, some of these workers may be used in the second phase (on-going operations of the mine) if their skills are transferable. The cessation of active mining and milling operations has been estimated as the third phase.

Chmura has also analyzed the indirect jobs created as a result of the start-up and ongoing operations from the mining and milling operations in Pittsylvania County. The IMPLAN Pro model,¹⁰ which is preferred by economists for impact studies, will be utilized in this analysis. In addition to indirect jobs (those created when the mine or mill purchases supplies from firms in the region), induced jobs will be estimated (those created when employees from the mine, milling operation, or suppliers spend their income in the region). Employment has been identified by industry (retail, medical offices, residential construction, etc.) as well as by geographic region. Since uranium mining and milling operations do not yet exist in Virginia, it is likely that some supplies will initially be purchased outside the region or state, but will later be purchased nearby as suppliers choose to expand into the region.

⁹ U.S. Department of the Interior, Bureau of Land Management. Available at: http://www.blm.gov/pgdata/etc/medialib/blm/ut/monticello_fo/Minerals/daneros_mine_project.Par.20380.File.dat/Final%20Environmental%20Assessment%20and%20Decision%20Record.pdf.

¹⁰ IMPLAN Pro was created by Minnesota IMPLAN Group, Inc. (MIG). It uses classic input-output analysis along with regional specific social accounting matrices and multiplier models.

Chmura has modeled the scope of the economic impact and jobs based on the geographic reach of the project (labor market shed) in terms of jobs that will be indirectly needed to support the operations.¹¹ The economic impact has been evaluated for both the Chatham labor market shed (this is defined in Section 4) and the entire Commonwealth. Chmura understands that the types of mining processes may be either surface mining (open pit) or below-the-surface (underground) excavation. Chmura's mining advisors as well as the Scoping Study prepared for Virginia Uranium Incorporated has provided the types of mining scenarios most likely to be deployed at the site. Chmura has analyzed both types of mining operations for start-up and operations through the life cycle of the mine and its eventual shut-down of operations. VUI has indicated that underground mining is the more likely technique to be employed at Coles Hill, so Chmura assumes this method of production in its baseline estimates, while open pit mining is addressed in the appendix.¹²

The economic impact of any business that may close due to the opening of the uranium mining and milling operation has been analyzed and estimated. The multiplier impact of any job lost due to this project has been estimated using the IMPLAN Pro model. Potential revenue losses have been measured based on the type of taxes assessed in the county. Revenue generated has been estimated from the IMPLAN Pro model as well as case studies of mining and milling operations.

The economic impact has been estimated for local and state taxes based on current taxes levied. Local taxes typically include: one percent portion of the sales tax; personal property; machine tool taxes; and business, professional, and occupational licenses (BPOL). State taxes include the state portion of the sales tax as well as personal and corporate income taxes. In addition to estimating the tax revenue, cost estimates have been created to address the infrastructure needs for the localities impacted by the new jobs in terms of the propensity of the localities to absorb the project. Some examples include police and fire protection, capacity for schools to absorb new students in the K-12 pipeline, and available housing.

Chmura has conducted a literature review regarding previous studies that addressed real estate-related impacts from mining and milling operations. There is a paucity of comparable sites in the United States that can be used to specifically conduct a before-and-after scenario for real estate values and housing as they would be impacted by uranium mining. However, the existing literature and research on the "stigma" effects on property values related to environmental contamination and undesirable industries is sufficient to draw some conclusions.

The economic impact of the cessation of active mining and milling operations has been addressed by first reviewing prior studies that address how the mine and mill will be shut down and/or whether they can be converted to another use. Case studies have also been utilized to estimate plausible scenarios for the Chatham facilities. Once scenarios are created, IMPLAN Pro will be used to identify the direct and indirect impact on employment in the region. Revenue generation will be assessed relative to taxes levied.

3.3. Government Service and Regulation

In keeping with the research methodology, Chmura has reached out to state and federal government regulatory and operating agencies including, for example, the Nuclear Regulatory Commission (NRC), the Federal Energy

¹¹ Chmura used Census commuting pattern data to define the labor market shed.

¹² VUI website: FAQ (<http://www.virginiauranium.com/faqs.php>).

Regulatory Commission (FERC), and the U.S. Navy to gather data on actual experiences related to all phases of the socioeconomic study.

Chmura has projected the costs of local and state regulatory and monitoring requirements of the entire spectrum of the uranium mining process. While historical data were utilized from other states—such as Arizona and Colorado—that currently monitor and regulate existing uranium mining operations, Chmura also utilized and updated the cost estimates provided in 1984 that relate to the cost of the Commonwealth of Virginia to take on the responsibility of regulating the uranium industry.

Given that some increases in both employment and population will accompany the mining operation and supporting industries, Chmura has projected the impact on existing public schools in the region. Chmura is aware of the presence of a number of private schools in the region and has sought their input on pertinent quality of life and socioeconomic issues.

Chmura has projected the local and state costs for contingency planning and disaster preparedness. Chmura—mindful of recent man-made and natural disasters—has analyzed the upstream and downstream costs associated with the mining and milling operations as well as the costs associated with environmental remediation efforts against four distinct scenarios.

Scenario 1: Negligible environmental impact. The qualities of air, water, noise, and soil are not materially altered from today's baseline norms.

Scenario 2: BASELINE: Moderate environmental impact in terms of the qualities of air, water, noise, and soil—all contamination remains within limits set by current federal standards.

Scenario 3: Significant environmental impact in terms of the qualities of air, noise, or soil (but not water). At least in one of these three areas, (air, soil, or noise, but not water) contamination exceeds the limits set by current federal standards.

Scenario 4: Severe environmental impact in terms of the qualities of air, water, noise, and soil. Contamination of both water and at least one other area (air, soil, or noise) exceeds the limits set by current federal standards.

Chmura makes no determination of the likelihood for each of these scenarios, save noting that the baseline scenario is more probable than the others to occur. The basis for this determination is detailed throughout this report but stems primarily from the strict regulatory environment that VUI will have to operate within and advances in tailings management technologies and industry practices that work to minimize the impact on the environment from the uranium mining and milling operations. This judgment assumes that the current regulatory environment—if fully enforced—is sufficient to result in a “moderate” environmental impact. There is some debate as to whether the current standards for regulating the uranium industry in the United States adequately protect the environment and public health. Such a debate is outside the scope of this report and will be addressed by the National Academy of Sciences study on uranium mining in Virginia.¹³ Accordingly, Chmura has simply utilized these four scenarios to provide context and cost comparison given these differing assumptions. Chmura is aware that watershed safety

¹³ See <http://dels.nas.edu/Study-In-Progress/Uranium-Mining-Virginia/DELS-BESR-09-06>.

issues are potentially the most volatile issues involved in the uranium mining and milling process. Chmura is not in a position to determine the likelihood of the risks associated with potential water contamination, because the type of mining operation to be employed and its tailings management system would first need to be established. However, the probability distribution of these water-related risks deserves additional study and consideration. Chmura has provided some suggestions for the sources of funding that would offset the costs of all items included in this section.

3.4. Public Health and Environment

Chmura recognizes that both public health and the environment are matters of great importance to consider in this study. Following the natural disaster in Japan, as well as man-made calamities such as the Massey Coal mining disaster in West Virginia, the BP oil spill in the Gulf of Mexico, and the dramatic rescue operation of copper-gold miners in Chile, the entire world has a new appreciation on the negative impacts of energy- and mining-related issues. Natural phenomena have repeatedly counseled us to be humble in our assumptions regarding the likelihood and extent of an extreme event. The August 2011 earthquake in central Virginia only adds to the sense of caution when evaluating the long-term impact of uranium mining and milling operations. Scientific studies concerning long-term exposure to heavy metals and mildly radioactive substances are incomplete and inconclusive. The possibility for extensive environmental degradation due to unseen natural disasters can never be ruled out. Additionally, the historic track record of the uranium industry—largely forged in the unregulated period of the 1950s and 1960s—is poor with an established legacy of water, soil, and air contamination, which has elevated the health risks for the surrounding communities.

In keeping with the case study approach, Chmura has reviewed the relevant public health research and instances of environmental contamination. This is to inform residents in Chatham and the surrounding areas about the impact of mining and milling operations on the quality of life. The issue of environmental justice is of great consequence in this case. Chmura has reached out to minority and vulnerable communities, as well as other key stakeholders to inform this study and hear directly the concerns of these groups. Utilizing previous impact assessments and existing case studies, Chmura has analyzed the impact of uranium mining and milling on the landscape, wildlife, and scenic appeal of Pittsylvania County and its historic sites. The impact of uranium mining and milling on tourism and recreational hunting, boating, and fishing are addressed in the economic impact section (Section 5). Chmura has investigated and modeled the added healthcare costs associated with the introduction of uranium mining and milling operations. Chmura has also reviewed both the problems and best practices associated with the post-closure process in order to give a balanced view of the legacy issues that will be the responsibility of subsequent generations of Virginians.

3.5. Social Impacts

Chmura evaluated the various economic impacts regarding the potential stigma associated with the uranium industry (Section 5). This section explores the impact on the region's overall image, aesthetics, and general investment attractiveness after the introduction of mining and milling operations. Chmura has reviewed the company controlling the Coles Hill deposit and has made some suggestions to bolster public confidence in this company. This section is inherently speculative and guided by the four scenarios outlined in Section 3.3. The impact on local schools has been explicitly addressed in the economic impact section (Section 5). Chmura's analysis in this section was highly influenced by extensive focus groups, interviews with regional stakeholders, industry experts, environmentalists, and other non-governmental organizations. Also included are case studies and interviews with public officials from localities in France with extensive uranium mining experiences and traditions.

4. Economic Background of the Region

4.1. Definition of Economic Region

The relevant economic area largely consists of Pittsylvania County as well as the surrounding areas that have strong economic linkages to the county. This area is referred to as the Chatham Labor Shed in this report. This section delivers a demographic and economic background of the Chatham Labor Shed, and provides a baseline that the economic impact of the potential uranium mining and milling operations will be measured against. The region for environmental impact analysis is different, as the boundary of the environmental impact could be as broad as the area defined by the natural watershed around the Coles Hill site.

The definition of the relevant economic (the Chatham Labor Shed) area is based on the commuting patterns to Pittsylvania County. Based on 2000 commuting flow to the county (latest data available), 94 percent of all individuals working in Pittsylvania County lived in the cities and counties shown in the map on the next page which are defined as the economic region in this study.¹⁴ The percentage of expected employment in each of the localities that make up the Chatham Labor Shed is shown in Table 4.1.

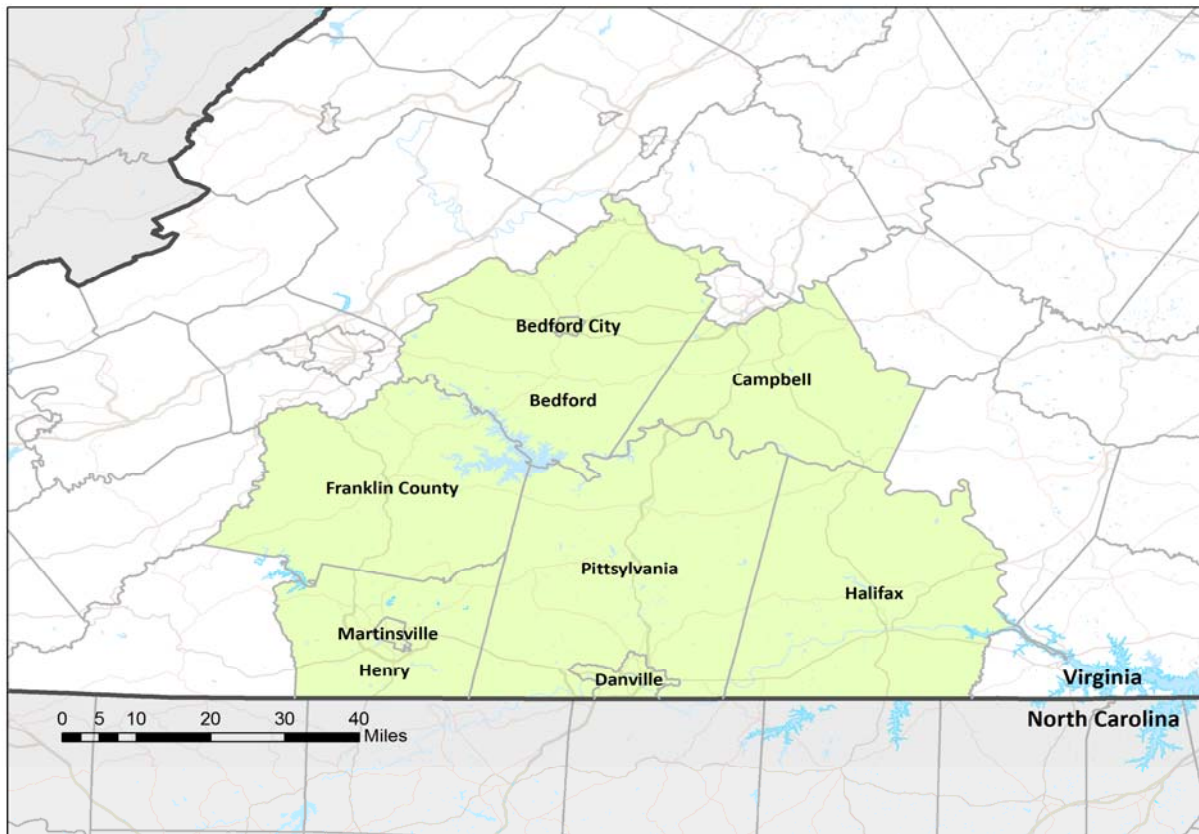
Table 4.1: Expected Residence of Workers Commuting to the Coles Hill Site Based on Census Commuting Data (2000)

Residents' Virginia Locality	% of Total Workers
Pittsylvania County	70%
Danville City	16%
Campbell County	3%
Halifax County	2%
Henry County	1%
Franklin County	1%
Bedford County	1%
Martinsville City	0%
Bedford City	0%

Source: U.S Census

¹⁴ Two North Carolina counties that supply a large number of commuters to Pittsylvania are excluded. They are Caswell with 355 commuters and Rockingham with 138 commuters. The reason for their exclusion is that the scope of the economic impact is restricted to Virginia. An industry expert suggested that it is not atypical for a miner to drive an hour to work. The most distant locality in this defined area, Bedford County, is 48 miles to Chatham, or roughly a one-hour commute.

Figure 4.1: Chatham Labor Shed



4.2. Demographics

4.2.1. Population Growth

Population growth is an important indicator of an expanding economy and of vibrant communities. Both an expanding labor force and economy attracts new residents. Further, the influx of population into an area stimulates the housing market, retail business, and overall consumption resulting in a larger tax base for the community.

Table 4.2: Service Area Population and Growth

Virginia locality	Population 2000	Population 2010	Average Annual Growth Rate
Pittsylvania County	61,745	63,506	0.28%
Danville City	48,411	43,055	-1.17%
Campbell County	51,078	54,842	0.71%
Halifax County	37,350	36,241	-0.30%
Henry County	57,930	54,151	-0.67%
Martinsville City	15,416	13,821	-1.09%
Franklin County	47,286	56,169	1.74%
Bedford County	60,371	68,676	1.30%
Bedford City	6,299	6,222	-0.12%
Total Labor Shed	385,886	396,683	0.28%
Virginia	7,079,030	8,001,024	1.23%

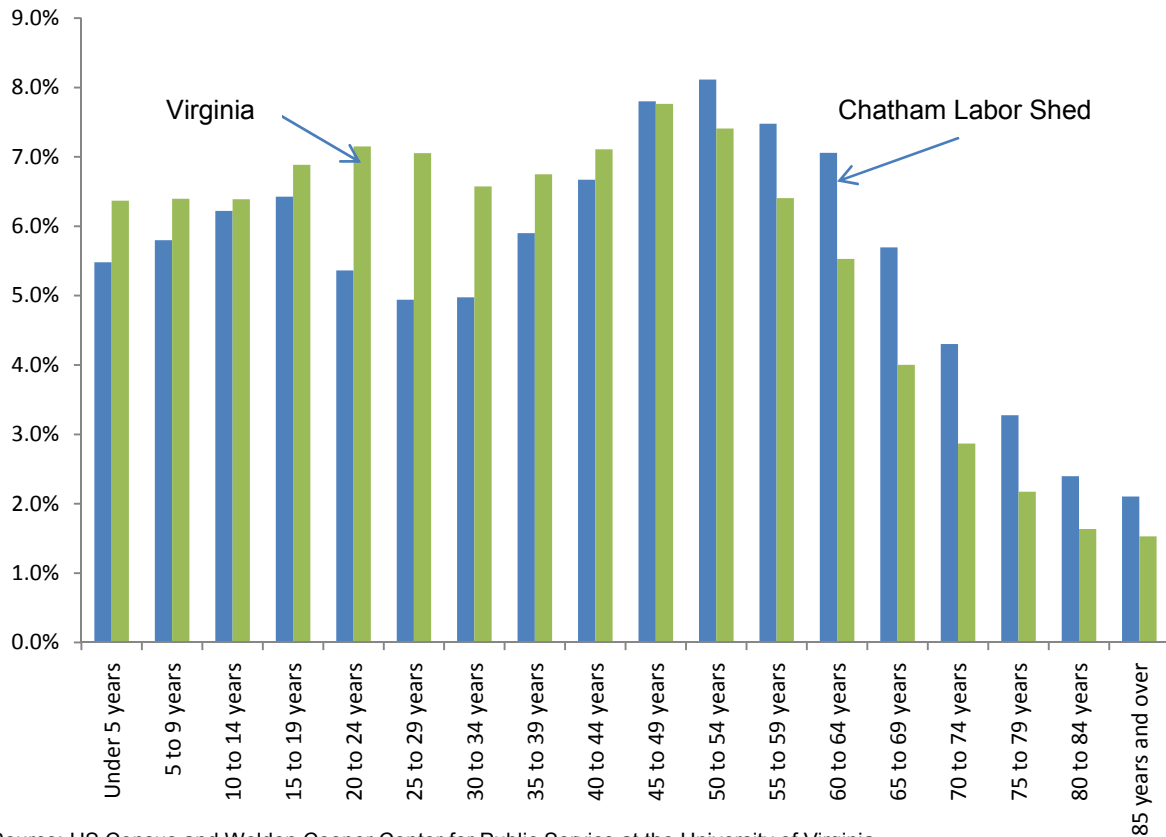
Source: U.S. Census and Weldon Cooper Center for Public Service

The total population in the Chatham Labor Shed was 396,683 based on the April 2010 Census.¹⁵ From 2000 through 2010, the pace of population change in the Chatham Labor Shed lagged behind the state average. The population of the Chatham Labor Shed grew at an annual rate of 0.3 percent per year, compared with 1.2 percent population growth statewide. Within the Chatham Labor Shed, Pittsylvania County grew 0.3 percent per year, similar to the regional average. The highest growth rate was in Franklin County (+1.7 percent), followed by Bedford County (+1.3 percent), both growing faster than the state as a whole. Population contracted an average of 1.2 percent per year in the city of Danville over the decade. Martinsville City, Henry County, and Halifax County also suffered population decline during the decade.

4.2.2. Age Distribution

Age distribution is affected by birth, death, and migration rates. An aging population implies more need for health care and related services for the region. On the other hand, a younger population comprises and defines the workforce of the future. However if the regional economy does not provide sufficient employment opportunities the region may risk losing some of the talented young population.

Figure 4.2: Age Distribution: Labor Shed vs. Virginia (2010)



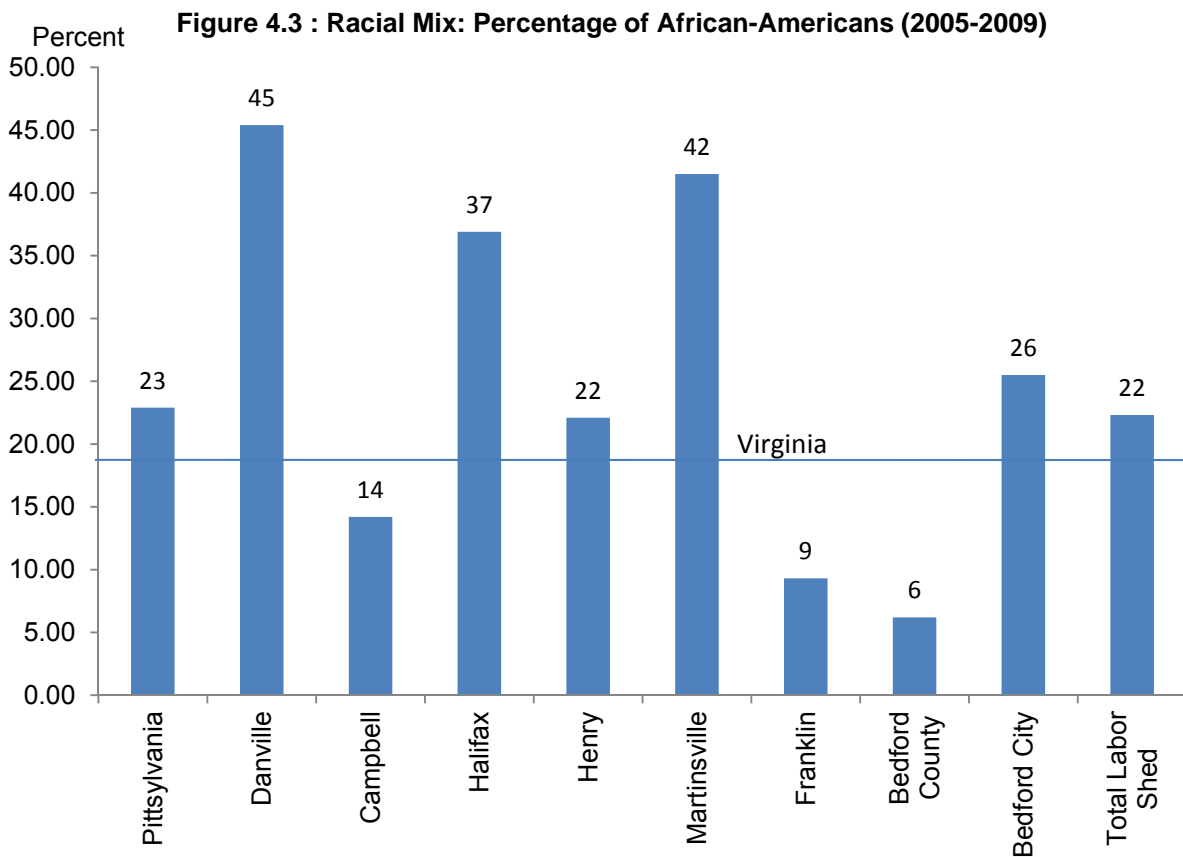
Source: US Census and Weldon Cooper Center for Public Service at the University of Virginia

¹⁵ U.S. Census and Weldon Cooper Center for Public Service at the University of Virginia.

The age distribution of the labor shed reflects an area with fewer young people and more senior residents than the state as a whole. In 2010, 23.9 percent of the labor shed population was under 20 compared to 26.0 percent in Virginia. Also in the same year, 17.7 percent of the labor shed's population was over 65 compared to only 12.2 percent in the state. Only 10.3 percent of the labor shed population was between age 20 and 30, while 14.2 percent of the state population belonged to that age group. These were young people in the phase of both going to college and entering the workforce. The low percentage of this age group indicates a lack of the economic opportunities for the region, as they had to seek employment elsewhere.

4.2.3. Race Distribution

The Chatham Labor Shed has a higher concentration of both whites and African-Americans than the state average. According to data from the 2005-2009 American Community Survey (ACS), 74.6 percent of the Chatham Labor Shed population was white and 22.3 percent was African-American. By comparison, 70.7 percent of Virginia's population was white and 19.6 percent was African-American during the same period. The racial composition of the service region varies greatly by locality as shown in Figure 4.3; the city of Danville had the highest proportion of African-Americans at 45.4 percent during the period of 2005 to 2009, followed by Martinsville with African-Americans making up 41.5 percent of its population. Less than 10 percent of Franklin and Bedford Counties' populations was African-American. Pittsylvania County's population was 22.9 percent African-American, which was close to the average for the labor shed.

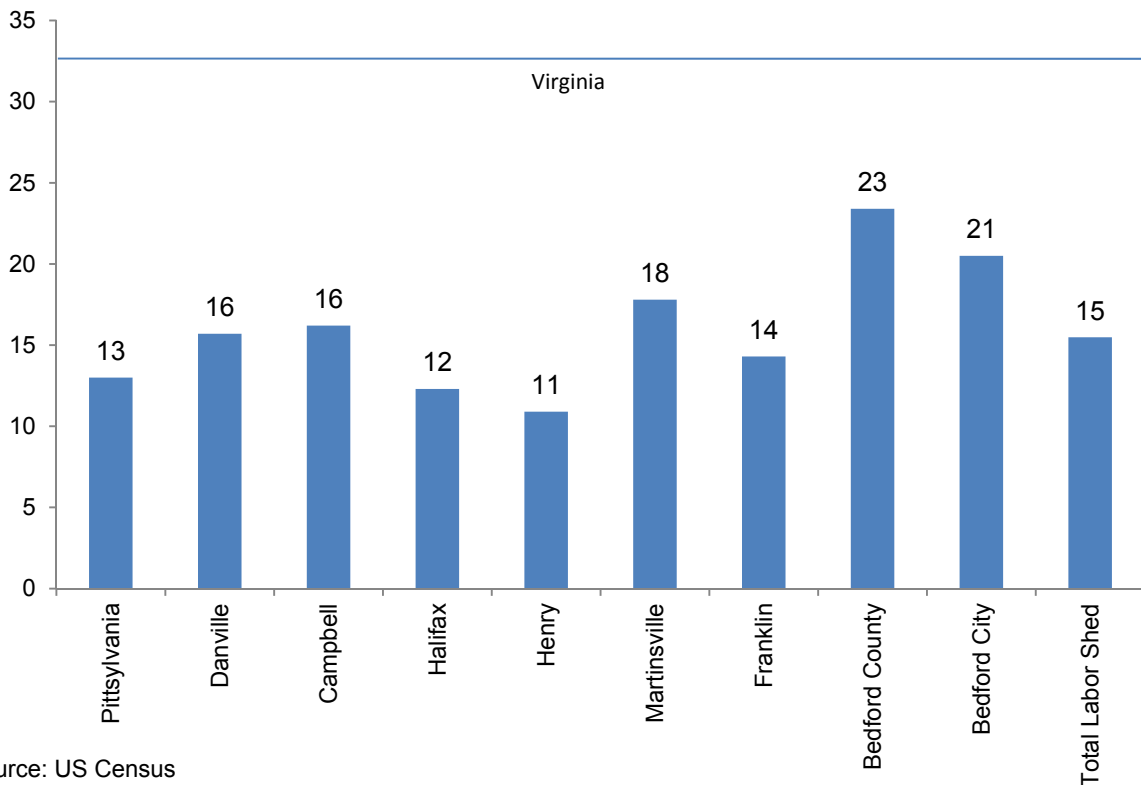


4.2.4. Educational Attainment

Average educational attainment in the Chatham Labor Shed is much lower than the state average. Based on U.S. Census estimates, 77.3 percent of the regional residents age 25 and over from 2005-2009 had at least a high school diploma or equivalent and 15.5 percent had a four-year degree and higher. Over the same period, 85.8 percent of Virginia residents age 25 and older had at least a high school diploma or equivalent and 33.4 percent had a four-year degree and higher. One of the most educated localities in the Chatham Labor Shed is Bedford County with 85.0 percent of its residents age 25 and over having a high school diploma or equivalent and 23.4 percent having a four-year degree and higher. Slightly lower than Bedford County was Bedford City with 84.1% of its residents age 25 and over having at least a high school diploma or equivalent, and 20.5 percent having a four-year degree and higher. Even as the most educated localities in the Chatham Labor Shed, Bedford County and the city of Bedford have a slightly lower percentage of their residents who were age 25 and over having a high school diploma or equivalent, and a significantly lower percentage having a four-year degree or higher. Residents of Pittsylvania are slightly less educated than the labor shed as a whole, with 75.8 percent of its residents having at least a high school diploma or equivalent and 13.0 percent having a four-year degree and higher. From 2005-2009, only 74.5 percent of Danville residents age 25 and over had at least a high school diploma or equivalent while 15.7 percent had a four-year degree or higher.

The implication of the lower educational attainment for the Chatham Labor Shed is that when the area has the need for highly-skilled occupations, it becomes more likely that a firm will recruit from outside the region.

Figure 4.4 : Educational Attainment: Percentage of Adults with a Bachelor's or Higher Degree (2005-2009)



Source: US Census

4.2.5. Personal Income

Average income in the Chatham Labor Shed is significantly below the state average. In 2009, the per capita income of the region was \$31,909, about 72 percent of the state average of \$44,057. Not only is the income level of the region lower than the state average, income growth in the region also trails income growth in the state. Annual income growth in the region was 3.6 percent per year as opposed to 3.7 percent per year in Virginia from 2000 through 2009. Bedford County and the city of Bedford had the highest per capita income in the region at \$37,715 and an annual growth rate of 3.3 percent.¹⁶ Per capita income in Halifax grew the fastest in the region at 4.3 percent per year over the period, although per capita income in Halifax was among the lowest in the region at \$29,047.

Table 4.3: Service Area Per Capita Income and Growth

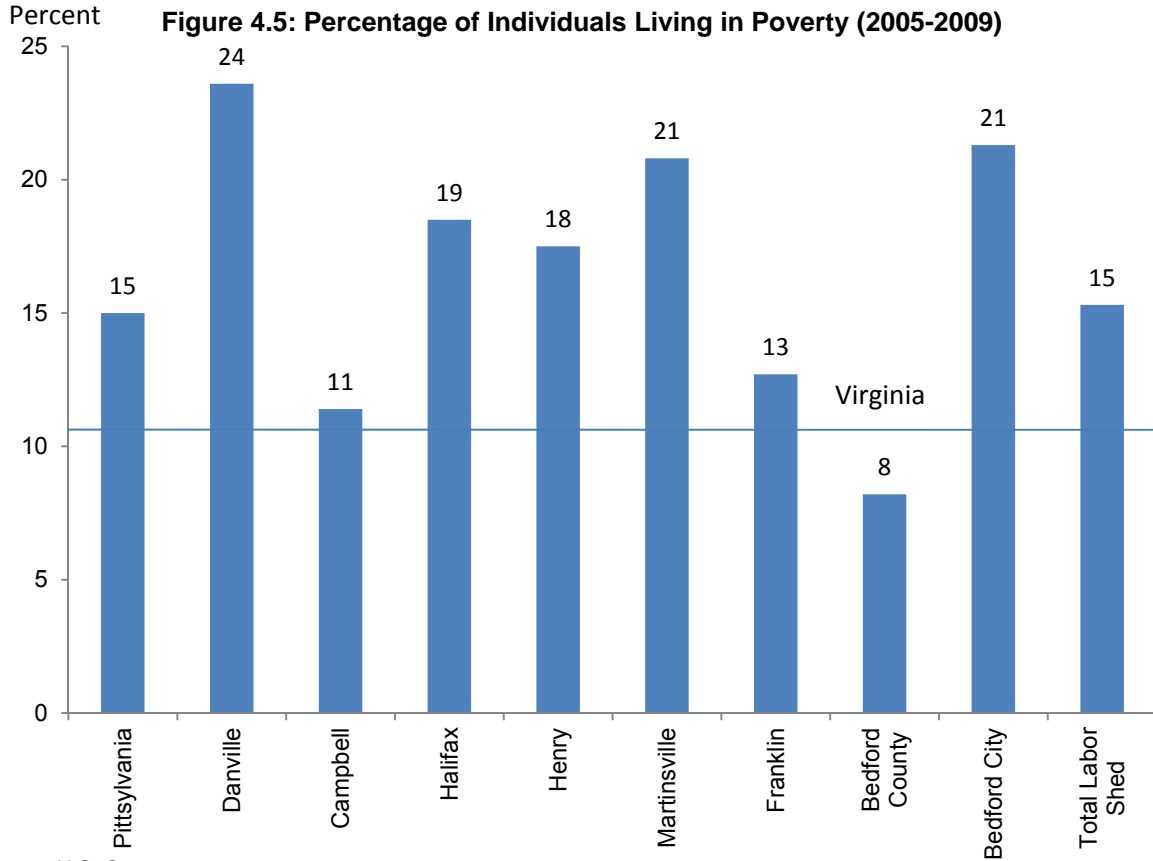
Virginia locality	Per Capita Income 2000	Per Capita Income 2009	Average Annual Growth Rate
Pittsylvania	\$21,791	\$30,092	3.7%
Danville City	\$21,791	\$30,092	3.7%
Campbell County	\$23,862	\$32,052	3.3%
Halifax County	\$19,936	\$29,047	4.3%
Henry County	\$21,766	\$28,773	3.1%
Martinsville City	\$21,766	\$28,773	3.1%
Franklin County	\$23,581	\$33,116	3.8%
Bedford County	\$28,221	\$37,715	3.3%
Bedford City	\$28,221	\$37,715	3.3%
Total Labor Shed	\$23,211	\$31,909	3.6%
Virginia	\$31,640	\$44,057	3.7%

Source: Bureau of Economic Analysis

4.2.6. Poverty

Per capita income is negatively correlated with poverty. Due to the region's lower average income, the labor shed has a higher percentage of individuals living in poverty compared to the state. The Census Bureau's 2005-2009 American Community Survey estimated that 15.3 percent of individuals in the Chatham Labor Shed were in poverty compared to 10.1 percent in Virginia. Danville, the city of Bedford, and Martinsville had the highest poverty rates in the service region at 23.6 percent, 21.3 percent, and 20.8 percent, respectively. Bedford and Campbell Counties had the lowest rates at 8.2 percent and 11.4 percent, respectively.

¹⁶ The Bureau of Labor Statistics considers both Bedford City and Bedford County as one economic area, and did not provide separate estimates for those two localities. The same situation also applies to both Pittsylvania County and Danville City, and for both Henry County and Martinsville City.



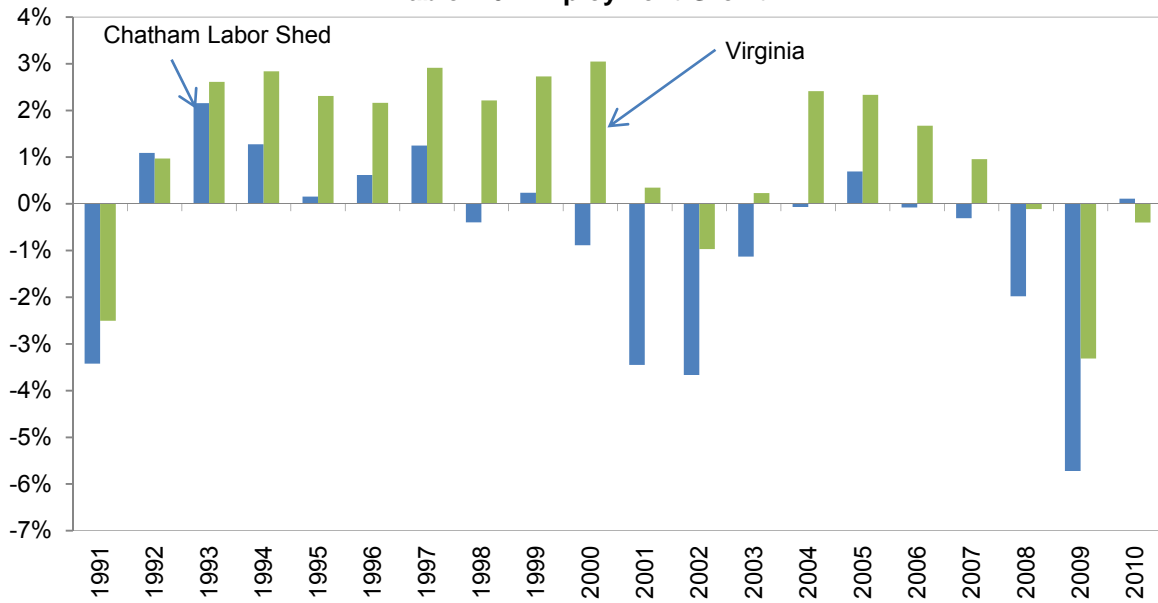
4.3. Economy in the Chatham Labor Shed

4.3.1. Employment and Wages

Overall, the economy of the labor shed region grew at a slower pace than the state average in terms of job creation and wage growth. The industry structure of the region is skewed toward manufacturing industries, a sector in decline at both the local and national level.

The economic baseline of the Chatham Labor Shed, measured by total employment, has been in decline. Overall employment in the region decreased from 139,894 in 1990 to 121,672 in 2010, declining an average of 0.7 percent per year (Figure 4.6). Meanwhile, overall employment in the state grew an average 1.1 percent per year. The most recent recession hit the labor shed region particularly hard. Employment in the second quarter of 2008 hit a five-year high of 130,747, but the region lost 8,678 jobs since then. Excluding job losses from the most recent recession, from 1990-2007, regional employment declined at a more moderate 0.4 percent per year.

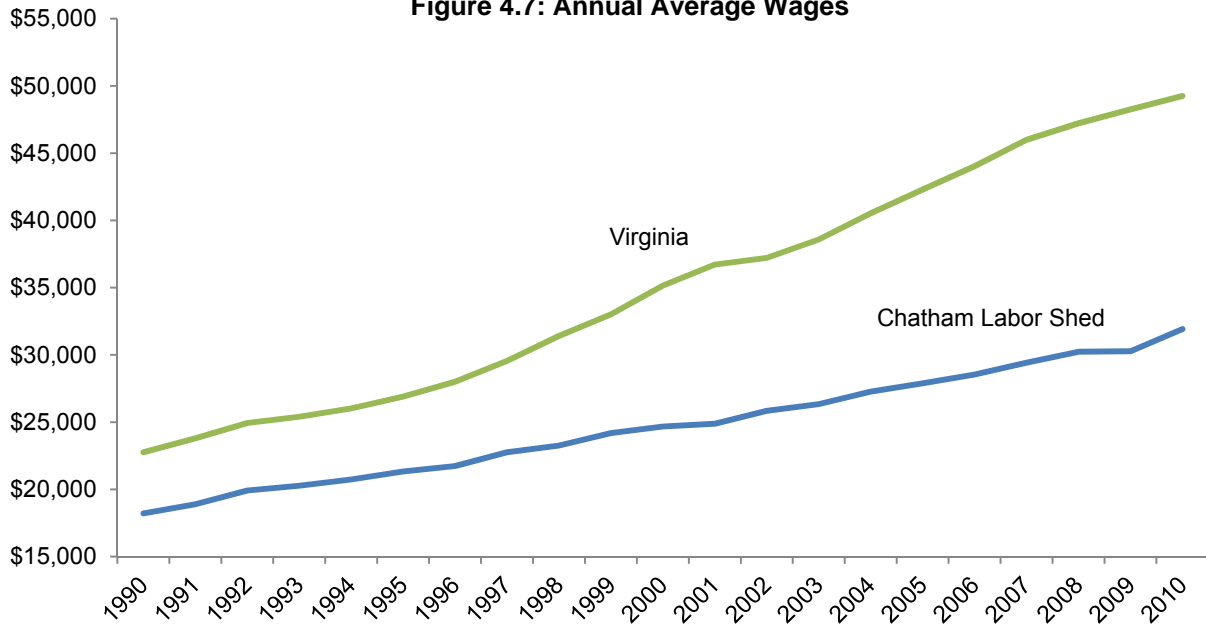
Table 4.6: Employment Growth



Source: Virginia Employment Commission

The wage level of the area also has lagged behind the overall state average (Figure 4.7). In 2010, the average wage of the Chatham Labor Shed was \$31,921, which is 65 percent of the state average wage of \$49,258. The wage gap between the area and the state is increasing. For example, in 1990 the average wage in the region was 80 percent of the average wage in the state. From 2000 through 2010, the average wage of the labor shed area grew at an average pace of 2.6 percent per year nominally—slower than the 3.4 percent state average.

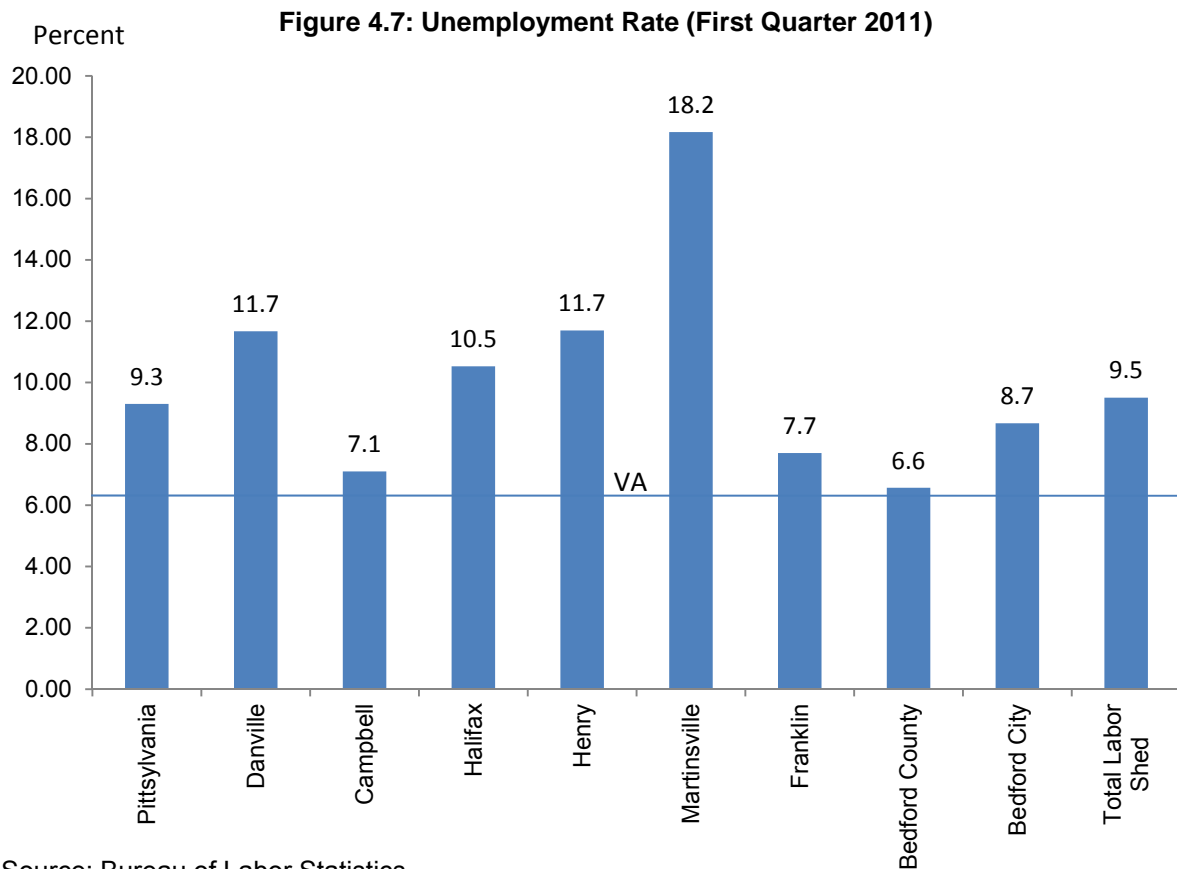
Figure 4.7: Annual Average Wages



Source: Virginia Employment Commission

4.3.2. Unemployment Rate

The Chatham Labor Shed has a higher unemployment rate than the state average. In the first quarter of 2011, the unemployment rate for the region was 9.5 percent, much higher than the state average of 6.6 percent. Among all localities in the labor shed, Martinsville has the highest unemployment rate at 18.2 percent, followed by Danville and Henry County, at 11.7 percent. Bedford County had the lowest unemployment rate in the labor shed and it was roughly the same as the state average. The higher unemployment rate in the labor shed implies that creating employment opportunities for the regional workforce is of paramount importance for local governments.



Source: Bureau of Labor Statistics

4.3.3. Industry Mix

Compared to the state, regional employment is heavily concentrated in the manufacturing sector (Table 4.4). Based on 2010 employment data, 18.0 percent of regional employment was in manufacturing compared with 6.7 percent in the state. The region has smaller percentages of employment in both the information sectors and in professional, scientific, and technical services than the state average.

Since 2000, the industry mix in the labor shed has changed considerably. The most significant difference is the decline of the manufacturing industry's share of total employment in the region. In 2000, 32.2 percent of regional employment was in manufacturing compared to 18.0 percent in 2010. Health care and social assistance as well as education also experienced large changes in their shares of total employment in the labor shed. In 2000, health care and social assistance employment accounted for 8.5 percent of total employment in the region; 10 years later,

it accounted for 12.9 percent. In 2000, 8.6 percent of regional employment was in educational services compared with 11.0 percent in 2010.

Table 4.4: Industry Mix of the Region (2000 & 2010)

Industry	2000		2010	
	Labor Shed	Virginia	Labor Shed	Virginia
Accommodation and Food Services	5.5%	7.5%	7.1%	8.3%
Administrative and Support, Waste Management and Remediation Services	5.1%	6.2%	6.7%	5.7%
Agriculture, Forestry, Fishing, and Hunting	0.5%	0.4%	0.7%	0.3%
Arts, Entertainment, and Recreation	1.2%	1.6%	1.4%	1.7%
Construction	6.5%	6.5%	6.2%	5.5%
Educational Services	8.6%	8.2%	11.0%	9.9%
Finance and Insurance	1.7%	3.6%	2.2%	3.4%
Health Care and Social Assistance	8.5%	9.4%	12.9%	12.1%
Information	1.1%	3.6%	1.3%	2.3%
Management of Companies and Enterprises	0.6%	2.1%	0.6%	2.1%
Manufacturing	32.2%	10.7%	18.0%	6.7%
Mining, Quarrying, and Oil and Gas Extraction	0.1%	0.3%	0.1%	0.2%
Other Services (except Public Administration)	2.8%	3.6%	3.0%	3.7%
Professional, Scientific, and Technical Services	2.2%	8.5%	2.6%	11.0%
Public Administration	3.0%	6.2%	4.2%	6.8%
Real Estate and Rental and Leasing	0.8%	1.6%	1.0%	1.5%
Retail Trade	12.5%	12.1%	13.0%	11.5%
Transportation and Warehousing	4.2%	4.0%	3.4%	3.4%
Unclassified	0.0%	0.1%	0.0%	0.1%
Utilities	0.6%	0.5%	0.6%	0.5%
Wholesale Trade	2.4%	3.3%	3.9%	3.1%

Source: JobsEQ¹⁷

4.3.4. Location Quotient

The competitiveness of the Chatham Labor Shed lies in its many manufacturing industries. Table 4.5 shows the twenty four-digit NAICS industries with the highest location quotients in the labor shed based on data from the third quarter of 2010.¹⁸ All but three of the top twenty are industries in the manufacturing sector. Rubber product manufacturing is the labor shed region's most competitive industry with a location quotient over 15.00. The second greatest competitive advantage of the region is in household and institutional furniture and kitchen cabinet manufacturing with a location quotient of 13.36, and the third greatest is veneer, plywood, and engineered wood product manufacturing with a location quotient of 12.63. Fabric mills; textile and fabric finishing and fabric coating mills; and fiber, yarn, and thread mills all had location quotients greater than 10. Despite years of jobs losses, the region still has a high concentration in manufacturing industries. In contrast, the other regions of the state have

¹⁷ JobsEQ® is proprietary software created by Chmura Economics & Analytics. JobsEQ® is Copyright © 2011, Chmura Economics & Analytics. All Rights Reserved. JobsEQ is protected by U.S. Patent 7,480,659; and patents pending.

¹⁸ The location quotient measures the degree to which an industry is concentrated or specialized in a region relative to the nation, by computing the ratio of the share of an industry's employment in a region to the same industry's share of employment in the nation.

developed competitiveness in the high-tech (Northern Virginia) and logistic (Hampton Roads) sectors that are poised to sustained growth.

Table 4.5: Industry Mix of the Region (Third Quarter 2010)

Industry	4-Digit NAICS	Labor Shed	Virginia
Rubber Product Manufacturing	3262	>15.00	1.34
Household and Institutional Furniture and Kitchen Cabinet Manufacturing	3371	13.36	1.27
Veneer, Plywood, and Engineered Wood Product Manufacturing	3212	12.63	1.35
Fabric Mills	3132	12.60	1.62
Textile and Fabric Finishing and Fabric Coating Mills	3133	10.61	0.93
Fiber, Yarn, and Thread Mills	3131	10.09	1.10
Other Wood Product Manufacturing	3219	9.26	1.25
Textile Furnishings Mills	3141	>7.00	1.24
Sawmills and Wood Preservation	3211	>5.00	1.65
Aquaculture	1125	>5.00	1.53
Architectural and Structural Metals Manufacturing	3323	>5.00	0.85
Logging	1133	>5.00	1.30
Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	3252	>5.00	2.16
Dairy Product Manufacturing	3115	>5.00	0.58
Electrical Equipment Manufacturing	3353	>5.00	1.57
Glass and Glass Product Manufacturing	3272	>4.00	0.59
Animal Food Manufacturing	3111	>4.00	0.60
Hunting and Trapping	1142	>4.00	0.27
Plastics Product Manufacturing	3261	4.07	0.80
Other Textile Product Mills	3149	3.95	1.08

Source: JobsEQ

4.3.5. Occupation Mix

The industry mix and the competitiveness of the Chatham Labor Shed imply that the occupations of the region will be concentrated in production workers and other basic skilled occupations. The low educational attainment of the region also points to a lack of highly skilled professional occupations. Table 4.6 shows the breakdown of the regions' workers by major occupational group. In particular, 12.2 percent of labor shed workers were employed in production occupations based on data from the third quarter of 2010 compared with 5.2 percent in the state. The labor shed also had a higher percentage of workers employed in education, training, and library; transportation and material moving occupations were also high compared with the mix in the state. Both production and transportation and material moving occupations have relatively low average wages while education, training, and libraries occupations have above average annual wages. Only 1.3 percent of workers in the labor shed were employed in computer and mathematical occupations compared with 4.2 percent in the state, while 3.0 percent of workers in the labor shed region were employed in business and financial operations compared with 5.4 percent in the state—both occupation groups have very high average wages. Architecture and engineering and office and administrative support occupations also employed a larger share of workers in the state compared to the labor shed region.

Table 4.6: Occupation Mix of the Region (2010)

Major Occupational Group	Labor Shed		Virginia	
	Share of Employment	Average Annual Wages	Share of Employment	Average Annual Wages
Architecture and Engineering	1.2%	\$59,750	2.3%	\$73,413
Arts, Design, Entertainment, Sports, and Media	1.0%	\$38,639	1.3%	\$50,541
Building and Grounds Cleaning and Maintenance	3.3%	\$20,918	3.7%	\$23,001
Business and Financial Operations	3.0%	\$51,321	5.4%	\$68,940
Community and Social Services	1.5%	\$36,345	1.4%	\$44,106
Computer and Mathematical	1.3%	\$60,045	4.2%	\$83,073
Construction and Extraction	5.0%	\$32,932	4.5%	\$38,221
Education, Training, and Library	8.0%	\$40,031	6.9%	\$50,030
Farming, Fishing, and Forestry	0.5%	\$20,205	0.3%	\$25,120
Food Preparation and Serving Related	7.9%	\$17,632	8.4%	\$20,295
Healthcare Practitioners and Technical	4.6%	\$58,586	4.9%	\$68,009
Healthcare Support	3.2%	\$22,657	2.7%	\$25,390
Installation, Maintenance, and Repair	3.9%	\$36,426	3.8%	\$42,507
Legal	0.4%	\$76,186	0.7%	\$94,418
Life, Physical, and Social Science	0.6%	\$50,421	1.3%	\$67,791
Management	4.1%	\$82,257	4.9%	\$108,409
Office and Administrative Support	15.0%	\$27,765	16.4%	\$33,384
Personal Care and Service	2.6%	\$19,616	2.8%	\$23,371
Production	12.2%	\$28,130	5.2%	\$31,588
Protective Service	2.2%	\$36,776	3.1%	\$42,895
Sales and Related	10.6%	\$28,213	10.1%	\$35,866
Transportation and Material Moving	7.9%	\$26,087	5.8%	\$30,610

Source: JobsEQ

The demographic and economic background of the region indicate that, due to the high unemployment rate and poverty rate, the potential development of uranium mining and milling operations may bring much needed jobs to the state. The abundance of the production workers in the Chatham Labor Shed suggest that many jobs at the mine or the mill can be filled by local workers. However, the dearth of skilled and professional workers in the labor shed means that some of the jobs of the mining and milling operations may be filled by workers outside the labor shed. The details of the economic impact are analyzed in the next section.

5. Economic Development Impact

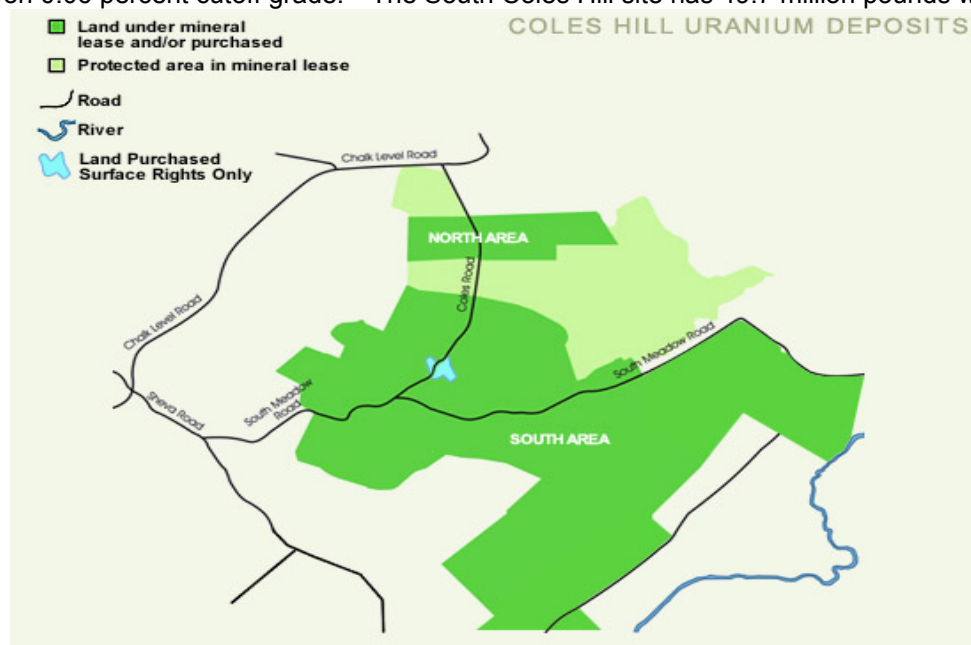
5.1. Uranium Deposit and Project Scope in Virginia

5.1.1. Location and Size of Uranium Deposit

The Coles Hill uranium deposit is located in Pittsylvania County in Southside Virginia. There are two deposit sites: South and North Coles Hill. The ore bodies are along Coles Hill Road (County Road 690) just north and south of South Meadows Road. The layout of the mining, milling, and tailings¹⁹ facilities can be found at the Virginia Uranium Incorporated (VUI) Coles Hill Uranium Project Scoping Study and Cost Estimate, prepared by Lyntek in 2010.²⁰ According to the scoping study, both the crushing plant and ore stockpile are to be located north of South Meadows Road and east of the junction of Count Road 690. A covered conveyor will transport the ore to the processing plant, which is to be located on the south side of South Meadows Road. Preliminary tailings impoundment areas are planned to be situated just east of the plant. A second tailings impoundment area can be placed west of the plant site for the final years of the project.²¹

The total minable uranium resource of the Coles Hill site is estimated to be 63.3 million pounds²² of uranium, based on 0.06 percent cutoff grade.²³ The South Coles Hill site has 49.7 million pounds while North Coles Hill has a

smaller deposit at 13.7 million pounds. The average grade of the Coles Hill site is 0.109 percent (of total weight), implying that a total of 29.0 million tons of uranium ore have to be extracted from underground. This minable uranium is considered by VUI to be the portion of the total uranium deposits “with sufficient grade, size and spatial distribution to be potentially mined at a profit under current foreseeable economic conditions.”²⁴



¹⁹ Tailings are the non-uranium bearing material that is left over from the milling process and permanently stored in state-of-the-art containment facilities at the mill site, all under the most stringent federal regulations. Source: <http://www.virginiauranium.com/pdf/VaUranium-Reprint-DanvilleRegisterBee-Oct09-2011-OpEd.pdf>.

²⁰ This study will be referred to as the Scoping Study in this report.

²¹ Note the Scoping Study for the Coles Hill site indicates the design of the tailing management system—particularly its size—is tentative (pgs. 30-33) and further testing will need to be performed before a final system and process is fully defined.

²² The approximately 63 million pounds of “minable” uranium at the Coles Hill site is in contrast to the roughly 119 million pounds of total uranium that may actually be present in the ground.

²³ “Coles Hill Uranium Project Scoping Study and Cost Estimate” Lyntek & BRS, October 2010.

5.1.2. Uranium Mining and Milling Operation Assumptions

The economic impact of uranium mining and milling is analyzed for both the Chatham Labor Shed and Virginia. The construction and operational costs of uranium mining and milling depends on the mining method, estimated life of the mine, the output of uranium (yellowcake), as well as the market price of uranium. Chmura evaluates a baseline scenario that is most likely to occur. Many of the assumptions for the baseline scenario came from the Scoping Study prepared by Lyntek. The economic impacts for several scenarios that are different from the baseline scenario are presented in the Appendix. The baseline analysis of economic impact utilizes the following assumptions:

- The mining method is underground mining. This is the main scenario analyzed in this report. Open-pit mining will result in different economic and social impacts, which are discussed in the appendix.
- The length of the operation is assumed to be 35 years, with 700,000 tons of uranium ore mined in the first year, 1.05 million tons each year from years 2 to 21, and 350,000 tons mined each year from years 22 to 35. The uneven schedule reflects the fact that the mining operation will start on the sections where mining is relatively easy, and proceed to more difficult sections. The uneven schedule also poses the possibility that mining and milling operations may not break even in the later years if uranium price becomes low. The possibility is addressed in the Appendix.
- The price of uranium is assumed to be \$60 per pound in estimating operational impacts. This is the baseline scenario considered in this study. The appendix provides impact analysis of both a high price scenario (\$75 per pound) and low price scenario (\$45 per pound).
- The environmental impact of the mining and milling operations are moderate (environmental scenario 2 described in Section 3.3). Any contamination affecting the qualities of air, water, noise, and soil is localized and remains within limits set by current federal standards. Other environmental scenarios are addressed in the appendix.

5.2. Spending and Employment Impact of Capital Expenditure

5.2.1. Estimated Total Capital Spending

The total capital spending of the project is expected to \$315.4 million, in nominal dollars, over the life of the mine (LOM) (Table 5.1). This amount includes not only the initial capital spending to construct the mining and milling facilities, but also the continuous capital spending during the operational phases of the mine. Granted, more than half of the capital expenditure (\$172.6 million) is scheduled to be spent during the initial three years, but the continuous capital spending after the mining and milling operation starts is also substantial. For example, there is continuous need to build tailings impoundment cells after the initial capital expenditure. Additional mining equipment will also be acquired and installed over the life of the mine.

²⁴ "Preliminary Economic Assessment for the Coles Hill Uranium Property" Lyntek & BRS Engineering, 2010.

Table 5.1: Capital Expenditures-Alkaline Leach Process; 3,000 Ton-Per-Day

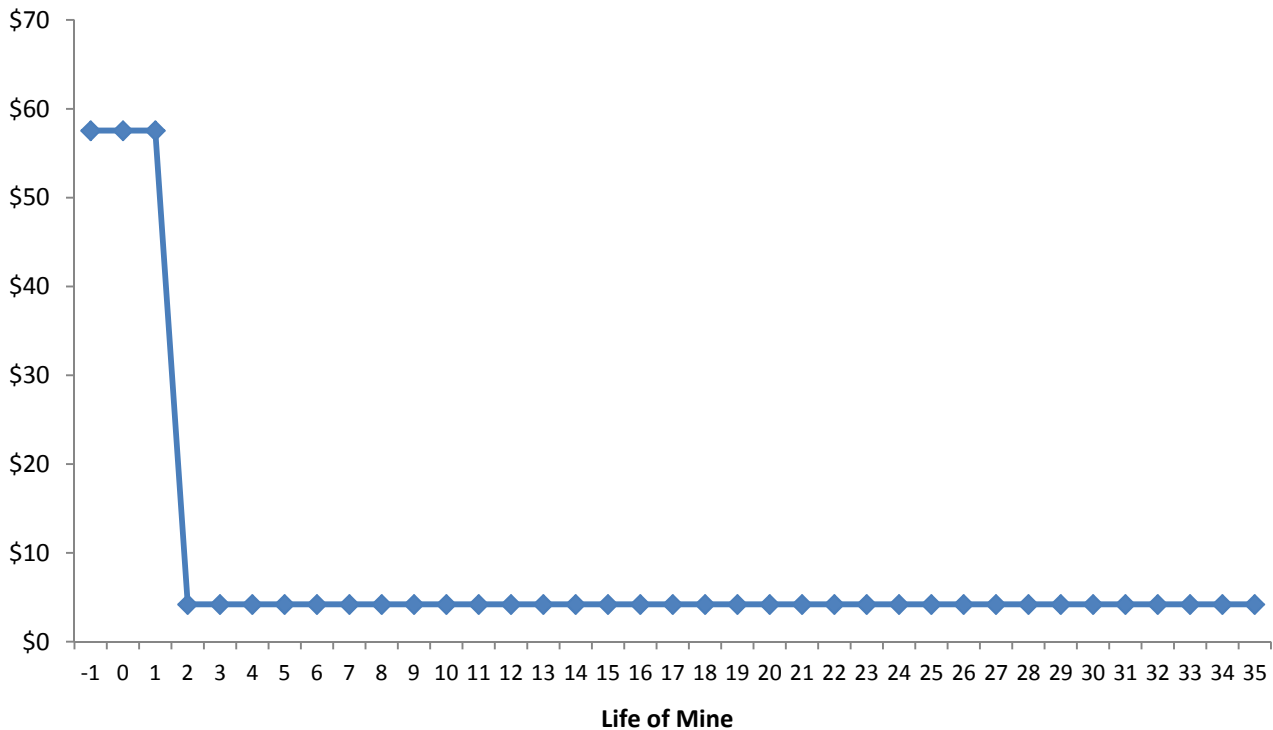
	Initial (Year 1)	Total Capital (LOM)
Permitting/Bonding	\$10.00	\$10.00
Development (pre-production)	\$5.00	\$5.00
Mine	\$28.91	\$89.70
Mill	\$74.56	\$74.56
Tailings		
Paste Fill Plant and Equipment	\$3.95	\$3.95
Pipe to Impound Cell	\$0.02	\$2.43
Tailings Impound Cells	\$15.65	\$66.72
Contingency (25%)	\$34.55	\$63.09
Total	\$172.63	\$315.44

Source: Lyntek and BRS, Scoping Study and Cost Estimate, Table 8.1 (some numbers may not total exactly due to rounding)

Of the total LOM capital spending of \$315.4 million, over half of this amount will be used to purchase mining and milling equipment, while the rest is planned for building milling and tailing structures, site development and permit purposes, and the contingencies. The high percentage of equipment purchases will limit the impact of capital spending in the Chatham Labor Shed, as the regional manufacturing industries cannot produce such equipment and they will have to be purchased elsewhere.

Assuming that initial capital spending of \$172.6 million is spread evenly over the first three years, and the remainder of the capital spending is spread evenly over the rest of the life of the mine, the capital expenditures over the years can be illustrated as shown in Figure 5.1.

Figure 5.1: Capital Spending by Year (\$ Million)



Source: Lyntek and BRS, Scoping Study and Cost Estimate

The capital costs estimated in this section do not include infrastructure development costs such as building access roads or connecting water, electricity, and other utility services. The effect of mining and milling operations on public infrastructure and local governments is discussed in Section 6.2.

5.2.1. Economic Impact of Capital Spending

The capital spending on the uranium mining and milling project will create jobs in construction and related industries in the Chatham Labor Shed as well as in the Commonwealth of Virginia. This direct capital spending will bring more business opportunities to local suppliers supporting the construction companies.²⁵ In addition, area restaurants and shops will benefit as the construction workers on the project spend money at local establishments.²⁶

The total construction spending of the project is estimated to be \$315.4 million over the life of the mine, measured in nominal dollars.²⁷ The capital spending includes site development, equipment, construction of the mining, milling and tailings structures, and soft costs such as permit fees and architecture and engineering fees. The Scoping Study provided the estimated capital spending in those categories. The capital spending in each category was entered into the corresponding IMPLAN model sectors to estimate job creation and the ripple economic effects of the construction activities in the Chatham Labor Shed and the state of Virginia.

Table 5.2.1 details the estimated economic impact of the capital spending of the uranium mining and milling project in the Chatham Labor Shed and Virginia. During the life of the mine, it is estimated that the capital spending of the project will generate total economic impacts (including direct, indirect, and induced effects) of \$166.8 million in the Chatham Labor Shed, which can support 1,756 jobs in aggregate. Among the total economic impacts, \$120.3 million will be direct spending within the labor shed, with direct jobs amounting to 1,299 in aggregate during the life of the mine.²⁸ The indirect impact in the labor shed is expected to total \$18.9 million and support 178 jobs during the life of the mine in industries supporting capital spending activities. The induced impacts in the labor shed during the life of the mine are expected to be \$27.6 million, supporting 279 jobs concentrated in consumer service-related industries.

²⁵ This is the indirect impact.

²⁶ This is the induced impact.

²⁷ All dollars in the economic impacts are measured in nominal terms. Source: Virginia Uranium Inc.

²⁸ This number is smaller than the total capital spending, because not all products and services necessary can be found in the Chatham Labor Shed. For example, over 60% of capital spending is for equipment, which has to be spent elsewhere as the region does not have the capacity to manufacture mining and milling equipment.

Table 5.2.1: Economic Impact of Capital Spending

		Direct	Indirect	Induced	Total
Annual Average (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$3.3	\$0.5	\$0.7	\$4.5
	Employment	35	5	8	47
State of Virginia	Spending (\$ Million)	\$3.8	\$1.2	\$1.6	\$6.6
	Employment	37	8	14	59
Annual Average (Initial 3 years)					
Chatham Labor Shed	Spending (\$ Million)	\$17.9	\$3.4	\$3.9	\$25.2
	Employment	176	32	40	247
State of Virginia	Spending (\$ Million)	\$22.5	\$7.7	\$8.7	\$38.9
	Employment	189	54	80	323
Total (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$120.3	\$18.9	\$27.6	\$166.8
	Employment	1,299	178	279	1,756
State of Virginia	Spending (\$ Million)	\$142.3	\$43.0	\$57.8	\$243.0
	Employment	1,357	302	532	2,192

Source: Chmura Economics & Analytics and IMPLAN Pro 2009

On an annual average basis, during the life of the mine, the total economic impact of capital spending is expected to be \$4.5 million per year that can support 47 jobs in the Chatham Labor Shed. However, since the majority of capital spending will be concentrated in the initial three years of the uranium project, the annual economic impact during the initial three years will be more than five times the annual impact in the ensuing years. The total annual impact during the initial three years can reach \$25.2 million per year, supporting 247 jobs in the labor shed.

The economic impact of capital spending in Virginia is larger than that in the Chatham Labor Shed because additional businesses outside the labor shed will also benefit from capital spending of the uranium project. During the life of the mine, it is estimated that the capital expenditure will generate total impacts of \$243.0 million in spending and 2,192 jobs in Virginia. On an annual average basis, total economic impacts of capital expenditures are estimated at \$6.6 million and 59 jobs per year in Virginia. During the initial three years of the project, the economic impacts of capital spending can average \$38.9 million in spending and 323 jobs in Virginia.

Chmura compared its forecast for the direct jobs created during the capital procurement and construction phase of the project with impact studies of several other mining sites and one milling site (see table 5.2.2). Given the size of the capital investment at Coles Hill, the estimate of job creation is conservative given the range shown in recent impact studies of other mining and milling sites, and there is the potential that the construction of the Coles Hill mines and mill will create a greater number of construction jobs than the model predicts.

Table 5.2.2: Economic Impact of Capital Spending

<u>Site</u>	<u>Mine and/or Mill</u>	<u>Peak Annual Construction Jobs</u>	<u>Approximate Total Capital Investment</u>	<u>Capital Expenditures per Worker</u>
Coverse & Campbell Counties, Wyoming	3 mines	272	\$ 82,000,000	301,471
Coconino & Mohave Counties, Arizona	26 mines	305	\$ 313,560,000	1,028,066
Cibola & Mckinley Counties, New Mexico	15 mines & 3 mills	1384	\$ 2,067,000,000	1,493,497
Pinon Ridge Mill, Colorado	1 mill	200	\$ 150,000,000	750,000
Coles Hill, Pittsylvania County, Virginia	2 mines & 1 mill	176	\$ 340,000,000	1,931,818

Source: Various industry scoping reports

5.3. Economic Impact of Mining and Milling Operations

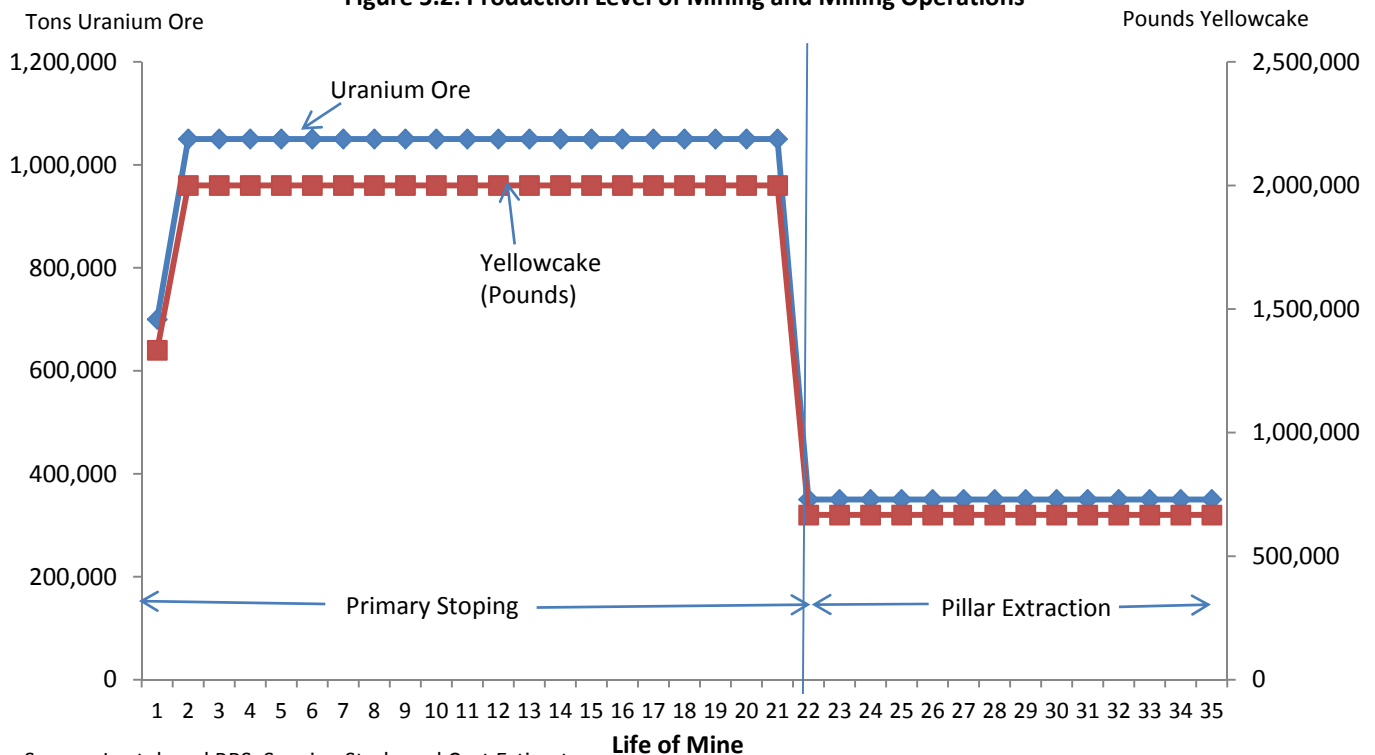
5.3.1. Production Capacity of Mining and Milling Operations

The magnitude of the economic development impacts of mining and milling operations in the Coles Hill area will depend on the production level of the operations, as a high level of production requires more workers and more suppliers. In addition, the annual production level also affects how many years the mining and milling operations will last.

The product of the mining operations will be metal ores that contain uranium. The uranium ores are then processed by milling, which involves crushing, grinding, and alkaline leaching of the uranium ore. The final product is triuranium octoxide (U₃O₈), more commonly called “yellowcake.”

During the first 21 years, the uranium will be removed by a technique called primary stopping. This method involves creating large openings in the ground to reach the rock containing uranium ore. The mined material can be brought to the surface by trucks, or in large containers called skips that travel up and down the mine shaft.²⁹ This practice is expected to yield 1.05 million tons of uranium ore each year (Figure 5.2), with the exception of the first year, whose production level is expected to be 700,000 tons of uranium ore. From years 22 to 35, the mining method will be pillar retrieval, which yields much lower levels of production of uranium ore, about 350,000 tons per year. This is roughly one third of the production under the primary stopping method.

Figure 5.2: Production Level of Mining and Milling Operations



Source: Lyntek and BRS, Scoping Study and Cost Estimate

²⁹ <http://uraniumsa.org/processing/underground.htm>.

The total production of yellowcake is estimated to be 46.2 million pounds during the life of the mine. As shown in Figure 5.2, the annual production level will be much higher from year 1 to year 21, when the mining method is primary stoping. The total production of yellowcake during those years amounts to \$37.0 million pounds, accounting for 80% of LOM production. For the remaining 14 years, the mining method is pillar retrieval and the site is expected to produce an additional 9.2 million pounds of yellowcake.

5.3.2. Estimated Revenues and Cost of Mining and Milling Operations

Aside from the production level, the total revenue of the milling and mining operations will also depend largely on the price of yellowcake. This economic impact study assumes that the price of yellowcake will be \$60 per pound under the baseline scenario. Chmura judges this price to be a reasonable estimate of the average long-term price that VUI will realize for its sales of yellowcake. This estimate is consistent with the historic price dynamics of uranium—particularly price data from the past 15 years—as well as with the price fluctuations of the past few years. The latest data in August 2011 indicated that the spot price of uranium was just above \$50 per pound and the long-term price was about \$65 per pound.³⁰ An examination of audited financial records of large uranium mining companies, such as Denison Mines Corporation or Cameco Corporation indicates that uranium mining and milling companies typically sell their yellowcake utilizing a mix of both spot prices and long-term contractual arrangements.³¹ Thus Chmura’s utilization of a \$60 per pound figure represents a relative 33 to 66 percent mix of the current spot price and long-term price, which is consistent with industry norms.

Figure 5.3: Historic Uranium Price (Dollar per Pound U₃O₈)



Source: InfoMine.com

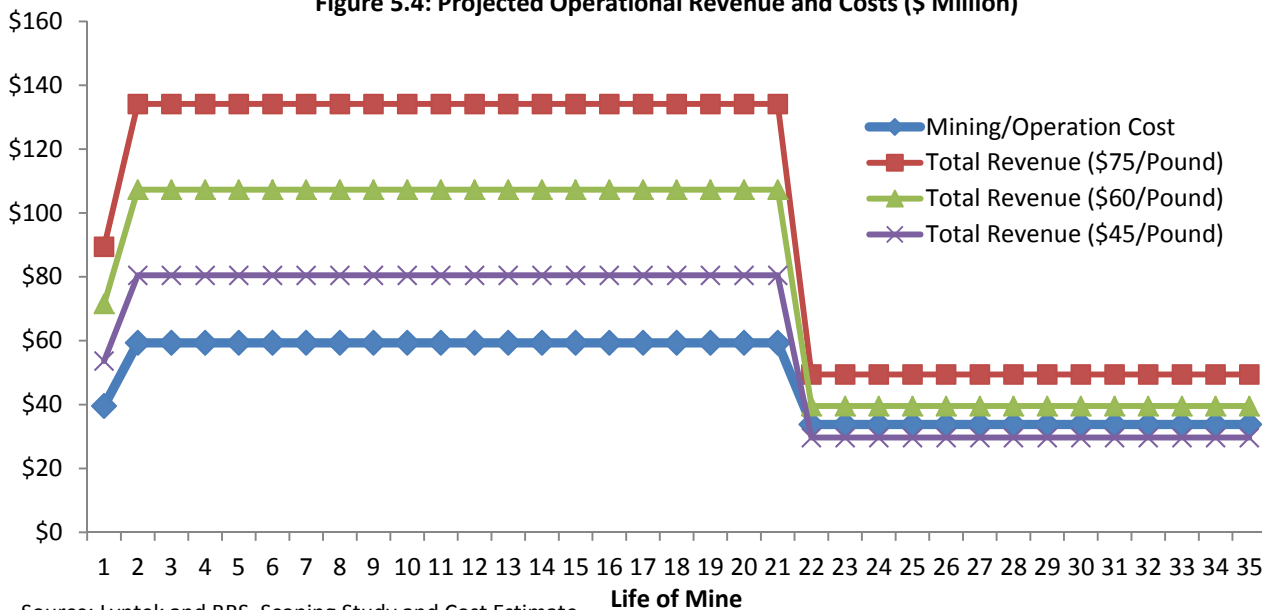
³⁰ High price and low price scenarios are presented in the Appendix.

³¹ 2010 Annual Report for Cameco Corporation and Denison Mines Corporation.

The 2011 Japan nuclear power plant accident notwithstanding, most economists predict that the demand for uranium will be increasing, as the United States and other industrial countries strive to reduce greenhouse gas emissions and shift energy source fuels to those with low or no greenhouse gas emissions.^{32,33} Nuclear energy is a key component of the strategy to reduce greenhouse gas emissions. However, the nuclear accident in Japan has highlighted the risk of nuclear energy, and some countries, such as Germany, announced that it would phase out nuclear power plants completely by 2022.³⁴ Other major nuclear generation countries, such as the United States and France, have no plan to reduce their nuclear energy-generating capabilities. Several developing countries, such as China, Russia, South Korea, and India, are planning major expansions in nuclear power over the next 5 to 7 years.³⁵ While both the Japanese disaster and the change in German nuclear policy have dampened the upward movement in uranium prices since March 2011, it is expected that the spot price of uranium may have stabilized and will be at the current level (\$50-\$60 in U.S. dollars) for the foreseeable future.³⁶

The price of uranium will have a significant effect on the profitability of the uranium mining and milling operations. Under the baseline price of \$60 per pound, the annual revenue can reach \$107.3 million from years 2 to 21, and \$39.5 million from years 22 to 35, with accumulative revenues of \$2.8 billion during the life of the mine. Under the high-scenario price of \$75 per pound, holding the production level constant, the accumulative total revenues during the life of the mine will be \$3.5 billion. Under the low-scenario price of \$45 per pound, holding the production level constant, the accumulative total revenues during the life of the mine will be \$2.1 billion.

Figure 5.4: Projected Operational Revenue and Costs (\$ Million)



Source: Lyntek and BRS, Scoping Study and Cost Estimate

³² "Uranium: Re-Assessing Uranium and Uranium Equities Post Japanese Nuclear Disaster" Royal Bank of Scotland, 2011.

³³ "U₃O₈: Demand Hit Priced In – Supply Strips Not Yet Factored" Bank of America/Merrill Lynch, July 2011.

³⁴ Source: <http://www.ndtv.com/article/world/germany-announces-end-to-nuclear-power-by-2022-108997>.

³⁵ "U₃O₈: Demand Hit Priced In – Supply Strips Not Yet Factored". Bank of America/Merrill Lynch, July 2011.

³⁶ For example, some industry consultants have forecasted that the price of uranium will be \$55 per pound through 2021.

Source: http://www.clearonmoney.com/dw/doku.php?id=investment:commentary:2011:08:02-uranium_value_and_volatility_assured.

The annual operation costs are estimated to be \$59.4 million from years 2 to 21, and \$33.8 million from years 22 to 35, including both mining and milling costs. In terms of unit cost per ton, the unit mining cost for pillar extraction is \$52.4 per ton of uranium ore, much higher than that of the primary stoping mining method, at \$23.2 per ton. The unit costs for milling are the same for both the primary stoping and pillar extraction periods, at \$17.5 per ton of uranium ore processed.

**Table 5.3: Summary of Underground Mining Cost Estimate
(Dollar per Ton Uranium Ore)**

	Primary Stopping (Years 1 to 21)	Pillar Extraction (Years 22 to 35)	Average LOM
Equipment Operation	\$1.3	\$1.3	\$1.3
Supplies	\$4.7	\$16.5	\$6.9
Hourly Labor	\$7.5	\$20.2	\$9.8
Administration	\$4.8	\$7.8	\$5.4
Sundries	\$1.8	\$4.6	\$2.3
Total per Ton	\$20.1	\$50.4	\$25.7
Per ton of Material	\$18.3	\$45.8	\$23.3
Additional Allowance	\$4.9	\$6.7	\$5.2
Total Mining Cost/Ton	\$23.2	\$52.4	\$28.6
Milling Cost/Ton	\$17.5	\$17.5	\$17.5
Total Mining & Milling Cost /Ton	\$40.6	\$69.9	\$46.0

Source: Lyntek and BRS, Scoping Study and Cost Estimate, Table 7.4 and 4.3 (some numbers may total exactly due to rounding)

Comparing total revenue and total operational costs, the revenues exceed operation costs for every year during the life of the mine when the price of the uranium is \$60 per pound (Figure 5.4). The positive operational profit also occurs for each year under the high-price scenario. However, for example, if the price of uranium is \$45 per pound under the low-price scenario, the operation costs will exceed the revenues in the pillar extraction phase of the life of the mine. Even though the economic impact study is based on the assumptions that both the uranium price will be \$60 per pound, and that the mining operations will continue for 35 years, it is possible that the operation may be discontinued if the uranium price falls below the break-even point, which is defined as the price point where operational revenues equal operational costs. The discontinuation of the mining and milling operation is especially possible after year 22, during the pillar extraction phase of the mining. That is because the break-even price for uranium is \$51.4 per pound during that phase. As a comparison, during the primary stoping phase, the break-even uranium price is \$33.2 per pound. As a result, under all price scenarios, the first 21 years of the operations will be profitable. But under the low price scenario, the uranium price may fall below the \$51.4 per pound break-even price of the pillar extraction phase, making the operation unprofitable. The appendix provides a scenario where the uranium price falls below the break-even price, and the company stops the production before the scheduled 35-year life of the mine.

5.3.3. Direct Mining and Milling Operation Jobs

The mining and milling operations are expected to hire a total of 324 workers, 224 for the mining and 100 for the milling operations. This is the full-capacity staffing level to meet the peak production level. The list of positions is presented in Table 5.4. About one third of those are salaried positions, including managers, supervisors, technicians, and engineers; there are also openings for accountants, human resource professionals, and purchasing agents. The rest are hourly positions, including miners, mechanics, and process line workers at mills.

Table 5.4: Direct Operation Jobs

Direct Mining Jobs		Direct Milling Jobs	
Salaried Positions			
Managers	1	Mill Superintendents	1
Superintendents	3	Asst. Mill Superintendents	1
Foremen	12	Mill General Foremen	1
Engineers	6	Shift Foremen	4
Geologists	6	Maintenance General Foremen	1
Shift Supervisors	8	Maintenance Foremen	4
Technicians	8	Instrument Technicians	4
Accountants	4	Employee Relations Managers	1
Purchasing	4	Secretaries	3
Personnel	4	Safety Supervisors	1
Administrative Assistants	8	Environmental Officers	1
Clerks	12	Purchasing Agents	1
		Warehousemen	2
		Metallurgists	1
		Chief Chemists	1
		Controllers	1
		Clerks	2
Hourly Positions			
Stope Miners/Drillers/Blasters	16	Electricians	2
Development Miners	16	Electrician Helpers	2
Equipment Operators	8	Mechanics	10
Support Miners	8	Mechanic Helpers	10
Diamond Drillers	2	Plant Technicians	2
Crusher/Backfill Operators	8	Safety and Environmental Techs	3
Electricians	12	Laboratory Analysts	3
Mechanics/Electricians	16	Loader Operators	4
Maintenance Workers	20	Crusher Operators	4
Helpers	8	Grind/Leach Operators	4
UG Laborers	22	CCD Operators	4
Surface Laborers	12	Precip Operators	4
		Tailings Operators	4
		Plant Helpers	8
		Utility Workers	2
		Bull Gang	4
Total Jobs	224		100

Source: Lyntek and BRS, Scoping Study and Cost Estimate, Table 4.4 and 7.6

When fully staffed, the annual payroll is forecast to be \$13 million for mining and \$6 million for milling, resulting in a total annual payroll of \$19 million for the whole operation. For salaried positions, annual salaries are expected to range from \$35,000 to \$250,000 per position. The rates for hourly positions will range from \$20 to \$35 per hour.³⁷

The above staffing plans are based on the mining and milling capacity of 3,000 tons per day. That level of operation will last only for the first 21 years of operation, during the primary stoping phase. Afterwards, the mining and milling productions level will decline to less than half of the production level, during the pillar extraction phase. Though the scoping document did not provide any estimates of the staffing pattern during the period of reduced production, Chmura assumes that number of mining jobs under the pillar extraction will be the same as the full capacity number, while the number of milling workers under the pillar extraction phase will be reduced to about one third of the full capacity level.

The reason for this assumption can be found in Table 5.3 of the scoping document. Comparing the hourly labor costs under primary stoping and pillar extraction phases, the unit cost per ton for pillar extraction is almost three times the unit labor cost under primary stoping method. Since the total annual mining production in the pillar extraction phase is one third of the production level in the primary stoping phase, it can be reasoned that total annual labor costs under two mining methods are similar. That implies a similar number of workers will be working in the mine regardless what mining method is being used. However, the milling operation has the same unit costs for the life of the mine, which implies the total annual labor milling cost in the pillar extraction phase is about one third the cost of the primary stoping phase. As a result, the milling operation will only need about one third of the workers during the pillar extraction phase, when compared to the primary stoping phase.

Chmura compared the VUI Scoping Study estimates with that of the employment estimates contained in other impact studies completed for other mining and milling operations for sites in America and Canada. The VUI estimates for 224 direct mine workers producing about 2 million pounds of yellowcake are consistent with industrial norms. Examining the average workforce and productivity of 15 active mines in the United States and Canada shows that the average annual productivity per worker in the mine is roughly about 11,340 pounds of yellowcake. If the VUI Coles Hill site achieved that level of productivity, they would be able to produce their estimated annual output of 2 million pounds of yellowcake with approximately 176 workers. The VUI estimate of 224 workers is slightly above the industry average, but this average reflects mining operations in the American southwest where topological and environmental conditions are very different than in Virginia. Chmura further compared the mix of maintenance and trade workers (mechanics, electricians, and other maintenance) projected to be employed at the Coles Hill site with the ratios of western counties in the United States—such as San Juan County, Utah, and Coconino, Arizona—with longstanding uranium mining sectors. This analysis also indicates that the projection of employment at the Coles Hill site is in line with industry norms. It is difficult to compare VUI's estimates of employment in its milling operations because of the paucity of operating mills in the United States. Currently there is only one: the White Mesa mill operating near Blanding, Utah. Given that White Mesa mill employs about 125 workers, and the proposed Piñon Ridge mill plans to employ about 85 workers, the estimate for 100 mill workers at the Coles Hill site seems in line with industry norms.

Because the direct employment at the Coles Hill site for both the mine and mill is within industry norms, Chmura judged it reasonable to utilize these employment projections, without adjustment, in analyzing the socioeconomic impact of the uranium operation in the Chatham Labor Shed. Chmura's analysis further assumes that the payroll

³⁷ "Coles Hill Uranium Project Scoping Study and Cost Estimate" (Section 8.0) Lyntek & BRS, October 2010.

costs for the Coles Hill site will remain constant for the initial 20 years of production and then fall in the final 15 years because of reduced production at the milling portion of the operation. This can be interpreted in two ways. The first interpretation would be that VUI holds its staffing level constant over the first 20 years (at 324 workers) and realizes no labor productivity gains in either the mining or milling portion of the operation. The second interpretation would be that VUI realizes gradual improvements in labor productivity—slowly diminishing the number of mine and mill workers at the Coles Hill site, but pays its remaining workers higher wages than it did initially to reflect their added productivity. A review of the single operating mill in the United States suggests that increasing labor productivity in the milling portion of the operation may be difficult to achieve. Conversely, it is possible that VUI may be able to achieve some labor productivity gains in the mining portion of the operations over the life of the mine.

5.3.4. Indirect and Induced Spending and Jobs

The total revenue and direct jobs from the mining and milling operation were entered into the IMPLAN model to estimate job creation and the ripple economic effects of the operation in the Chatham Labor Shed and the State of Virginia. For uranium mining, Chmura used IMPLAN sector 25, corresponding to the North American Industry Classification System (NAICS) code 212291: uranium-radium-vanadium ore mining. For uranium milling operations, Chmura used IMPLAN sector 125, corresponding to NAICS 331419: other nonferrous metal production and processing, except copper and aluminum.

Table 5.4 details the estimated economic impact of the mining and milling operations. On an annual average basis, during the life of the mine, it is estimated that the mining and milling operations will generate a total economic impact (including direct, indirect, and induced effects) of \$102.9 million in the Chatham Labor Shed, which can support 510 jobs in the region. Among the total economic impacts, \$79.2 million will be direct spending within the labor shed, with direct jobs amounting to 297 jobs per year during the life of the mine. The indirect impact in the labor shed is expected to total \$6.9 million and support 42 jobs per year during the life of the mine in industries supporting mining and milling operations, including utilities and trucking services. The induced impacts in the labor shed during the life of the mine are expected to be \$16.8 million and 171 jobs per year, which will be concentrated in consumer service-related industries.

Since the production levels of the primary stoping phase and the pillar extraction phase are different, the average annual economic impacts also vary. From years 1 to 21, the annual total economic impact (including direct, indirect, and induced effects) is estimated to be \$137.3 million, supporting 561 jobs in the Chatham Labor Shed. The annual economic impacts of the mining and milling operations are smaller from years 22 to 35. The total annual impacts during that phase can reach \$51.2 million per year, supporting 433 jobs in the labor shed.

Table 5.5: Annual Impact of Uranium Mining and Milling Operations

		Direct	Indirect	Induced	Total
Annual Average (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$79.2	\$6.9	\$16.8	\$102.9
	Employment	297	42	171	510
State of Virginia	Spending (\$ Million)	\$79.2	\$27.0	\$30.6	\$136.7
	Employment	297	348	407	1,052
Annual Average (Primary Stopping Year 1 to Year 21)					
Chatham Labor Shed	Spending (\$ Million)	\$105.6	\$9.6	\$22.1	\$137.3
	Employment	324	53	184	561
State of Virginia	Spending (\$ Million)	\$105.6	\$36.5	\$41.3	\$183.5
	Employment	324	391	442	1,157
Annual Average (Pillar Extraction Year 22 to Year 35)					
Chatham Labor Shed	Spending (\$ Million)	\$39.5	\$2.8	\$8.9	\$51.2
	Employment	257	25	151	433
State of Virginia	Spending (\$ Million)	\$39.5	\$12.7	\$14.4	\$66.6
	Employment	257	282	355	894
Total (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$2,770.5	\$240.7	\$589.3	\$3,600.5
	Employment	10,407	1,460	5,982	17,849
State of Virginia	Spending (\$ Million)	\$2,770.5	\$945.0	\$1,069.7	\$4,785.2
	Employment	10,407	12,164	14,246	36,817

Source: Chmura Economics & Analytics and IMPLAN Pro 2009 (some numbers may total exactly due to rounding)

The economic impacts of the mining and milling operations in the Commonwealth of Virginia are larger than those in the Chatham Labor Shed, as more businesses outside the labor shed also benefit from the mining and milling operations. During the life of the mine, it is estimated that the mining and milling operations will generate annual total impacts of \$136.7 million in spending and 1,052 jobs in Virginia. During the primary stopping phase, from years 1 to 21, the annual economic impacts of the mining and milling operation can average \$183.5 million in spending and 1,157 jobs in Virginia. During the pillar extraction phase, from years 22 to 35, the annual economic impacts of the mining and milling operation will average \$66.6 million in spending and yield 894 jobs in Virginia.

5.3.5. Direct Jobs Benefiting Current Residents

As Section 4 has shown, the Chatham Labor Shed has an elevated unemployment rate, compared with the rest of Virginia. As a result, the new jobs brought in by the mining and milling operations will provide much needed job opportunities for the region. For the project to benefit the existing residents in the labor shed, it needs to be seen how many jobs in mining and milling operations can be filled by local residents.³⁸ In this analysis, Chmura treats the fully-staffed milling and mining operations as the peak labor demand for each occupation, even though the labor demand will be smaller in the pillar extraction phase of the mining and milling operations. Chmura then compares the labor demand with current labor inventory in the labor shed to see how many of those workers are currently available in the region, and whether any of those jobs need to be filled by bringing in workers from outside the labor shed.

³⁸ This analysis only considers the mining and milling jobs. Though ongoing capital expenditure will also generate additional jobs during the life of the mine, those job numbers are low, and can be easily filled with the current workforce. The jobs created due to the capital expenditure during the initial three years of the construction are temporary.

As Table 5.4 shows, when fully staffed, the mining and milling operations will directly employ 324 workers. Those workers can be grouped into four major occupation categories: 1. Mining, including drillers, mining machine operators, mechanics, mining assistants, supervisors, and foremen; 2. Milling (production), including crushers, equipment operators, and mechanics at the mill; 3. Business Professionals, including managers, accountants, purchasing agents, human resource professionals, secretaries, and clerks; and 4. Technical Professionals, including geologists, chemists, engineers, and various supporting technicians.

Table 5.6 lists occupations required by the mining and milling operations, grouped by four major categories based on the job functions. It also lists current employed and unemployed workers for similar occupations in the Chatham Labor Shed, as of the first quarter of 2011.

Table 5.6: Mining and Milling Jobs in the Chatham Labor Shed

	Jobs Needed at Coles Hill Site	Current Workforce	Unemployed
Milling Workers Total	74	20,409	3,773
Bull Gang	4	2,553	323
CCD Operators	4	32	4
Crusher Operators	4	315	15
Electrician Helpers	2	105	16
Electricians	2	661	95
Grind/Leach Operators	4	76	5
Loader Operators	4	17	2
Maintenance General Foremen	1	2,330	221
Maintenance Foremen	4	2,330	221
Mechanics	10	2,122	205
Mechanic Helpers	10	246	107
Mill General Foremen	1	2,330	221
Plant Helpers	8	1,183	917
Precip Operators	4	32	4
Shift Foremen	4	2,330	221
Tailings Operators	4	32	4
Utility Workers	2	1,183	917
Warehousemen	2	2,535	275
Mining Workers Total	168	16,727	2,009
Crusher/Backfill Operators	8	34	12
Development Miners	16	17	9
Diamond Drillers	2	13	7
Electricians	12	661	95
Equipment Operators	8	5	1
Foremen	12	2,330	221
Helpers	8	6	4
Maintenance Workers	20	1,642	187
Mechanics/Electricians	16	2,130	212
Shift Supervisors	8	2,330	221
Stope Miners/Drillers/Blasters	16	17	9

Table 5.6: Mining and Milling Jobs in the Chatham Labor Shed

Support Miners	8	15	7
Surface Laborers	12	3,764	513
UG Laborers	22	3,764	513
Business Professionals Total	48	27,094	1,628
Accountants	4	789	60
Administrative Assistants	8	2,964	128
Asst. Mill Superintendents	1	1,481	133
Clerks	14	11,819	622
Controllers	1	329	31
Employee Relations Managers	1	563	17
Environmental Officers	1	66	4
Managers	1	1,734	141
Mill Superintendents	1	1,481	133
Personnel	4	563	17
Purchasing	4	354	37
Purchasing Agents	1	354	37
Safety Supervisors	1	155	7
Secretaries	3	2,964	128
Superintendents	3	1,481	133
Technical Professionals Total	34	1,708	303
Chief Chemists	1	41	7
Engineers	6	722	137
Geologists	6	17	1
Instrument Technicians	4	301	53
Laboratory Analysts	3	10	0
Metallurgists	1	14	0
Plant Technicians	2	291	53
Safety and Environmental Techs	3	10	0
Technicians	8	301	53

Source: Chmura Economics & Analytics

Staffing the business-related positions with local workforce does not appear to be a serious issue. There are currently over 27,000 people working in business-related professions, plus an estimated 1,628 unemployed workers in those occupations in the labor shed. The company only needs about 48 such workers to fill its vacancies in both mining and milling operations. For each of these positions, the current number of unemployed workers is greater than the number needed to be employed. Therefore, there is considerable slack for each of these occupations, and the company will have little problem hiring people locally to fill these positions. Hence, Chmura judges there is little chance that VUI will need to hire workers from outside the labor shed to fill these business-related jobs. However, some of those available for hire may not have prior experience in managing mining and milling operations; proper training may be necessary. It is likely, however, that a few select senior managers may be brought in from outside the Chatham Labor Shed.

This assessment also applies to milling positions in that the local workforce can meet the labor demand at the milling facility. The skills required by the positions needed in the milling facilities resemble the skills associated with many production-type occupations, and there are a large number of unemployed manufacturing workers in the Chatham Labor Shed that can fill these positions. The number of milling workers required at the full capacity is 74. For almost all positions, the estimated number of unemployed workers is larger than the number needed by the uranium mill. The only exception is for loader operators. But the additional demand for this occupation is only 2, and this basic skills job can be filled with unemployed production workers having experience from other industries. As a result, there is also no need to hire workers from outside the labor shed to fill the milling jobs.

For miners and mining-related positions, the Chatham Labor Shed currently does not have certain specialized occupations because the region does not have any large mining companies. Some of these occupations include development miners, mining equipment operators, and stope miners. In total, there are 26 positions that cannot be met by the current workforce in the region, and at first glance, it may seem that these positions would need to be brought in from outside the region. Chmura judges, however, that the positions can potentially be filled with unemployed production workers in the region, provided the company is committed to offer both operational and safety training for these workers.

Similarly, for technical professions, a majority of positions such as engineers and various technicians can be filled by local workers. The demand for these jobs is less than the number of existing unemployed workers in the region. As a result, these positions can be readily filled by local residents. There are only three occupations for which the region does not have workers with clearly applicable skills: geologist, safety and environment technician, and laboratory analyst (total 12 jobs). Of these three occupations, it does seem likely, however, that some positions can be filled by current workers in the region, if the company is willing to invest in some training. For example, both the laboratory technician and safety and environment technician position can be filled by workers with experience in other industries. In this case, some training would be necessary to prepare them for work at the Coles Hill site. On the contrary, unlike technicians, geologists require formal training and experience, so hiring local workers with no geology background would be detrimental. Equally, it is crucial that individuals in senior management have significant experience in the uranium mining and milling industry. It is likely that the geologist positions and certain senior management positions would be hired elsewhere.

Overall, out of 324 mining and milling jobs, only some of the geologist positions and senior management positions are likely to be filled by people from outside the Chatham Labor Shed, which at most would be 3 percent of total jobs directly created by the uranium operation the area. That leaves roughly 97 percent of positions to be filled from the working-age residents in the Chatham Labor Shed.

5.3.6 Jobs Distribution among Localities-by Work Location

Aside from the direct jobs that can be met from local residents, the indirect and induced jobs from mining and milling operations will also create additional job opportunities for residents in the labor shed. The indirect and induced jobs estimated in Section 5.3.4 for the Chatham Labor Shed are jobs in the region based on their work location. The estimates of indirect and induced jobs are based on the existing industry mix of the labor shed. They do not account for the potential that additional businesses, such as equipment service business, may move to the region to take advantage of the mining and milling operations in Chatham.

With the creation of hundreds of jobs in the Chatham Labor Shed from mining and milling operations, the majority of those jobs will be located in Pittsylvania County. For example, from years 1 to 21 of the mining and milling operations, a total of 561 jobs will be created in the Chatham Labor Shed. Of those, there will be 324 direct jobs, 53 indirect jobs, and 184 induced jobs. The distribution of those jobs among localities within the labor shed is

estimated separately. For direct jobs, all of those positions will be located in Pittsylvania County. The localities with a larger economic base will be more likely to have products and services that meet the needs of mining and milling operations, so these would supply indirect jobs. As a result, Chmura utilized the industry employment as a method to distribute indirect jobs to localities in the Chatham Labor Shed. For induced jobs, since they are consumer-related jobs derived from employee income, Chmura first used the commuting patterns to Pittsylvania County to estimate the potential number of mining and milling workers living in each locality that commute to the site. Chmura then used the number of employed workers living in each area to distribute induced jobs within those localities.

The resulting job distributions based on work locations are listed in Table 5.7. Of the 561 jobs created from both mining and milling operations from years 1 to 21, 83 percent (or 466) of those jobs are expected to be located in Pittsylvania County. In Danville City, 42 positions (8 percent) can be allocated. Since Danville City has the largest economic base in the labor shed, Danville City can potentially secure the most indirect jobs from the milling and mining operations. The rest of the localities in the Chatham Labor Shed are also expected to receive a small number of indirect and induced jobs.

Table 5.7: Estimated Location Distribution of Mining and Milling Operations Jobs (Years 1-21)

Virginia locality	Direct	Indirect	Induced	Total Jobs
Pittsylvania County	324	5	138	466
Danville City	0	11	31	42
Campbell County	0	7	6	13
Halifax County	0	5	3	8
Henry County	0	6	3	8
Franklin County	0	6	2	7
Bedford County	0	7	1	8
Martinsville City	0	5	1	6
Bedford City	0	1	0	1
Total	324	53	184	561

Source: Chmura Economics & Analytics (some numbers may total exactly due to rounding)

Since the mining and milling operations will employ fewer workers from years 22 to 35, the overall jobs distributed among localities in the Chatham Labor Shed will also decrease. Of the 433 total jobs (including direct, indirect, and induced) created from mining and mining operations, 372 of those jobs will be located in Pittsylvania County and 30 will be located in the city of Danville. The remaining localities in the Chatham Labor Shed are also expected to receive a small number of jobs.

Table 5.8: Estimated Location Distribution of Mining and

Virginia locality	Direct	Indirect	Induced	Total
Pittsylvania County	257	2	113	372
Danville City	0	5	25	30
Campbell County	0	3	5	9
Halifax County	0	2	3	5
Henry County	0	3	2	5
Franklin County	0	3	2	4
Bedford County	0	3	1	4
Martinsville City	0	2	1	3
Bedford City	0	1	0	1
Total	257	25	151	433

Source: Chmura Economics & Analytics (some numbers may total exactly due to rounding)

5.3.7 Jobs Distribution among Localities-by Residence

Since the jobs created by mining and milling operations (including direct, indirect, and induced) in the Chatham Labor Shed can attract commuters inside and outside the labor shed, the residence distribution of the jobs are different from the jobs distribution based on work locations. Table 5.9 illustrates the residence distribution. Of the 561 jobs created from mining and milling operations from years 1 to 21, 61 percent (or 345) of those workers are likely to live in Pittsylvania County. Some 17% (or 93) of them would live in Danville City. Approximately 7 percent of the workers would live outside the labor shed. The residence distribution during the pillar extraction phase (years 22-35) follows a similar pattern.

Table 5.9: Estimated Distribution of Mining and Milling Jobs by Residence

Virginia locality	Primary Stopping Phase (Years 1-21)	Pillar Extraction Phase (Years 22-35)
Pittsylvania County	345	274
Danville City	93	73
Campbell County	23	17
Halifax County	16	11
Henry County	16	10
Franklin County	12	8
Bedford County	10	6
Martinsville City	4	3
Bedford City	1	0
Outside Labor Shed	42	31
Total	561	433

Source: Chmura Economics & Analytics (some numbers may total exactly due to rounding)

5.4. Spending and Employment Impact of Reclamation

The capital expenditure estimated in Section 5.2 does not include the reclamation costs.³⁹ Though the reclamation costs are typically assumed to be spent when mining and milling operations end, the scoping document suggests that reclamation efforts for tailings impoundment can start in the middle of the mining and milling operations. The reclamation effort on tailings involves installing five feet of cover, six inches of topsoil, and re-vegetation. As each individual tailings impoundment cell is filled, the reclamation can start on that cell. For example, Cell 1A has a capacity to hold tailings resulting from processing 2.8 million tons of uranium ore. The average production of the mine is about 1.1 million tons in uranium ore. After three years, Cell 1A will be filled, and reclamation can start in year 4, to minimize the environmental impact. It is also assumed the reclamation effort will last one year after each tailings cell reaches its capacity. As Table 10 indicates, the total reclamation cost of tailings impoundment cells is estimated to be \$4.8 million.

³⁹ The cost of constructing tailings facilities is included in the capital expenditure.

Table 5.10: Tailings Capacity and Reclamation Cost

	Capacity (Tons Ore Mined)	Reclamation Cost
Cell 1A	2,768,958	\$696,125
Cell 1B	2,768,958	\$673,250
Cell 1C	2,768,958	\$554,250
Cell 1D	2,768,958	\$754,250
Cell 1E	2,768,958	\$760,125
Cell 1F	2,768,958	\$583,000
Cell 2A	1,549,992	\$410,575
Cell 2B	1,104,868	\$354,775
Total	19,268,608	\$4,786,350

Source: Lyntek and BRS, Scoping Study and Cost Estimate, Table 6.9 and 7.3

Aside from securing and reclaiming the tailings impoundment cells from uranium mining, the total reclamation cost typically includes the cost of dismantling and closing the mining and milling facilities when operation ceases. The estimated cost for those activities is \$10.2 million.⁴⁰ It is assumed this cost is spent at the end of the life of the mine.

As a result, the total reclamation spending of the project is estimated to be \$14.9 million over the life of the mine, measured in nominal dollars. The reclamation spending was entered into the IMPLAN model to estimate job creation and the ripple economic effects of the reclamation effort in the Chatham Labor Shed and the state of Virginia.

Table 5.11 details the estimated economic impact of the reclamation spending. During the life of the mine, it is estimated that the reclamation spending will generate a total economic impact (including direct, indirect, and induced effects) of \$16.3 million in the Chatham Labor Shed, which can support 183 jobs. Among the total economic impacts, \$11.5 million will be direct spending within the labor shed, with direct jobs amounting to 134 during the life of the mine. The indirect impact in the labor shed will total \$2.1 million and support 22 jobs during the life of the mine, while the induced impacts in the labor shed during the life of the mine are expected to be \$2.8 million with 28 jobs concentrated in consumer service-related industries.

Table 5.11: Economic Impact of Reclamation

		Direct	Indirect	Induced	Total
Annual Average (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$0.3	\$0.1	\$0.1	\$0.4
	Employment	4	1	1	5
State of Virginia	Spending (\$ Million)	\$0.4	\$0.1	\$0.2	\$0.7
	Employment	4	1	2	7
Total (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$11.5	\$2.1	\$2.8	\$16.3
	Employment	134	22	28	183
State of Virginia	Spending (\$ Million)	\$14.3	\$4.6	\$6.5	\$25.3
	Employment	165	38	61	264

Source: Chmura Economics & Analytics and IMPLAN Pro 2009 (some numbers may total exactly due to rounding)

⁴⁰ "Coles Hill Uranium Project Scoping Study and Cost Estimate" (appendix L) Lyntek & BRS, October 2010.

The economic impacts of reclamation spending in Virginia are larger than in the Chatham Labor Shed, as more businesses outside the labor shed also benefit from reclamation activities. During the life of the mine, it is estimated that reclamation spending will generate total impacts of \$25.3 million in spending and 264 jobs in Virginia.

Some VUI officials have indicated the amount of mill tailings that will be produced may exceed the 26 million tons that is estimated in VUI's scoping study.⁴¹ Chmura's estimates in this section are predicated solely on the figures in the Scoping Study. Additional remediation spending would be required if the tonnage of mill tailings produced increases beyond the 26 million tons. While this extra remediation spending will unambiguously create additional jobs it will also increase the breakeven price of yellowcake needed by VUI to remain profitable. Simultaneously, Chmura judges there is a positive correlation with the amount of mill tailings produced and the likelihood for environmental contamination.

Chmura cannot ascertain if the remediation cost estimate of \$14.9 is appropriate for the Coles Hill site because there is insufficient data in the Scoping Study. Chmura's research indicates that remediation costs vary widely by site and depend greatly on the mining techniques and technology employed, as well as the physical, environmental, and weather conditions of the surrounding area. With the caveat that every site is different, the estimated decommissioning costs for the Piñon Ridge uranium mill—projected to produce less than half the amount of mill tailings as the Coles Hill site—was approximately \$12 million dollars.⁴² This would suggest the VUI estimate for its decommissioning costs are conservative.

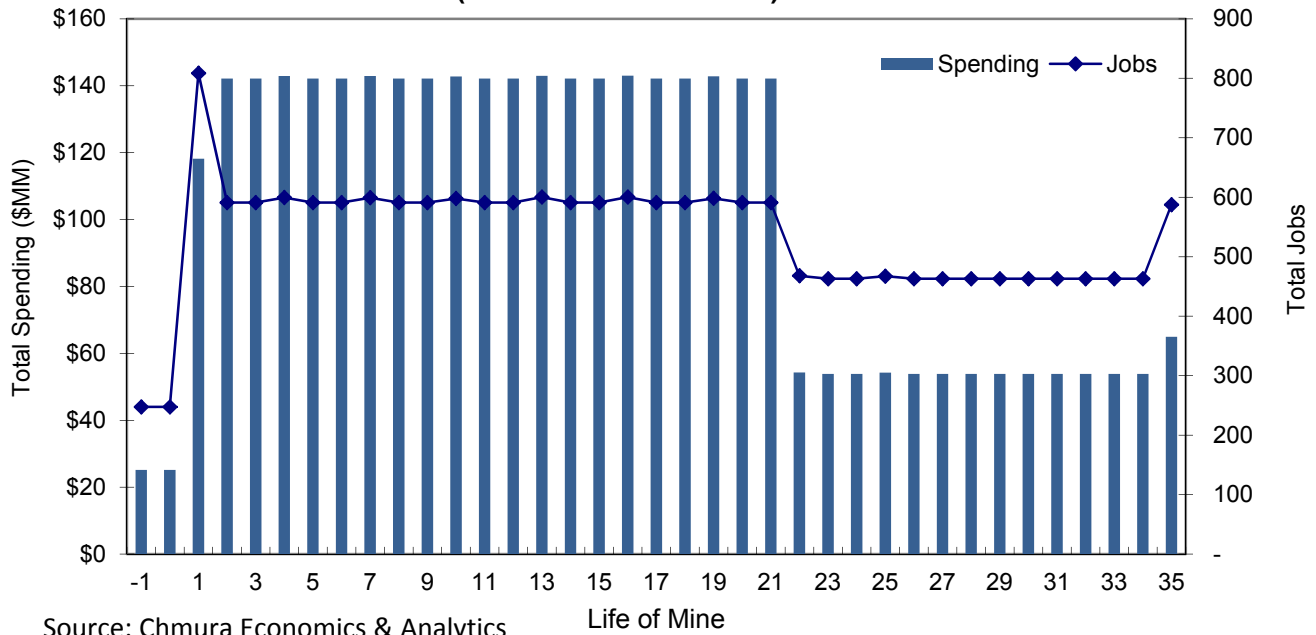
5.5. Spending and Employment Impact Summary

Given that construction, operations, and reclamation will overlap, the economic impact of the uranium project in the Chatham Labor Shed and Virginia will vary over time. In the first three years, the majority of economic impacts will come from capital expenditure. From years 1 to 35, the economic impacts will come from mining and milling operations, with a small amount of impact from continuous capital expenditure and the reclamation effort. During the mining and milling operations phase, the economic impact will decline after year 21, as the production level is reduced. The slight improvement in economic impact at the end of the life of the mine represents the reclamation effort, such as the dismantling of mining and milling facilities. During the life of the mine, the cumulative economic impacts (including direct, indirect, and induced) are estimated to be \$3.8 billion, with 19,788 jobs in the Chatham Labor Shed. The annual average impact is estimated to be \$102.3 million that can support 535 jobs in the labor shed during the life of the mine. Among those, the annual direct impact of uranium mining is \$78.4 million that can support 320 jobs in the region.

⁴¹ VUI Representative, public comments "Uranium: What Should Virginia Do?" 53rd Garden Club of Virginia Conservation Public Education Forum, University of Richmond, 3-November-2011

⁴² "Appendix C Piñon Ridge Mill Decommissioning and Reclamation Cost Estimate" Energy Fuels Resources Corp, 2009

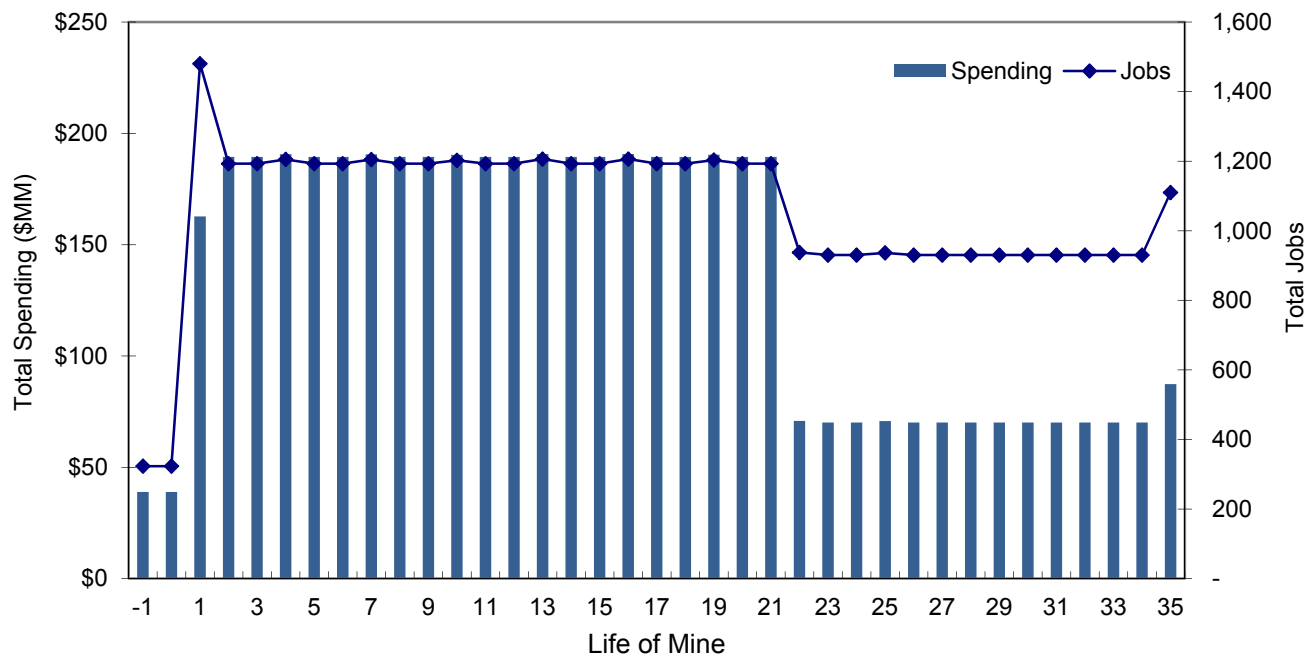
**Figure 5.5: Economic Impact Summary (Chatham Labor Shed)
(Direct+Indirect+Induced)**



Source: Chmura Economics & Analytics

The combined economic impacts of construction, operations, and reclamation spending in Virginia are larger than in the Chatham Labor Shed, but they follow similar patterns over time. During the life of the mine, the cumulative economic impacts (including direct, indirect and induced) are estimated to be \$5.1 billion, with 39,273 jobs in Virginia. The annual impact is estimated to be \$136.6 million that can support 1,061 jobs in Virginia.

**Figure 5.6: Economic Impact Summary (Commonwealth of Virginia)
(Direct+Indirect+Induced)**



Source: Chmura Economics & Analytics

5.6. Impact on Property Values and the Housing Market

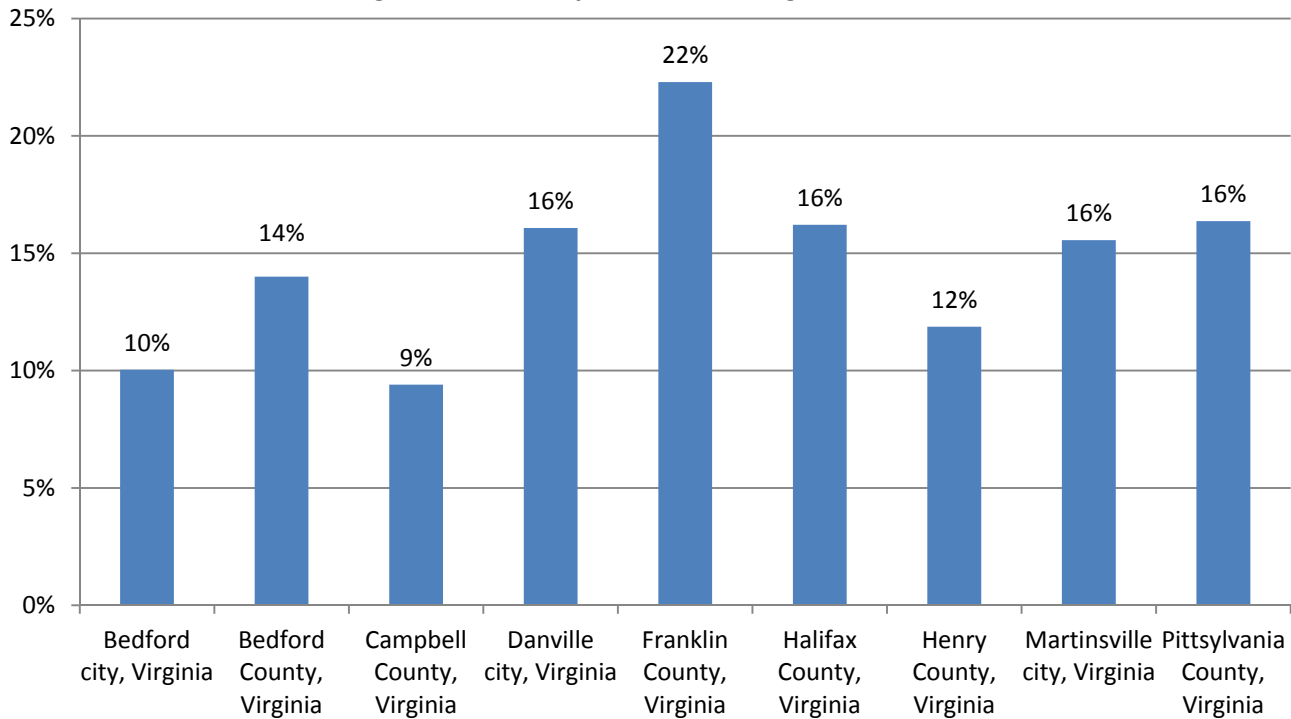
There are two forces that could impact the housing market in the Chatham Labor Shed. First, with the new jobs and possible new residents moving to the region to take those jobs, increased demand could put an upward pressure on housing prices in the region. Secondly, there are concerns that the presence of the uranium mining and milling operations will create a negative “stigma” effect in the region, which will negatively affect property values.

5.6.1. Impact on Property Value from Incremental Population

The analysis in Section 5.3 indicates that the majority of jobs in mining and milling operations can be filled with the existing workers in the Chatham Labor Shed, with a few of the skilled jobs being filled with individuals outside the labor shed. As a result, there are potentially only a dozen new households moving in from outside the region, resulting in minimal additional demand for housing in the area. This limited incremental demand is unlikely to be significant enough to drive up housing prices.

For example, based on the latest data on housing occupancy, 15.2 percent of the total housing units, 29,516 units, in the Chatham Labor Shed were vacant in 2010. As a comparison, the vacancy rate for Virginia was 9.2 percent for the same period. The housing vacancy rates for Pittsylvania and Danville were 16.4 percent and 16.1 percent, respectively, in 2010. As a result, the limited number of persons moving into the region can be easily accommodated by the current housing inventory in the labor shed. Similarly, there is a limited probability that the “wealth effects” spurred by the new employment opportunities created by the uranium industry in Pittsylvania County will be enough to significantly push up overall housing prices in the region.

Figure 5.7: Vacancy Rates of Housing Units , 2010



Source: U.S. Census

5.6.2. Stigma and Environmental Contamination Risks on Real Estate Values

Portions of the public, media, and other stakeholders have questioned the impact of introducing uranium mining and milling operations near Chatham, Virginia on local real estate values. The underlying fear is that a stigma or negative public perception associated with the uranium industry will result in lower property values. Chmura's research has confirmed that as it currently exists, the limited public discourse on the uranium industry is largely negative. The public generally associates this industry with environmental degradation, water contamination, and increased health risks. This sentiment is particularly prevalent among environmental groups. In short, the uranium industry could be a source of negative stigma, and people when asked if they would like to live near mild radioactive industrial waste generally say no.⁴³ But ample research has also shown the economic impact of this type of stigma on property values is limited to properties in close proximity to the site and is by and large temporary.^{44 45 46 47 48 49} In the case of Coles Hill, the economic impact is likely to be mixed, with properties within approximately five miles of the site potentially experiencing some temporary negative stigma effects on their property values. The remainder of Chatham's real estate market benefits somewhat mildly from the added economic activity and small influx of people. This research consists entirely of studies examining the effect of known environmental contamination on property values or on the presence of undesirable industrial sites, such as landfills, coal power-plants, and metal smelting. Chmura found no studies quantifying the stigma related to specific "potential" environmental risks stemming from a uranium mining and milling operation, and therefore the conclusions are presented with caution.

The current research suggests the economic loss in value associated with the stigma effect is likely to range from a 2 to 8 percent discount for properties within a five-mile radius of the facility. This is compared to the average value of a corresponding peer group of properties located beyond the 5-mile radius. The studies all conclude that distance is a relevant factor in determining the economic loss attributable to stigma, and properties closest to the mining and milling operations should experience the greatest discount.⁵⁰ Properties within 2 miles of the mining and milling operations have the greatest potential to be affected, and those impacts will likely be sustained over the operational life of the uranium mine and mill. These impacts could potentially linger even after both the mine and mill has been closed.⁵¹ These studies generally show that properties beyond a 5-mile radius either exhibit no stigma effects—at least none that can be validly detected using established statistical techniques—or the negative effects are negligible.

⁴³ "Socioeconomic Analysis Receipt of Maywood Material: Cotter Corporation Milling Facility" RPI Consulting Inc., 2003.

⁴⁴ "A Meta-Analysis of the Effect of Environmental Contamination and Positive Amenities on Residential Real Estate Values" Robert A. Simons and Jesse D. Saginor, 2006.

⁴⁵ "Undesirable Facilities and Property Values: A Summary of Empirical Studies" Stephen Farber, 1997.

⁴⁶ "Stigmatized Asset Value: Is it Temporary or Long-term?" Jill J. McCluskey and Gordon C. Rausser, 2003.

⁴⁷ "Do Landfills Always Depress Nearby Property Values?" Richard C. Ready, 2005.

⁴⁸ Source: Environmental Contamination and Industrial Real Estate Prices. T. Jackson, *Journal of Real Estate Research*, Volume 23, Page 179-99, 2002

⁴⁹ Source: The Effects on Residential Real Estate prices from Proximity to Properties Contaminated with Radioactive Materials. By William Kinnard Jr. and Mary Beth Gekler. *Real Estate Issues*, Volume 16, Number 2, page 25-36, 1991

⁵⁰ Source: The Economic Impact of Nuclear Plant Disasters and Accidents: From the Oak Ridge Reservation to the Fukushima Daiichi Nuclear Plant. Bu Sepideh Khavari, 2011.

⁵¹ "Stigmatized Asset Value: Is it Temporary or Long-term?" Jill J. McCluskey and Gordon C. Rausser, 2003.

Nonetheless, the transitory nature of negative stigma effects suggests that should the qualities of water, air, and soil near any mining and milling operation remain unaffected during the early years of operation, the majority of the stigma effects on most of the properties within five miles would disappear. In short, Chmura judges that if no accidents occur, and the mine and milling sites are properly maintained and reclaimed afterwards, any negative effect on residential property value in Pittsylvania County is likely to be short-lived, localized, and in most cases negligible.

A study in Colorado, perhaps the most germane to the case of Pittsylvania County, dealt with the impact of a now-closed uranium mill on property values and concluded the closed facility exerted “little influence” on real estate prices.⁵² Furthermore, the study noted that real estate prices in this Colorado county had risen overall during the period in question and were consistent with state and national trends. However, the study leaves open the possibility that the price appreciation observed could have been greater had it not been for the presence of the closed uranium mill.⁵³ Similar trends were noted in other superfund sites, where real estate prices moved upward and mirrored state and national trends rather than actually declining in value. Nevertheless, despite the notion that an outright fall in real estate prices is unlikely, for the purposes of this study, Chmura assumes for the baseline assessment that the full value of all homes (approximately 175) that lie within 2 miles of Coles Hill will see their property values permanently diminished by five percent.⁵⁴ This is a loss of aggregate housing wealth of approximately \$1.9 million⁵⁵ and would imply property tax loss to the county of nearly \$10,600.⁵⁶ Also, given the vacancy rate, Chmura judges there is only a marginal chance that the increased need for housing will noticeably improve the value of the remainder of Chatham’s housing stock and commercial properties.

Some industries with stigma effects have presented “offsets” to populations where property values could be impacted by their operation. For example, some landfill operators monitor long-term housing trends in their area and provide a formula for property owners within a 2-mile radius to seek compensatory payment from the company if they sell their house below its fair market value due to the presence of the landfill.⁵⁷ Such methods have been known to dramatically raise the community acceptance for locating such facilities in their area.⁵⁸

⁵² “Socioeconomic Analysis Receipt of Maywood Material: Cotter Corporation Milling Facility” RPI Consulting Inc. 2003.

⁵³ “Socioeconomic Analysis Receipt of Maywood Material: Cotter Corporation Milling Facility” RPI Consulting Inc. 2003.

⁵⁴ Five percent represents the median loss value in the available research.

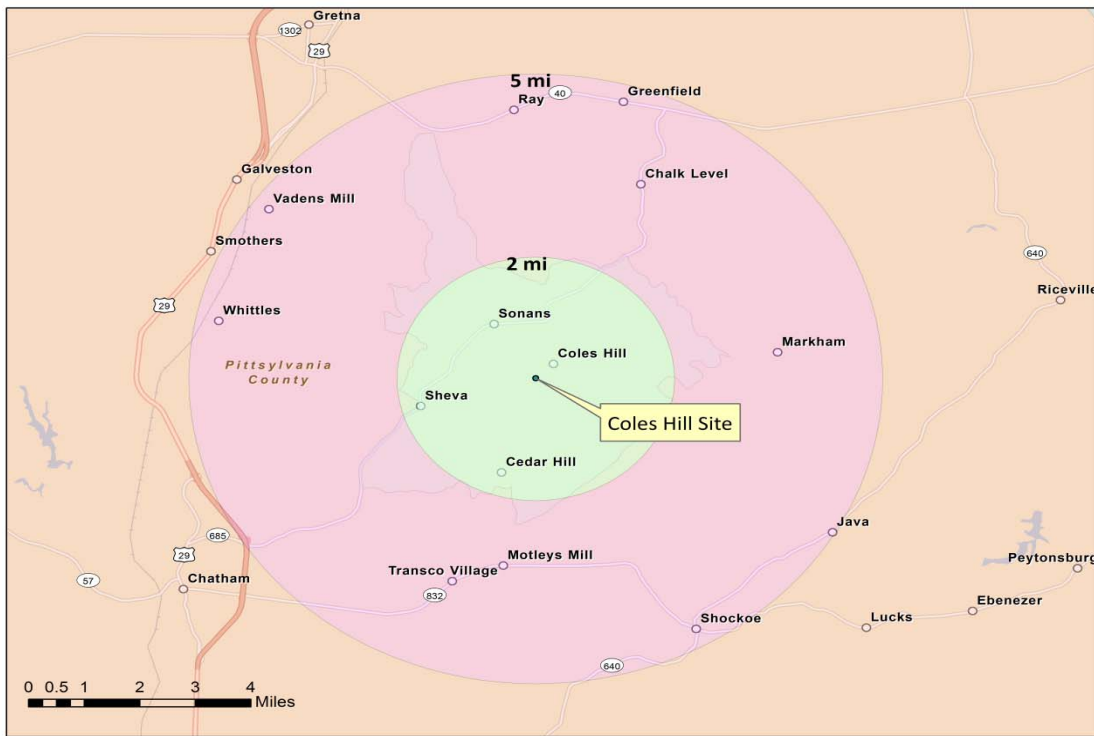
⁵⁵ Utilizing census data yields about 175 households with a median value of \$81,000 per dwelling plus about 7,850 acres valued at \$3000.00 per acre.

⁵⁶ Assumes a tax rate of \$0.52 per \$100 of assessed (or in this case approximated) value.

⁵⁷ “Risk, Media and Stigma: Understanding Public Challenges to Modern Science and Technology”, Kunreuther & Slovic, 2001.

⁵⁸ “Risk, Media and Stigma: Understanding Public Challenges to Modern Science and Technology”, Kunreuther & Slovic, 2001.

Figure 5.8: Communities around Coles Hill



There are few additional points of caution that should be emphasized to Virginia lawmakers. Some studies have noted that rural areas with relatively “thin” or illiquid real estate markets—which would seem to fit Chatham—could see stigma effects that are higher than average and skewed towards the upper end of the economic loss range.^{59 60} A study which polled property lenders and property appraisers in Yucca Mountain, Nevada suggested that a significant contamination of the air, water, or soil—above the prescribed federal limits—could diminish property values up to 30 percent while remediation efforts were underway.⁶¹ While this study involved contamination stemming from spilled nuclear waste with levels of radiation dramatically higher than what would be occurring at Coles Hill, these results remain informative. Similarly, a study on industrial properties in Colorado found that properties with confirmed contamination sell at 43-56 percent discount, and a separate study on contaminated industrial properties in Southern California concluded that these properties sell at a price approximately 30 percent less than unimpaired properties.⁶² The economic impact of other scenarios involving various levels of environmental contamination on the local housing market is addressed in the appendix.

⁵⁹ “Undesirable Facilities and Property Values: A Summary of Empirical Studies” Stephen Farber, 1997.

⁶⁰ “The Impact of Hazardous Waste Superfund Sites on the Value of Houses Sold in New Jersey” M. Greenberg and J. Hughes, 1992.

⁶¹ “Yucca Mountain Impact Assessment Report Clark County” UNLV CBER, 2002.

⁶² “Determinants and Effects on Property Values of Participants in Voluntary Cleanup Programs: The Case of Colorado” Anna Alberini, Contemporary Economic Policy, Volume 25, Number 3, Page 415-432, 2007.

5.7. Fiscal Impact on State and Local Governments

In addition to creating hundreds of jobs and injecting millions of dollars into the regional and state economy, the capital expenditure, the mining and milling operations, and reclamation activities will also produce significant tax revenue for both Pittsylvania County and the Virginia state government. Major revenue sources for local governments from this project are the following: real estate; machine tool; and business, professional, and occupational license (BPOL) taxes. For the state government, major tax revenues include individual and corporate income taxes. In order to be conservative, only tax revenue from the direct impact is estimated.⁶³

The current tax rates of local and state governments are used in estimating the tax revenues for local and state governments, even though the tax rate can change in the future. For example, Pittsylvania County has neither a natural resource severance tax nor a BPOL tax as of now. It may impose those taxes, should mining and milling operations start in the future. Thus, the tax revenues estimated here may be conservative.

The following assumptions on tax rates are used in calculating the fiscal impacts on the mining and milling projects:

- The assessed value of real estate property is assumed to be the construction cost
- The original cost of machine tools is assumed to be the capital expenditure on equipment
- The Virginia individual income tax rate is 5% and the corporate income tax rate is 6%⁶⁴

The Pittsylvania county tax rate assumptions are:⁶⁵

- Real estate tax: 0.52 percent of assessed value⁶⁶
- Personal property tax: 8.5 percent of assessed value⁶⁷
- Machine tool tax is 4.5 percent of assessed value, assessed at 10 percent of original cost
- Pittsylvania County has no BPOL tax
- Pittsylvania County has no natural resource severance tax

5.7.1. Fiscal Impacts from Capital Expenditure

Pittsylvania County does not have a BPOL tax, but other localities in the Chatham Labor Shed, such as Danville City and Campbell County, have BPOL taxes, as well as many other localities in Virginia. Only the capital expenditure spent outside the county will be subject to BPOL tax. Chmura uses a weighted average of regional and state local tax rates to estimate potential BPOL tax revenues to local governments in the Chatham Labor Shed and in Virginia. Since the majority of the construction spending will occur in Pittsylvania County, the resulting BPOL tax revenues for local governments in the labor shed and elsewhere in Virginia are considered minor. For example, during the life of the mine, BPOL tax revenues for all local governments in the Chatham Labor Shed are estimated to be \$23,731. The BPOL tax revenues for all local governments in Virginia are estimated to be \$44,790, including the \$23,731 for local governments in the Chatham Labor Shed.

⁶³ This approach is recommended by Burchell and Listokin in *The Fiscal Impact Handbook*.

⁶⁴ Source: Virginia Department of Taxation.

⁶⁵ Unless otherwise stated, all taxes rates are from: Virginia Local Tax Rate, 2010. Weldon Cooper Center for Public Service, University of Virginia.

⁶⁶ Source: Pittsylvania County website: http://www.pittgov.org/realestate_tax.htm.

⁶⁷ Source: Pittsylvania County website: http://www.pittgov.org/property_tax.htm.

Table 5.12: Tax Revenues Capital Expenditure (Total LOM)

	Local Governments in Chatham Labor Shed	Local Governments in Virginia	State of Virginia
BPOL Tax	\$23,731	\$44,790	
Income Tax-Individual			\$2,009,635
Income Tax-Corporate			\$539,150
Total			\$2,548,785

Source: Chmura Economics & Analytics

For the state government, individual and corporate income taxes from capital expenditure are estimated to total \$2.0 million and \$0.5 million, respectively, over the life of the mine.

All numbers in Table 5.12 represent the total tax revenues from capital expenditure for the life of the mine. Section 5.7.3 details the estimated tax revenue by individual year.

5.7.2. Fiscal Impacts from Mining and Milling Operations

The ongoing operation of uranium mining and milling in Pittsylvania County will contribute a significant amount of tax revenue to both state and local governments. The main tax revenues for local governments from the uranium mining and milling industry are real estate tax from the structure of the facilities and machine tool tax from equipment. Mining and milling operations are not subject to BPOL taxes. For state governments, major tax revenues include individual and corporate income taxes.

Virginia laws provides two tax options for local governments regarding mining activities. Under § 58.1-3286 of the Code of Virginia, localities are required to “specially and separately assess at the fair market value all mineral lands and the improvements thereon” and enter those assessments separately from assessments of other lands and improvements. Mineral lands are taxed at the same rate as other real estate in the locality. Pittsylvania County does not have a special assessment for mineral land.⁶⁸ As a result, the assessment of land value will be the same as its current value. Any new real estate tax will come from the improvement and structure of the mining and milling facilities.

The real estate tax for Pittsylvania County is \$0.52 per \$100 assessed value. Since capital expenditures will be conducted each year even after the mining and milling facilities are in full operation, the real estate tax base for the county of Pittsylvania will also increase over the life of the mine. Based on the capital expenditure schedule, it is estimated that during the life of the mine, the annual average of county real estate taxes will be \$0.4 million per year. During the first 21 years of the mining operation (primary stoping phase), the annual average real estate tax is estimated to be \$0.3 million. In the pillar extraction phase, the annual average real estate tax is estimated to be \$0.5 million. The cumulative real estate tax for the county during the life of the mine can reach \$14.1 million.

⁶⁸ Virginia Local Tax Rate, 2010. Weldon Cooper Center for Public Service, University of Virginia.

Table 5.13: Tax Revenues From Mining and Milling Operations

	Annual Average (Years 1-21)	Annual Average (Years 22-35)	Annual Average (LOM)	Cumulative (LOM)
Real Estate Taxes	\$0.3	\$0.5	\$0.4	\$14.1
Machinery Tool Taxes	\$0.6	\$0.8	\$0.7	\$25.0
Tax on Natural Resources	\$0.0	\$0.0	\$0.0	\$0.0
Total Pittsylvania Taxes	\$0.9	\$1.3	\$1.1	\$39.1
Individual Income Tax	\$0.8	\$0.3	\$0.6	\$21.6
Corporate Income Tax	\$2.0	\$0.7	\$1.5	\$52.3
Total State Taxes	\$2.8	\$1.1	\$2.1	\$73.9
Total Local and State Taxes	\$3.7	\$2.4	\$3.2	\$112.9

Source: Chmura Economics & Analytics (some numbers may total exactly due to rounding)

The equipment installed in the mining and milling facilities will be subject to a county machinery tool tax. Under § 58.1-3507 of the Code of Virginia, certain machinery and tools, which are used for “manufacturing, mining, processing and reprocessing (excluding food processing), radio or television broadcasting, dairy, and laundry or dry cleaning, are segregated as tangible personal property for local taxation”. According to Virginia law, the tax rate on machinery and tools may not be higher than personal property taxes. In Pittsylvania County, the rate for machinery tool tax is 4.5 percent of the assessed value, while county personal property tax was 8.5 percent in 2010. In addition, Pittsylvania computed the assessed value of machinery tools as 10 percent of their original cost.⁶⁹

Since capital expenditures on equipment will be carried out each year even after the mining and milling facilities are in full operation, the machinery tool tax for the county of Pittsylvania will also increase over the life of the mine. It is estimated that during the life of the mine, the average for the county machinery tool tax will be \$0.7 million per year. During the primary stoping phase, the annual average real estate tax is estimated to be \$0.6 million, compared with \$0.8 million annual average during the pillar extraction phase. The cumulative machinery tool tax for the county during the life of the mine can reach \$25.0 million.

Virginia law allows localities to levy a severance tax on natural resources extraction, based on the gross receipt of the mining business. In Virginia, only counties in southwest Virginia have severance tax, as most other counties are not endowed with mineral resources. Currently, Pittsylvania County does not have a severance tax (see Section 6.7 for a discussion of taxing options). Many other states in the United States impose severance taxes in the range of 2 to 5 percent of the gross value of the ore extracted, but typically allow for some of the extraction costs to be netted out of the taxable gross value.⁷⁰

The state government will also benefit from individual income taxes as a result of new jobs created from mining and milling operations. Since production and employment for these operations will decrease after year 22, the state tax revenue will also drop sharply during the pillar extraction phase of the operations. During the primary stoping phase of the mining and milling operations, the annual individual and corporate income tax revenues are estimated to be \$0.8 million and \$2.0 million, respectively. During the pillar extraction phase, the annual individual and corporate income tax revenues are estimated to be \$0.3 million and \$0.7 million, respectively. The cumulative state tax revenues during the life of mine can reach \$73.9 million, with the average of state tax revenue of \$2.1 million per year.

⁶⁹ Virginia Local Tax Rate, 2010. Weldon Cooper Center for Public Service, University of Virginia.

⁷⁰ “Uranium Severance Taxes in Other States” North Dakota Legislative Tax Committee, 2010.

In summary, during the life of the mine, Pittsylvania County is expected to receive an annual average of \$1.1 million in tax revenues from mining and milling operations, while the state government is expected to collect \$2.1 million per year. Mining and milling operations can bring a total of \$3.2 million per year in tax revenues to both local and state governments. The cumulative state local tax revenues during the life of the mine can reach \$112.9 million.

Because Pittsylvania County does not have BPOL tax, only the reclamation expenditure spent outside Pittsylvania will be subject to BPOL tax. Since the majority of estimated reclamation spending will occur in Pittsylvania County, the resulting BPOL tax revenues for local governments in the Chatham Labor Shed and elsewhere in Virginia are considered minor. For example, during the life of the mine, the BPOL tax revenues for all local governments in the Chatham Labor Shed are estimated to be \$2,536. The BPOL tax revenues for all local governments in Virginia are estimated to be \$5,866.

Table 5.14: Tax Revenues from Reclamation (Total LOM)

	Local Governments in Labor Shed	Local Governments in Virginia	State of Virginia
BPOL Tax	\$2,536	\$5,866	
Income Tax-Individual			\$226,200
Income Tax-Corporate			\$63,482
Total			\$289,682

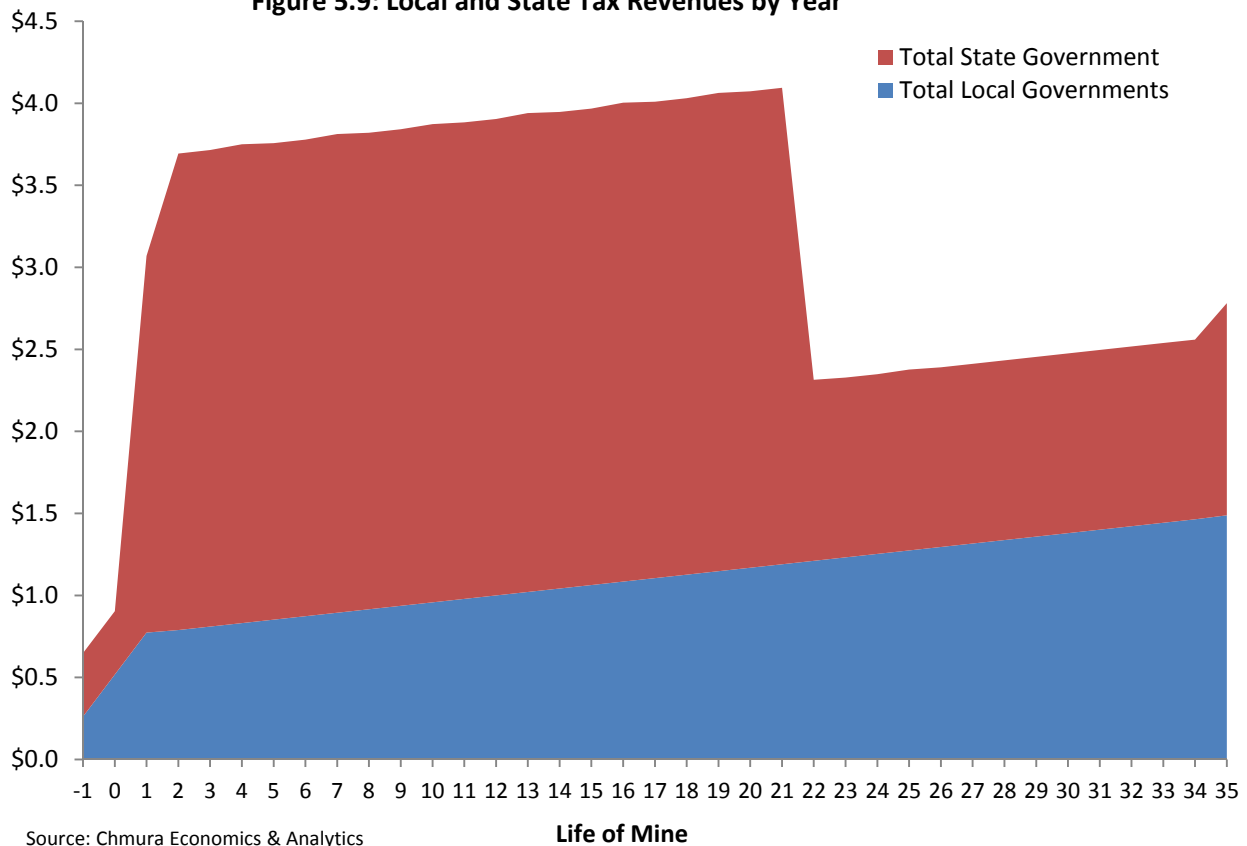
Source: Chmura Economics & Analytics

For the state government, both individual and corporate income taxes from reclamation spending are estimated to total \$226,200 and \$63,482, respectively, over the life of the mine.

5.7.4. Annual Fiscal Impacts Summary

Since capital expenditure of the project will last throughout the life of the mine, and mining and milling operation size varies, local and state governments will have an uneven tax revenue stream over the years. Figure 5.9 illustrates the total local and state tax revenues by year. The county tax revenues will increase sharply after the first three years, as a large amount of capital expenditure will occur during the initial three years in the life of the mine. Local tax revenues will increase steadily afterwards during the life of the mine, as additional capital expenditure on structure and equipment will steadily increase this tax base. But state tax revenues drop after year 22, as the production and employment sector of the mining and milling operation declines significantly.

Figure 5.9: Local and State Tax Revenues by Year



Source: Chmura Economics & Analytics

In summary, the cumulative state and local tax revenues during the life of the mine can reach \$115.8 million, with \$39.1 million allotted to local governments and \$76.7 million for the state government. Only a small portion of the tax revenue (\$2.9 million) comes from capital expenditure and reclamation spending, while the dominant share (\$112.9 million) results from the mining and milling operations. On an annual average basis, total state and local tax revenues are estimated to be \$3.1 million per year.

5.8. Impact of Potential Job Losses

Although people generally avoid noxious and/or dangerous locations when they choose their place of residence, it is not known (and no model can readily predict) exactly how potential residents, visitors, and new businesses will evaluate the presence of the uranium industry in Pittsylvania County. Nevertheless, during the period Chmura conducted the study, the Chmura team spoke with many local businesses and communities to understand which jobs can potentially be moved or relocated due to the mining and milling operations. Four industries—education, manufacturing, tourism, and agriculture—were repeatedly identified in discussions with various stakeholders, focus groups, and targeted interviews. For each of these industries, any possible job loss scenarios were considered, although Chmura judges that in its baseline scenario, none of these situations are likely to occur. The following sections estimate the economic impact of these sectors, and convey the impact of job losses. While these estimates are not included in the baseline assessment, they are incorporated in alternate scenarios involving various levels of environmental contamination that are addressed in the appendix.

5.8.1. Chatham Hall

Chatham Hall is an all-girls college preparatory boarding school located in Chatham, Virginia. The school has publically voiced its concern regarding potential stigma effects impacting its ability to recruit students to its campus. The school has been highly successful in establishing its brand, reputation, and educational niche. The school has endured if not flourished for more than 100 years, and its impairment or loss to the community would be a tragedy. Thus, Chatham Hall leaders have every right to question what impact uranium mining and milling will have on their business model. Chmura judges, however, that absent environmental contamination of the air, water, noise, or soil that exceeds current federally established levels—consistent with the baseline scenario—the school is unlikely to suffer any long-lasting stigma effects. It is possible that during the years of the site’s development and initial operations, the school will have to dispel issues of uncertainty regarding the safety of their student population. However, unless a significant contamination event should occur, the school along with VUI and local, state, and federal officials should be able to provide credible assurances for the public’s as well as Chatham Hall’s students’ safety. However challenging for the school, Chmura concludes Chatham Hall’s endowment and reputation should be able to withstand any temporary uncertainties regarding its students’ safety while maintaining its market position in the education industry.

Currently, Chatham Hall has 129 enrolled students, with 84 percent of them living on campus. International students make up 27 percent of the student body. To support those students, Chatham Hall employs over 80 staff members, including teachers, administrators, and food and service workers.

The economic impacts that Chatham Hall contributes to regional and state businesses come from different sources. Primarily, the ongoing operation of the school is a significant benefit. The second source is the capital expenditure of the school. Another is off-campus student spending, which does not include tuition or room and board. Lastly, since a large portion of students are from outside the area, visiting parents and family members also spend money in the region, benefiting the local economy.

The total annual economic impacts of Chatham Hall on the Chatham Labor Shed are summarized in Table 5.14. The total annual economic impacts (direct, indirect, and induced) are estimated to be \$13.7 million in fiscal year (FY) 2011, which supported 178 jobs in the region.

Among the four sources of economic impacts, the largest component is the impact of Chatham Hall’s ongoing school operations. In fiscal year 2011 (FY2011), the total revenues of the school were \$6.8 million, which represents the direct fees charged by Chatham Hall, including both tuition and fees for room and board services. The direct employment impact is the number of people employed by the school, which is 85 in FY2011, including 60 full-time professional faculty/staff, 17 non-professional staff, and 8 part-time staff.⁷¹ Indirect impacts are estimated to be \$1.2 million and 35 jobs, benefiting other businesses within the region that support Chatham Hall operations. Induced impacts are estimated at \$1.8 million and 18 jobs in the region for FY 2011, mostly accruing to consumer-related business such as retail shops and restaurants.

⁷¹ Source: Chatham Hall.

Table 5.14: Chatham Hall Economic Impact Summary-Chatham Labor Shed, FY2011

Impact Category		Direct	Indirect	Induced	Total Impact
Operation	Spending (\$ Million)	\$6.8	\$1.2	\$1.8	\$9.9
	Employment	85	35	18	139
Capital Investment	Spending (\$ Million)	\$2.5	\$0.5	\$0.6	\$3.6
	Employment	25	5	6	36
Student Spending	Spending (\$ Million)	\$0.1	\$0.0	\$0.0	\$0.1
	Employment	1	0	0	2
Visitor Spending	Spending (\$ Million)	\$0.1	\$0.0	\$0.0	\$0.1
	Employment	2	0	0	2
Total Impact	Spending (\$ Million)	\$9.5	\$1.8	\$2.4	\$13.7
	Employment	113	40	24	178

Source: Chmura Economics & Analytics (some numbers may total exactly due to rounding)

In addition to operational expenditures, Chatham Hall also invests millions of dollars each year in capital investment projects that generate important economic impacts in the region. From 2007 to 2011, the school spent roughly \$6.4 million on capital projects. In the next five years, plans for capital projects exceed \$20.0 million. Unlike the operational impact, capital expenditure varies greatly from year to year. As a result, Chmura uses an annual average of both the past five and future five years as a benchmark for the annual impact of the capital expenditure of the school. The total annual economic impacts (direct, indirect, and induced) of Chatham Hall capital expenditure are estimated to have been \$3.6 million in FY2011. Of this impact, \$2.5 million was the direct impact that created 25 jobs in the region, mostly in construction trades and related engineering services. Indirect impacts are estimated to have been \$0.5 million and 5 jobs for other businesses within the region that support construction. Induced impacts are estimated to be \$0.6 million and 6 jobs, mostly accruing to consumer-related businesses in the region such as retail shops and restaurants.

Since the majority of the Chatham Hall students live on campus, their food and lodging expenses are paid directly to the school, which is part of the operational impact of the school. The additional impact from student spending comes from occasional off-campus student spending, which is relatively low. For example, Chatham Hall's website advises that parents should budget \$50-\$60 per month for student spending money, which presumably will be used off-campus.⁷² This study assumes that annual student spending outside campus is \$720 per year. The total annual economic impacts (direct, indirect, and induced) of student spending are estimated to have been \$0.1 million in FY2011, which supported 2 jobs in the region.

Chatham Hall School attracts hundreds of visitors to the region every year, and the majority of them are family members visiting their daughters at the boarding school. For example, annual graduation can attract 500 visitors, while annual alumnae and parent weekends, each typically bring 200 visitors to the region. As a result, the annual number of outside visitors to Chatham Hall is estimated to be 900. The average spending per visitor per day is derived from the visitor profile survey conducted by the Virginia Tourism Corporation (VTC).⁷³ The VTC data indicated from 2007 to 2009, the average spending in Virginia was \$48 per visitor per day with major spending categories being food, lodging, and transportation. Assuming visitors spend an average of two nights in the region,

⁷² <http://www.chathamhall.org/admissions/documents/FEESANDEXPENSES2011-12.pdf>.

⁷³ <http://www.vatc.org/research/visitation.asp>.

all Chatham Hall visitors spent an estimated \$86,310 in the region in FY2011. Adding indirect and induced impacts, the total annual economic impacts (direct, indirect, and induced) from visitor spending are estimated to have been \$0.1 million in FY 2011 which supported 2 jobs in the region.

In summary, if Chatham Hall closes or chooses to relocate to another region, the Chatham Labor Shed can potentially lose a total of 178 jobs, and the economic impacts of the loss of Chatham Hall on the state of Virginia will be even larger. As Table 5.15 shows, the total statewide economic impact of Chatham Hall reached \$17.4 million and 197 jobs in FY2011. These impacts are utilized in alternate scenarios involving various levels of environmental contamination that are addressed in the appendix. Other private schools in the area did not provide detailed information about their student enrollment, operational spending, and capital budgets so as to enable modeling of their economic impact, but Chmura judges the results for Chatham Hall to be illustrative of the economic impact of other major private schools in the area.

Table 5.15: Chatham Hall Economic Impact Summary-Statewide FY 2011

Impact Category		Direct	Indirect	Induced	Total Impact
Operation	Spending (\$ Million)	\$6.8	\$2.5	\$3.2	\$12.5
	Employment	85	39	26	150
Capital Investment	Spending (\$ Million)	\$2.5	\$0.9	\$1.1	\$4.6
	Employment	25	7	10	43
Student Spending	Spending (\$ Million)	\$0.1	\$0.0	\$0.0	\$0.1
	Employment	1	0	0	2
Visitor Spending	Spending (\$ Million)	\$0.1	\$0.0	\$0.0	\$0.1
	Employment	2	0	0	2
Total Impact	Spending (\$ Million)	\$9.5	\$3.5	\$4.4	\$17.4
	Employment	113	47	37	197

Source: Chmura Economics & Analytics (some numbers may total exactly due to rounding)

5.8.2. Manufacturing Jobs

Though it is unlikely, some manufacturing companies in the region, especially those relying heavily on local resources such as water and agricultural products, may have concerns regarding uranium mining and milling operations. This section models a hypothetical scenario where a sizable manufacturing firm, with employment size of 600, leaves the region.⁷⁴ As with the case of Chatham Hall or any other private school, this is not expected to take place so it has been excluded from the baseline scenario. The impact of such a manufacturing closure is modeled and incorporated into alternate scenarios involving various levels of environmental contamination that are addressed in the appendix.

The total annual economic impacts (direct, indirect, and induced) of such manufacturing firms in the Chatham Labor Shed are estimated to have been \$289.5 million which could support 1,203 jobs in FY2011. In terms of direct impact, the ongoing operations of the manufacturing firm are estimated to have an annual direct spending impact of \$198.3 million while employing 600 workers in the Chatham Labor Shed. An additional indirect impact of \$41.7

⁷⁴ This scenario can also be interpreted as several small size companies leaving the region.

million and 386 jobs will benefit other regional businesses that support manufacturing. The induced impact is estimated to have been \$49.4 million that supported 217 jobs in the region in 2011.

The economic impacts of the ongoing operations of such manufacturing firms for Virginia are greater than that of the Chatham Labor Shed, and the total annual economic impacts (direct, indirect, and induced) are estimated to have been \$400.8 million which could support 1,581 jobs in FY2011.

Table 5.16: Annual Impact of Potential Manufacturing Jobs (FY2011)

		Direct	Indirect	Induced	Total
Chatham Labor Shed	Spending (\$ Million)	\$198.3	\$41.7	\$49.4	\$289.5
	Employment	600	386	217	1,203
State of Virginia	Spending (\$ Million)	\$198.3	\$91.5	\$111.0	\$400.8
	Employment	600	589	392	1,581

Source: Chmura Economics & Analytics and IMPLAN Pro 2009 (some numbers may total exactly due to rounding)

5.8.3. Tourism

Some groups have raised the issue of the impact of uranium mining and milling on the tourism sector and on the region’s “heritage” tourism in particular.⁷⁵ Some have posited that the uranium industry may directly affect access to or degrade the condition of historic buildings or other resources. Others have feared that people will be less willing to travel to the region due to the presence of the uranium mining and milling industry. The planned mining and milling locations do not have any historic resources onsite, so there would be no resources to destroy or degrade. Similarly, the industry should not impede access to any historic sites. On the subject regarding the impact of potential stigma effects on the number of tourists visiting the region, the evidence is limited and inconclusive. Chmura interviewed several officials in France, including a current mayor and past mayors of towns where uranium mining and milling operations were located; they indicated that their towns and communities did not experience any negative effects on tourism because of their uranium industry legacies.⁷⁶ Similarly, a Colorado-based study concluded that a shuttered uranium mill had no “measurable impact” on the tourism industry. The Colorado study, however, was inconclusive as to whether the presence of a uranium mill or bringing additional uranium tailings waste to the region would negatively impact the choice of retirees to settle in the area.⁷⁷ Meanwhile, an ongoing study by the Bureau of Land Management in Arizona examining the possibility of allowing uranium mining of federal land noted in its initial analysis that mining activity posed little threat to tourism, concluding the “regional tourist activity and associated employment” were unlikely to be affected.⁷⁸

Chmura judges that absent environmental contamination in excess of federal regulations—consistent with the baseline scenario—the region is unlikely to suffer any significant impact on its tourism industry. However, under scenarios where contamination exceeds mandated standards—scenario 3—the tourism sector could see a decline and previous estimates have placed this decline in the 8 to 10 percent range.⁷⁹ A larger case of contamination—as outlined in scenario 4—could spur a decline in the tourism sector and decrease activity in this area by as much as

⁷⁵ For example, see <http://www2.godanriver.com/news/2011/aug/10/mining-could-impact-heritage-tourism-ar-1231272/>.

⁷⁶ Chmura interviews conducted Bessines, France, 2011.

⁷⁷ “Socioeconomic Analysis Receipt of Maywood Material: Cotter Corporation Milling Facility” RPI Consulting Inc. 2003.

⁷⁸ “Northern Arizona Proposed Withdrawal Draft Environmental Impact Statement (Chapter 4)” BLM 2010.

⁷⁹ “Socioeconomic Analysis Receipt of Maywood Material: Cotter Corporation Milling Facility” RPI Consulting Inc. 2003.

20 percent, during remediation efforts and perhaps years beyond.^{80 81} However, much of the research and analysis in the area of potential stigma effects on tourism is theoretical or heavily caveated. For instance, after more than a decade of research by the state of Nevada, state officials cannot accurately quantify the potential stigma effects that hosting a nuclear waste repository would have on its tourism sector, if any. The economic impact of various environmental contamination scenarios, including the impact to the tourism sector, is addressed in the appendix.

5.8.4. Stigma and Environmental Contamination Risks to the Agricultural Sector

Another key concern highlighted both in public forums and by key stakeholders is that the introduction of uranium mining and milling operations will negatively impact the agricultural sector and depress the sales of locally produced foodstuffs and farm-related items. The existing science suggests that threats to Pittsylvania County's agricultural sector are limited and related to the public health risks associated with sustained exposures to low-level radiation. Studies have shown that uranium mill tailings can spread radionuclides to forage grasses and other vegetation—such as vegetables or grains—that can then be consumed directly by people or by cattle or other livestock, which will then produce milk or meat for human consumption.⁸² However, the limited research that exists regarding the exposure to humans of uranium via the food chain concludes that animals and vegetables exposed to uranium tailings pose only “minimal” risk to human health, although at least one study recommends against eating liver and kidneys (the organs where radionuclides tend to accumulate) from cattle that forage on land near uranium tailings.⁸³⁸⁴

Since current research suggests vegetables, meat, and milk produced in the local area would be safe for human consumption, these products should not be subject to any stigma. However, Chmura recognizes that there is substantial risk to the future of Chatham Labor Shed's agriculture if uncertainty over the safety of the locally produced foodstuffs exists. Studies show that when the public faces uncertainties about reality, they tend to rely on “rule-of-thumb” frameworks that typically feature psychological contagion.⁸⁵ For example, studies regarding public perceptions to reclaimed wastewater—indisputable scientific evidence can demonstrate it is safe to drink—make it clear that a break in the psychological connection between the reclaimed water and its former state as sewage is necessary before the public will accept the water as drinkable. For example, reclaimed water sells for 40 percent less than water from other conventional sources in the Dallas-Fort Worth area of Texas, and is used primarily for irrigation and industrial use rather than for direct human consumption.⁸⁶

Ample research indicates, however, that public perception and popular stereotypes are malleable and evolve over time, suggesting outreach by industry groups and governmental agencies can mitigate any potential stigma effects. Key to this endeavor would be to credibly and quickly provide information about the safety of the locally produced foodstuffs and agricultural products. In the aftermath of the Three Mile Island accident, the U.S. Environmental

⁸⁰ “Socioeconomic Analysis Receipt of Maywood Material: Cotter Corporation Milling Facility” RPI Consulting Inc. 2003.

⁸¹ “Summary of Yucca Mountain Oversight and Impact Assessment Findings” State of Nevada: Nuclear Waste Project Office, 1997.

⁸² “Estimated Does to Man from Uranium Milling via the Terrestrial Food-Chain Pathway”. Donald R. Rayno, 1982.

⁸³ “Recent Research Involving the Transfer of Radionuclides to Milk”. Gerald Ward, 1989.

⁸⁴ “Health implications of radionuclide levels in cattle raised near uranium mining and milling facilities in Ambrosia Lake, New Mexico”. S. C. Lapham, J. B. Millard, and J. M. Samet, 1989.

⁸⁵ “Why Cleaned Wastewater Stays Dirty in Our Mind” NPR, 2011.

⁸⁶ “Can Sewage Help Solve Texas' Water Problems?” Texas Tribune, 2011.

Protection Agency began testing milk from some of the 570 dairies located within 25 miles of the nuclear reactor.⁸⁷ Initially, the EPA and other federal and state governmental bodies warned the public to curtail its milk consumption while the testing was ongoing.⁸⁸ Over the course of several weeks, government officials were able to demonstrate that only trace amounts of radiation were present in the locally produced milk, at levels far below established safety benchmarks, and therefore the milk was safe to drink. Milk consumption, which had been depressed for several weeks, quickly rebounded to normal levels.⁸⁹ The Three Mile Island example shows that credible and timely information can reduce uncertainties and virtually eliminate stigma regarding the public's perception about the safety and public health risks associated with consuming agricultural products. Similarly, polling done in Canada by the uranium industry shows that the public trust in the industry can grow over time and the information provided by the uranium industry with regard to public safety and environmental responsibility can be received as credible and accurate.⁹⁰

In France, a combination of local and national governmental agencies as well as the industry itself monitors the concentrations of uranium, radon, and lead radionuclides (U_{238} , Ra_{226} , and Pb_{210} , respectively) in fruits and vegetables (carrots, beets, leeks, apples, turnips, and cabbages), milk, fish, and animals (hens and rabbits) and makes this information available to the public and environmental community to demonstrate the safety of these products.⁹¹ In the case of Pittsylvania County, monitoring the water quality of private wells for radionuclides—a source of drinking water for humans and animals—and other toxic substances should be included in any regulatory regime. Chmura interviewed various French officials from the towns where uranium mining and milling took place and they noted no adverse stigma effects burdening local agricultural producers.⁹² Thus, the monitoring efforts in France have proven sufficient to fully mitigate any potential stigma effects as they could relate to the local agricultural sector. Accordingly, Chmura has not included any economic harm to the agricultural sector in its baseline assessment. The economic impact from higher levels of environmental contamination is addressed in different scenarios in the appendix.

5.9. Spending and Employment Impact of the cessation of Mining and Milling

5.9.1. Temporary Idling of Mining and Milling Operations

The temporary idling of mining and milling operations has been the norm in the industry since the price of uranium dropped in the early 1980s and remained below \$20 per pound for nearly 25 years. The sole functioning uranium mill (White Mesa) in the United States is located near Blanding, Utah and is operated by Denison Mines, a Canadian mining company. White Mesa was opened in 1979, but has been repeatedly idled and has not run at full capacity since the late 1980s.⁹³ Throughout the last decade White Mesa has operated at partial capacity and relied heavily on processing “alternate feed” material, rather than milling traditional uranium feed stock.⁹⁴

⁸⁷ “EPA's Role At Three Mile Island” EPA Journal, 1980.

⁸⁸ “Tell It Like It Is: Seven Lessons from Three Mile Island” IAEA Bulletin, 47/2, 2006.

⁸⁹ “Recent Research Involving the Transfer of Radionuclides to Milk” Gerald Ward, 1989.

⁹⁰ “Blind River Public Opinion Survey” Cameco Corporation, June 2009.

⁹¹ “An overview of uranium mining in France with focus on the Limousin region” IRSN, 2011.

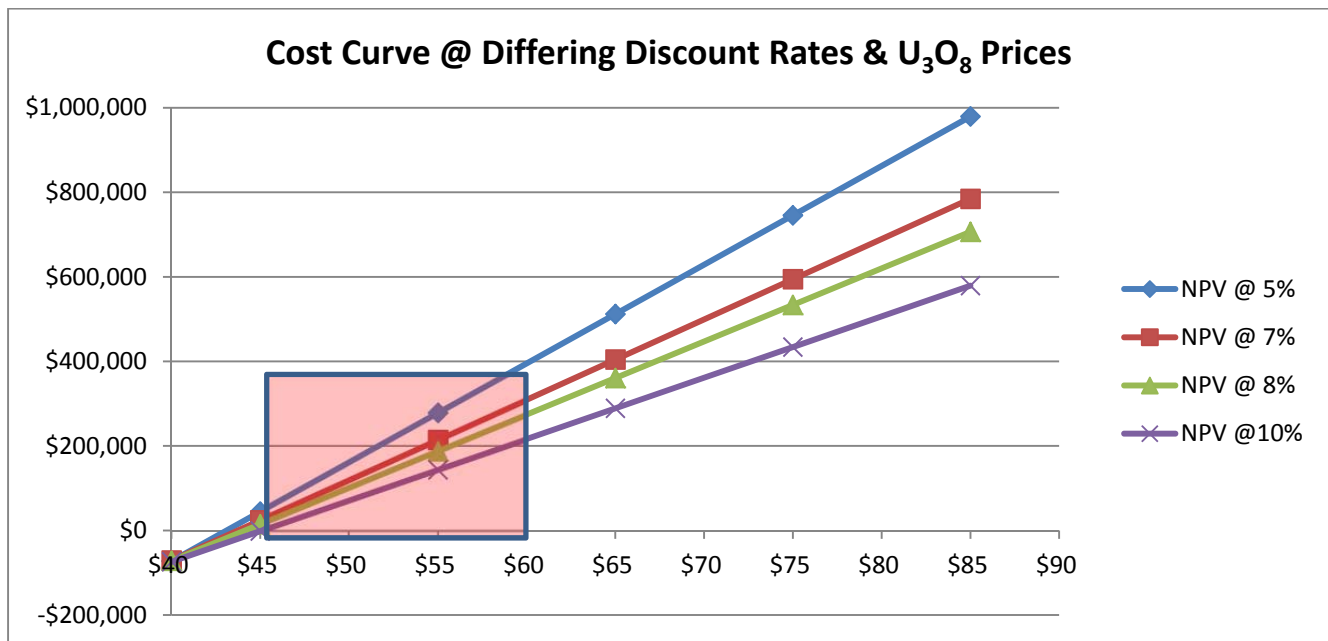
⁹² Chmura interviews conducted in Bessines, France. 2011.

⁹³ “Environmental Assessment for International Uranium Corporation Mill Site, White Mesa, San Juan County, Utah” US NRC, 2002.

⁹⁴ “Annual Reports 2005-2010” Denison Mines Corporation/International Uranium Holdings Corporation

Given the low grade quality of the uranium deposits at the Coles Hill site and the uniqueness of the physical environment of Pittsylvania County—particularly its high levels of precipitation and population density compared to the American southwest—it is unlikely the VUI will be a low cost producer of uranium. The Scoping Study indicates that should the average price VUI receives for its uranium fall below \$45 per pound, then the net present value of the entire operation would approach zero.⁹⁵ Additional unforeseen regulatory burdens—as well as a general bias among scoping studies to underestimate the initial capital costs^{96 97}—argue that VUI’s actual break-even point will be higher than \$45 per pound. For instance, the Scoping Study explicitly states the tailings holding cells’ design is tentative as it is based on scientific measurements taken in the 1980s and represent “approximate” results.⁹⁸ While additional research by VUI⁹⁹ has indicated they may be able to realize greater efficiencies than what was assumed by their Scoping Study, their consultants conclude that even small changes in some of their assumptions could greatly increase their costs estimates.¹⁰⁰ For these reasons specific to VUI as well as the track record of the only other functioning US-based uranium mill, we judge there is a non-trivial chance that VUI’s operation could suffer extended periods of reduced production or may even be idled. This would necessarily entail that some of the economic benefits—both jobs and taxes—would be foregone. Regulations would need to be developed to establish protective measures necessary to ensure public health and safety while the plant was idled and VUI was unready or unwilling to implement full remediation and reclamation efforts.

Figure 6.0: VUI Profitability (Net Present Value-NPV) at Different Prices for Yellowcake and Discount Rates



Source: Lyntek Scoping Study 2010

⁹⁵ “Coles Hill Uranium Project Scoping Study and Cost Estimate” (Table 1-2), Lyntek & BRS, October 2010.

⁹⁶ The VUI Scoping Study does contain 25% contingency cost provisions, but so have other engineering assessments that ultimately prove to have estimated costs too conservatively.

⁹⁷ “Bias and Error in Mine Project Capital Cost Estimation” Jasper Bertisen & Graham Davis, 2008.

⁹⁸ “Coles Hill Uranium Project Scoping Study and Cost Estimate”, pp. 28-30, Lyntek and BRS, October 2010.

⁹⁹ “Update on Metallurgical Studies for Coles Hill” VUI News Release, 26-Sep-2011.

¹⁰⁰ “Coles Hill Uranium Project Scoping Study and Cost Estimate”, pp. 28-30, Lyntek and BRS, October 2010.

Certainly VUI, as with any mining or manufacturing operation of considerable size, would be able to ride out many months of low prices for its yellowcake without significant disruption to the pace of its operations and overall employment levels. At the present time there are several industry groups, investment banks, and specialized consultant agencies that have independently surmised that growing long-term demand for uranium should allow uranium prices to drift upwards over the coming years rather than fall^{101 102} (see Section 5.3.2 for a full discussion of uranium price trends).

However, the history of the uranium market has exhibited long periods of price stability interrupted by periodic and dramatic shifts in the equilibrium price. The expected life of the Coles Hill site goes well beyond what three- to five-year uranium price forecasts can reasonably predict. While no technologies exist today to cost-effectively convert the existing U.S. nuclear generation plants from using newly processed enriched uranium to utilizing recycled nuclear fuel—the normal fuel utilized by the nuclear industry in France—such technologies are currently being researched. Technological change over the next twenty to thirty years could result in profound shifts in the equilibrium price of uranium. The commercial viability of either converting the existing nuclear plants to utilizing recycled fuel, or the emergence of a new generation of nuclear facilities that run on recycled fuel would substantially change the supply and demand equilibrium. This could undermine current uranium price trends and precipitate a significant and sustained drop in the price of uranium.

¹⁰¹ “Uranium: Re-Assessing Uranium and Uranium Equities Post Japanese Nuclear Disaster” Royal Bank of Scotland, 2011.

¹⁰² “U₃O₈: Demand Hit Priced In – Supply Strips Not Yet Factored” Bank of America/Merrill Lynch, July 2011.

6. Government Service and Regulation

6.1. Government Cost for Regulation

This section is predicated on the assumption that the Commonwealth of Virginia chooses (a) to become an “agreement state” for the purposes of regulating mill tailings (i.e., the waste-rock residue leftover after the crushing and initial processing of raw uranium ore), and (b) to remain an “agreement state” for the purposes of regulating uranium mining. Should Virginia choose to allow the federal Nuclear Regulatory Commission (NRC) to manage and regulate the milling portion of the Coles Hills site, then the additional costs to the Commonwealth of Virginia are likely to be relatively minimal. Correspondingly, Chmura judges that the Virginia Department of Mines, Minerals, and Energy (DMME) currently has adequate resources and the technical expertise to manage solely the mining portion of the uranium operation. DMME has longstanding experience in successfully supervising a variety of underground mining operations in terms of ensuring mine worker safety, environmental protections, and public health. DMME through its six divisions, regulates the mineral industry, provides mineral research, and offers advice on wise use of resources. DMME’s programs directly serve the citizens who live near mining operations, mining labor groups, other regulatory agencies, the educational community, the mineral industry, and environmental, consumer and industry special-interest groups.¹⁰³ DMME provides the Virginia government, the business community, and citizens with a focal point for the development of innovative policies, and for the implementation of comprehensive programs for energy and mineral resources consistent with modern safety and conservation practices.¹⁰⁴

Conversely, a decision for the DMME to supplant the NRC for licensing, permitting, and inspecting the milling portion of the operation would involve hiring new personnel as well as utilizing existing resources and personnel. Other Virginia agencies may incur some additional hiring if Virginia becomes a full-agreement state. These costs are conservatively estimated to be \$2.5 million per year and they are examined briefly in the sections that follow.

6.1.1. Virginia Department of Environmental Quality

The Virginia Department of Environmental Quality (DEQ) in 2011 has an annual operating budget of roughly \$158 million. The total budget appropriation for DEQ from 2008-2010 to 2010-2012 was reduced by 28%. DEQ would likely have to hire 2 to 3 additional employees to monitor water, soil, and air standards as a result of the introduction of uranium mining and milling in Virginia. The direct cost to DEQ of such hires is likely to be roughly \$200,000¹⁰⁵ in salaries and benefits and they would likely need an amount roughly equal to this in budgetary expenses, equipment, and supplies based on the analysis conducted in 1985 for the Virginia Coal and Energy Commission.¹⁰⁶

6.1.2. Virginia Department of Health

The Virginia Department of Health (VDH) in 2011 has annual operating budget of roughly \$570 million. The total budget appropriation for VDH from 2008-2010 to 2010-2012 was reduced by 0.4%. VDH anticipates the need to

¹⁰³ DMME website “about us” See: <http://www.dmme.virginia.gov/aboutus.shtml>.

¹⁰⁴ DMME website “about us” See: <http://www.dmme.virginia.gov/aboutus.shtml>.

¹⁰⁵ All salary figures noted in Section 6.1 are in current nominal dollars.

¹⁰⁶ Virginia Coal Energy Commission Senate Document No. 15 Appendix I: Cost Estimates for a State Program to Regulate Uranium Mining and Milling 1985

hire up to 4 additional employees with expertise in biology and engineering to conduct appropriate monitoring and field testing to ensure the health of the workers at the Coles Hill site and surrounding communities. The direct cost to VDH of such hires is estimated to be \$500,000 in salaries and benefits and they would likely need an amount roughly equal to this in budgetary expenses, equipment, and supplies based on the analysis conducted in 1985 for the Virginia Coal and Energy Commission.¹⁰⁷ Because VDH is a fee-based operation, most if not all of these costs will be recouped via various fees charged to the industry or company requiring VDH services, and thus these additional expenses would be budget-neutral.

6.1.3. Virginia Department of Mines, Minerals, and Energy

The Virginia Department of Mines, Minerals, and Energy (DMME) in 2011 has an annual operating budget of roughly \$33 million. The total budget appropriation for DMME from 2008-2010 to 2010-2012 was increased by 0.8%. In 1985 the Virginia Coal and Energy Commission (VCEC), in conjunction with its recommendation to allow uranium mining and milling in Virginia, recommended that DMME hire additional technical and engineering expertise. Based on the previous VCEC recommendation in 1984-85, discussions with public officials, and public comments by DMME officials, it is likely that DMME would need to hire roughly four additional personnel. The direct cost to DMME of such hires is likely to be \$300,000 in salaries and benefits. An amount nearly equal to this would be needed for budgetary expenses, equipment, and supplies based on the analysis conducted in 1985 for the Virginia Coal and Energy Commission.¹⁰⁸

6.1.4. Virginia Department of Conservation and Recreation

The Virginia Department of Conservation and Recreation (DCR) in 2011 has an annual operating budget of approximately \$156 million. The total budget appropriation for DCR from 2008-2010 to 2010-2012 was increased by 15%. DCR would bear relatively little additional costs for regulating the Coles Hills site, as its responsibilities for permitting and monitoring are few and would not require new procedures or regulations. DCR would be responsible for the permitting of storm water management issues from both the non-production and non-processing areas of the Coles Hill site. According to DCR regulations and guidelines, actual permitting and follow-up inspection is likely to be delegated by the DCR to local zoning authorities. As a result, DCR does not anticipate hiring any additional staff due to the introduction of uranium mining and milling operations in Pittsylvania County, Virginia.

6.1.5. Other Virginia Departments Impacted

In 1985, the VCEC estimated that the cost of agricultural sampling would be \$1,500 (roughly \$3,120 adjusted for inflation) per year and they anticipated no other costs to the Virginia Department of Agriculture and Consumer Services (VDACS).¹⁰⁹ Chmura judges the costs to VDACS will be much greater than this. In addition to a new program for testing both radionuclides¹¹⁰ and heavy metals in grasses, grains, fruits, vegetables, and livestock, a

¹⁰⁷ Virginia Coal Energy Commission Senate Document No. 15 Appendix I: Cost Estimates for a State Program to Regulate Uranium Mining and Milling 1985.

¹⁰⁸ Virginia Coal Energy Commission Senate Document No. 15 Appendix I: Cost Estimates for a State Program to Regulate Uranium Mining and Milling 1985.

¹⁰⁹ Virginia Coal Energy Commission Senate Document No. 15 Appendix I: Cost Estimates for a State Program to Regulate Uranium Mining and Milling 1985.

¹¹⁰ A nuclide is a general term applicable to all atomic forms of an element. Nuclides are characterized by the number of protons and neutrons in the nucleus, as well as by the amount of energy contained within the atom. A radionuclide is an unstable form of

marketing and communication campaign will need to be implemented to counteract any potential stigma effects (see Section 5.8.4). Chmura judges these costs could easily reach the same level as the combined costs of the added personnel and operating expenses for DEQ and DMME, or approximately \$1 million per year.

6.1.6. Interagency Coordination and Program Development

In addition to the direct costs of personnel, supplies, equipment, and testing, the Commonwealth of Virginia will incur some costs in developing a program and interagency process to coordinate the comprehensive monitoring and regulation of the uranium mining and milling industry. While most of these costs are likely to manifest themselves as additional time demands on mid- and upper-level management of the various Virginia agencies, other costs for additional legal fees or external laboratory testing are likely to require cash outflows.¹¹¹ Chmura estimates an additional \$500,000 will be needed to develop a program that will comprehensively monitor the uranium industry in Virginia. It will be important for these state agencies to work together. In real dollars, the sum of the operating budget appropriations between 2008-2010 and 2010-2012 for DEQ, DMME, VDH, and DCR were reduced by nearly \$85 million. In addition, authorized hiring of personnel in these same agencies has been stagnant or trending slighter lower as well in the same period. All of this takes place before any fiscal burden stemming from uranium regulation and monitoring is taken into account.

Table 6.1: Estimated Annual Expense to Virginia Departments and Agencies to Regulate the Uranium Industry

Virginia Governmental Department	Additional Personnel Expenses	Additional Operating Expenses	Offsetting Revenue from Industry
DEQ	\$200,000	\$200,000	unknown
DMME	\$300,000	\$300,000	unknown
VDH	\$500,000	\$500,000	-\$1,000,000
DCR	\$0	\$0	\$0
VDACS	\$500,000	\$500,000	unknown
Other	\$0	\$500,000	\$0
<i>Subtotal</i>	<i>\$1,500,000</i>	<i>\$2,000,000</i>	<i>-\$1,000,000</i>
Total Cost		\$2,500,000	

For purposes of comparison Chmura considered the budgets of the Arizona State Mine Inspector and the Arizona Department of Environmental Quality. These Arizona agencies' actual operating budgets for 2010 were approximately 60 percent higher compared to the combined operating budgets for Virginia DEQ and DMME. However, adjusting for the number of miners¹¹²—a rough proxy for the regulatory burden of the mining industry—Virginia spends approximately the same on a per miner basis. Because Arizona has a great deal of land that is

a nuclide. They may occur naturally, but can also be artificially produced. Source: <http://water.epa.gov/lawsregs/rulesregs/sdwa/radionuclides/basicinformation.cfm>.

¹¹¹ Virginia Coal Energy Commission Senate Document No. 15 Appendix I: Cost Estimates for a State Program to Regulate Uranium Mining and Milling 1985.

¹¹² Mining (except oil and gas): NAICS Code # 212.

either federally owned or belongs to various Native American Indian tribes, Phoenix relies on federal authorities to inspect, permit, monitor, and regulate many of the mining operations that operate in Arizona. Thus the true cost of regulating the mining industry in Arizona may well be higher than this budgetary comparison would suggest. Several environmental groups and even some Arizona state legislators have criticized Arizona state authorities for inadequate supervision of the mining industry, and poor oversight over uranium mines in particular.^{113 114 115} These criticisms argue that current spending levels in Arizona for mining supervision are inadequate to provide timely and comprehensive industry monitoring. In 2010, the spending per miner in Arizona was \$29,208; in Virginia for the same year, it was slightly less at \$28,752.

6.2. Infrastructure and Public Service Impacts

6.2.1. Increases in Road Capacities and Upgrade Costs

This section relies on several assumptions, as the exact traffic routes into and out of the Coles Hill site in the development and operational phases are not yet known. It is most likely that inbound equipment, supplies, and workers, as well as the outbound shipment of yellowcake, will use the following route: Coles Hill Road – Chalk Level Road (County Road 685) – US 29.¹¹⁶ Generally, the Virginia Department of Transportation (VDOT) mandates that land developers absorb the costs of improvements required to address the impacts of their projects.¹¹⁷ Therefore, the Coles Hill project is likely to require that Coles Hill Road be upgraded at the expense of Virginia Uranium Incorporated. Currently, the Coles Hill Road is classified as a Rural Local Road, and it does not meet current VDOT design standards. If the road were to be improved to accommodate the current traffic volume, it would need to be widened to at least 18 feet with a two-foot shoulder and a four-foot wide front slope to the ditch line. Assuming traffic volume will increase with development of the Coles Hill site, Chmura judges the road will likely require expansion to 22 feet. Also, the intersection of Coles Hill Road and Chalk Level Road does not provide sufficient sight distance to the right for a vehicle preparing to turn onto Chalk Level Road. The sight distance required by VDOT standards is 610 feet, but current visibility is only 310 feet. Chalk Level Road is classified as a Rural Major Collector, and it does not meet current VDOT design standards. Using current traffic volumes, the standards would require this road to have a paved surface that is 22 feet wide with five-foot shoulders and a six-foot front slope to the ditch line. The costs of these upgrades are estimated and summarized in the table below.

¹¹³ See <http://www.biologicaldiversity.org/index.html>.

¹¹⁴ “Mining on the Honor System” Arizona Daily Sun, January 16, 2011.

¹¹⁵ See Grand Canyon Trust http://www.grandcanyontrust.org/documents/gc_uranium_letterToADEQ.pdf.

¹¹⁶ Alternately, equipment and supplies could utilize a Gretna-Roanoke route that would use Taylors Mill Road to VA Route 40 to US 220. This route has not been analyzed in this report, but would require extensive upgrades including a new bridge on Taylors Mill Road.

¹¹⁷ “VDOT Response to Questions on Road Upgrades & Traffic Incidents for the Uranium Mining Socioeconomic Study” VDOT, 2011.

Table 6.2: Estimated Road Upgrade Costs¹¹⁸

<u>Road</u>	<u>Distance (miles)</u>	<u>Upgrade Cost</u>	<u>Design Specifications</u>
Coles Hill Road	0.8	\$ 2,078,703	Widen to 22', 5' shoulder, & 6' front slope to ditchline
Coles Hill/Chalk Level Road Intersection	0.1	\$ 380,596	Improve sight distance from 310' to 610'
Chalk Level Road	6.3	\$ 6,300,223	Widen to 22', 5' shoulder, & 6' front slope to ditchline
Total Road Upgrade Costs		\$ 8,759,522	

6.2.2. Increases in Usage of Electricity & Impact on the Grid

The Coles Hill site is about 9 to 12 miles from each of three different substations connected to two different 138 kilovolt (kV) lines running through Pittsylvania County. It is standard for the industry in question to pay for any additional substation it would need to power its facility. At the time of this report, it is not clear if the Coles Hill site would have to tap directly into the 138 kV line or if a smaller voltage electric line—115 kV or 69 kV—would be available for utilization by the Coles Hill operation. Nevertheless, Chmura’s discussions with mining engineers suggest the cost of a substation to service the Coles Hills site would be less than \$2 million and the approximate utilization of 25,000 horsepower energy consumption would neither strain the grid nor negatively impact the electrical supply for the local community. Chmura judges accordingly that there are unlikely to be any adverse effects on the cost of electricity to the region.

6.2.3. Increased Usage of Public Services

As discussed in Section 5.3.5, Pittsylvania County is likely to see an influx of only a small number of new residents and families. Given this, the impact of the Coles Hill site is likely to have only a minimal impact on the utilization rates of most public services—police, parks, schools (discussed in detail in Section 6.3), libraries, and community centers. Traffic, however, would be expected to increase (discussed in full in Section 8.4), but Chmura judges that an expansion of the existing police force for the purposes of traffic control and vehicular accident response is unlikely. These findings are consistent with other socioeconomic impact studies of mining and milling sites that similarly conclude that the utilization of most public services will be only minimally impacted, if at all, by the presence of a uranium mine or mill.^{119 120}

The impact on local fire departments may prove to be larger than for other public services, but is likely only to require additional training and perhaps the purchase of some additional material and equipment in order to ensure their ability to effectively fight a fire at the Coles Hill facility, as well as deal with the hazardous material contained on site. It is unlikely that the 33-member Chatham Volunteer Fire Department—currently responding to approximately 250 calls per year¹²¹—will need to significantly expand the size of its force due to the Coles Hill site, nor would the approximately 22-member Gretna Volunteer Fire Department. The Haz-Mat team contained at Fire Station #7 in Lynchburg is approximately 46 miles away, and may be able to provide training and back-up assistance in the case of an emergency situation at the Coles Hill site.

¹¹⁸ Cost estimates provided by VDOT.

¹¹⁹ “Socioeconomics Baseline and Impact Analysis for the Proposed Pifon Ridge Uranium Mill” Louis Berger 2009.

¹²⁰ “Final Environmental Impact Statement Canyon Uranium Mine” USDA Forest Service 1986.

¹²¹ Chatham Volunteer Fire Department website, <http://www.chathamfd.com>.

The healthcare facilities in the town of Chatham are limited to two facilities that operate during normal business hours (a more detailed look at regional healthcare facilities is addressed in Section 7.1.5). There is also a health clinic in nearby Gretna. None of these facilities are open 24 hours and all of them are leanly staffed. The nearest trauma center is located in Danville, approximately 27 miles away. There are few medical resources currently available for industries operating on a 24-hour schedule. However, assuming the Coles Hill site operates within industry norms, only about 12 OSHA-recordable injuries are likely to occur in a given year, which should not overload even the limited health resources of the community.¹²²

Table 6.3: Data on Select Health and Safety Service Providers

Emergency Resources Available	Number of Non-Administrative Personnel
Chatham Police Department	4
Chatham Fire Department	33
Gretna Police Department	3
Gretna Fire Department	22
Pittsylvania County Sherriff's Office	115
Health Centers of the Piedmont	3
Chatham Family Medical Center	3
Danville Regional Medical Center-Gretna Clinic	3

Source: local websites and direct discussion with service providers

6.2.4. Increased Usage of Water

The Coles Hill site is expected to use approximately 300,000 to 390,000 gallons of water per day during normal operations, which is roughly between two-thirds to four-fifths of the 450,000 gallons-per-day currently consumed by the Town of Chatham.^{123 124 125} Even if some on-site recycled water is utilized and wastewater from the town is reprocessed, the Coles Hill site will place significant additional demand for water on the Pittsylvania County water utility. The Town of Chatham, however, has access to upwards of 1.3 million gallons-per-day via Cherry Stone Lake and Cherry Stone Creek, as well as other water sources.¹²⁶ Therefore, so long as VUI bears the cost of its connection to the water delivery system, the additional water demand is unlikely to result in upward pressure on utility rates in the region during its normal operations. VUI estimates that in the first two years of Coles Hill site's operation its water usage could temporarily exceed 1 million gallons a day.¹²⁷ In the extreme, the Coles Hill site, in its initial start-up phase, could absorb all the "daily" water available for the Town of Chatham. While this is unlikely to precipitate water shortages, it could spur utility officials in Pittsylvania County to employ graduated water fees for heavy water usage so as to encourage water conservation and incentivize VUI to balance its water consumption.

¹²² "Numbers of Nonfatal Occupational Injuries and Illnesses" Department of Labor 2009. This is based on NAICS Code 212 (Mining, except oil and gas), based on OSHA data indicating a rate of 3.1 injuries per year for every 100 workers.

¹²³ VUI website FAQs <http://www.virginiauranium.com/faqs.php>.

¹²⁴ "Coles Hill Uranium Project Scoping Study and Cost Estimate" Lyntek & BRS, October 2010.

¹²⁵ Town of Chatham water usage statistics.

¹²⁶ Town of Chatham water usage statistics.

¹²⁷ "Preliminary Economic Assessment for the Coles Hill Uranium Property" Lyntek & BRS Engineering 2010.

6.3. Impact on Public Schools

6.3.1. Increase in Enrollment

The local school system is unlikely to see a strain on its resources. Of the approximately 466 jobs (direct, indirect, and induced; see Sections 5.3.3 to 5.3.7) that will be created in Pittsylvania County, Chmura judges the vast majority of these jobs will be filled locally. In fact, Chmura estimates that less than 20 of these jobs are likely to be filled by non-residents that will be relocating to the area. According to the 2010 U.S. Census, only about 50 percent of all households (of all races) have children under the age of 18 years. Of these households with children, the average number of children in a family is two. Given this, the maximum number that would be expected for any single school district to accept—this necessarily assumes that all the newly arrived families with children settle in the same town and choose to utilize its public schools—would be approximately 20 new students. In this extreme, a public school system, if it received all these new students, would have to accommodate less than two students per grade level. This is assuming the students range in age from kindergarteners through high school seniors. The schools in Gretna and Chatham have roughly 1,600 and 1,500 students, respectively, and each should be able to absorb an additional 20 students, which would be a 1.5 percent increase in their student base, without straining their current resources.

6.4. Cost of Contingency Planning and Disaster Preparedness

In this section, Chmura considered two scenarios that appear to have the highest probability of occurrence (although no probability projections are made): (1) an underground mining accident that leaves miners trapped underground; and (2) a transportation accident that spills yellowcake onto a Virginia roadway. Both of these events are specific to an underground uranium mine and mill and require an advanced planned response.

The tragic explosion at the former Massey Coal Upper Big Branch mine in Raleigh County, West Virginia, and the successful rescue of 33 Chilean gold and copper miners (in which U.S. authorities played a large, understated role), both within the last eighteen months, have provided new insights to the roles of federal officials at the Mine Safety and Health Administration (MSHA) and those at the state level—in the case of Virginia at the Department of Mines, Minerals, and Energy (DMME). Many in the coal industry believe the Massey accident was preventable; accordingly, with proper regulations and inspections, a similar explosion event at Coles Hill should not happen, but if it does, there is ample experience with which to handle it.¹²⁸

Other states, particularly the uranium mining states, already have rules and regulations in place to handle such industrial accidents. Combined with the expertise available from the federal agencies, it should not be difficult for DMME to complete a best-practices approach to uranium mining and milling disaster preparedness by modifying or augmenting its existing procedures and accident response plans that address Virginia's other mining concerns.¹²⁹ Because DMME updated its mine emergency response plan in January 2011—in light of the tragic events at the Massey Coal Upper Big Branch mine—Chmura judges the costs to modify this plan to cover a uranium mine, as opposed to a coal mine, to be minimal.

¹²⁸ "Independent investigation says Upper Big Branch disaster was preventable" The Register Harold, 19-May-2011.

¹²⁹ "Mine Incident Response and Recovery Plan" DMME, 13-January-2011.

Another uranium state, Colorado, offers insight into contingency planning regarding the transport of uranium ore and processed yellowcake. By Colorado state statute, both materials are only considered hazardous and are not designated as nuclear materials. During Colorado's state legislature deliberations regarding a permit for the new Piñon Ridge uranium mill, the issue of responding to an accidental release of yellowcake during its transport was addressed by Colorado state transportation and health officials. The Colorado State Patrol Hazardous Materials Transport Safety and Response Team (HMTSR) respond to spills and releases of hazardous material on Colorado roadways.

"When you're dealing with yellowcake shipments, they get carried in pretty much a dump truck," said Captain Allan Turner of the Colorado State Patrol's HMTSR team. "We actually had one of those turn over in the city of Colorado Springs, turn over in the median, and people were going to the hospitals with facemasks on, thinking they were contaminated with radiation, when in actual fact it doesn't really present that much of a hazard." Turner emphasized that both yellowcake and unprocessed ore are not considered nuclear materials.¹³⁰

Similarly, Colorado State Patrol's Turner said the crash of a truck hauling raw (unprocessed) uranium ore in Colorado Springs presented no extraordinary health risk. The Fremont County Independent Outreach Committee, a community-based watchdog group monitoring the cleanup activities at the Cotter Uranium Mill near Cañon City, Colorado, appears to agree.¹³¹ In fact, the emergency response procedures utilized by the now-closed Cotter Uranium Mill have been cited by the International Atomic Energy Agency (IAEA) as a best practice. Below is an excerpt from the IAEA's "Best Practice in Environmental Management of Uranium Mining":¹³²

The Cotter Corporation transports uranium–vanadium ore from West Slope Mining Operations (>300 km), and for 50 years until 2001 uranium ore from the Schwarzwaldler mine (200 km) to the Cañon City Milling Facility (CCMF), utilizing trucking contractors. The Schwarzwaldler mine is approximately 30 km west of Denver, Colorado, a metropolitan area with a population of approximately two million. A 25 ton transport from the Schwarzwaldler Mine was involved in a traffic accident in Colorado Springs, Colorado, population 400,000, on the Interstate freeway during the evening rush hour. Most of the ore spilled onto the highway. Response authorities immediately closed down the highway, initially in both directions, and rerouted traffic. Notifications were made according to the Schwarzwaldler Emergency Response Plan to regulatory agencies as well as to the Schwarzwaldler Mine and the CCMF. The local response authority assumed incident command. Both sites dispatched monitoring personnel with a pre-made emergency kit to assist in the cleanup, monitoring, and evaluation of the incident. The CCMF personnel arrived first, about one and a half hours after the incident, and reported to the incident commander. These monitoring personnel were joined one hour later by the representative from the Schwarzwaldler Mine. These Cotter personnel provided technical information on the relative hazard of spilled ore (0.5% U₃O₈) to incident command, recommended the necessary precautionary measures for response personnel, assisted with cleanup and provided cleanup verification. The trucking contractor dispatched personnel, another transport tractor-trailer, a front-end loader, shovels and brooms, arriving at the accident site approximately two hours after the incident. The spilled ore was loaded into the new tractor-trailer and delivered to the CCMF. The damaged tractor-trailer was loaded on a transport and also

¹³⁰ "Colorado officials: Yellowcake uranium trucks 'can go wherever they want' " The Colorado Independent, 2009.

¹³¹ "Colorado officials: Yellowcake uranium trucks 'can go wherever they want'" The Colorado Independent; 2009.

¹³² "Best Practice in Environmental Management of Uranium Mining" IAEA Technical Report # NF-T-1.2; 2010.

sent to the CCMF for further accident investigation, decontamination and release. Both transport operations were completed according to U.S. Department of Transportation (DOT) shipping requirements. Cleanup and verification monitoring were completed, and the Interstate freeway reopened approximately twelve hours after the accident. Monitoring results indicated no significant radiological exposure to accident victims or to response personnel. A follow-up report of the incident was submitted to the regulatory authority, the Colorado Department of Public Health and Environment (CDPHE). Subsequently a month later, a meeting was held with response authorities, regulatory agencies, Cotter personnel and the transport contractor to evaluate the incident. Generally, the response went well, including the public information aspects, with the exception that some passers-by in the vicinity of the accident were initially advised by incident command to report to a medical facility for evaluation.

The U.S. Department of Transportation operates the Pipeline and Hazardous Materials Safety Administration (PHMSA) which is responsible for ensuring the safe transportation of hazardous materials by air, rail, highway, and water. PHMSA's Office of Hazardous Materials Safety Field Operations (OHMS) provides technical expertise and specialization in various areas including enforcement programs and inspection guidelines. PHMSA offers "innovative education and training programs designed to increase the numbers of talented individuals who will become the next generation of transportation (hazmat) professionals." These hazmat programs link industry, academia, professional associations, and all levels of government. Virginia is part of the Eastern Region of PHMSA, with regional offices based in West Trenton, New Jersey; the regional hazmat safety office is also located there along with its Hazmat Safety Assistant Team (HMSAT).

Currently, the Virginia State Police enforces the regulations pertaining to the transportation of hazardous materials in Virginia. Through its Safety Division, the state police have established Motor Carrier Safety Teams to respond to hazmat incidents. Troopers assigned to the teams present informational programs to the public. The Virginia Department of Transportation (VDOT) is involved if hazardous materials are transported through any of six tunnels that are state-owned. VDOT refers transporters to CHEMTREC, a public service hotline for emergency responders to obtain information and assistance for hazardous material events. CHEMTREC was established in 1971, offers 24/7/365 communications, and assists shippers with compliance to government regulations in the United States and Canada. Services range from education and training to extensive databases of first responders and physicians and toxicologists who can provide information for treating patients exposed to hazardous materials. The company is headquartered in Falls Church, Virginia. CHEMTREC also sponsors Transportation Community Awareness and Emergency Response (TRANSCAER) in the United States to assist communities with training, planning, and exercises in preparing for and responding to hazmat incidents.

In the case of the Coles Hill site and Virginia Uranium Inc., an integrated hazmat response team could be formed and trained to include teams from the company itself, local fire and rescue departments, highway patrol, health department, and regional PHMSA staff. As with any disaster or emergency, communication and coordination is critical, as local emergency service providers are the likely first responders. The costs of such an emergency response program are largely confined to training, coordinating procedures, and conducting event simulations for testing and validating procedures. For the sake of this study, Chmura assumes these costs can be absorbed by the existing training budgets for state and local emergency response organizations and agencies.

6.5. Cost to Upstream and Downstream Localities

The baseline scenario assumes that the environmental impact is moderate and the contamination to the water (ground and surface), air, soil, or excess noise is assumed to be within federal limits. Given these assumptions, Chmura estimates there will be no costs to upstream or downstream localities. However, in alternate scenarios that

assume greater environmental degradation, surrounding communities (particularly downstream) could face some negative economic impact from environmental contamination related to the uranium industry in the Coles Hill area. These scenarios are addressed in greater detail in the appendix (see Sections A5 and A6).

6.6. Cost and Responsibility for Remediating Potential Environmental Damage

Our baseline scenario assumes that the environmental impact is moderate and the contamination to the water (ground and surface), air or soil or excess noise is assumed to be within federal limits. However, as with the Fukushima disaster in Japan, worst-case scenarios that surpass what we can reasonably or prudently model with any accuracy in advance can occur. For example, an earthquake struck in both Mineral, Virginia (118 miles from Chatham, Virginia) and in Trinidad, Colorado (611 miles from Fredonia, Arizona – Arizona 1 Uranium Mine) on the same date (Tuesday, August 23, 2011). The fact that these earthquakes struck about 12 hours apart (1:46 a.m. EDT in Colorado and 1:51 p.m. EDT in Virginia) is remarkable, even if they are unrelated. Extreme weather is another factor to consider, and Pulaski County (approximately 78 miles from Chatham, Virginia¹³³) was hit by tornadoes in April 2011. The National Weather Service estimated the tornado to be an EF2, with winds of approximately 120-125 mph, and a swath of destruction measuring 350 yards wide by 8 ½ miles long. FEMA did not provide an estimate of the cost of the damage; however, Pulaski County officials cited 400 damaged homes and total property damage of nearly \$8.5 million.¹³⁴ Additionally, a concern that has been previously raised is the difference in population density where uranium is typically mined in the American west and that of the proposed Coles Hill area, whereby the ramifications to the surrounding communities of these extreme weather events could be magnified.

With this in mind, Chmura has outlined two additional scenarios (see Section 3.3). The first is scenario 3, and represents a case with more extensive environmental degradation. Second, scenario 4 represents a worst-case type scenario—either due to an extreme weather occurrence, tailings containment design flaw, or other unforeseen events—where contamination of the groundwater and either air or soil exceed federal limits and require extensive remediation. The cost and responsibility for both scenarios 3 and 4 are addressed in the appendix (see Sections A5 and A6).

6.6.1. Responsibility of Industry versus Government

In many cases, both the federal and state governments are the primary funding source of remediation efforts in the western portions of the United States where numerous uranium mining and milling operations functioned from the early 1950s to the late 1970s. One of the common criticisms of the uranium mining industry is that the industry has historically underestimated the costs and likelihood of environmental contamination. When this has happened in the past, the mining companies that operated the mine or the mill were able to “walk away” from the contaminated sites. This left state and federal officials responsible for remediating the site and mitigating any public health risks.¹³⁵ Times have changed, and, as is discussed in Section 6.7.3, the insurance bonding process provides some assurances that money will be available even in the event of a company bankruptcy to complete remediation efforts. Additionally, the current state of corporate responsibility, the potential for negative public relations, and legal proceedings can compel payment by industries to fund remediation efforts that in the past may have been left to taxpayers. For example, British Petroleum (BP) has put aside \$41 billion to compensate individuals, state, and local

¹³³ Please see: <http://www.geobytes.com/>.

¹³⁴ Please see: <http://www.roanoke.com/news/nrv/wb/283034>.

¹³⁵ Sheep Mountain Alliance Website.

governments and to fund clean-up efforts of the Gulf oil spill.¹³⁶ Furthermore, the U.S. government has billed BP – and has been paid – for 10 invoices, which total \$694 million. The eleventh bill sent on May 10, 2011 in the amount of \$17.1 million is still pending. In round numbers, the Gulf oil spill resulted in over \$710 million in direct (billable) invoices from the U.S. government to BP.

Despite the positive dynamics in the risk-sharing area with regard to energy and mining companies, Chmura judges that should large-scale environmental contamination occur—as assumed in scenario 4—then the finances of VUI and its partners will likely be insufficient to fully offset the costs of remediation. In this case, it would be federal or state money that funds the remaining remediation efforts. Scenario 4 and its underlying assumptions are further addressed and analyzed in the appendix (see Section A6).

6.6.2. Responsibility of VUI

The primary responsibility for addressing any environmental contamination—even if it remains within federal guidelines and limits—will reside with VUI. In theory, advanced processing systems—such as a semi-autogenous grinding mill, abrasion and corrosion-resistant HDPE piping, a zero-discharge vacuum dryer, and other technologies¹³⁷—will keep toxic dust and other harmful chemicals on site and contained. The tailings management system is expected to fully isolate the uranium mill tailings from the greater Coles Hill environment. These technologies, coupled with environmental-minded process management, and strict regulation of the industry, give Chmura confidence that the environmental impact of the Coles Hill uranium mine and milling operation will be moderate and consistent with the baseline scenario.

The Scoping Study allows for a 25 percent cost contingency in both capital and operating budget projections. In terms of the operating budget, this contingency would yield close to \$13 million per year for the first 20 years of production and about \$6 million for the final 15 years of production to handle unanticipated expenses.¹³⁸ The baseline scenario assumes that the environmental impact is moderate and the contamination to the water (ground and surface), air, and soil, or excess noise is assumed to be within federal limits. Chmura judges that the contingent operational funds should provide the needed cushion to address any unforeseen but necessary anti-contamination and remediation efforts.

6.6.3. Responsibility of State and Federal Agencies

The baseline scenario assumes that the environmental impact is moderate and the contamination to the water (ground and surface), air or soil or excess noise is assumed to be within federal limits. Given these assumptions, Chmura estimates there will be no costs to state and federal agencies—outside of the normal costs of regulation and monitoring (see Section 6.1)—for any remediation efforts at the Coles Hills site.

6.7. Source of Funding to Offset above Government Cost

The majority of environmental damages from uranium mining and milling that occurred prior to 1980 have no responsible party (known as ‘continuing responsible parties’). Accordingly, the federal government is the primary

¹³⁶ “BP Profit Falls as Costs of Gulf of Mexico Spill Outweigh Higher Oil Prices” New York Times April 27, 2011.

¹³⁷ VUI officials in their public comments and the VUI website professes a desire to utilize “best practices” to protect the environment and public health. (See: <http://www.virginiauranium.com/faqs.php>) Thus, Chmura assumes these and other similar technologies will be employed.

¹³⁸ “Coles Hill Uranium Project Scoping Study and Cost Estimate” Lyntek & BRS, October 2010.

funding source for uranium mine and mill reclamation projects. Simply stated, the federal government is ‘the funder of last resort.’

Among most mineral extracting industries, it was a common practice for them to have insufficiently protected the environment and passed along the remediation costs to state and federal governments. Because of this legacy, regulations have been tightened and a combination of fees, bonding insurance, and taxes have been put in place at the federal and state-government levels to ensure mineral extracting industries provide adequate funds for any clean-up, remediation, and mine closure efforts. For example, money from the federally established “Abandoned Mine Land (AML) Trust Fund” (on the federal, state, and tribal authorities) is used to fund cleanup efforts at abandoned mines—predominantly coal, gold, and uranium mines.¹³⁹ The AML was established as part of the Surface Mining Control and Reclamation Act of 1977 and receives funds from a special tax levied on active coal mines. The funds are available to ‘certified states’ and the Act was reauthorized in 2006 by Congress.

A more detailed report on the AML Trust Fund is well beyond the scope of this project; however, it is clear that the AML Trust Fund is inadequate to cover the full cost of mining contamination clean-up from past incidents. Other federal monies—derived from non-industry sources such as general taxes—have been utilized to offset these costs.

With all this information as background, the Coles Hill property is on privately-owned land. This means it is not subject to federal land leases, royalties, nor the AML coal tax. To provide a hedge from responsibility of funding unforeseen reclamation costs, Virginia may consider some innovative or alternative taxing schemes to raise additional revenue from the industry as a precaution against any unforeseen remediation or regulation liabilities that may fall on Virginia to fund.

6.7.1. Fines

The EPA is empowered to impose fines on uranium mining operators, but it is standard practice for the mining industry (of all types) to contest the violations both administratively and through the courts. If the EPA prevails and actually collects the fines, those funds are available for remediation. Ostensibly, current environmental laws and the EPA’s ability to enforce those laws should enable any mining site to be properly remediated, but in actuality the issue is much more complicated.

Similarly, Virginia agencies such as DEQ, DMME, and DCR all have the ability to directly or indirectly (via a judge’s decision in a civil case regarding a levied fine) to fine a company if permitting conditions are breached or specific laws or regulations are broken. However, current Virginia law does not allow for civil penalties to be brought against Virginia’s mining industry, which is currently dominated by coal mining and hard-rock quarries.

Fines are never easy to administer even when the actions of the firm in question can clearly be sanctioned. Determining the size of the penalty can take time, such as in the case of the BP oil spill in the Gulf of Mexico. A number of complicating issues can enter the equation, one of which is the debate on the amount of the fines. Also, there may be a delay in collecting the funds (and who is the responsible party to pay for clean-up while litigation is ongoing). In addition to established fines under the legislation, circumstances may warrant civil penalties.

¹³⁹ Abandoned Mine Lands Portal <http://www.abandonedmines.gov/>.

A recent Bloomberg report describes the vast ranges of dollars being argued about in federal court relating to fines issued to BP for the oil spill.¹⁴⁰ U.S. government representatives said in its complaint that it will seek \$1,000 per barrel of oil spilled, or in the case of negligence, \$4,300 per barrel (as provided in the Clean Water Act). The Act provides an alternative fine of \$32,500 per day instead of the per-barrel calculation. While the government declined to speak on the record during litigation, various former federal experts predict the government will use the per-barrel method for calculating fines. The difference in overall fines is staggering: by the per-day method, estimates range from \$2.8 million to \$4.9 million (depending on whether the date the well was capped is the determining factor or the date the well was permanently sealed); by the per-barrel method, the fines range from \$4 billion to \$20 billion, depending on the degree of negligence.

6.7.2. Severance Taxes in Other States

Most U.S. states with established uranium mining industries levy a state-level severance tax on the uranium extracted. These severance taxes are complex and some states allow different provisions to reduce the tax liability. These provisions generally allow for various aspects of the cost of production and processing to be subtracted from the taxable amount. Severance taxes in these states have typically ranged from 2 to 5 percent (see table below). Some states like Colorado and Arizona have specific provisions in place to earmark how the funds are spent that are derived from the uranium industry. In Colorado these funds are primarily used in conjunction with federal funds to remediate environmental damage stemming from the uranium industry's activities prior to 1993.¹⁴¹ In Arizona the state and county governments share the severance tax proceeds so that the funds can be utilized by different levels of government for different purposes.¹⁴²

Table 6.4: Select States Severance Tax Rates

State	Tax Rate
Colorado	2.25%
New Mexico	3.50%
Arizona	2.50%
Utah	2.60%
Wyoming	4.00%
South Dakota	4.50%
Nebraska	2.00%

Source: North Dakota Legislative Tax Committee & various state websites

Utilizing a 3 percent severance tax for uranium would yield as much as an additional \$3.6 million¹⁴³ per year from VUI for state coffers. The Commonwealth of Virginia might consider levying a tax of this sort at the state level and utilize these funds partially to offset the additional costs of regulating the industry, as well as placing a portion of these proceeds aside in a special remediation fund. This money, in addition to any remediation bonding provided by VUI, could be used in the case that environmental cleanup or other unforeseen remediation costs go beyond what the uranium company is directly able to fund.

¹⁴⁰ "BP, Spill Partners Seek Smaller Civil Fine for Gulf Spill," April 5, 2011. See <http://www.bloomberg.com/news/2011-04-05/bp-spill-partners-seek-smaller-civil-fine-for-gulf-oil-spill.html>.

¹⁴¹ "Uranium mill tailings remedial action program fund" State of Colorado 39-29-116.

¹⁴² "Transaction Privilege and Other Tax Rates" Arizona Department of Revenue, 2011.

¹⁴³ Production of 2 million pounds of yellowcake per year at \$60.00 per pound x 3% severance tax yields \$3.6 million in tax revenue—assumes no deductions for processing or extraction costs.

6.7.3. Bonding Estimates

Following over a half-century of abandoned and unreclaimed uranium mines numbering in the thousands—costing the U.S. taxpayers billions of dollars in various clean-up programs—the regulatory authorities now agree that both the reclamation of uranium mines and decommissioning of uranium mills should be the mining company's responsibility. This allowance should be included in the up-front cost planning, namely in the form of insurance bonding. Based on current laws and experience that the bonding industry has gained in providing bonds to other mining operations, Chmura judges that appropriately priced performance bonds should provide reasonable assurances of funding available to remediate the site under the baseline scenario.

Congress enacted the "Uranium Mill Tailings Radiation Control Act of 1978" in 1978.¹⁴⁴ The 1978 Act required the NRC to develop decontamination, decommissioning, and reclamation standards to be imposed upon mill licensees during the operation of a uranium mill. The Act also required the land used for mill tailings disposal, as well as the tailings themselves, to be transferred to either the United States or the state in which the land is located. The legislation empowered the NRC to require the governmental entity to "undertake such monitoring, maintenance, and emergency measures as are necessary to protect the public health and safety." The burden of responsibility over long-term maintenance could be a major consideration in a state's determination of whether to accept custody of tailings sites via a decision to become a full "agreement" state for the purposes of regulating and managing the mill portion of the operation. The Act also required "an adequate bond, surety, or other financial arrangement" be provided by the uranium mill licensee "to permit the completion of all requirements established by the Commission for the decontamination, decommissioning, and reclamation of sites, structures, and equipment used in conjunction with byproduct material." These provisions do not preclude state and local governments from establishing independent bonding requirements.

Bonding protocols have become less onerous over time; for example, the coal mining industry has been required to provide bonding since the passage of The Surface Mining Control and Reclamation Act of 1977 (SMCRA).¹⁴⁵ The posting of a 'reclamation bond' was a prerequisite to obtaining a coal mining permit, which ensured that the regulatory authority will have sufficient funds to reclaim the site if the permittee fails to complete the reclamation plan approved in the mining permitting process. The biggest differences between coal bonding and uranium bonding are the 1,000-year DOE monitoring requirement and the longevity of radiation (the half-life of some mildly radioactive elements can reach as high as 4.5 billion years).¹⁴⁶

When mining on federal property (leased federal coal or land in federal surface ownership), corporate surety bonds may only be accepted from surety companies that are listed in the U.S. Department of the Treasury's Listing of Certified Companies,¹⁴⁷ which is updated annually. The list of approved bonding companies contains literally hundreds of insurers, including such well-known names as Aegis, Chubb, Cincinnati, Erie, Farmers, Hartford, Liberty Mutual, and Nationwide, to name a few. Companies providing bonding services range from insurance, to indemnity, to specialized bonding. Licensing is provided by individual states and a review of the approved federal listing indicates numerous options for VUI to select which are approved to operate in Virginia. In fact, Virginia may

¹⁴⁴ See: http://www.state.co.us/gov_dir/leg_dir/olls/sl1997/sl_95.pdf

¹⁴⁵ See: <http://www.osmre.gov/topic/bonds/BondsOverview.shtm>

¹⁴⁶ See <http://www.epa.gov/radiation/radionuclides/uranium.html>.

¹⁴⁷ See: http://www.fms.treas.gov/c570/c570_a-z.html#m.

want to use the Treasury Department as a first screen for suitable bonding companies if specific uranium bonding legislation is written by the Virginia legislature.

There are generally three basic types of reclamation bonds:

- Corporate Surety Bonds (a fee is paid for the amount of bonding required)
- Collateral Bonds (the bond is secured by cash, first-liens on real estate, letters of credit, investment-grade securities, etc.)
- Self-Bonds (legally binding corporate agreements without separate collateral, and available only to certain companies who meet certain financial tests – a few states have excluded this option)

For an underground uranium mine and milling operation like the one proposed at Coles Hill, there are a number of reclamation and decommissioning issues for which bonding should be provided, as further outlined in the NEA and IAEA joint publication *Environmental Remediation of Uranium Production Facilities*:¹⁴⁸

- The entire permitted land area must be covered
- Remediation of any contamination (short term and long term)
- Site reuse (varying on a site-by-site basis per the mining plan)
- Public exposure to radon
- Contamination of groundwater and surface water
- Disturbance of natural habitat
- Instability of the land (such as erosion and slope stability failure)
- Misuse of radioactive wastes as building materials
- Proper cleanup of uranium mining and extraction wastes
- Cost of data collection, risk analysis, reclamation plans, and monitoring programs
- Hydrogeochemistry¹⁴⁹ studies and plans (depending on the topography and climate)
- The dismantling and removal of all buildings and equipment on the site
- Re-vegetation and landscape restoration
- Miner health and safety (ongoing monitoring and health trust fund)
- Mining disaster remediation (explosions, flooding, cave-ins, etc.)

A more complete listing of all the items of the reclamation and decommissioning plan exceeds the scope of this report, but the above examples provide an initial understanding. As the seriousness of reclamation and remediation has gained attention in recent years, the number of ‘best-practice’ examples is plentiful. In addition, suggested reclamation methods are also readily available, such as an extensive preparation by the state of Utah.¹⁵⁰ This report, inter alia, highlights the needs for advanced planning, establishment of a reclamation checklist or guide, and for the design of the reclaimed site to robustly manage water and drainage issues. Some academic studies suggest reviewing the bond amount every five years, or more frequently if conditions warrant, so as to adjust the bonding amount based on the “actual current conditions and reclamation and closure requirements.”¹⁵¹ Chmura would add that bonding estimates made by an independent party, not subject to any conflict of interest or remuneration by the uranium industry, would add to the estimates credibility.

¹⁴⁸ “Environmental Remediation of Uranium Production Facilities” IAEA/OECD, 2002

¹⁴⁹ Hydrogeochemistry is the study of the chemical characteristics of ground and surface waters as related to areal and regional geology. Source: McGraw-Hill Dictionary of Environmental Science, 2008.

¹⁵⁰ See: https://fs.ogm.utah.gov/PUB/MINES/Coal_Related/RecMan/Reclamation_Manual.pdf.

¹⁵¹ “Hardrock Reclamation Bonding Practices in the Western United States, Summary Report” Kuipers and Carlson, 2000.

7. Public Health and Environment

Evaluating and compartmentalizing the risks stemming from uranium mining and milling to the general public as well as the environment present some of the most difficult issues regarding the decision to allow the uranium industry to operate in Virginia. In this section, more than anywhere else, that the available science is continuously evolving and may in certain regards be considered incomplete, or at times, inconclusive. Therefore, all judgments and conclusions in this section are stated with caution.

Uranium mining and milling operations unambiguously increase the exposure of the public and the environment to mildly radioactive substances, toxic chemicals, heavy metals and other carcinogenic material. Even under the best of circumstances, Chmura judges some adverse health effects and environmental contamination is likely. Under the baseline scenario these health and environmental risks are estimated and analyzed in the sections that follow and are ultimately characterized as minimal. Implicit in this assumption is the notion that so long as any contamination at the Coles Hill site of air, water, or soil remains within current federal regulations, then the impact on the environment is moderate and the health risks to the general public are reduced to negligible levels. While this is the view of all U.S. government agencies, there are some scientists that would argue the current standards, even if complied with fully by the uranium industry, are insufficient to protect public health and the environment. These federal standards for water, air, and soil quality—which Chmura would characterize as “strict”—were largely enacted in the late 1970s and early 1980s. Because the environmental and health impact of the uranium mine and mill can take decades to fully understand, it is fair to stay that the ability of the current regulations to fully and comprehensively protect the environment and public health for the long-term remains an open question.

However, in dealing with issues of public health, the instance of increased sickness always involves personal tragedy, and no tragic event is deemed minimal by those whose lives are impacted. Alternate scenarios, which address more significant environmental contamination and the public health implications, are contained in the appendix (see sections A5 and A6). When dealing with the issues of public health and environmental protection, the risks are unbalanced to the down-side. There is relatively little chance, if any, the uranium industry will improve the environment or be a force to increase the health profile for the region. Conversely, the history of uranium mining in America indicates the potential for extremely harmful effects to both public health and the environment. The adverse effects the uranium industry has had on many Native American tribes in decades past, particularly the Navajo, are well documented¹⁵² (see appendix Section A7.10 for further detail) and demonstrated a tragic disregard for public health and the environment. The industry is not condemned to repeat past mistakes, but it would be naïve to think that all health and environmental risks can be removed by employing the latest technologies or advanced design techniques.

7.1. Impact on Public Health

Mentioning the word radiation creates a sense of alarm for many individuals. Chmura starts its public health and environment review by providing some basic background information on radiation and units of measure so that readers can transcend the scientific studies and have a better understanding of what are very complicated issues without easy answers. Additional detail on various health studies can be found in the appendix (see Section A7).

¹⁵² “Uranium Exposure and Public Health in New Mexico and the Navajo Nation: A Literature Study” Southwest Research and Information Center, 2008.

We are exposed to radiation every day, as it exists naturally all around us. Radiation is naturally present in our environment and has been since the birth of our planet. Most of the radiation we receive comes via cosmic rays from outer space, but other exposure is received through naturally radioactive substances that are found in the earth's crust and even in our own bodies. Levels of natural or background radiation can vary greatly from one location to the next, but the average person receives about 310 millirems (a measurement of radiation amounts) of radiation per year from natural sources.¹⁵³ According to the National Regulatory Commission, radon and thoron gases account for two-thirds of this exposure, while cosmic, terrestrial, and internal radiation account for the remainder.¹⁵⁴ Man-made sources of radiation from medical, commercial, and industrial activities contribute another 310 millirems to our annual radiation exposure. In total, we receive an exposure of roughly 620 millirems per year. One of the largest of these sources of man-made radiation exposure are medical procedures, such as computed tomography (CT) scans, which account for about 150 millirems per year, while other medical procedures together account for another 150 millirems each year. In addition, some consumer products such as tobacco, fertilizer, welding rods, exit signs, luminous watch dials, and smoke detectors contribute another 10 millirems to our annual radiation exposure.¹⁵⁵

All radioactive material (natural or man-made) can be a cause of cancer, even at low-doses.¹⁵⁶ For example, a dental x-ray produces radiation, and for protection, a lead vest is placed over a patient's chest. However, no human cancer has been documented as a result of exposure to naturally occurring radiation alone.¹⁵⁷ In fact, people living in areas with high levels of background radiation—above 1,000 millirems per year such as Denver, Colorado—have shown no adverse biological effects.¹⁵⁸ Research shows that lung cancers are the cancers most associated with uranium mining and milling, but renal cancer and kidney disease are also cited in the literature as being linked to the uranium industry.^{159 160}

7.1.1. Sources of Risk to Public Health and the Environment

While naturally occurring uranium poses negligible risks to the public and is already present in the environment, processed uranium poses additional health risks and can contaminate the environment. After raw uranium ore is mined, it is processed and the waste by-products (mill tailings) of this processing will retain some remnants of uranium (radioactive progeny)—along with other heavy metals—that can decay into other radionuclides. These radioactive progeny are known carcinogens if human exposure to them is great enough and for a long enough period of time. Mill tailings are essentially a concentrated form of naturally occurring radioactive substances that is termed “Technologically Enhanced Naturally Occurring Radioactive Material (TENORM).” TENORM is defined as:

¹⁵³ Fact Sheet on Biological Effects of Radiation NCR website <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/bio-effects-radiation.html>.

¹⁵⁴ Fact Sheet on Biological Effects of Radiation NCR website <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/bio-effects-radiation.html>.

¹⁵⁵ Fact Sheet on Biological Effects of Radiation NCR website <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/bio-effects-radiation.html>.

¹⁵⁶ “Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII – Phase 2” NAS, 2005.

¹⁵⁷ Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010.

¹⁵⁸ Fact Sheet on Biological Effects of Radiation NCR website <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/bio-effects-radiation.html>.

¹⁵⁹ “Solid-Tumor Mortality in the Vicinity of Uranium Cycle Facilities and Nuclear Power Plants in Spain” National Center for Epidemiology, Madrid Spain; 2001.

¹⁶⁰ “Northern Arizona Proposed Withdrawal Draft Environmental Impact Statement” US Department of Interior BLM 2010.

naturally occurring radioactive materials that have been concentrated or exposed to the accessible environment as a result of human activities such as manufacturing, mineral extraction, or water processing.¹⁶¹ Mill tailings are different and separate from overburden, which is the non-uranium-bearing soils surrounding ore-bearing rock. The waste-rock by-product of uranium milling is TENORM, which is radioactive, carcinogenic, and may also contain toxic materials such as some heavy metals.¹⁶²

When uranium is extracted from ore and chemically converted into yellowcake (uranium oxide or U_3O_8) or another chemical form usable in industry, the radioactive progeny of uranium that remains in the mill tailings is actually a radioactive decay chain consisting of a series of 13 different radionuclides before finally reaching stability as lead-206.¹⁶³ These radionuclides each emit alpha or beta radiation and some also emit gamma radiation. Some of these progeny radionuclides (such as radium) can pose significant human health risks if inhaled, ingested, or if a person is physically in close proximity to large concentrations of the tailings. One of those radionuclides is a radioactive gas, radon-222, which is the progeny of radium-226—which, in turn, is a progeny of uranium. Similarly, as mentioned before, a number of heavy metals may occur in association with uranium deposits and will ultimately be present in the mill tailings (TENORM) from uranium mining, such as arsenic. Heavy metals on site, particularly arsenic (if present in the ore), can be of concern, and can pose serious risks if they migrate to groundwater.¹⁶⁴ This has been a consistent problem with unlined uranium mill tailings ponds utilized in decades past by the uranium industry, but these risks have been substantially reduced because unlined tailings ponds are no longer permitted under Federal regulations. Understanding the health risks associated with exposure to many heavy metals could be seen as incomplete and evolving, but it is known that these toxic substances are particularly harmful to infants and young children.^{165 166}

There are 22 different cancers associated with radiation exposure, and the most common cancer associated with uranium mining and milling workers is lung cancer. This is most likely because radon and its decay products are primarily airborne and pose the greatest cancer risk of all the radionuclides emitted per the findings of an EPA study.¹⁶⁷ Other studies have indicated that long-term worker exposure to uranium mill tailings is weakly associated with elevated risks for birth defects, stillbirths, and other adverse outcomes of pregnancy; however, the authors stated “a lack of clear evidence for an increase in cancer risk to miners should be reassuring.”¹⁶⁸ A different study conducted in 2008 reviewing multiple papers on the health risks relating to the uranium industry found that the association of worker uranium exposure and cancer “is limited.”¹⁶⁹ There are also several studies that have indicated no detectable increases in cancer to populations surrounding uranium mines or mills.^{170 171 172}

¹⁶¹ “Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining” EPA 2007.

¹⁶² “Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining” EPA 2007.

¹⁶³ “Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining” EPA 2007.

¹⁶⁴ “Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining” EPA 2007.

¹⁶⁵ “Heavy Metals and Health” World Resources Institute, <http://www.wri.org/publication/content/8375>.

¹⁶⁶ “Environmental Heavy Metal Pollution and Effects on Child Mental Development” NATO Science for Peace & Security Series, 2011.

¹⁶⁷ “Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining.” V2 EPA 2007.

¹⁶⁸ “Navajo Birth Outcomes in the Shiprock Uranium Mining Area” Shields et al. Health Physics, November 1992.

¹⁶⁹ “Navajo Birth Outcomes in the Shiprock Uranium Mining Area” Shields et al. Health Physics; November 1992.

¹⁷⁰ “Cancer Risk in Nuclear Workers Occupationally Exposed to Uranium – Emphasis on Internal Exposure” Canu et al. Health Physics, Vol. 94, 2008.

While the science could be viewed as inconclusive, mixed, and still evolving, prudence dictates caution. The absence of evidence—in this case an indisputable body of scientific work linking uranium industry to increased cancer rates in the nearby population—should not be construed as evidence of absence. The risk is unambiguously skewed to the downside. As time permits more long-term studies and medical technologies advance scientific understanding, there is an ever-present possibility that heretofore unknown linkages between the uranium industry and a specific illness will be uncovered.

7.1.2. Pathways of Exposure to Harmful Material

The EPA and scientific authorities have defined three primary pathways by which mine and mill workers, as well as the public, can be exposed to the harmful effects of uranium mining and milling by-products. These are (1) breathing air containing windblown dust and radon decay products, (2) drinking water containing uranium and its decay products, or (3) eating food contaminated by either air or water.^{173 174} Via these pathways, exposure to uranium can be harmful and carcinogenic under any one of three conditions—if it is inhaled, ingested, or in contact with exposed skin.¹⁷⁵ Inhalation exposure to uranium can cause potentially harmful health effects from both chemical and radioactive exposure, especially if the exposure is over a long period. Potentially harmful health effects from ingestion or skin exposure to natural and depleted uranium appear to be solely chemical in nature, not radiological.^{176 177} Inhalation, ingestion, or skin exposure to uranium could result from exposure at the mines on site, and if material is carried home on a worker's skin, hair, or clothing (which is now in violation of Federal regulations), the miner's family would also be exposed to uranium. The practice of not wearing protective clothing or taking unwashed clothing home was more common prior to the Mine Safety and Health Administration (MSHA) and the Federal Mine Safety Act, both which were created in 1977.¹⁷⁸ Currently, every mine must impose safety mechanisms designed to reduce on-site and off-site exposure, such as wearing protective clothing and gear, removing this clothing or gear before leaving the mine site, and taking a shower, to name a few. Additionally, per MSHA [30 CFR 75.1712], mine operators are required to provide adequate facilities for miners to change from the clothes worn underground, to provide for the storing of such clothes from shift to shift, and to provide sanitary and bathing facilities.¹⁷⁹

While previous health and environmental studies have focused on exposure to airborne radon and radon-decay products (called daughters, such as polonium-210) or the potential for uranium or its decay products (daughters

¹⁷¹ "Cancer and Noncancer Mortality in Populations Living Near Uranium and Vanadium Mining and Milling Operations in Montrose County, Colorado, 1950-2000" Boice et al. *Radiation Research*, Vol. 167, pp. 711-726, 2007.

¹⁷² "Cancer Mortality in a Texas County with Prior Uranium Mining and Milling Activities", 1950-2001. Boice et al. *J. Radiol. Prot.* Vol. 23 pp.247-262, 2003.

¹⁷³ "Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining." EPA 2007.

¹⁷⁴ "Fact Sheet on Biological Effects of Radiation" NCR website: <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/bio-effects-radiation.html>.

¹⁷⁵ "Northern Arizona Proposed Withdrawal Draft Environmental Impact Statement" US Department of Interior, BLM 2010.

¹⁷⁶ "Northern Arizona Proposed Withdrawal Draft Environmental Impact Statement" US Department of Interior BLM 2010.

¹⁷⁷ Toxicological Profile for Uranium, Center for Disease Control, Agency for Toxic Substances and Disease Registry, Draft for public comment, July 29, 2011.

¹⁷⁸ "Northern Arizona Proposed Withdrawal Draft Environmental Impact Statement" US Department of Interior BLM 2010.

¹⁷⁹ "Northern Arizona Proposed Withdrawal Draft Environmental Impact Statement" US Department of Interior BLM 2010.

such as radium-226) to seep into the groundwater,¹⁸⁰ the relatively wet environment of southern Virginia suggests that rain runoff may be one of the most important pathways to control in order to limit the spread of radionuclides, other acidic compounds, and heavy metals into nearby surface waters and soil. Areas very close to the Coles Hill site's South deposit have flooded in the recent past.¹⁸¹

VUI has estimated that the 26.6 million tons of mill tailings—7.4 million returned to the underground mine and 19.2 million placed in containment cells—will be large by U.S. standards. The other operating uranium mill in the nation, White Mesa, only has the capacity to store about 10 million tons of mill tailings on site, and data from the US Energy Information Agency indicates that only Ambrosia Lake mill located near Ambrosia Lake, New Mexico, currently has more tailings waste of approximately 33 million tons.¹⁸² ¹⁸³ Additionally, some VUI officials have indicated that the amount of tailings that will be produced and stored at the Coles Hill operation will be substantially greater than the 26 million currently estimated in their scoping study.¹⁸⁴

7.1.3. Cost Estimates of Treating Additional Cancer Cases

In the 1980s the EPA studied a number of active and inactive uranium mine sites, collected soil and water samples, and took measurements at sites in four states (Colorado, New Mexico, Texas, and Wyoming). The information was used by the EPA to develop models for mines and mills regarding their average impact on public health. Using these models, in 1983 the EPA estimated the health effects to populations within 50 miles of each mine, and on a hypothetically 'most exposed' individual living one mile from an inactive surface and underground mine.¹⁸⁵ In 1989, the EPA conducted risk assessments for both active underground uranium mines and surface uranium mines, as well as for uranium milling operations.¹⁸⁶ The table 7.1 below summarizes their estimates of the public health risks associated with uranium mining as they relate to radionuclides and carcinogens.

¹⁸⁰ "Evaluation of EPA's Guidelines for Technologically Enhanced Naturally Occurring Radioactive Materials" EPA, 2000.

¹⁸¹ "Historic and potential flooding at proposed uranium mine and mill site Coles Hill, Pittsylvania County, Virginia" Blue Ridge Environmental Defense League, Sep-2011.

¹⁸² Denison Mines website: http://www.denisonmines.com/SiteResources/data/html/pdf/operations_mills.swf.

¹⁸³ "Decommissioning of U.S. Uranium Production Facilities" EIA, 1995.

¹⁸⁴ VUI Representative, public comments "Uranium: What Should Virginia Do?" 53rd Garden Club of Virginia Conservation Public Education Forum, University of Richmond, 3-November-2011.

¹⁸⁵ "Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining" V2 EPA, 2007.

¹⁸⁶ "Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining" V2 EPA 2007.

Table 7.1: Summary of EPA Health Risk Findings

	1-Mile Radius	50-Mile Radius
	Maximum Exposed Individual	Average Exposed Individual
Inactive Surface	3.4 cases in 100,000	6.3 cases in 100,000,000
Inactive Underground	2.0 cases in 100,000	8.6 cases in 100,000,000
Active Surface	4.8 cases in 100,000	6.6 cases in 100,000,000
Active Underground	4.4 cases in 1,000	5.5 cases in 10,000
Mill Tailing Site	1.6 cases in 10,000	7 cases in 10,000,000

These EPA models were developed more than 25 years ago and were based on data gathered from many mines and mills constructed decades earlier. The EPA models also explicitly state that they are estimating the health risks assuming no actions are taken to mitigate exposure to radionuclides and other carcinogens—i.e. the uranium mine and the mill tailings are simply abandoned with no remediation or decommission process taking place. This of course would be a violation of current Federal regulations.¹⁸⁷ Thus there is potential that these EPA-derived estimates overstate the likelihood for increased cancer cases, for underground mining in particular.¹⁸⁸ On the contrary, however, other potential sources for fatal illnesses (such as kidney disease or other lung ailments) that may be associated with uranium mining and milling operations may not be captured in the EPA estimates. For instance at least one study suggests that mine workers exposed to uranium dust developed non-cancerous lung diseases (such as silicosis, emphysema, pneumonia and bronchitis) equivalent to the rate of developing lung cancer.¹⁸⁹ Other considerations that bear mentioning are that these EPA models and subsequent estimates were derived from the study of uranium mining and milling sites almost exclusively in areas in the American west that are drier than Virginia.

The most germane estimate for the purposes of analyzing scenario 1 or scenario 2 (which is the baseline) would be to estimate the health impact of an underground uranium mine and mill for the population of both a one-mile and 50-mile radius around the Coles Hill site. However, subsequent to the development of these risk models and based on their findings, the EPA adopted in 1989 “a National Emission Standard for Hazardous Air Pollutants” (NESHAP)

¹⁸⁷ “Standards for Remedial Actions at Inactive Uranium Processing Sites” 40CFR Part 192 EPA; 1985

¹⁸⁸ “Standards for Remedial Actions at Inactive Uranium Processing Sites” 40CFR Part 192 EPA; 1985

¹⁸⁹ “Exposure Pathways and Health Effects Associated with Chemical and Radiological Toxicity of Natural Uranium: A Review” Doug Brugge, et al., 2005.

for radon emissions from operating uranium mill tailings that would limit the public health risks to negligible levels.¹⁹⁰ The NESHAP standard laid out in 40 CFR 61.250 (Subpart W—National Emission Standards for Radon Emissions From Operating Mill Tailings) stipulates that radon emissions do not exceed “20 pCi/(m² -sec) (1.9 pCi/(ft² -sec)) of radon-222.” In this case a pCi is a picocurie, or measurement of radiation. This standard establishes an “acceptable emissions level corresponding to a maximum individual risk of about 1 in 10,000 lifetime cancer risk, with the vast majority of exposed individuals at a lifetime risk lower than one in 1,000,000, and with the total fatal cancers per year in the exposed population of less than one.” Thus, if a proposed facility were to comply with current Federal regulations, risks from radiation to members of the public surrounding Coles Hill would be negligible.

Because the baseline scenario assumes that the impact of the uranium mining and milling operation remains within federally established requirements, calibrating the EPA’s standard to the region’s population the area around Coles Hill, the region is unlikely to face any additional costs related to cancer treatment.

Chmura has utilized the 1983 EPA models to estimate the cost of additional cancer cases under different scenarios of environmental contamination that could negatively impact public health and has included these estimates in the appendix (see appendix Sections A5 and A6 for additional detail). Additional testing of the uranium body at the Coles Hill site may yield a more precise understanding of the type of radionuclides likely to be present in mill tailings at the site, then the MILDOS¹⁹¹ model—recommended by the NRC for modeling the health risks stemming from uranium mining and milling—could be utilized to produce more refined estimates as to the risks to public health posed by the uranium industry in Virginia.

Table 7.2: Population Estimates in the Vicinity of the Coles Hill Site

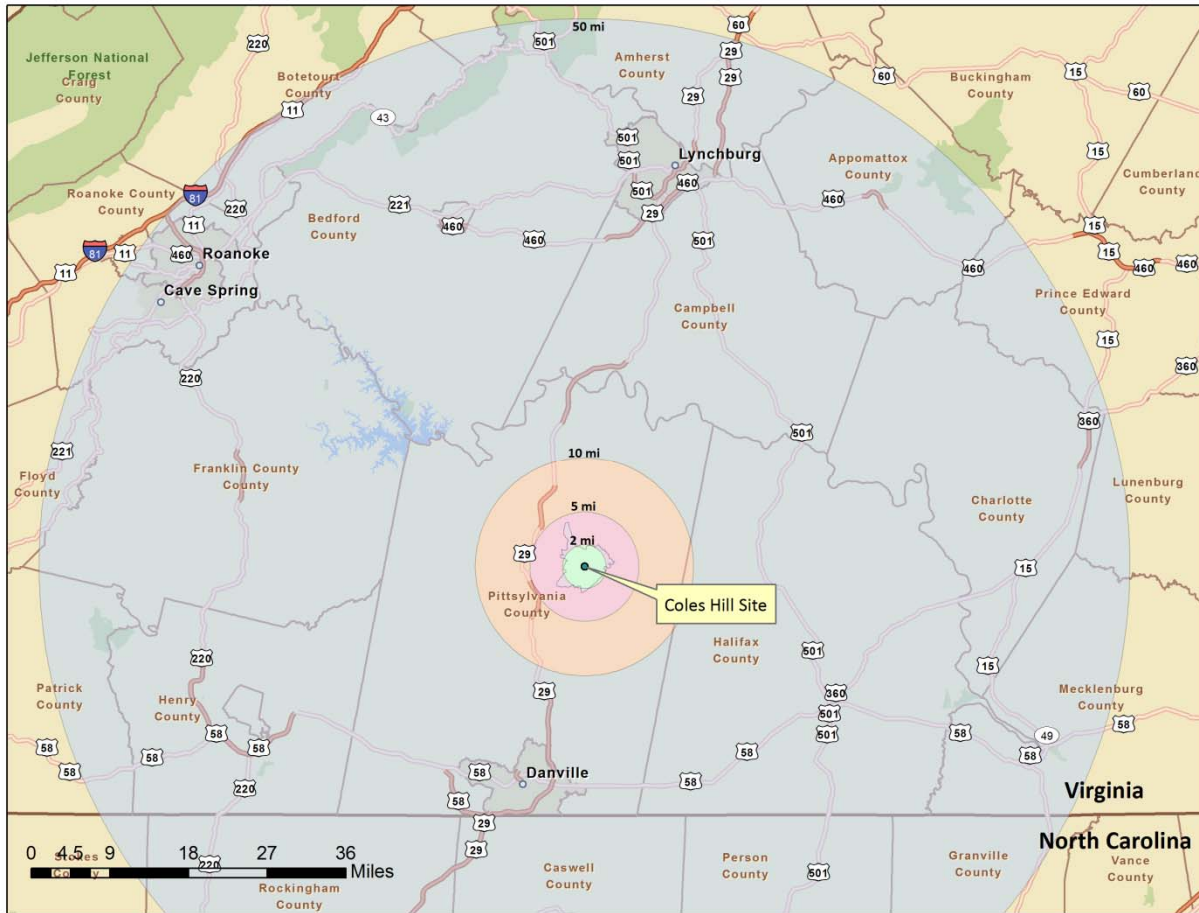
Radius (miles)	Population	Number of Virginia Cities/ Counties
1	<100 (estimate 70)	1
2	311	1
5	2,730	1
10	15,718	2
50	742,391	18

¹⁹⁰ “History and Basis of NESHAPs and Subpart W” EPA; 2008

¹⁹¹ MILDOS, Argonne National Laboratory,

<http://web.ead.anl.gov/mildos/milttitle.html?CFID=61477454&CFTOKEN=388af9b87f2ca637-4171A303-E69C-F353-7BB3AC6B883414F8> (see Argonne National Laboratory website: <http://web.ead.anl.gov/mildos/history.html> for additional detail.

Figure 7.1: Radius Map of Coles Hill Area



The Coles Hill operation is likely to increase airborne particulates (dust) because of the increased truck traffic into and out of the site as well as industrial vehicular traffic located on-site. While terrain, wind speed, temperature, and the level of industrial activity will, at any given time, impact the amount of particulates in the air,¹⁹² Chmura judges that the population living within 5 miles of the site will bear the majority of the impact from the increased amount of air-borne particulates. The portion of the approximately 2,700 people living in this area who are sensitive to poor air quality could experience increased asthma-related symptoms or other respiratory problems.

7.1.4. Health Assessment of the Citizens in the Coles Hill Region

Chmura has analyzed the health profiles of various groups in Pittsylvania County in order to provide context for the health risks described above. This analysis draws heavily on the Virginia Department of Health’s Virginia Health Equity Report, its 2009 Health Statistics, and the Dan River Region Health Assessment.¹⁹³¹⁹⁴¹⁹⁵ Overall, the area

¹⁹² “Air Pollution and Environment Impact Assessment & Model” AIR-EIA: <http://www.ess.co.at/AIR-EIA/JAVA/PointSource/Start.html>.

¹⁹³ “Virginia Health Equity Report 2008: Unequal Health Across the Commonwealth” VDH, 2009.

suffers from inequities in birth outcomes, life expectancy, and mortality when comparing it to more socially advantaged populations elsewhere in the Commonwealth. Simply put, this region already has a compromised health profile.

Consistent with its education and poverty profile, this region has a consistently poorer health status across almost all health indicators.¹⁹⁶ The region's primary minority group, African-Americans, experience an even more distressed health situation, as they typically face shorter life expectancies and higher mortality rates for most of the major causes of death compared to other racial and ethnic groups.¹⁹⁷

Chmura notes the following observations from the health review:^{198 199}

- Pittsylvania County has a significantly higher rate for malignant neoplasm (cancerous malignant tumors) than the state-wide norm
- Pittsylvania County and Danville City both have significantly higher rates for heart disease, cerebrovascular diseases (strokes), chronic lower respiratory diseases, and diabetes mellitus than state-wide norms
- Pittsylvania County and Danville City both have elevated rates for chronic liver disease, septicemia (blood poisoning), nephritis and nephrosis (kidney diseases), and influenza and pneumonia than state-wide norms
- The Pittsylvania County area has a significant smoking population which is increasing and exceeds national and state levels
- Lung cancer rates in Danville are increasing and exceed national and state levels

Several studies suggest that the health risks posed by uranium mining and milling will exacerbate the health risks that stem from lifestyle choices, such as smoking, already associated with the population of Pittsylvania County and the remaining labor shed, and further elevate the already high lung cancer rates in the region.²⁰⁰ At least one study suggests that African-Americans may be more sensitive to the health effects of long-term exposure to uranium byproducts—primarily inhalation of radon gas—than other peer groups, and African-American women may be more at risk than other peer groups for breast cancer should uranium or its byproducts contaminate surface or groundwater.²⁰¹

7.1.5. Overview of Regional Health Facilities

Chmura researched the current health centers in order to quantify the existing capacity for provision of healthcare services. As was noted in Section 6.2.3, neither of the closest towns, Chatham and Gretna, currently have a 24-

¹⁹⁴ "Virginia 2009 Health Statistics" VDH, 2010.

¹⁹⁵ "Dan River Region Health Assessment" Danville Regional Foundation, October 2007.

¹⁹⁶ "Virginia 2009 Health Statistics" VDH, 2010.

¹⁹⁷ "Virginia Health Equity Report 2008: Unequal Health Across the Commonwealth" VDH, 2009.

¹⁹⁸ "Virginia 2009 Health Statistics" VDH, 2010.

¹⁹⁹ "Dan River Region Health Assessment" Danville Regional Foundation, October 2007.

²⁰⁰ "Radon and Cancer: Questions and Answers" National Cancer Institute:

<http://www.cancer.gov/cancertopics/factsheet/Risk/radon>.

²⁰¹ "Hypertension and Hematologic Parameters in a Community Near a Uranium Processing Facility." Wagner et al. Environmental Research, 2010.

hour medical facility. The greater region is served both by a for-profit healthcare system and two non-profit healthcare systems:

- LifePoint – a non-profit health system (holding company; spin-off from former Columbia HCA; Nasdaq – LPNT; focus is on non-urban markets in the Southeastern U.S.) consisting regionally of Danville Regional Medical Center (290 beds) and Martinsville Memorial Hospital of Martinsville and Henry County (220 beds).
- Centra Health – a for-profit health system consisting of Lynchburg General Hospital (358 beds; Level II trauma center), Virginia Baptist Hospital (317 beds), and Southside Community Hospital (93 beds; Short Term Acute Care hospital). Centra has 6,000 employees and a medical staff of 490.
- Carilion Health System – a non-profit health system with Roanoke Memorial Hospital (703 beds) and a Level I trauma center.

At the present time, neither of the LifePoint hospitals (Danville and Martinsville) – which are closest to the proposed mining site – are certified trauma centers (Level I, II, or III). The closest is Centra’s Lynchburg General Hospital (a Level II trauma center, located roughly 50 miles from Chatham by road). The closest Level I trauma center is Carilion’s Roanoke Memorial Hospital (approximately 65 miles from Chatham by road); at the time of this report, Carilion’s Level 1 rating was in jeopardy.²⁰²

Additional Level I trauma center locations within reasonable proximity to Chatham, Virginia are as follows:

- University of Virginia (Charlottesville) – 115 miles
- Duke (Durham, North Carolina) – 82 miles
- Wake Forest (Winston-Salem, North Carolina) – 95 miles
- WakeMed (Raleigh, North Carolina) – 106 miles
- University of North Carolina (Chapel Hill, North Carolina) – 78 miles

In 2004, the General Assembly directed the Joint Legislative Audit and Review Commission (JLARC) to study, among other things, the accessibility of trauma centers in Virginia.²⁰³ The study reviewed all three levels of trauma centers in Virginia and found that trauma centers, cumulatively, suffered a loss of \$44 million across the state in 2003 (by providing needed but non-reimbursable emergency medical care). The report noted that this level of financial loss could cause other trauma centers to reduce or eliminate their services (the study was precipitated by a downgrade in the Virginia Beach trauma level rating due to staff shortages). The report also noted that the Commonwealth may want to investigate providing financial support to trauma centers; further, state funding could also provide an incentive for other hospitals to seek trauma level status.

Importantly, the study looked at the geographical location of trauma centers and identified areas within the Commonwealth that are underserved. Chatham is one area that is underserved, as defined by taking more than an hour to drive to a trauma center (of any level). The study noted the fact that air medevac service improves access, but also noted is the fact that air transportation is not always available. JLARC estimates that between 20 and 40 percent of Virginia citizens do not have access to trauma centers within an hour’s drive.

²⁰² “Carilion lacks enough surgeons for Level I trauma credentials,” Roanoke Times, May 12, 2011. Please see: <http://www.roanoke.com/news/roanoke/wb/286268>.

²⁰³ “The Use and Financing of Trauma Centers in Virginia” JLARC, House Document No. 62, 2004.

In addition, there are three burn centers in Virginia: University of Virginia (Charlottesville); Virginia Commonwealth University (Richmond); and Sentara (Norfolk). The University of Virginia facility is the closest to Chatham and is still 115 miles away with an estimated drive time of over 2 hours (double the time factor used in the JLARC study).

North Carolina Jaycee Medical Center and Wake Forest University Baptist Medical Center both have verified burn centers.²⁰⁴ In Virginia, the only verified burn center is the Virginia Commonwealth University Evans Haynes Burn Center in Richmond, which has a 16-bed burn unit and is also a Level I Trauma Center. It is 162.6 miles and approximately 3 hours and 4 minutes from the Chatham area.

As to the question of whether the presence of a uranium mining and milling operation in Chatham would provide the incentive for area hospitals to become trauma centers, there is no way to make such a prediction with any degree of certainty. However, Chmura would logically conclude that given the national turmoil in the healthcare industry, a hospital system is not likely to be in a financial position to upgrade either its Danville facility or its Martinsville facility without the financial support by the state, as indicated in the JLARC study. Presently, Chmura believes the region is best described as adequately served, but it falls within the rural areas of concern in the JLARC study. In addition, Chmura's research indicates that trauma centers are an issue of concern across the nation.

7.2. Impact on Quality of Life vis-à-vis Uranium Industry's Impact on Public Health

In order to predict quality of life impacts, we first need to define quality of life (QOL). This is a detailed and specialized field of study unto itself, and is beyond the scope of our research. However, in keeping with the decision to maximize information available to the reader, background information is presented that should be helpful in understanding the issues contributing to quality of life; and, the difficulty in devising 'objective' measures for what is a very 'subjective' issue.

For example, most residents describe Pittsylvania County, the Town of Chatham, and Danville as a "good" place to live with high quality of life.²⁰⁵ In fact, most citizens in most regions of the United States are pleased and protective of their perceptions about quality of life in the places they have chosen to live. Accordingly, there are both subjective measures and objective measures that need to be considered when defining "quality of life."

With this in mind, *International Living*, a world-renowned English language publication that has been around since 1979, conducts an annual quality-of-life rating for countries around the globe. *International Living's* print publications, including its annual QOL rankings, reach nearly 500,000 people worldwide. The following excerpt is from a 2010 publication:

Every January, we rank and rate 194 countries to come up with our list of the places that offer you the best quality of life. This isn't about best value, necessarily. It's about the places in the world where the living is, simply put, great.²⁰⁶

²⁰⁴ Please see: http://www.ameriburn.org/verification_verifiedcenters.php.

²⁰⁵ "Dan River Region Health Assessment" Danville Regional Foundation, October 2007.

²⁰⁶ This includes the ranking of 194 countries in 2010. Please see: <http://www1.internationalliving.com/qofl2010/>.

Below are the nine factors utilized by International Living for their annual quality of life index and their corresponding weights:

- Cost of living 15%
- Leisure and culture 10%
- Economy 15%
- Environment 10%
- Freedom 10%
- Health 10%
- Infrastructure 10%
- Risk and safety 10%
- Climate 10%

While a case can be made for including additional factors, different weights, or different methods to measure or score each of these 9 factors, they do provide a basis for thinking about quality of life.

7.2.1 Relating the Quality of Life Study to Chatham and Pittsylvania County

After reviewing both the ranking and the factors, Chmura assessed each factor utilizing measures appropriate for comparing locations within the United States and applied them to Pittsylvania County to make a determination if scores would change as the result of the Coles Hill uranium operation. As the *International Living* website points out, there are some subjective decisions that go into the rankings:

- **Cost of Living** – This is one of only two categories that were weighted above 10 percent (its rating is 15 percent). Pittsylvania County and the rest of the labor shed enjoy a cost of living of roughly 11 to 15 percent below the average cost of living in the United States. The region compares even more favorably to the average cost of living for the Commonwealth of Virginia, which is about 20 percent higher. Chmura judges there is little risk that the cost of living would be adversely affected by the uranium operation, despite the benefit to the local economy.
- **Leisure and Culture** – This category included a subjective component regarding the variety of cultural and recreational offerings. It also includes literacy rates, newspaper subscriptions, and school enrollment ratios. Chmura found no reason why Leisure & Culture would be affected either positively or negatively by the uranium operation.
- **Economy** – This is the other category that is weighted at 15 percent. It includes inflation, economic growth statistics, unemployment, and interest rates. Chmura judges the Coles Hill uranium operation has the potential to substantially improve the economy in the region.
- **Environment** – Total protected land, greenhouse emissions, population density, and population growth rate are included in this category. As per the four scenarios, and under the baseline (see Section 3.3), Chmura judges that the negative impact to the Environment factor would be modest.
- **Freedom** – There is no reason to assume that Pittsylvania County's rating would be different from the rating applied to the United States. Chmura found no reason why freedom would be affected positively or negatively by the uranium operation.

- Health – Unfortunately, as was noted earlier in this report, several health studies show that Pittsylvania County residents do not compare favorably to Virginia or U.S. norms. Chmura judges under the baseline scenario that a few of these health indicators could be impacted in a small but negative fashion.
- Infrastructure – Railways, highways, airports, and motor vehicles were included in this category. Chmura judges the Coles Hill uranium operation to have the potential to modestly improve infrastructure because of the additional tax revenues to state and local coffers.
- Risk and Safety – This category can encompass a variety of indicators of violence or premature death, such as suicide rates, traffic accidents, violent crime, and drug use. Chmura judges that only the area of traffic accidents is likely to be negatively impacted (under the baseline scenario).
- Climate – Average rainfall and temperatures—along with consideration for risk of natural disasters—are included in this factor. Chmura found no reason why the region’s climate would be affected either positively or negatively by the uranium operation.

What is relevant to this study is that a uranium mining and milling operation will have relatively little impact on most of these nine factors. Cost of living, climate, freedom, and leisure and culture should be impacted minimally, if at all, by the presence of the Coles Hill uranium operation. In the areas of infrastructure and the economy—under the baseline scenario—the uranium operation should benefit the region substantially. In the areas of environment, health, and risk and safety, the uranium mine has the potential to detract modestly from the region. However, under the baseline scenario, these impacts will be relatively small.

7.3. Impact on Quality of Life vis-à-vis Uranium Industry’s Impact on the Environmental Landscape

We have analyzed the impact of uranium mining and milling operations, utilizing the assumptions of the baseline scenario (see Section 3.3), on the environment of the Coles Hill area. Chmura has confined this portion of the study area to a two-mile radius around the actual Coles Hill site because it seems reasonable that no location farther than this distance will be impacted by the sight, sounds, and other physical attributes of the Coles Hill industrial site. In general, industry norms have migrated to site and facility designs that minimize any adverse visual disturbances and minimize industrial noise.²⁰⁷ However, the close proximity of the Coles Hill uranium operation to a large number of residents may pose unique challenges to control noise and industrial lighting—particularly at night—so as to minimally disrupt the quality of life for the approximately 311 Virginians residing within two miles of the facility.

7.3.1. Quality of Life: Impact of Noise, Lights, and Trucks

The mining industry is inherently noisy. Based on reviews of the National Institute for Occupational Safety in Health (NIOSH), hearing loss was the second most reported injury among miners. A reduction in noise is considered to be a high priority area for research in the National Occupational Research Agenda (NORA)²⁰⁸ and a top priority in NORA-2 (NIOSH, 2005b). An estimated 25 percent of miners are exposed to noise levels exceeding 90 dB

²⁰⁷ “Special Use Permit Application, Piñon Ridge Mill Facility, Montrose County, Colorado” Energy Fuel Resources, 2008.

²⁰⁸ <http://www.cdc.gov/niosh/nora>.

(decibel)—the permissible exposure limit for a full 8-hour work shift—despite utilizing some hearing protection.²⁰⁹ Correspondingly, the Occupational Safety and Health Administration (OSHA) established noise exposure standards for the construction industry in order to protect workers. Every 10 dB increase represents a doubling in loudness. Although somewhat arbitrary, 70 dB was selected as the basis tolerable by most individuals and is the standard by which noise is measured. Per OSHA regulations, noise levels must be monitored and hearing protection provided. NIOSH states the following on the issue of noise:

Noise is both a health and safety threat to miners. The main health effect of overexposure to loud noise is permanent hearing loss caused by damage to the sensory cells in the inner ear. Noise is also an indirect safety hazard because it can “mask” important sounds like backup alarms and spoken warnings. These hazards are well known and beyond scientific dispute. Still, noise remains a significant problem in mining. The use of heavy equipment, the drilling of rock and the confined work environment are just a few factors that contribute to high levels of noise exposure in mining.²¹⁰

However, the issue of importance in this study is the potential for noise to pose a negative impact on the area surrounding Coles Hill. The following assessment speaks directly to the noise issue:

In a joint report by the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA), environmental activities in uranium mining and milling were studied. Among the factors considered was noise. It was concluded for an underground mine – whether the ore grade was high or low, whether the facilities were new or old, whether the local population was dense or sparse – noise does not pose a significant impact on the local population or the environment, either during or after the mining (OEDC, 1999, Table A2, page 157, taken from Appendix A of the 1996 IAEA report on *Health and Environmental Aspects of Nuclear Fuel Cycle Facilities, IAEA-TECDOC-918*).²¹¹

Simple and straightforward practices can assure noise levels are kept to an acceptable level, such as the use and maintenance of good quality equipment (so that engines run smoothly), construction of earth barriers, planting of trees in areas where sound is likely to be most prevalent, and the use of sound-proofing walls around unavoidably noisy equipment, such as ventilation fans or diesel generators.

Similarly, given the location of the Coles Hill site, the fact that the majority of the mining operation will be underground, and the milling operation will be enclosed in a building, the negative impact across the night sky from lighting of the industry site at night will be minimal.

The issue of truck traffic is often a concern. In a Section 6.2.1, both the necessity and the cost of improving road access to the Coles Hill site was explored. According to the organization pavementinteractive.org, a diesel truck at 150 feet measures 90 dB, which is four times as loud as the human judgment of noise at 70 dB. While this noise will undoubtedly be masked by the walls of homes and natural vegetation, Pittsylvania County may, nonetheless,

²⁰⁹ http://www.nap.edu/openbook.php?record_id=11850&page=109.

²¹⁰ <http://www.cdc.gov/niosh/mining/topics/topicpage6.htm>.

²¹¹ “Environmental Activities in Uranium Mining and Milling: a Joint Report.” International Atomic Energy Agency, 1999.

consider enacting a special noise ordinance or other measures designed to encourage VUI to balance their truck traffic throughout the day and avoid night deliveries.

7.3.2. Quality of Life: Impact on Natural Landscape and Scenic Appeal

The Coles Hill site has previously been an agricultural property – tobacco (and other crops) and cattle (and other livestock) have grown and grazed the land for many years. An historic home place (elevation 677 feet) and various outbuildings still occupy the property; Walter Coles, Sr. and his wife live in the home place on the property.

The topography of the Coles Hill area (approximately 2,300 acres, per literature provided by VUI) can best be described as gently rolling farmland, with various moderately flat areas of about 20 to 30 acres in size. The elevation of the home place is among the highest points on the property; elevations drop to 480 feet near the river—a nearly 200-foot drop which provides for the vistas surrounding the property.²¹²

Therefore, the scenery would be described as Virginia Piedmont—farm fields, small creeks, broken forest areas. Vistas include mountain-like scenery, although the mountains are really foothills and gently rolling land. From the crest of the property, at the home, the Banister River Valley can be seen to the east with ridge lines. Hardwood stands are visible throughout the property and a mature bottom land exists along the river.

Observing the proposed mining and milling site from a vehicular approach to the property, the mining equipment and associated buildings would ultimately come into view—particularly once the mine headframe (typically ranging from 60 to 100 feet high)—is encountered. The topography appears to allow the mining facility to be largely hidden from most views, both on the property itself and on parcels contiguous to it. Despite these favorable topographic conditions, the Coles Hill site—while in operation—will undoubtedly alter the natural vistas for those that live in close proximity. New power lines will likely be visible, as will any new or upgraded roads into the property. Buildings and other mine infrastructures will be at least partially visible from a distance and the property will necessarily be enclosed in fencing.

7.3.3. Quality of Life: Impact on Wildlife, Hunting, Fishing, and Boating

Unlike the thousands of uranium mines in the western portion of the United States that occupy federal lands, the Coles Hill site sits on private property. The extent to which hunting is allowed is unknown, although it would be realistic to expect that the acreage immediately surrounding the mining and milling operation would be restricted from hunting. Similarly, the enclosure of the mining and milling operation along with other wildlife deterrents should dramatically lower quantity of wildlife on the Coles Hill site itself—which is necessary in order to protect wildlife as well as the overall area from exposure to toxic materials. However, other properties in the area are likely to experience relatively little change in the abundance or quantities of wildlife, given most animals are able to adapt and acclimatize to the noise and lights of the nearby operations. Chmura judges little if any negative impact on hunting given the baseline scenario. The issue of stigma as it relates to agriculture and animal consumption with potential exposure to uranium by-product contamination is fully addressed in Section 5.8.4.

Overall, there is an abundance of wildlife on site and in close proximity, including: deer, turkey, foxes, coyotes, wildcats, black bears, and other wildlife typical to a large wooded and field area. Ducks, Canadian geese, herons,

²¹² Observations are made based on a site visit by Chmura.

and a wide range of neotropical migratory birds²¹³ populate the property. Given the size of the overall adjacent parcels of land with identical habitats, Chmura's opinion is that wildlife would not be adversely affected on the non-mining acreage.

The Bannister River is contiguous to the Coles Hill site on the eastern portion of the south deposit. Fish nearest to the subject property are smallmouth bass, red eye, and perch, along with other typical freshwater aquatic life. Further downstream are blue catfish and white catfish. The Bannister River is not conducive to boating and recreation in the traditional sense of a lake or a pond. However, canoeing and kayaking are achievable, even in the typically shallow places in the river, and would remain so after the mining and milling operation were commenced.

It is acknowledged that protection of the watershed is of utmost importance; however, the baseline scenario calls for no abnormalities, so the aquatic life in the river would remain unchanged.

7.3.4. Issues Relating to the Watershed

Water management and isolation is a major challenge to any firm in the uranium mining and milling industry. Any plan to mine and mill uranium at Coles Hill must consider negative water implications arising from run-off of moisture (from rain, snow, fog, dew, etc.) from mine waste, mill tailings, and stockpiled ore that will be located on site. Additional consideration must be made for the dewatering of underground works through constant pumping of water to the surface for processing. Lastly, contaminated water must be isolated from leaching into the groundwater that is utilized by the surrounding communities which ultimately forms part of the greater Roanoke River basin. There is also the long-term challenge of keeping waterfowl, mammals, and unsupervised persons out of contaminated water which will be held above ground. The risks to both public health and the environment stem in large part from the potential exposure of nearby surface and groundwater sources to water from the Coles Hill site that may contain unsafe levels of radionuclides, heavy metals, and other toxins.

The only hydrogeological study of the Coles Hill site that Chmura is aware of was limited in scope and recommended a more thorough and comprehensive study be conducted.²¹⁴ In general, this study found the groundwater system "complex" and extensive. It noted that the "groundwater at Coles Hill is recharged not only locally but also at more distant locations."²¹⁵ The complexity of how groundwater moves through fractured rock only adds to the level of caution that is warranted when considering the issues of water management and the health risks it poses to the broader community and environment.

The Coles Hill prospects lie in Pittsylvania County northeast and approximately 6.5 miles from Chatham in Virginia's Piedmont. Preliminary research shows the mineralized area has two main deposits: the "north deposit" and the "south deposit," both of which are found in the Roanoke (Staunton) River Basin Watershed. Specifically, the deposits lie between Whitethorn and Mill Creeks, which have their confluence approximately 1.5 miles eastward, and they flow as one into the Banister River. The confluence with the Banister River is approximately 3.2

²¹³ These birds breed in the United States and Canada, but migrate to wintering grounds in the Caribbean, Mexico, and southward. Source: "Neotropical Migratory Birds: Natural History, Distribution, and Population Change." Richard M. DeGraffe and John H. Rappole, 1995.

²¹⁴ "Evaluation of Fracture Flow at the Coles Hill Uranium Deposit in Pittsylvania County, Virginia using Electrical Resistivity, Bore Hole Logging, Pumping Tests, and Age Dating Methods" John P. Gannon II 2009.

²¹⁵ "Evaluation of Fracture Flow at the Coles Hill Uranium Deposit in Pittsylvania County, Virginia using Electrical Resistivity, Bore Hole Logging, Pumping Tests, and Age Dating Methods" John P. Gannon II 2009.

miles from the deposits at 101 degrees true. The Banister River forms Banister Lake, from which the Town of Halifax draws drinking water, and flows under State Route 501 at Halifax before finally joining the Dan River five miles east of South Boston within Halifax County. The Dan and Roanoke (Staunton) Rivers converge to form the John H. Kerr Reservoir (“Buggs Island Lake”) in close proximity to the borders of Halifax, Mecklenburg, and Charlotte Counties. The 50,000 acre lake extends 39 miles up the wooded, cove-studded shoreline of the Roanoke River.²¹⁶

The City of Clarksville, Virginia, the City of Henderson, North Carolina (which may draw up to 20 million gallons per day), the Virginia Department of Corrections, and the Mecklenburg Cogeneration Limited Partnership all use water from Kerr Reservoir. The 120 megawatt coal-fired cogeneration facility at Clarksville, Virginia, uses raw water from Kerr Reservoir as process water, cooling water, and steam supply for the facility.²¹⁷ Kerr Reservoir is located on either side of the Virginia/North Carolina border and as the Roanoke River flows over the Kerr Dam in Mecklenburg County, Virginia, it then forms Gaston Lake (aka “Lake Gaston”) as it flows eastward toward the Albemarle Sound. Of special note is that Virginia Beach draws drinking water from Gaston Lake and has done so since 1997. This is because the Federal Energy Regulatory Commission (FERC) authorized a rare interbasin transfer, which is the transfer of water from one watershed to another. This allows Virginia Beach to tap into Lake Gaston and withdraw up to 60 million gallons of water per day for its municipal water supply (Virginia Beach is outside of the Roanoke River watershed).

Lake Gaston is approximately 34 miles in length, contains 20,300 acres of water surface, and has a shoreline of approximately 350 miles.²¹⁸ It has a population around its shore and immediate adjacent area of 150,000 residents, and, like Kerr Reservoir upstream, is a popular vacation destination/recreation spot for the Research Triangle area of North Carolina. Boating, fishing and hunting are popular pastimes on both the Kerr Reservoir and Lake Gaston. The Roanoke River leaves Lake Gaston, passing north of Roanoke Rapids, North Carolina, then briefly turns northward past Williamston, meandering southward, then northward again at Plymouth as it enters Batchelor Bay on the western end of the Albemarle Sound. Both the river and its tributaries support an important recreational and commercial fishery. Anadromous fish, which are born in fresh water, spend most of their lives in the sea and return to fresh water to spawn. There are several anadromous fish using these waters, including striped bass, blueback herring, Atlantic sturgeon, alewife, hickory shad, and American shad. A portion of this area is also important for striped bass spawning.²¹⁹

The Roanoke River Watershed below the Coles Hill site involves the Virginia counties of Pittsylvania, Halifax, Charlotte, and Mecklenburg, but also receives water from Campbell, Appomattox and Prince Edward counties. Please note that both of the Virginia cities of Virginia Beach and Chesapeake are connected by water to the Currituck Sound (which is one of the sounds west of North Carolina’s Outer Banks, all of which are interconnected). Virginia Beach is connected by way of the North Landing River and Knotts Island and Back Bay; Chesapeake is connected by Northwest River and the Intracoastal Canal as well as the old Dismal Swamp Canal, which also drains Lake Drummond, the largest of Virginia’s two natural lakes. Lake Drummond, located in the Great Dismal Swamp, lies partially within the City of Suffolk. Additionally, the Intracoastal and Dismal Swamp Canals connect the Currituck Sound to the Chesapeake Bay between Chesapeake, Portsmouth, and Norfolk at the Elizabeth River.

²¹⁶ USA.gov “Recreation.gov” (see www.recreation.gov/campground/Details.do?contractCode=NRSO&parkID=732).

²¹⁷ WATER WIKI July 2009, see www.sogweb.sog.unc.edu/water/index.php/Kerr_216:_Water_Supply.

²¹⁸ See www.dgjf.virginia.gov/fishing/waterbodies/display.asp?id=55.

²¹⁹ See <http://www.lib-pdf.com/doc/roanoke.html> or h2o.enr.state.nc.us/basinwide/roanokech2.doc.

7.4. Environmental Justice

Chmura spoke to a wide range of stakeholders in order to identify any vulnerable groups, typically minority or low-income groups that could be disproportionately impacted by the proposed Coles Hill site and to ensure a comprehensive set of stakeholders were able to voice their opinions and register any concerns. In general, all stakeholders—schools, the business community, Non-Governmental Organizations (NGOs), and public advocacy groups, among others—have indicated they would like more information about what the uranium mine and milling operation will involve, including what types of mining techniques and technologies will be employed to minimize the risks to both public health and the environment. These disparate groups raised very similar concerns relating to both health and safety. Opinions within and across groups were split as to whether the potential economic gains—as they understood them at the time—outweighed the health and environmental risks to the community.

Directly addressing the issue of environmental justice,²²⁰ the entire labor shed (as was noted in Section 4) has both below-average incomes and higher rates of poverty. Thus Chmura's treatment of the public as well as a comprehensive group of stakeholders throughout the labor shed was an appropriate focus for soliciting views and ensuring ample opportunity for input. The socioeconomic profile for the labor shed is quite similar to that of the broader watershed, and in both areas the most relevant minority group is the African-American community.

The EPA's Office of Environmental Justice defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies."²²¹

Meaningful involvement means that (1) community residents in the potential impact area—primarily Pittsylvania County—have an appropriate opportunity to participate in decisions about a proposed activity that will affect their environment and/or health; (2) the public's contribution can influence the regulatory agency's decision, as in the Virginia state legislature; (3) the concerns of all participants involved will be considered in the decision-making process; and (4) the decision-makers seek out and facilitate the involvement of those in the potential impact area. Environmental justice can be achieved when everyone—regardless of race, culture, or income—enjoys the same degree of protection from environmental and health hazards and has equal access to the decision-making process.

Within the labor shed, the relevant definition of a minority community—African-American, Hispanic, Asian and Pacific Islander, American Indian, or other non-white persons—would be when the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. In this case, the African-American community is of sufficient size, at roughly 25 percent of the population, to meet this definition. The African-American community in the region has lower average incomes and poverty rates of more than double their white neighbors.²²² The health profile of the

²²⁰ The 1994 Executive Order 12898 requires federal agencies to address "environmental justice" when implementing their respective programs. The VCEC specifically asked that Chmura address the issue in its socioeconomic study.

²²¹ EPA website: Environmental Justice Homepage <http://www.epa.gov/environmentaljustice/basics/index.html>.

²²² "Labor Shed 2005-2009 American Community Survey 5-Year Estimates" US Census Bureau.

African-American community is also less robust than their white peers, with higher rates of several chronic diseases and slightly shorter life spans.²²³

Chmura's interview with the Pittsylvania County chapter of the NAACP (National Association for the Advancement of Colored People) found their concerns were very similar and consistent with the issues raised by other stakeholders in the region. The local NAACP chapter concluded that the African-American population would not be impacted any differently by a potential Coles Hill uranium mining and milling operation than would any of their non-African-American peers. The NAACP local chapter's main concerns were whether this type of operation could be performed safely in terms of the workers employed in the operations, the health of the surrounding community, and the environment. The NAACP was additionally concerned that should the uranium mine and mill gain full approval—both by state and local authorities—for operations that enforcement of safety, health, and environmental standards would be eroded over a time and thus raise the risks to worker safety, public health, and environmental contamination beyond prudent and acceptable limits. The organization generally felt its membership—mirroring trends in the broader population—was generally split on whether or not they supported the introduction of uranium mining and milling operations in the area. Some of their members felt the uranium operation could be conducted safely and in an environmentally responsible manner and would bring much needed jobs to the area. Other members felt the risks to public health and the environment were too great to support the uranium mining project despite the potential for economic development. Chmura is aware, however, that the state level chapter of the NAACP in Virginia is opposed to allowing uranium mining and milling in Virginia²²⁴ and some members of the Virginia NAACP have publically voiced their opposition to the Coles Hill site.²²⁵

Chmura concludes that based on the assumptions of the baseline scenario, demographic statistics and residential records, the African-American community is unlikely to experience any greater environmental risks than any other community in the Coles Hill labor shed. Two reasons for this are that the African-Americans neither disproportionately live in proximity to the Coles Hills site, nor live disproportionately along the main transit corridors to and from the site. Similarly, in the broader watershed, the African-American community is not at any disproportionate risk than any other community. Also at this point, Chmura has no reason to believe the African-American community will face any additional risks associated with working in the mines. This comes from the assumption that they would not be hired in greater numbers than would their non-African-American peers or other peer group.

7.5. Post-Closure Procedures

In the United States as well as in other countries, relatively few mines have been remediated or have undergone a comprehensive 'post-closure' procedure.²²⁶ In the Abandoned Mine Land (AML) policy handbook, it is reported that 11,000 known sites were in the AML database as of September 2006. It is also estimated that hundreds of

²²³ "Virginia Health Statistics" Virginia Department of Health, Volume I, 2009.

²²⁴ "NAACP opposes uranium mining in Virginia" Washington Post Blog October-2011 (http://www.washingtonpost.com/blogs/virginia-politics/post/naacp-opposes-uranium-mining-in-virginia/2011/10/31/gIQAsXRGZM_blog.html).

²²⁵ "Uranium Mining in Virginia: A Risky Experiment" Southern Environmental Law Center video (<http://www.youtube.com/watch?v=bL1Ich2dWRw>).

²²⁶ Abandoned Mine Land Program Policy Handbook, March 20, 2007.

thousands of sites have not yet been inventoried.²²⁷ The historic legacy of uranium mining is that neither the mining companies nor federal and state authorities took appropriate action to ensure that abandoned uranium mines were closed in a way that minimized any adverse environmental or public health effects.

The state of inaction is described very well by the U.S. Department of Labor Historian in a paper that was delivered in 1998.²²⁸ It is a detailed account of confusion among federal agencies (many of which no longer exist in their previous establishment) and the 'lack of authority' which prolonged the inaction by multiple agencies. Not until the Johnson administration did the United States get serious about admitting, researching, and acting upon the low-level radiation exposure issues that began a couple of decades prior. Johnson appointed a task force, headed by Labor Secretary Willard Wirtz, "to free up a process that had become bogged down in bureaucratic gridlock."²²⁹ Below is an excerpt from the 1998 report:

Then, on March 9, 1967, Willard Wirtz, still unengaged in the issue, picked up his morning *Washington Post*. At the top of the front page was the headline "Washington's Air Declared Fourth Dirtiest in Nation," but what really got Wirtz' attention was a little story below the fold. Titled "Hidden casualties of Atom Age emerge; cancer: uranium mine occupational hazard," it told a tragic story built around a uranium miner named John Morrill. Like many of his colleagues, Morrill was dying of lung cancer caused by exposure to the radioactive products of radon gas with the harmless sounding name of "radon daughters." It was also a story of multiple federal agencies failing for decades to come to grips with the problem, even though it was well documented. Furthermore, according to *Post* reporter John Reistrup, it was a problem that was expected to become even more serious because of an anticipated doubling of uranium production to meet the needs of the expanding nuclear power industry. Reistrup later recalled that even though the problem was well known to the government the news media had never previously publicized it. In his article he charged that: "The problem of the uranium miners just has not caught on." But it did with Wirtz that morning. What struck him about the situation was "the realization that I didn't know anything about it and that I thought I should."²³⁰

Post Closure Issues in the European Union

In the past, the majority of the world's uranium production did not occur in the United States. Much of the uranium production occurred within the European Union (EU), but currently this is no longer the case. Uranium mining in Europe began in the 1940s and by the 1990s almost all of these mines had been formally shut down. Decommissioning has occurred to varying degrees regarding these mines, and the European Commission—the

²²⁷ Abandoned Mine Land Program Policy Handbook, March 20, 2007. See 1.2 Context, p. 2.

²²⁸ U.S. Department of Labor, "Tragedy in the Uranium Mines: Catalyst for National Workers' Safety and Health Legislation," Judson MacLaury, April 27, 1998. (<http://www.dol.gov/oasam/programs/history/lbjsym98.htm>).

²²⁹ U.S. Department of Labor, "Tragedy in the Uranium Mines: Catalyst for National Workers' Safety and Health Legislation," Judson MacLaury, April 27, 1998. (<http://www.dol.gov/oasam/programs/history/lbjsym98.htm>).

²³⁰ U.S. Department of Labor, "Tragedy in the Uranium Mines: Catalyst for National Workers' Safety and Health Legislation," Judson MacLaury, April 27, 1998. (<http://www.dol.gov/oasam/programs/history/lbjsym98.htm>).

executive arm of the EU governance structure—staff produced a working paper on these decommissioning efforts that was finalized in March 2011.²³¹

The residues of these past six decades of mine and mill processing of uranium ore in Europe have resulted in a considerable *legacy*. Although this legacy is much smaller in volume than that resulting from other types of metal or coal mining, the enhanced radioactivity associated with uranium mining requires specific attention.²³² (emphasis included)

Between 2006 and 2008, the EU “identified the current tailings liabilities in Europe, their status, the future plans for these sites, and any associated hazards.”²³³ The report refers to “long-term stewardship” of uranium mine and mill tailings and concludes “the need for an effective set of measures for coordinated institutional control of uranium mine and mill tailings.”²³⁴ Further, the report “addresses issues concerning both managing existing uranium mine and mill legacies and improving sustainability while meeting the increased demand for uranium.”²³⁵

The EU situation is as follows: mine and mill tailings in the EU are located in 12 “Member States” (countries); there are a total of 87 tailings piles at 63 different mine/mill sites, containing 314 million cubic meters. The EU does not measure its uranium tailings in tons (weight), but in cubic meters (volume). The tailings cover a total area of 2,530 ha (hectare – metric system; 1 hectare = 2.471 acres), or 6,252 acres. Most sites are no longer in operation. Remediation progress is as follows: about 40 sites have been completed; about 20 sites are in progress; and about 3 have not been started.²³⁶ The following is an excerpt of the study by the European Union:

Many of these uranium mine and mill tailings disposal sites were constructed and operated at a time when public and workplace health risks and environmental concerns were less of a focus than they are today. The growing awareness of national authorities over the last two or three decades coupled with increased public concern has not only led to the closure of tailings disposal sites, but in most cases to the need to remediate them. *The main purpose of remediation has been to interrupt pathways of radiological and non-radiological exposure and to mechanically stabilize the sites against natural processes.*

The costs of remediation work are site-specific and can be considerable. In cases where uranium production has ceased and the mines and mills are abandoned, especially where companies have ceased to operate or even exist, the responsibility for remediation, including financing, falls to the state.

²³¹ European Commission, “Situation Concerning Uranium Mine and Mill Tailings in the European Union,” March 11, 2011. http://www.ipex.eu/ipex/cms/home/Documents/doc_SEC20110340FIN.

²³² European Commission, “Situation Concerning Uranium Mine and Mill Tailings in the European Union,” March 11, 2011. http://www.ipex.eu/ipex/cms/home/Documents/doc_SEC20110340FIN.

²³³ European Commission, “Situation Concerning Uranium Mine and Mill Tailings in the European Union,” March 11, 2011. http://www.ipex.eu/ipex/cms/home/Documents/doc_SEC20110340FIN.

²³⁴ European Commission, “Situation Concerning Uranium Mine and Mill Tailings in the European Union,” March 11, 2011. http://www.ipex.eu/ipex/cms/home/Documents/doc_SEC20110340FIN.

²³⁵ European Commission, “Situation Concerning Uranium Mine and Mill Tailings in the European Union,” March 11, 2011. http://www.ipex.eu/ipex/cms/home/Documents/doc_SEC20110340FIN.

²³⁶ European Commission, “Situation Concerning Uranium Mine and Mill Tailings in the European Union,” March 11, 2011. http://www.ipex.eu/ipex/cms/home/Documents/doc_SEC20110340FIN.

One area of particular concern has been the legacy from the extensive uranium mining and milling activities in Central and Eastern European Countries. The governments of these countries have faced not only financial difficulties, but also lacked local expertise for remediation.

To date, individual Member States and the European Union have dedicated considerable efforts and resources to dealing with the legacies and liabilities from uranium mining and milling activities. The situation in each country is different and each site is unique in many aspects. Local climate, geology and topography largely determine the extent of remediation measures needed. These measures must be identified with close regard to locally available resources, which means each country or each site will use 'best practice', as evidenced in many cases.

The EU case study can be summarized as follows:

- There is sizable uranium tailings exposure in about 12 countries within the EU
- Long-term 'stewardship' is required (i.e. 'legacy')
- Some sites have no funding – even at the national level
- Some countries do not have the expertise to conduct mine closures
- More analysis is needed to document best available techniques

A recurring theme that is not unique to the United States—or the EU for that matter—is that awareness of the need to remediate uranium mines and mills has grown world-wide, but the resources and capabilities have thus far proven insufficient. In many so-called third-world countries, the uranium mines have been completely abandoned as those countries have no resources for remediation.²³⁷

Remediation Costs: Three Global Examples

There is no easy way to answer the question of remediation costs, as the variables are too vast. However, Chmura looked at some specific examples identified in an IAEA report to draw some initial conclusions.²³⁸

- From the German section of the report: The permanent closure and decommissioning of eastern Germany's WISMUT (originally a Russian stock company), the world's third largest national uranium producing industry, is expected to cost 13 billion DM (\$9.3 billion in April 2011) over 10 to 15 years.²³⁹ The Wismut operation lasted from 1946 to 1990 with more than 400,000 people having worked at Wismut site, many in forced labor. All uranium produced was sent to the Soviet Union for subsequent processing. The grade of uranium was low (0.07%), making the mining cost, amounts of waste, and amounts of tailings unusually high. Uranium mining was discontinued in Germany following its unification in 1990.²⁴⁰ The suspected radioactive contamination areas cover a surface of 240 square kilometers (93 square miles) with 1,520 hectares of waste piles and 724 hectares of tailings. Total uranium extracted by Wismut was 251,000 metric tons (approximately 277,000 U.S. tons).²⁴¹
- From the U.S. section of the report: Decommissioning costs of uranium mills vary substantially by site, and caution should be used when calculating or interpreting "average" costs. For example, groundwater reclamation costs range from \$300,000 to \$9.7 million. Recently built mill sites incorporate better design features (such as liners to the tailings ponds), which reduce decommissioning costs. The tailings

²³⁷ Please see: <http://www.wise-uranium.org/uddeur.html>.

²³⁸ International Atomic Energy Agency: "Planning and management of uranium and mill closures," May 1994. http://www-pub.iaea.org/MTCD/publications/PDF/te_824_web.pdf.

²³⁹ International Atomic Energy Agency: "Planning and management of uranium and mill closures," May 1994.

²⁴⁰ Please see: <http://www.wise-uranium.org/uwis.html>.

²⁴¹ International Atomic Energy Agency: "Planning and management of uranium and mill closures," May 1994.

reclamation costs averaged \$32,000 per acre of tailings, with a range of \$9,000 to \$57,000 per acre. The wide range reflects differences in the design and configuration of the tailings piles and the reclamation measures required. The total costs of the tailings reclamation, including contingencies and allowances, averaged \$1.13 per ton of tailings and ranged from \$0.57 to \$2.62 per ton.²⁴²

- From the Slovenia section of the report: Mining operations at the Zirovski mine began in 1985, stopped in 1990, and the government decided to permanently shut down the mine in 1992. The estimated amount of contaminated waste is as follows: 4,300 cubic meters of building materials; 110 cubic meters of equipment; 666,000 metric tons (approximately 734,000 U.S. tons) of tailings on an area of 4.3 hectares, and a volume of 375,000 cubic meters; 1,472,150 metric tons (1,565,936 U.S. tons) of waste rock total (1,420,350 tons of waste rock, 48,000 tons of red mud; and 3,800 tons of filtration waste). Total estimated costs for the 6-year closeout are 60 million euros (or roughly \$89 million).²⁴³

Summary of the Global Cost Studies

Throughout the majority of the research Chmura has conducted for this project, determining typical costs for remediation have been elusive, and the research strongly suggests the concept that “every site is different.” However, the results of the three examples are as follows:

1. Germany – \$9.3 billion/277,000 tons = \$33,574 per U.S. ton average
2. U.S. – \$1.13 per U.S. ton average
3. Slovenia – \$89,000,000/734,000 tons = \$121 per U.S. ton average

The wide range in average costs proves the point that averages are not a good predictor of remediation costs. Among the three examples used above, note that the German example (due to an unusually low grade of uranium) made the mining area quite large, and therefore the waste rock and tailings were quite extensive. Accordingly, the remediation costs are extremely high.

Similarly, the U.S. Energy Information Administration conducted a study in 1999 to analyze in detail the various clean-up costs remediating more than 20 uranium mines.²⁴⁴ The estimates for the remediation costs per pound of uranium (yellowcake) produced ranged from \$0.79 to \$97.27, with an average value of \$12.67. A separate U.S. Department of Energy study conducted in 2007 provided an overview of costs of reclamation and remediation at uranium mines (of all types) and covered a total of 75 production facilities.²⁴⁵

Some of the key findings of the 2007 DOE report are listed below:

- Title I Uranium Mills and Facilities, abandoned and unlicensed during Atomic Energy Commission (AEC) existence: 26 sites; average closure cost per site was \$56.9 million; total closure cost (including groundwater) for all sites was \$1.695 billion.

²⁴² International Atomic Energy Agency: “Planning and management of uranium and mill closures,” May 1994.

²⁴³ International Atomic Energy Agency: “Planning and management of uranium and mill closures,” May 1994.

²⁴⁴ “Uranium Mill Sites Under the UMTRA Project” EIA, 1999 see <http://www.eia.gov/cneaf/nuclear/page/umtra/title1sum.html>

²⁴⁵ “Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining – Volume 1: Mining and Reclamation Background” US EPA, June 2007 see: <http://www.epa.gov/rpdweb00/docs/tenorm/402-r-08-005-voli/402-r-08-005-v1-ch4.pdf>

- Title II Uranium Mills and Facilities, licensed by Nuclear Regulatory Commission (NRC) or Agreement States after 1978: 28 sites; average closure cost per site was \$20.9 million; total closure cost for all sites was \$585.8 million.
- Combined costs for Title I and Title II sites averaged \$42 million per mine and totaled \$2.279 billion.
- There are broad ranges for the clean-up costs: EPA's cost for Lucky Lass and White King uranium mines in Oregon, under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) was approximately \$8 million in 2001; The Navajo Abandoned Mine Lands Agency reclaimed 20 mines in 2000 for an average cost of \$45,000 per mine.

These findings from the 2007 DOE study have been utilized to inform Chmura's estimates for remediation costs under alternate scenarios (scenarios 3 and 4 described in Section 3.3), which assume more extensive environmental contamination. These alternate scenarios are addressed in detail in the appendix (see appendix Sections A5 and A6).

8. Social Impacts

This section relies heavily on both Chmura's discussions with local stakeholders and the interviews with officials in former uranium mining towns in France. Based on outreach to local businesses, various local stakeholders, educational institutions, and other civic bodies, as well as public opinion (via letters to the editor and Virginia state authorities), Chmura found that opinions regarding the relative positive and negative aspects of uranium mining and milling was largely balanced between two opposing views. Most individuals acknowledged the notion that uranium mining and milling could potentially help the region via jobs and economic development while simultaneously posing risks to public health and the environment. Those who felt the economic benefits would outweigh the health and environmental risks were roughly equal to those who felt the contrary was the case. Only a small portion of those interviewed had firmly made up their minds on the issue, and nearly all groups indicated they would like more information on the socioeconomic impact before making an informed decision.

8.1. Image of the Region

During Chmura's discussions in the area, some individuals voiced their concerns that the introduction of uranium mining and milling operations would introduce "business risk" into the area. Some openly wondered if Chatham and Pittsylvania County would become known as the "uranium town" or the "uranium county" and many worried that should this occur, it could deter other investment into the region and harm the areas of tourism and agriculture. As noted in Sections 5.6 and 5.7, despite advances in regulation, waste-rock management, and remediation technologies, the uranium industry is unlikely to fully and immediately mitigate the "stigma" associated with its mining and milling operations. People, for a time, may well fear the unknown. However, over time, providing the Coles Hill site is operated within the established health, safety, and environmental guidelines, any stigma effect initially posed by the uranium mine and mill should fade. Public and media perceptions can and will change, and they will ultimately warm towards the uranium operation providing that the management of Virginia Uranium Incorporated (VUI) adequately engages with community stakeholders and maintains its intention to be a good steward of the environment.

From the discussions in France, it was apparent that negative stigma surrounding the uranium industry did not deter other business investment, nor did it affect agriculture or tourism.²⁴⁶ Government and industry officials in France took specific efforts to disclose health and environmental testing and monitoring in order to mitigate any potentially negative stigma effects. In general, Chmura's conversations in France indicated unequivocally that the uranium operations had been a net-economic benefit to the area and the health and environmental risks had been minimized by the prudent management of the industrial site. While the relative size of the mine in Bessines, France, was smaller than what potentially will be located in Pittsylvania County (as are French uranium sites in general), the nature of the risks it posed to public health, worker safety, and the environment were fundamentally the same.

Similarly, leading up to a June 2010 Ground Water Discharge Permit for Denison Mines at its White Mesa uranium mill facility (described in the permit as a uranium milling and tailings disposal facility) relating to its construction of a new tailings holding cell (4B) on the White Mesa site, the Utah Division of Water Quality and the Department of

²⁴⁶ Chmura interviews conducted in Bessines, France, 2011.

Environmental Quality held requisite public hearings and took public comments, both oral and written.²⁴⁷ The review of this report contained a clear majority of positive and supportive comments from citizens and local government leaders and indicated that the management of the mill had been “good neighbors” to the community. Chmura judges the following statement as representative of the views expressed at that public hearing:

One person reported his impression that by and large White Mesa management has been responsible with what they've done at the mill site. This person reported seeing opposition to activity at the mill that has not been well founded. This person expressed his belief that he represented many people who, if they were able to come and speak, would support the mill.²⁴⁸

Chmura’s research has generally found that in recent years—as opposed to the experience in the 1950s, 1960s, and 1970s—communities’ experience with the uranium industry has been positive, and the negative stereotypes associated with the industry no longer seem justified. This is not to say examples of environmental degradation have not happened in recent years, indeed they have,²⁴⁹ but the scope of these contaminations and the industry’s positive response to address these occurrences, to right the environment, and comply with the relevant state and federal regulations seems fundamentally different than in the early years of the industry.

8.2. Public Confidence in the Company

Determinations of public confidence naturally involve the review of past performance, the prediction of future performance, and the analysis of associated risks. However, not only is public perception a study of the facts, but many times a reaction to perceived facts. Chmura has reached out to a wide-ranging group of stakeholders in order to ascertain perceptions regarding VUI, its ability to adequately balance the risks for public health and the environment, and its desire for profits. In general, opinions were split about whether VUI would be able ensure the safety of the general public and the environment.

There are at least three types of risks for the public to consider in evaluating this type of project:

1. Execution Risk: The risk of the success/failure of the company to perform its business (which is within its control).
2. Political Risk: The risk of global political changes that affect the view toward nuclear energy (which is beyond its control).
3. Calamity Risk: The risk of any unforeseen major catastrophe that puts people and natural resources in danger (which may be a combination of company control and outside forces).

From its website and numerous public speeches by its officials, VUI has stated that it is committed to prioritizing the long-term health, environment, and general welfare of the community which will host its mining and milling operations.²⁵⁰ VUI has indicated that it will utilize the best practices and technologies available to mitigate the health

²⁴⁷ Utah Division of Radiation Control, “Public Participation Summary,” for the Modification to the Ground Water Discharge Permit and the Amendment to the Radioactive Materials License at Denison Mines White Mesa Uranium Mill, June 14, 2010.

²⁴⁸ Utah Division of Radiation Control, “Public Participation Summary,” for the Modification to the Ground Water Discharge Permit and the Amendment to the Radioactive Materials License at Denison Mines White Mesa Uranium Mill, June 14, 2010.

²⁴⁹ “Community Concerns Related to the Uranium Mining in Virginia” Halifax County Chamber of Commerce, 2010 appendices 10 & 12.

²⁵⁰ Community Section, VUI website: <http://www.virginiauranium.com/community.php>.

and environmental risks and will endeavor to have as small a footprint—meaning least disruptive to the landscape and community—as possible.²⁵¹ VUI has emphasized that the mining and mineral rights are held predominantly by local investors with strong and longstanding ties to the region.²⁵² In short, it will address the “execution risk”, and as much as possible the “calamity risk”, by doing all it can to ensure its business systems and processes, mining technologies and methods, and management philosophy are supportive of the community and keep the interests of public health and environment at the forefront.

Indeed, many of the stakeholders who are most positive about VUI’s ability to mitigate these risks and ensure the safety of the environment and the community base their assessment, at least in part, on their personal knowledge of the integrity and reputation on the VUI management team and its principal owners. However, other stakeholders, notwithstanding their positive opinion of VUI, are concerned that ultimately ownership of the Coles Hill site will pass out of the control of local investors and into the sphere of control of large mining ventures that will re-prioritize profits over protecting the community and the environment as well as spreading the benefits of the operation to the region. Similarly, some environmental groups have posited that precisely because VUI does not have actual mining and milling operating experience, it is highly likely that VUI will either partner with or sell its mining and mineral rights to an established uranium mining company.²⁵³

Chmura’s research gives some credence to the concern that VUI will not remain under local ownership and control over the long-term. The ownership and corporate structure surrounding VUI has continuously evolved since its inception—this is not unusual, particularly in the mining industry—and it is possible that ownership shares may have changed even further by the time this report is finalized. As of mid-2011, the mining and mineral rights in Pittsylvania County remain effectively controlled by a handful of local Virginia-based investors, however, a large Canadian uranium mining company (Denison Mines Incorporated) as well as Canadian financier Sprott Resource Corporation—essentially a private equity firm specializing in natural resource ventures and mineral exploration—and at least one Canadian venture capital firm, have obtained minority shareholdings in VUI (see appendix Section A8 for additional detail and the company structure). Should VUI ultimately gain full approval by state and local authorities for the commencement of uranium mining and milling operations in Pittsylvania County, the value of these mining and mineral rights will increase. It is possible and entirely legitimate that the current Virginia-based investors will decide to realize a profit by selling some or all their stake in VUI. The inclusion of large, well-established mining companies, however, may be a positive factor in raising the trust of the public by reassuring Virginians that VUI has brought on board the technical expertise to effectively manage the operations of the Coles Hill site—although the reputation of some mining companies that may be involved is poor in the view of many environmental groups.

The International Atomic Energy Agency (IAEA) recommends two best practices that can help alleviate some of the concerns that ownership of the mine and mill will eventually be transferred to unknown investors or corporate entities that may not share the same philosophy as the current ownership of VUI. The first is an “Impact-Benefit Agreement”, and one of these was first signed between several communities in northern Saskatchewan, Canada,

²⁵¹ FAQ Section, VUI website: <http://www.virginiauranium.com/faqs.php>.

²⁵² Ownership Section, VUI website: <http://www.virginiauranium.com/ownership.php>.

²⁵³ Interview with Roanoke River Basin Association President, August 2011.

and two separate uranium mining companies.²⁵⁴ The agreement created a legally binding mechanism to address three issues:

- Environmental protection and compensation
- Employment, training, and business development opportunities
- Benefits sharing

The IAEA notes that one of the major projects and successes of this agreement was the development of a community-based environmental monitoring program.²⁵⁵

The objective of the environmental monitoring program is to identify contaminants within local air, water, sediment, plants, and animals through regular sampling. Individuals from the communities collect the samples, often from sites identified through traditional knowledge, and an independent contractor is used to interpret the data and write the reports. This approach has led to an increase in the level of comfort the communities have with the results.²⁵⁶

Both fulfillment of and compliance with this type of agreement could be tied to the issuance of any special-use permits issued by local Pittsylvania County authorities to ensure that whoever the owner of the Coles Hill uranium operation would be both bound to comply with and engage on specific topics with the local community.

The second best practice highlighted by the IAEA to increase public confidence in the uranium mining industry is the creation of permanent Environmental Quality Committees (EQCs) that provide a regular forum for local communities, regulatory agencies, and industry officials to discuss and evaluate performance of the mining and milling operation as it relates to the environment.²⁵⁷ These EQCs were first developed in Saskatchewan, Canada. Because these EQCs are considered permanent—with defined roles and obligations—they would obligate the current owner of the Coles Hill site to participate. Because of the EQC's implicit or explicit roles in both permitting and regulation development, industry representatives are then given an incentive to actively participate.

The IAEA found that EQCs provided an “effective means for community participation in monitoring the uranium mining industry, influencing decision making about the industry and providing two-way communication” between local communities and the industry and/or the government departments tasked with regulating the industry.²⁵⁸ “In addition to their providing routine consultative advice to government and industry, the committees have also clearly influenced the decisions of federal and provincial regulatory authorities. They have participated in the amendment of government policy with regard to uranium development and have taken an active role in advising regulatory agencies during the company operating license renewals, proposal evaluations, and industry planning for site modification or close-out.”²⁵⁹

These two measures, the Impact-Benefit Agreement, and the standing Environmental Quality Committees were instrumental in raising the trust of the local communities in the safety of uranium mining in the area. The IAEA

²⁵⁴ “Best Practice in Environmental Management of Uranium Mining” IAEA Technical Report # NF-T-1.2; 2010.

²⁵⁵ “Best Practice in Environmental Management of Uranium Mining” IAEA Technical Report # NF-T-1.2; 2010.

²⁵⁶ “Best Practice in Environmental Management of Uranium Mining” IAEA Technical Report # NF-T-1.2; 2010.

²⁵⁷ “Best Practice in Environmental Management of Uranium Mining” IAEA Technical Report # NF-T-1.2; 2010.

²⁵⁸ “Best Practice in Environmental Management of Uranium Mining” IAEA Technical Report # NF-T-1.2; 2010.

²⁵⁹ “Best Practice in Environmental Management of Uranium Mining” IAEA Technical Report # NF-T-1.2; 2010.

attributes the vast jump in Canadian survey respondents signaling trust in the uranium mining sector—from around 10 percent in the 1970s to more than 80 percent in 2003—to these measures.²⁶⁰

The third major risk confronted by the public in evaluating VUI's ability to ensure the safety of public health and the environment stems from an unknown, low-probability extreme event. This could be the result of a natural disaster such as an earthquake, a rare and heretofore unseen weather event, or the failure of a system or technology in a way that was never anticipated or deemed impossible—similar to the BP oil disaster. The recent experience of Virginians with hurricanes, flooding, and earthquakes as well as the shared experience of all Americans with the tragedy of the oil spill in the Gulf of Mexico and the explosion at the Upper Big Branch mine in West Virginia urges humility about what can realistically be anticipated: the risk of an extreme event can never be eliminated and simple negligence can undermined even the best systems and technologies.

The IAEA recommends that “adaptive management” practices can help mitigate these risks. This involves the continuous updating and reassessment of business practices and mining techniques and technologies in light of environmental and socioeconomic performance, and technological change; it also includes the updating of environmental, weather, and engineering-design risk models.²⁶¹ In normal times these adaptive systems serve to refine and track performance of the operation with regard to health, safety, and environmental standards, but adaptive management practices can also be used to periodically re-think the risks the operation faces by extreme natural phenomenon.²⁶² This iterative philosophy, which strives to continuously improve and refine business systems, also enables mining companies to regularly address the concerns of community and adapt their mining and milling practices accordingly.

A useful method to determine public confidence in a company is to first look at its past track record, which provides a reasonable baseline to formulate assumptions for projecting future operating outcomes. While VUI has no track record to evaluate and Sprott Resources Corporation does not typically operate mines, the other significant minority shareholder, Denison Mines Incorporated, has been operating in the uranium mines and mills for many years. Chmura would characterize Denison's stewardship of the environment as “acceptable” and its uranium mining and milling operations conform to applicable laws and standards. Some adjudication of permit violations by Denison Mines Corporation has occurred in recent years in Arizona,^{263 264} although industry experts relate that adjudication and interpretive disputes regarding the parameters of permits is not unusual, and that these disputes have been resolved to the satisfaction of state and federal authorities. Additionally, the Mine Safety and Health Administration required Denison to change several safety procedures and protocols in 2008 and 2009 due to numerous potential

²⁶⁰ “Best Practice in Environmental Management of Uranium Mining” IAEA Technical Report # NF-T-1.2; 2010.

²⁶¹ “Best Practice in Environmental Management of Uranium Mining” IAEA Technical Report # NF-T-1.2; 2010.

²⁶² “Best Practice in Environmental Management of Uranium Mining” IAEA Technical Report # NF-T-1.2; 2010.

²⁶³ “State of Utah Ground Water Discharge Permit No. UGW370004 White Mesa Uranium Mill - Notice Pursuant to Part I.G.3 of the Permit and UAC R317-6-6.16(C)” Denison Mines Corporation, 2010.

²⁶⁴ “Denison Mines (USA) Corporation CLASS II Air Quality Permit Numbers 51803, 52790, and 52522 for the Pinenut, EZ, and Canyon Mines, Respectively and General Aquifer Protection Permit Number P-106193 for the EZ Mine Responsiveness Summary to Public Comments” Arizona Department of Environmental Quality, 2010.

mine safety violations.²⁶⁵ Additional detail on Denison’s existing uranium operations can be found in the appendix Section A7.

8.3. Public Confidence in the Ability of Government to Uphold Proper Regulations

If there is skepticism that VUI will be able to operate a uranium mine and mill in such a way as to ensure the safety of public health and the environment, there is an equal if not greater amount of skepticism that governmental agencies at either the federal or state level will be able to ensure public health and environment via regulation and monitoring. Chmura found a broad spectrum of stakeholders that were skeptical of the efficacy of additional regulations to balance the risks posed to public health and the environment by the uranium industry. There was a slight preference among most stakeholders that local oversight—whether it be from local authorities over state authorities, or state oversight over federal oversight—was preferable, but Chmura found a high degree of cynicism as to the ability of government to mitigate any potential negative impacts.

Chmura judges that this cynicism and skepticism of government is a result of a myriad of local and international events that have exposed government and industry efforts to protect society from natural and man-made disasters as inadequate. From hurricane Katrina to the Fukushima disaster, from the Upper Big Branch explosion to the trapped Chilean copper miners, and from the internet stock bubble to the sub-prime mortgage crisis, industry and governmental contingency plans and preventative measures have either been inadequate or circumvented so as to negate their protective properties to the detriment of the general public.

Throughout Chmura’s research, one concern that was expressed time and time again was that the existing safeguards, standards, and regulations that are designed to protect public health, worker safety, and the environment will be “watered down” by an overly cozy relationship between the uranium industry and those charged to both monitor it and protect the broader public and environment. Similarly, problems at the Nuclear Regulatory Commission (NRC) are well known,²⁶⁶ and many environmental groups and other skeptics have indicated that these problems could further undermine credible efforts to regulate the industry.

8.3.1. Global Events Over the Past 18-Month Period

Global events over the past 18 months have damaged public perception of governments and companies, based on the handling of these events:

- the April 5, 2010 Massey Coal disaster in West Virginia
- the April 20, 2010 BP oil spill in the Gulf of Mexico
- the August 5, 2010 mine collapse that trapped 33 Chilean miners for two months
- the March 11, 2011 Japanese nuclear disaster following the tsunami and earthquake
- the June 20, 2011 Missouri floodwaters breach berms at Nebraska nuclear plants

²⁶⁵ “Denison Mines (USA) Corporation CLASS II Air Quality Permit Numbers 51803, 52790, and 52522 for the Pinenut, EZ, and Canyon Mines, Respectively and General Aquifer Protection Permit Number P-106193 for the EZ Mine Responsiveness Summary to Public Comments” Arizona Department of Environmental Quality; 2010.

²⁶⁶ “Inspector General’s Assessment of the Most Serious Management and Performance Challenges Facing NRC” OIG, October 2010.

- the June 27, 2011 wildfire (125 square miles) that came within 3.5 miles of Los Alamos National Laboratory
- the August 23, 2011 magnitude 5.8 earthquake near Mineral, Virginia
- the August 27, 2011 category 1 Hurricane Irene hits 1,000 mile Atlantic coast swath

For example, eighty-one percent of respondents of a survey by Fuji Television Network said they did not trust government information on the crisis at the tsunami-hit Fukushima Daiichi nuclear plant. This poll was conducted May 28-29 and had 1,000 responses. Nearly 85 percent of respondents said the utility that operates the plant is dealing with the crisis poorly. No margin of error was given, but a poll of that size would normally have a margin of error of 4 percentage points. The survey's results were released May 30, 2011.²⁶⁷

What do Americans think?²⁶⁸ There are no shortages of public opinion polls – following the Japanese nuclear disaster – that measure public attitudes toward the energy sector and the ability of the U.S. government to regulate this industry. Chmura randomly selected 18 polls from varied and respected sources (this data appears in the appendix see Section A8.10). In summary, not a single poll following the Japanese nuclear disaster shows that Americans generally have soured on both the federal government and large energy companies, as well as the nuclear industry. However, these attitudes are not static and public confidence in the ability of government to regulate the energy sector may rebound.

The Disaster Cluster and Public Perception

Public perception regarding preferences for future energy sources has been shaped by an almost unbelievable, ironically-timed, disaster cluster involving three major events:

- Massey Energy's Upper Big Branch coal mining disaster occurred on April 5, 2010. There were 29 miners killed, potential criminal charges are pending, and the company was purchased by Alpha Natural Resources on June 1, 2011.²⁶⁹
- BP's Deepwater Horizon oil disaster in the Gulf of Mexico occurred on April 20, 2010. There were 11 rig workers killed, potential criminal charges are pending, BP's CEO was terminated, and still yet there are potential long-term unknown costs to the environment, workers, landowners, and shareholders.²⁷⁰
- Tokyo Electric Power Company's (TEPCO) nuclear disaster at Fukushima occurred on March 11, 2011. There were 3 workers killed, 21 workers who experienced radiation doses five times the annual allowable amount, and it may be years before the full effects to plants, animals, people, and sea-life are fully known.²⁷¹

In the time of a little less than one year (April 5, 2010 to March 11, 2011), public and political perception has intensified even higher against coal, oil, and nuclear energy.

²⁶⁷ Please see: <http://m.usatoday.com/article/news/47785944>

²⁶⁸ Please see: <http://www.pollingreport.com/energy.htm>

²⁶⁹ Please see: <http://www.winchesternewsgazette.com/articles/2011/07/27/news/doc4d1cf90b54c5d131324580.txt>

²⁷⁰ Please see: <http://www.cnn.com/2011/US/04/20/oil.spill.year.later/index.html>

²⁷¹ Please see: http://www.world-nuclear-news.org/RS_Deaths_confirmed_at_Fukushima_Daiichi_0304111.html

8.3.2. Public Confidence in Government to Enforce Stringent Health and Environmental Standards

It is a valid question to ask if problems relating to conflicts of interest could arise as government agencies and regulators attempt to regulate and monitor the industry. In an article entitled, “Building Public Confidence in the Government-Industry Relationship,” by Howard Schweitzer,²⁷² he points out “that public concern that light regulation contributed to the (BP oil spill) accident,” and that “allegations by the Inspector General at DOI regarding ethical lapses at the Minerals Management Service has exacerbated concerns about the Government-industry relationship.”²⁷³ The article centers on the question that “given the interconnectedness between industry and government, how can the industry protect its interests while helping to build public confidence in the industry-government relationship?” Not surprisingly, the remainder of the article speaks to the importance of ethics rules, lobbying behavior, employee gifts, perceptions and appearances, and top leaders setting the proper example.²⁷⁴

This sentiment was echoed by many stakeholders in Virginia with regard to the potential for the Commonwealth to take on the responsibility of regulating the uranium industry in Virginia. Bob Burnley, director of the Virginia Department of Environmental Quality from 2002 to 2006, wrote an article entitled, “How Will Virginia Regulate Uranium Mining?” On the subject of regulation, he states in part:

The regulatory landscape for uranium mining and milling operations is complex and invokes both federal and state authority across the entire matrix of legal constructs for environmental protection. Mining operations would fall under Virginia regulatory authority. The regulation of the milling process—whereby uranium ore is milled into yellowcake—is regulated largely under federal authority. The Nuclear Regulatory Commission is charged with enforcing milling regulations. However, states can apply to become ‘agreement states,’ whereby the commission delegates day-to-day enforcement, management, and monitoring of milling sites to state regulators. In Virginia’s case, the delegation would be to the Department of Mines, Minerals, and Energy. Should the moratorium be lifted, evidence is strong that Virginia will become an agreement state, taking over all aspects of uranium mining, milling, and hazardous waste disposal from the federal government. Virginia is already a ‘partial agreement state’ in regard to source material and all by-product materials except uranium mill tailings.

In his article, he goes on to address the question “How Well Will Virginia Regulate Uranium Mining?” by stating, in part:

A marginal effort to control an extremely serious threat to the health of Virginians and Virginia’s environment will benefit no one. The decision makers and political leaders want economic success, and that often translates into fewer regulations, a less burdensome regulatory climate, and low environmental protection costs. Unhealthy tension and competition between business and environmental protection does not promote either. Without a serious commitment to human health and environmental protection, the mining and processing of uranium is potentially disastrous. It remains to be seen whether environmental protection funding, historical weather

²⁷² Originally published in “Corporate Compliance Insights” on October 6, 2010.

²⁷³ “Corporate Compliance Insights” on October 6, 2010.

²⁷⁴ “Corporate Compliance Insights” on October 6, 2010.

patterns that are inconsistent with safe mining, risks to existing business interests, the size of the potentially effected population, and the numerous local, regional, and statewide environmental issues will get the same consideration as the promised economic benefits.

The Burnley article argues that if state and local authorities are going to allow uranium mining and milling in Virginia, then regulatory aspects must be accomplished in an unbiased manner. Additionally, in order to properly regulate the uranium industry, budgets will have to be raised, additional people will have to be hired, and both an interagency coordinating body and a regulatory program will need to be established. Uranium mining and milling is intended to be highly regulated, overseen by a number of different federal (and state) agencies, and guided by a number of federal and state regulations. Natural tension between the private sector and the government (federal, state, and local) will undoubtedly complicate enforcement and compliance.

Effective regulation requires regular and uncompromising inspections and unbiased, arms-length management of the industry. Additionally, public scrutiny and periodic third-party review will ensure that over time standards are not allowed to lapse and public health and environmental considerations are balanced against industry motives to increase profits. Rotating mine inspectors, independent review of test results, unannounced site inspections, and establishing standing bodies—such as the EQCs described in section 8.2—where local stakeholders can voice concerns and impact business practices and regulation development of the uranium mining industry—while costly—should increase public confidence in the federal, state, and local governmental agencies' ability to effectively regulate the uranium industry in Virginia.

8.4. Impact on Private Schools and Local Institutions

Overall, in the baseline scenario, the impact on private schools and local institutions is likely to be minimal. This impact on both the private and public schools was addressed in detail in Sections 5.8 and 6.3, respectively. Similarly, the impact on key public services was addressed in detail in Section 6.2. In addition to Chatham Hall, Chmura solicited the views of more than half a dozen other private schools located in Pittsylvania County and the surrounding areas. Only one school (located outside of Pittsylvania County) registered concerns with the prospect of uranium mining and milling operations in Pittsylvania County. These concerns were related to the public health and environmental risks that have been historically associated with the uranium industry, and the school generally felt the introduction of the mining and milling operations would be bad for the tourism and housing sectors of the economy.

8.5. Impacts on Aesthetics and Overall Quality of Life

In this report Chmura has analyzed the impact of the Coles Hill uranium mining and milling operation on public health (Section 7.1), the environment (Sections 7.1 & 7.2), the natural landscape and soundscape (Section 7.3), tourism (Section 5.8.3), hunting and fishing (Section 7.3.3), housing values (Section 5.6), public services and infrastructure (Section 6.2), and the overall image of the region (Section 8.1). Under the baseline scenario these impacts could reasonably be characterized as minimal. Indeed, as Chmura found in assessing quality of life from a health perspective, the health, safety, risk profile, and environment of the area were not substantially altered by the presence of a uranium mine and mill (Section 7.2)—given the baseline assumptions. Other aspects of quality of life were completely unaffected—freedom, cost of living, and climate—while some were boosted, such as some infrastructure and the economy.

The introduction, however, of any venture of this size and scope will induce change. For a period of time—even years—residents in and around Chatham will need to broadly adapt their lives to the increases in traffic and noise,

and to the presence of uranium mine and milling operations. For the vast majority of people, and the vast majority of aspects of everyday life, Chmura judges this impact will be minimal, but for some individuals highly accustomed to life in Pittsylvania County devoid of mining and milling operation, this transition could be jarring.

8.5.1. Impact on Aesthetics

As was discussed in Section 7.3.2 the presence of a uranium mine and mill will distort the natural landscape of the area immediately around the Coles Hill site. The largely undisturbed bucolic setting in the area of Coles Hill will be lost for a generation or more. However, most of the town of Chatham and nearly all of Pittsylvania County should see little, if any, impact on the overall attractiveness of the gentle rolling hills that defines much of the landscape. Given the potential for the influx of tax revenue to both local and state coffers (see Section 5.7 and 6.7.2), the town of Chatham (as the county seat) might see its urban areas beautified moderately during the period of the mine and mill’s operation.

8.5.2. Impact on Traffic Volume

We do not have enough information from the Scoping Study regarding potential trips into and out of the Coles Hill site to form the basis of a full traffic study, but the construction and operation of the mine and mill will unambiguously increase the traffic volume along several roads in and around the Coles Hill site. However, because the roads likely to be utilized by workers and suppliers have accident rates that are relatively small—and the fatality rate from car accidents is miniscule—the presence of the uranium mine and mill is unlikely to result in a significant number of additional traffic accidents. Given the established accident rates for Virginia, Chmura judges that less than twenty accidents a year—less than 10 resulting in an injury—are likely to be registered because of the additional traffic attributable to the mine and mill operation. Given the current fatality rates for the roads in and around Chatham, the area might experience one traffic fatality once every six to ten years due to the additional traffic volume attributed to the Coles Hill operation. Various estimates for accidents—assuming differing levels of traffic volume—are shown in the table below.

Table 8.1: Traffic Accident Projections

Additional Volume: Millions of Vehicle Miles per Year	Expected # Accidents per Year	Expected # Injuries per Year	Expected # Fatalities per Year	
1	3.6	1.8	0.0	
2	7.1	3.5	0.1	
3	10.7	5.3	0.1	
4	14.3	7.1	0.1	
5	17.9	8.9	0.2	
Road Segment	Road Type	VA Accident Rate per Million Vehicle Miles	VA Injury Rate per Million Vehicle Miles	VA Fatalites per Million Vehicle Miles
County Road 690 & 685	secondary road	2.04	0.99	0.019
Route 29 (controlled access)	4-lane divided highway	0.5	0.23	0.008
Route 29 (uncontrolled access)	4-lane divided highway	1.03	0.55	0.009

Source: Virginia Department of Transportation.

9. Summary and Conclusion

This study has laid out a comprehensive socioeconomic impact of a potential uranium mining and milling operation in Pittsylvania County, Virginia. Chmura has utilized four distinct scenarios to provide a context for assessing the magnitude of the costs associated with different levels of environmental contamination vis-à-vis public health, property values, remediation efforts, regulatory costs, and the impact on other industries and neighboring communities. Under the baseline scenario—a set of circumstances Chmura judges to be the most likely to occur—the industry brings substantial economic benefits to the region and the costs and risks to region’s image, public health, and environment are modest. The Coles Hill uranium operation would bring net benefits to Virginia in all its phases—construction, operations, and decommissioning. Most crucially, during the peak 35 years of active production, operations will support annually over 1,000 jobs, provide more than \$136 million annually in net-economic benefit, and generate more than \$3 million in additional state and local taxes. The majority of these jobs would benefit the residents in Pittsylvania County and surrounding areas. In the initial construction phase the operation would support more than 320 jobs, with more than 75 percent of these jobs going to citizens in the Pittsylvania County and surrounding areas.

Even after allowing for a much reduced price of uranium (an average price of \$45 per pound of yellowcake), the industry would still provide a substantial economic benefit to Virginia. Under this low-price scenario, the industry would yield \$90 million annually in net economic benefit and support close to 700 jobs at its peak employment. The industry would also generate at least \$1.7 million in additional state and local tax revenue, but this tax revenue would be unlikely to be large enough to offset the costs of regulating the industry. If the price of uranium moved higher than the baseline estimate (an average price of \$75 per pound of yellowcake), then the economic benefits would be about 23 percent higher than in the baseline estimate, and state and local tax revenue would be increased to \$4.3 million annually. The economic impact of these alternative price scenarios are addressed in detail in the appendix (see Sections A4, A5, and A6).

A key finding is that it is not the direct remediation and reclamation costs that drive the net negative economic impact in scenario 4. The greatest socioeconomic costs in both scenario 3 and 4 are driven by the potential stigma effects on agriculture, tourism, the closure of a private school, and in scenario 4 the closure of a large manufacturer. It is worth emphasizing while these negative stigma effects are certainly possible (given our assumptions), mitigating or reducing these stigma effects may be possible.

We have summarized a comprehensive list of the expected benefits and costs associated with each of the price scenarios in the figures and table below:

Summary Socioeconomic Benefit (Peak Year Impact)

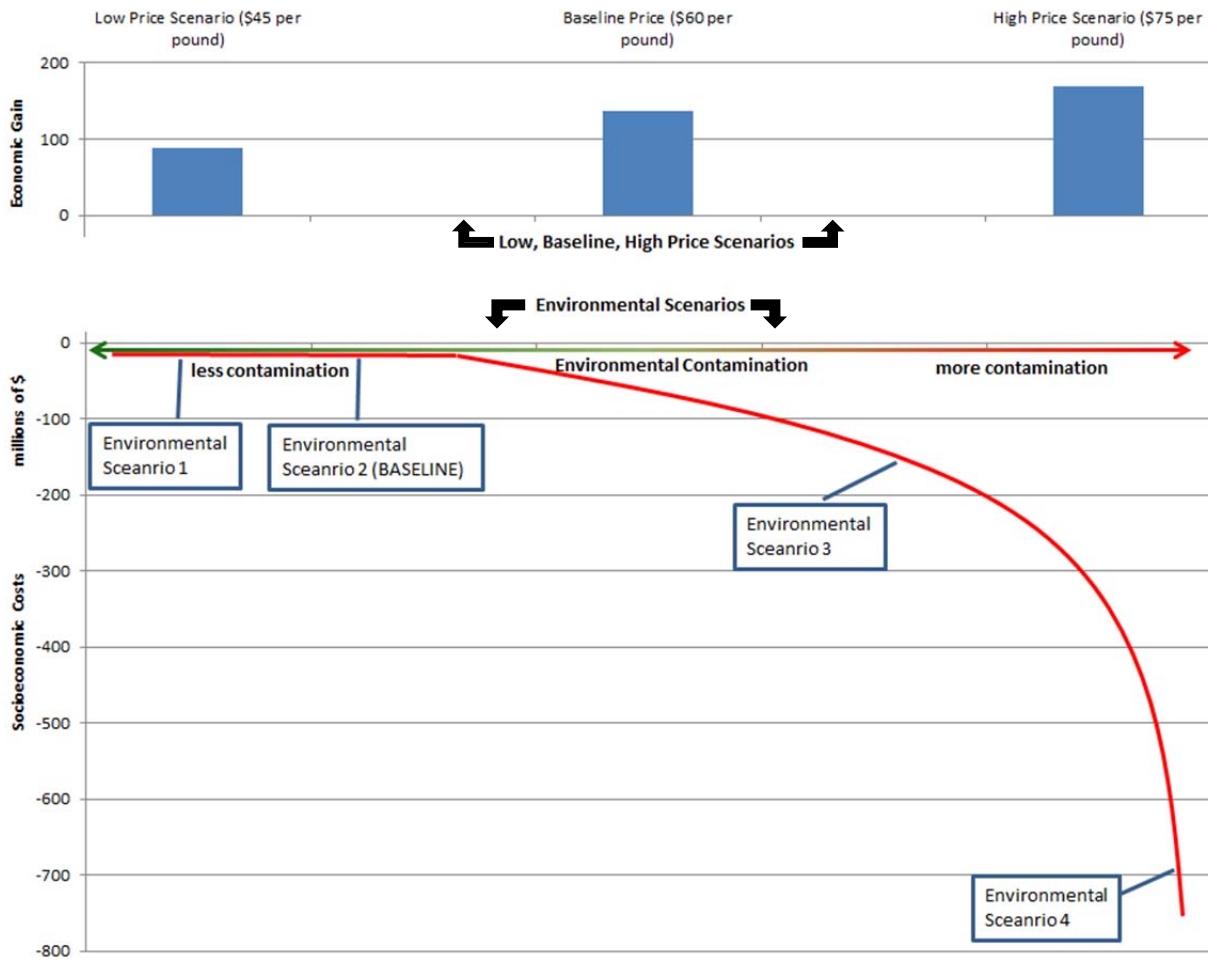
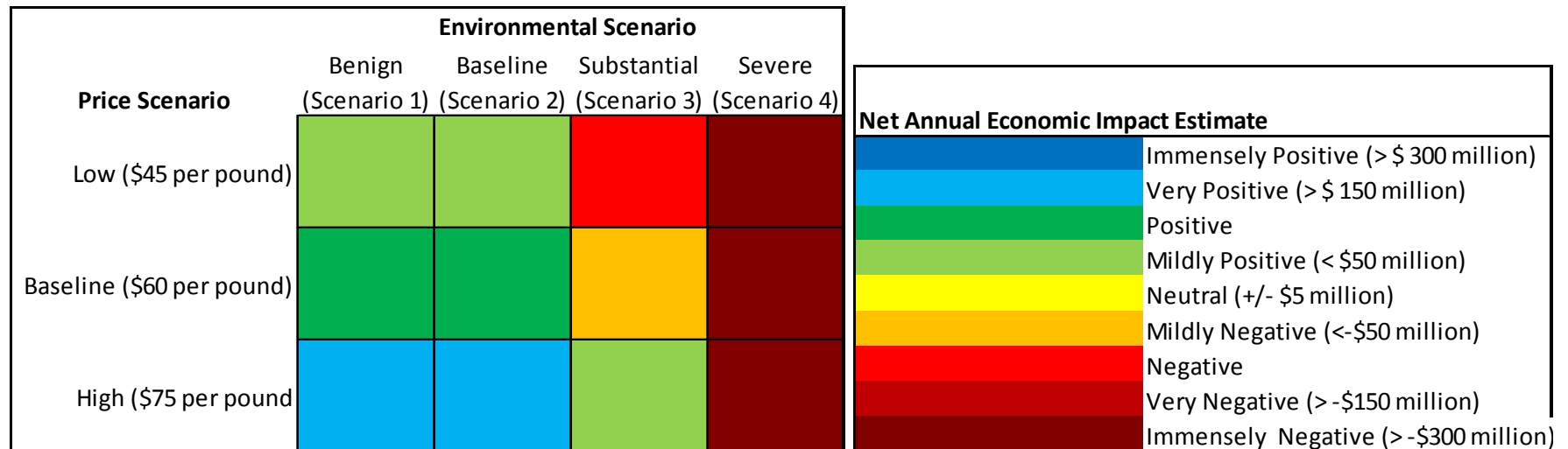


Table 9.1: Summary of Employment, Economic and Fiscal Impacts for the Commonwealth of Virginia

Price Scenario	Jobs		Economic Impact (Annual)											Fiscal Impact (Annual)				
	# of Jobs (Construction Phase)	# of Jobs (Mine & Mill Operational Phase)	Uranium Industry Economic Impact to VA	Infrastructure Upgrades	Private Schools	Other Manufacturing	Tourism	Agriculture	Reduced Property Values	Public Health Costs	Emergency Preparation Planning	Costs to Other Neighboring Communities	Remediation Costs to State & Federal Govt.	Net Economic Impact to VA	State & Local Taxes Generated	Lost Property Tax Revenue	Uranium Industry Regulation Costs	Net Tax Benefit to VA
Baseline Environmental Scenario (price of uranium = \$45 per pound)	323	694	88.5	0.29	0	0	0	0	(1.89)	0	0	0	0	86.90	1.8	(0.01)	(2.50)	(0.74)
Baseline Environmental Scenario (price of uranium = \$60 per pound)	323	1052	136.6	0.29	0	0	0	0	(1.89)	0	0	0	0	135.00	3.1	(0.01)	(2.50)	0.59
Baseline Environmental Scenario (price of uranium = \$75 per pound)	323	1052	168.9	0.29	0	0	0	0	(1.89)	0	0	0	0	167.30	4.3	(0.01)	(2.50)	1.79
	average annual	average annual	millions of \$	millions of \$	millions of \$	millions of \$	millions of \$	millions of \$	millions of \$	millions of \$	millions of \$	millions of \$	millions of \$	millions of \$	millions of \$	millions of \$	millions of \$	millions of \$

Figure 9.1: Annual Net Economic Value under different Environmental Scenarios



However, Chmura's analysis also suggests that the risks are not proportionally distributed and even under the most benign environmental scenario, the benefits to Virginia are only slightly greater than under the baseline scenario. The benefits of the industry drop considerably if environmental contamination exceeds federal guidelines; in a worst-case scenario the industry could present a substantial net cost to Virginia. This is visually depicted in Figure 9.1. For instance, from the time environmental contamination reaches the levels assumed in scenario 3 (see Section 3.3. for description), the negative stigma effects increase, and the annual economic value to Virginia would for a time be slightly negative. Virginia would temporarily lose jobs overall after accounting for employment declines in the agriculture and tourism sectors, and the net tax revenue to the state would also be negative. However, assuming this level of contamination would take years to develop, the accrued benefits of mining and milling operations may still outweigh the costs and after the contamination is cleaned-up Chmura would expect agriculture and tourism to gradually recover. Should environmental contamination become severe, as in scenario 4, the industry induces a net cost to Virginia well in excess of \$300 million per year mostly as a result of the negative stigma effect on other industries—agriculture, tourism, and other large manufacturers. These alternate scenarios are addressed in greater detail in the appendix.

Virginians, of all backgrounds, socioeconomic status, and age, hold their environment, health, and general well-being in the highest regard. It is no surprise then that Chmura found the Virginians residing in the area of Pittsylvania County to be no exception. After every interaction with these citizens Chmura came away ever more impressed with their character, intelligence, and determination to ensure their region made an informed decision on whether to allow uranium mining and milling in their area. Chmura judges that roughly half of the economic benefits that will accrue from the Coles Hill operation will be captured solely by the residents of Pittsylvania County. Even more important, the residents of this region will most likely bear the preponderance of the environmental and health risks posed by the Coles Hill site. While it is in the realm of possibility that Halifax and Virginia Beach could be negatively impacted by an extremely low-probability occurrence, it is certain that residents of Pittsylvania County will be impacted, both positively and negatively, by the Coles Hill operation. It is likely, that those most affected will be the residents in the nearby towns of Gretna and Chatham.

Appendix: Alternative Economic Impact Scenarios

A1. Alternative Scenario: Open-Pit Mining

This section provides an estimate of the potential economic impact should the open-pit mining method, rather than the underground mining method, were chosen. Changing from underground mining to open-pit mining will result in three major differences that will alter the economic impact of the uranium mining operation in southern Virginia.

1. Capital expenditure. Open-pit mining may have different capital expenditure. However, discussions with Virginia Uranium indicated that the differences in capital expenditures between the two methods were not significant. Since a complete capital expenditure is not available in the Scoping Study for the open-pit method, Chmura has assumed the same total amount of capital expenditures for both methods.
2. While the unit cost for milling operations will not be altered, the mining operations will be affected significantly. The mining cost per ton for open-pit mining is lower than that for underground mining. Assuming the same total production level and schedule, however, the utilization of open-pit mining will not affect total revenues of the company. Open-pit mining will result in a more evenly distributed uranium ore production over the years, and there would be no sharp drop in production toward the end of the life of the mine.
3. Reclamation costs of open-pit mining are likely to be higher, as not only tailings impoundment cells but the open-pit mining site needs to be reclaimed either by filling it with dirt or water. It is estimated that the reclamation cost can increase by 50 percent under the open-pit mining scenario, particularly if the company is required to utilize dirt to fill the mine pit rather than transform it into a lake.²⁷⁵

A1.1. Spending and Economic Impact of Capital Spending

Under the open-pit mining method, total capital spending of the project will total \$315.4 million over the life of the mine (LOM), the same as in the baseline scenario that models the impact of the underground method. This amount includes not only the initial capital spending to construct the mining and milling facilities, but also the continuous capital spending during the operational phases of the mine and mill. Of the total LOM capital spending of \$315.4 million, 61 percent will be used to purchase the mining and milling equipment, 33 percent is planned for building milling and tailings structures, while the rest of the money is for development of the site and to pay for various permits. The capital spending amount was entered into the IMPLAN model to estimate both the job creation and the ripple economic effects of the construction activities in both the Chatham Labor Shed and the state of Virginia.

Table A1.1 details the estimated economic impact from the capital spending portion of the project. During the life of the mine, it is estimated that capital spending of the project will generate a total economic impact (including direct, indirect, and induced effects) of \$166.8 million in the Chatham Labor Shed, which can support 1,756 jobs. Among the total economic impact, \$120.3 million will be direct spending within the labor shed, with direct jobs amounting to 1,299 during the life of the mine. The indirect impact in the labor shed will total \$18.9 million and support 178 jobs during the life of the mine in industries supporting construction. The induced impacts in the labor shed during the life of the mine are expected to be \$27.6 million with 279 jobs created, mostly concentrated in consumer service-related industries.

²⁷⁵ "Coles Hill Uranium Project Scoping Study and Cost Estimate" (appendix K) Lyntek & BRS, October 2010.

On an annual average basis, during the life of the mine, the total economic impact of capital spending will be \$4.5 million per year that can support 47 annual jobs in the Chatham Labor Shed. However, since the majority of the capital spending will be concentrated in the initial three years of the project, the annual economic impact during the initial three years will be much higher than in the ensuing years. The total annual impacts during the initial three years can reach \$25.2 million per year, supporting 247 jobs in the labor shed.

Table A1.1: Economic Impact of Capital Spending: Open-Pit Method

		Direct	Indirect	Induced	Total
Annual Average (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$3.3	\$0.5	\$0.7	\$4.5
	Employment	35	5	8	47
State of Virginia	Spending (\$ Million)	\$3.8	\$1.2	\$1.6	\$6.6
	Employment	37	8	14	59
Annual Average (Initial 3 years)					
Chatham Labor Shed	Spending (\$ Million)	\$17.9	\$3.4	\$3.9	\$25.2
	Employment	176	32	40	247
State of Virginia	Spending (\$ Million)	\$22.5	\$7.7	\$8.7	\$38.9
	Employment	189	54	80	323
Total (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$120.3	\$18.9	\$27.6	\$166.8
	Employment	1,299	178	279	1,756
State of Virginia	Spending (\$ Million)	\$142.3	\$43.0	\$57.8	\$243.0
	Employment	1,357	302	532	2,192

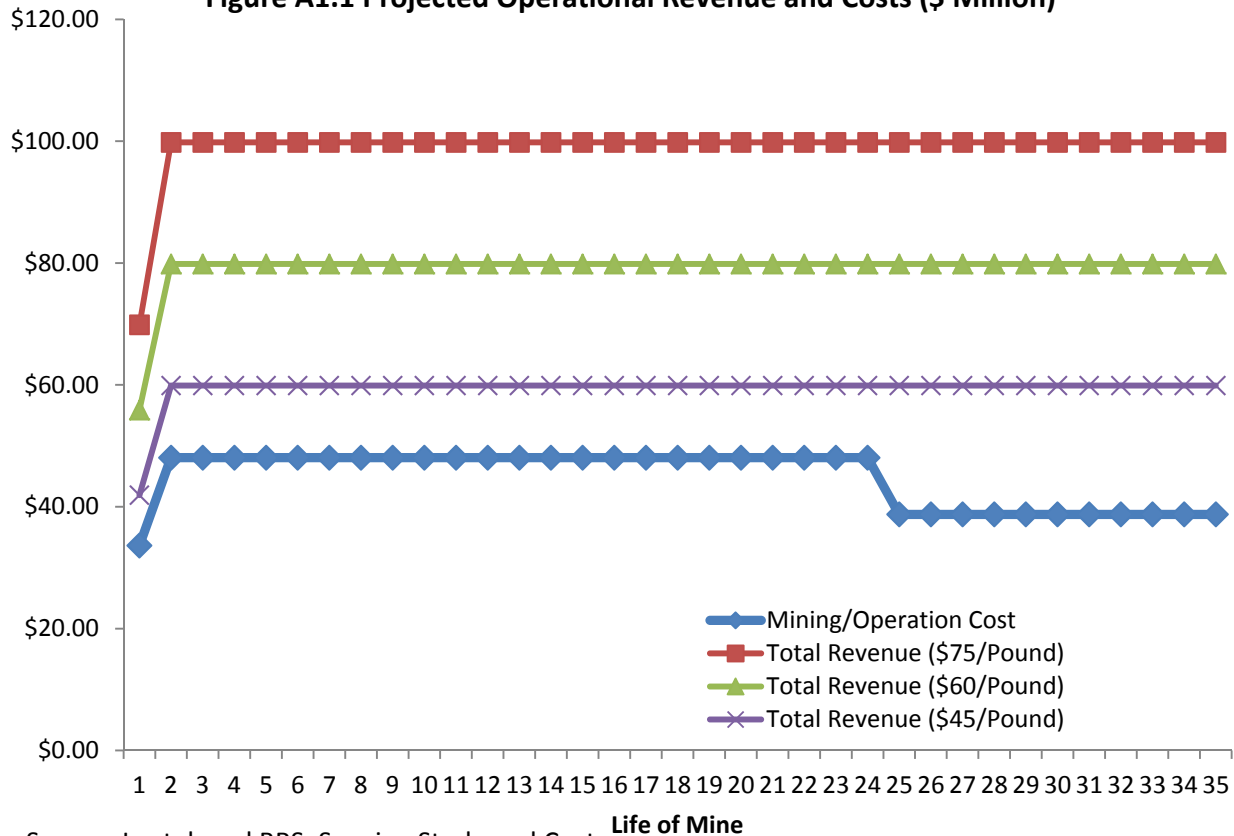
Source: Chmura Economics & Analytics and IMPLAN Pro 2009 (some numbers may not total exactly due to rounding)

The economic impact of the capital spending in Virginia is larger than that in the Chatham Labor Shed, as more businesses outside the labor shed also can benefit from capital spending. During the life of the mine, it is estimated that the capital expenditures will generate a total impact of \$243.0 million in spending and 2,192 jobs in Virginia. On an annual average basis, the total economic impacts of the capital expenditures are estimated to be \$6.6 million and 59 jobs per year for the Commonwealth of Virginia. During the initial three years of the mine, the economic impact of the capital spending portion of the project is estimated to average \$38.9 million in spending and to support 323 jobs in Virginia. Not surprisingly, these estimates for both economic impact and job creation for the capital expenditure portion of the project are the same as the baseline scenario which models the impact of the underground mining method.

A1.2. Economic Impact of Mining and Milling Operations

The total revenue of the mining and milling operations will depend largely on the average price the U₃O₈ per pound will realize VUI in its sales of yellowcake. Utilizing a price of \$60 per pound, the annual revenue can reach \$79.8 million from years 2 to 35. Under the price of \$75 and \$45 per pound, holding production levels constant, the total revenues will be \$99.8 million and \$59.9 million, respectively, per year from years 2 to 35. The analysis in the remainder of this Appendix is based on the baseline price of \$60 per pound.

Figure A1.1 Projected Operational Revenue and Costs (\$ Million)



Source: Lyntek and BRS, Scoping Study and Cost

The milling costs per ton are assumed to be the same as for underground mining. However, the unit mining costs for open-pit mining are 14 percent lower than the costs of underground mining. This is because excavation of an open pit is both easier and less involved than mining underground. The overall mining and milling cost is \$24.4 per ton for open-pit mining, as compared with \$28.6 per ton for underground mining. Since the southern site has more mineral deposits, it is assumed that mining will start in the southern deposit before moving to the northern deposit. The larger deposits of uranium in the south pit also means that the expense of open-pit mining will be higher than for the north pit. Additionally, both primary stoping and pillar extraction methods are unique to underground mining; conversely, the production levels for open-pit mining would be consistent over the life of mine.

The cost savings from the open-pit method are likely to occur from the reduced need of equipment purchases, rather than from the reduced need of labor. Therefore, it is assumed that for open-pit mining operations, the number of workers would be equal to that of the underground method. For the milling operation, the staffing pattern analyzed in Section 5.3 is based on the milling capacity of 3,000 tons per day. In the open-pit method, the daily processing capacity is estimated to be about 74 percent of peak underground milling capacity. Using the baseline scenario, Chmura assumes the labor needed for the open-pit milling operation will be about 74% of the underground milling labor needed for processing the peak amount of uranium ore.

Comparing both total revenues and total operational costs, revenues exceed operational costs for every year during the life of the mine when the price of the uranium is \$45, \$60, or \$75 per pound. This is different from the result of

modeling different uranium price points in the baseline scenario, which assumes the mining method is underground. In the baseline scenario, if the price of uranium is \$45 per pound, the operational costs will exceed the revenues in the “pillar extraction” phase of the life of the mine. When assuming the open-pit mining method, the breakeven price is roughly \$35.5 per pound. Therefore, when implementing an open-pit method of ore extraction, it becomes less likely that the Coles Hill site will be temporarily idled due to a low uranium price and more likely that the mine will operate for the full projection of 35 years. This assumes, however, the remediation efforts will utilize water to refill the open-pit mine rather than dirt. Because of the stable production throughout the life of the mine (particularly in the final 15 years of production), the average annual employment (in the baseline scenario) from the operational phase is essentially the same—298 for open-pit versus 297 for underground—even though the mill will require approximately 26 less workers per year.

Table A1.2 details the estimated economic impact of the mining and milling operations under the open-pit method. On an annual average basis, during the life of mine, it is estimated that the mining and milling operations will generate a total economic impact (including direct, indirect, and induced effects) of \$102.3 million for the Chatham Labor Shed, which can support 504 jobs in the region. Among the total economic impact, \$79.2 million will be from direct spending within the labor shed and support 298 direct jobs per year during the life of the mine. The indirect impact in the labor shed will total \$6.8 million and support 42 jobs during the life of the mine primarily in the industries supporting the mining and milling operations, such as utilities and trucking. The induced impact in the labor shed during the life of the mine is expected to be \$16.4 million and support of 164 jobs largely concentrated in consumer service-related industries.

Table A1.2: Annual Impact of Uranium Mining and Milling Operation: Open-Pit Method

		Direct	Indirect	Induced	Total
Annual Average (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$79.2	\$6.8	\$16.4	\$102.3
	Employment	298	42	164	504
State of Virginia	Spending (\$ Million)	\$79.2	\$26.5	\$29.9	\$135.6
	Employment	298	336	390	1,025
Total (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$2,770.5	\$238.2	\$572.3	\$3,581.0
	Employment	10,445	1,453	5,725	17,624
State of Virginia	Spending (\$ Million)	\$2,770.5	\$926.0	\$1,048.0	\$4,744.5
	Employment	10,445	11,757	13,657	35,859

Source: Chmura Economics & Analytics and IMPLAN Pro 2009 (some numbers may not total exactly due to rounding)

The economic impact of the mining and milling operations in the Commonwealth of Virginia will be larger than the impact to the Chatham Labor Shed, as more businesses outside the labor shed will also benefit from the mining and milling operations. During the life of the mine, it is estimated that the mining and milling operations will generate an annual total impact of \$135.6 million in spending and 1,025 jobs in Virginia. This economic impact relating to the operational portion of the mine and mill is only slightly less than in the baseline scenario—less than a one percent difference in terms of the overall economic impact and about 3 percent less in terms of jobs.

A1.3. Spending and Employment Impact of Reclamation

The reclamation costs for the underground mine are estimated to be \$14.9 million over the life of the mine. Reclamation costs related to the open-pit mining method will be higher than in the underground mining method baseline scenario. In addition to reclaiming tailings impoundment cells, the mining pit itself will need to be reclaimed by filling it with either dirt or water. It is estimated that the reclamation cost can increase by 50 percent under open-pit mining as a result of utilizing dirt to fill the mine pit—which Chmura will assume to be the case.²⁷⁶ As a result, the total reclamation spending of the open-pit method is estimated to be \$22.4 million over the life of the mine, measured in nominal dollars, or a 50 percent increase in reclamation spending over the baseline scenario.

Table A1.3 details the estimated economic impact of the reclamation spending. During the life of the mine, it is estimated that the reclamation spending will generate a total economic impact (including direct, indirect, and induced effects) of \$24.5 million in the Chatham Labor Shed, which can support 275 jobs over the life of the mine. Of the total economic impact, \$17.3 million will be from direct spending within the labor shed and the support of 200 direct jobs during the life of the mine. The indirect impact in the labor shed will total \$3.1 million and support 33 jobs during the life of the mine, and the induced impact in the labor shed during the life of the mine is expected to be \$4.1 million supporting 42 jobs largely concentrated in consumer service-related industries.

Table A1.3: Economic Impact of Reclamation: Open-Pit Mining Method

		Direct	Indirect	Induced	Total
Annual Average (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$0.5	\$0.1	\$0.1	\$0.7
	Employment	5	1	1	7
State of Virginia	Spending (\$ Million)	\$0.6	\$0.2	\$0.3	\$1.0
	Employment	7	2	2	11
Total (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$17.3	\$3.1	\$4.1	\$24.5
	Employment	200	33	42	275
State of Virginia	Spending (\$ Million)	\$21.4	\$6.8	\$9.7	\$38.0
	Employment	248	57	91	397

Source: Chmura Economics & Analytics and IMPLAN Pro 2009 (some numbers may not total exactly due to rounding)

The economic impact of the reclamation spending in Virginia is larger than that of the Chatham Labor Shed, as more businesses outside the labor shed will also benefit from the reclamation spending. During the life of the mine, it is estimated that the reclamation spending will generate a total impact of \$38.0 million in spending and support 397 jobs in Virginia. This represents an approximate 50 percent increase in both the overall economic impact and the number of jobs stemming from reclamation efforts, compared to the baseline scenario.

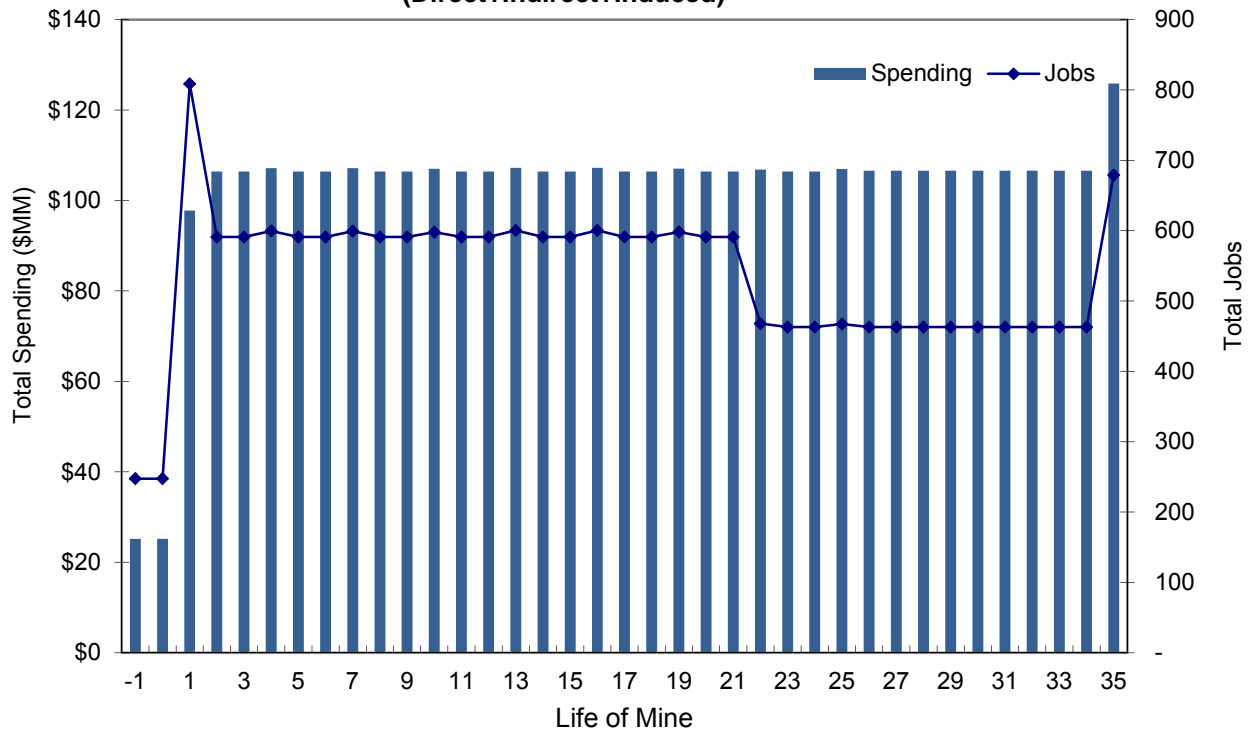
A1.4. Spending and Employment Summary

Given that construction, operations, and reclamation will overlap, the economic impact of the uranium mining project in Virginia will vary over time. In the first three years, the majority of economic impacts will come from capital expenditure. From years 1 to 35 of the mine, the economic impact will come from mining and milling operations, with a small amount of impact from continuous capital expenditure and reclamation effort. The uptick of economic

²⁷⁶ “Coles Hill Uranium Project Scoping Study and Cost Estimate” (Appendix K) Lyntek & BRS, October 2010.

impact at the end of LOM represents the intensive reclamation efforts, including dismantling mining and milling facilities and covering both the tailings cells and mining pits with vegetation. During the life of the mine, the cumulative economic impact (including direct, indirect and induced) is estimated to be \$3.8 billion dollars, with the addition of 19,654 jobs in the Chatham Labor Shed. The annual impact is estimated to be \$102.0 million that can support 531 jobs in the labor shed.

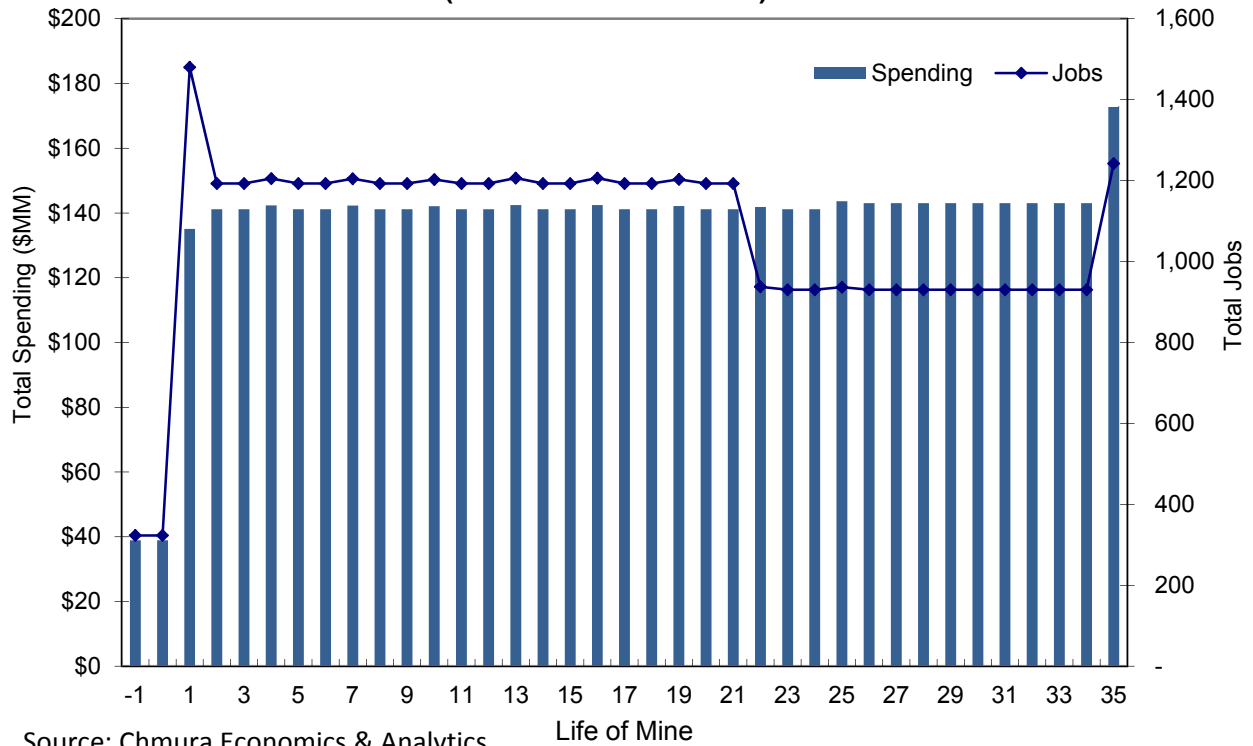
**Figure A1.2: Economic Impact Summary (Chatham Labor Shed)
(Direct+Indirect+Induced)**



Source: Chmura Economics & Analytics

The combined economic impact of construction, operation, and reclamation spending in Virginia are larger than that in the Chatham Labor Shed, but they follow similar patterns over the life of the mine. During the LOM, the cumulative economic impact (including direct, indirect, and induced) is estimated to be \$5.0 billion, with 38,447 jobs in the Commonwealth of Virginia. The annual impact is estimated to be \$135.8 million, which can support 1,039 jobs in Virginia, or about 2 percent less than the overall impact of the baseline scenario.

**Figure A1.3: Economic Impact Summary (Commonwealth of Virginia)
(Direct+Indirect+Induced)**

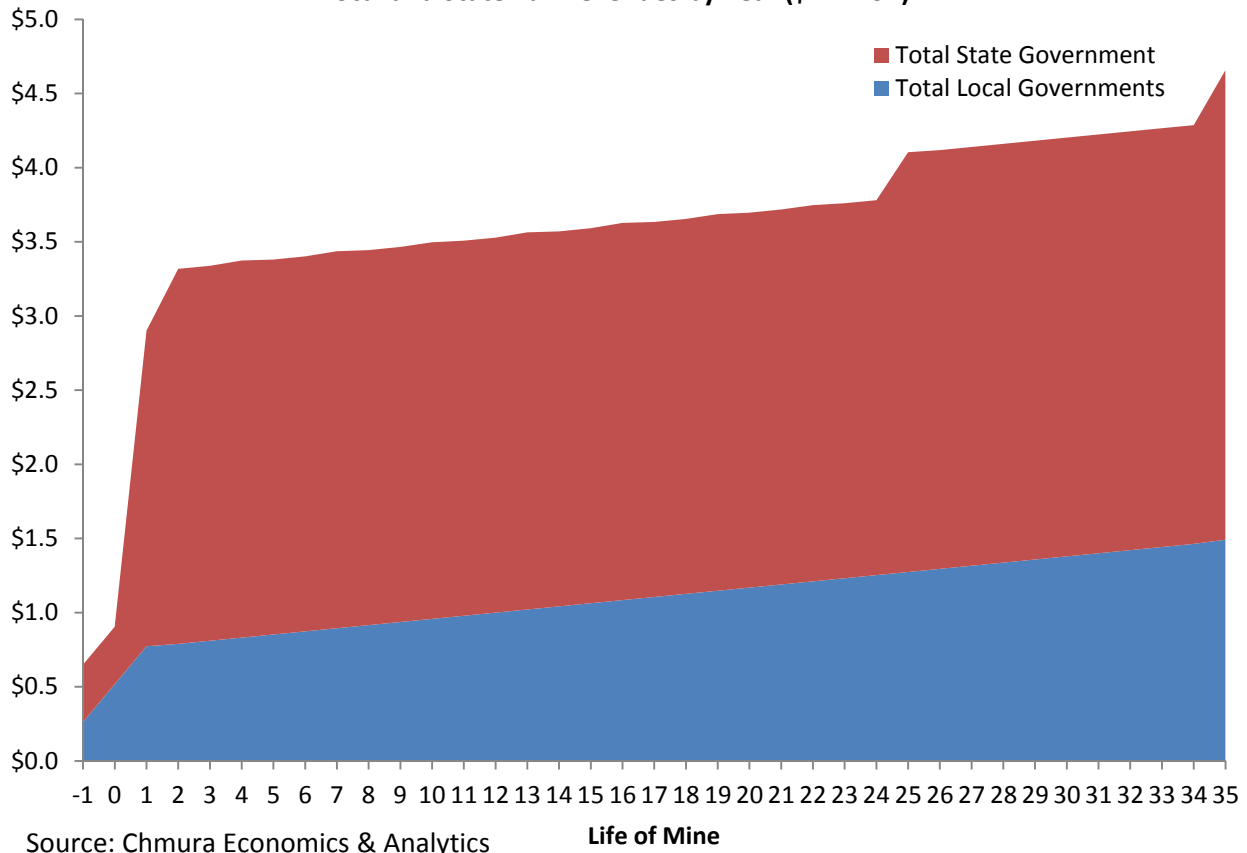


Source: Chmura Economics & Analytics

A1.5. Fiscal Impact Summary

Using the same methodology of estimating state and local tax revenues, Figure A1.4 shows the summary tax revenue by year (including capital expenditure, mining and milling operations, and reclamation). The local tax revenues will increase sharply after the first three years, as a large amount of capital expenditure will occur at the beginning of the project. Local tax revenues will increase steadily afterwards during the life of the mine, as additional capital expenditures for mining infrastructure and equipment steadily increase its tax base. State tax revenues will be steady, but will increase slightly after year 24, as mining moves from the southern pit to the northern pit, which has slightly lower operational costs. The increase at the end of the project reflects the tax revenues from reclamation activities.

A1.4: Local and State Tax Revenues by Year (\$ Million)



In summary, during the life of the mine, the cumulative state and local tax revenues are estimated to reach \$131.6 million. On an annual average basis, total state and local tax revenues are estimated to be \$3.6 million per year.

A2. Alternative Scenario-High Uranium Price, Underground Mining

This section provides an estimate of the potential economic impact of underground mining under the high-price scenario. All assumptions are the same as the baseline scenario except for the uranium price of \$75 per pound.

A2.1. Spending and Economic Impact of Capital Spending

The impact of capital spending under the high-price scenario will be the same as in the baseline scenario. Table A2.1 details the estimated economic impact of capital spending of the uranium mining and milling operations. During the life of the mine, it is estimated that the capital spending of the project will generate a total economic impact (including direct, indirect, and induced effects) of \$166.8 million in the Chatham Labor Shed, which can support 1,756 jobs. Of the total economic impact, \$120.3 million will be direct spending within the labor shed, with direct jobs amounting to 1,299 during the life of the mine. The indirect impact in the labor shed will total \$18.9 million and will support 178 jobs during the life of the mine primarily in the construction industry. The induced impact in the labor shed during the life of the mine is expected to be \$27.6 million with 279 jobs concentrated mostly in consumer service-related industries.

On an annual average basis, during the life of the mine, the total economic impact of capital spending will be \$4.5 million per year, which can support 47 annual jobs in Chatham Labor Shed. However, since the majority of capital

spending will be concentrated in the initial three years of the life of mine, the annual economic impact during the initial three years will be much higher than in the ensuing years. The total annual impact during the initial three years can reach \$25.2 million per year, supporting 247 jobs in the labor shed.

Table A2.1: Economic Impact of Capital Spending: Underground, High-Price Scenario

		Direct	Indirect	Induced	Total
Annual Average (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$3.3	\$0.5	\$0.7	\$4.5
	Employment	35	5	8	47
State of Virginia	Spending (\$ Million)	\$3.8	\$1.2	\$1.6	\$6.6
	Employment	37	8	14	59
Annual Average (Initial 3 years)					
Chatham Labor Shed	Spending (\$ Million)	\$17.9	\$3.4	\$3.9	\$25.2
	Employment	176	32	40	247
State of Virginia	Spending (\$ Million)	\$22.5	\$7.7	\$8.7	\$38.9
	Employment	189	54	80	323
Total (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$120.3	\$18.9	\$27.6	\$166.8
	Employment	1,299	178	279	1,756
State of Virginia	Spending (\$ Million)	\$142.3	\$43.0	\$57.8	\$243.0
	Employment	1,357	302	532	2,192

Source: Chmura Economics & Analytics and IMPLAN Pro 2009 (some numbers may not total exactly due to rounding)

The economic impact of capital spending in Virginia is larger than that of the Chatham Labor Shed, as more businesses outside the labor shed also benefit from capital spending. During the life of the mine, it is estimated that capital expenditures will generate a total impact of \$243.0 million in spending and support 2,192 jobs in Virginia. On an annual average basis, the total economic impact from capital expenditures is estimated at \$6.6 million and the addition of 59 jobs for the Commonwealth of Virginia. During the initial three years, the economic impact of capital spending can average \$38.9 million in spending and support 323 jobs in Virginia.

A2.2. Economic Impact of Mining and Milling Operations

Because the operational costs as well as the number of jobs supported in the mining and milling operations are not expected to vary in response to an upward movement in uranium prices, higher uranium prices are likely to result in additional revenue for the operation and translate into higher profits for mine and mill owners or its shareholders. When applying the price of \$75 per pound, the annual revenue can reach \$134.1 million per year during the primary stopping phase, and \$49.4 million during the pillar extraction phase.

Table A2.2 details the estimated economic impact of the mining and milling operations. On an annual average basis, during the life of mine, it is estimated that operations will generate a total economic impact (including direct, indirect, and induced effects) of \$128.6 million in the Chatham Labor Shed, which can support 510 jobs in the region. Of the total economic impact, \$98.9 million will be from direct spending within the labor shed, which supports 297 jobs per year during the life of the mine. The indirect impact in the labor shed will total \$8.6 million and support 42 jobs during the life of the mine, primarily in industries supporting the mining and milling operations. The induced impacts in the labor shed during the life of the mine are expected to be \$21.0 million and the support of 171 jobs concentrated in consumer service-related industries.

Table A2.2: Annual Impact of Uranium Mining and Milling Operations: High-Price Scenario

		Direct	Indirect	Induced	Total
Annual Average (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$98.9	\$8.6	\$21.0	\$128.6
	Employment	297	42	171	510
State of Virginia	Spending (\$ Million)	\$98.9	\$33.7	\$38.2	\$170.9
	Employment	297	348	407	1,052
Total (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$3,463.1	\$300.8	\$736.6	\$4,500.6
	Employment	10,407	1,460	5,982	17,849
State of Virginia	Spending (\$ Million)	\$3,463.1	\$1,181.2	\$1,337.2	\$5,981.5
	Employment	10,407	12,164	14,246	36,817

Source: Chmura Economics & Analytics and IMPLAN Pro 2009 (some numbers may not total exactly due to rounding)

The economic impact of the mining and milling operations in the Commonwealth of Virginia is larger than in the Chatham Labor Shed, as more businesses outside the labor shed will benefit as well. During the life of the mine, it is estimated that the mining and milling operations will generate an annual total impact of \$170.9 million in spending and support 1,052 jobs in Virginia.

A2.3. Spending and Employment Impact of Reclamation

Table A2.3 details the estimated economic impact of reclamation spending, which will be the same as in the baseline scenario. During the life of the mine, it is estimated that reclamation spending will generate a total economic impact (including direct, indirect, and induced effects) of \$16.3 million in the Chatham Labor Shed, which can support 183 jobs.

Table A2.3: Economic Impact of Reclamation: High-Price Scenario

		Direct	Indirect	Induced	Total
Annual Average (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$0.3	\$0.1	\$0.1	\$0.4
	Employment	4	1	1	5
State of Virginia	Spending (\$ Million)	\$0.4	\$0.1	\$0.2	\$0.7
	Employment	4	1	2	7
Total (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$11.5	\$2.1	\$2.8	\$16.3
	Employment	134	22	28	183
State of Virginia	Spending (\$ Million)	\$14.3	\$4.6	\$6.5	\$25.3
	Employment	165	38	61	265

Source: Chmura Economics & Analytics and IMPLAN Pro 2009 (some numbers may not total exactly due to rounding)

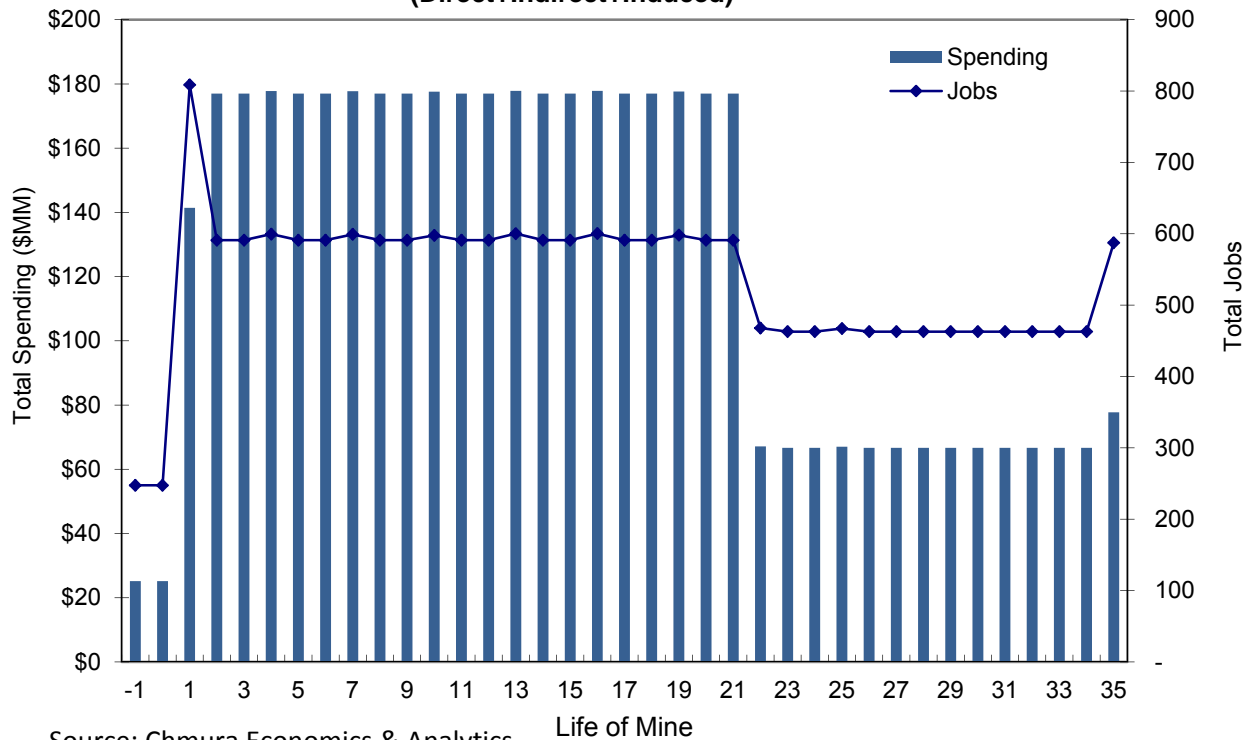
The economic impact of reclamation spending in Virginia is larger than in the Chatham Labor Shed, as more businesses outside the labor shed also will benefit from the reclamation spending. During the life of the mine, it is estimated that reclamation spending will generate a total impact of \$25.3 million in spending and support 265 jobs in Virginia.

A2.4. Spending and Employment Summary

Given that construction, operations, and reclamation efforts overlap, the economic impact of the uranium mining project in Virginia will vary over time. In the first three years, the majority of economic impact will come from capital expenditures. From years 1 to 35 of the mine, the economic impact will come from operations, with a small amount

of impact from continuous capital expenditures and some reclamation efforts. The uptick in the economic impact at the end of the life of the mine represents the intensive reclamation effort, including dismantling both mining and milling facilities. During the life of the mine, the cumulative economic impact (including direct, indirect and induced) is estimated to be \$4.7 billion. The annual impact is estimated to be \$126.6 million, which would support 535 jobs in the labor shed.

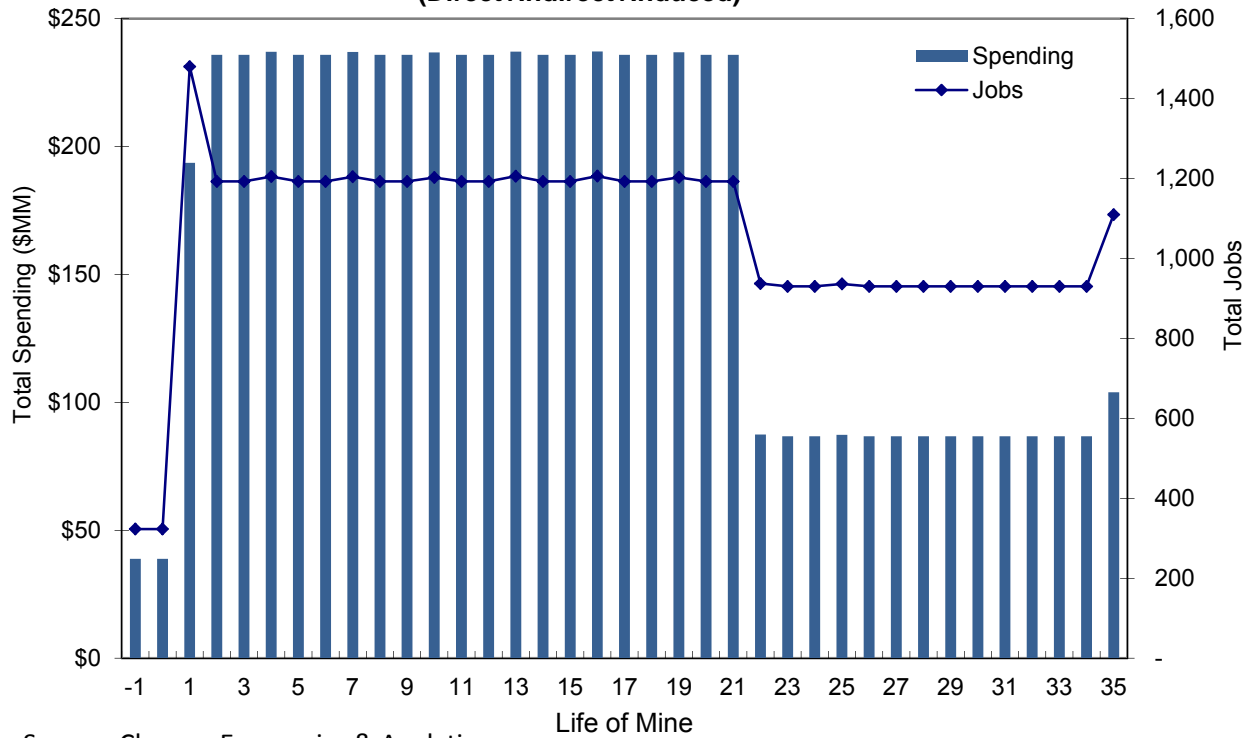
**Figure A2.1: Economic Impact Summary (Chatham Labor Shed)
(Direct+Indirect+Induced)**



Source: Chmura Economics & Analytics

The combined economic impact of the construction phase, mining and milling operations, and reclamation spending in Virginia is larger than in the Chatham Labor Shed, but they following a similar pattern over the years. During the life of the mine, the cumulative economic impact (including direct, indirect and induced) is estimated to be \$6.3 billion. The annual impact is estimated to be \$168.9 million, which would support 1,061 jobs in Virginia.

**Figure A2.2: Economic Impact Summary (Commonwealth of Virginia)
(Direct+Indirect+Induced)**

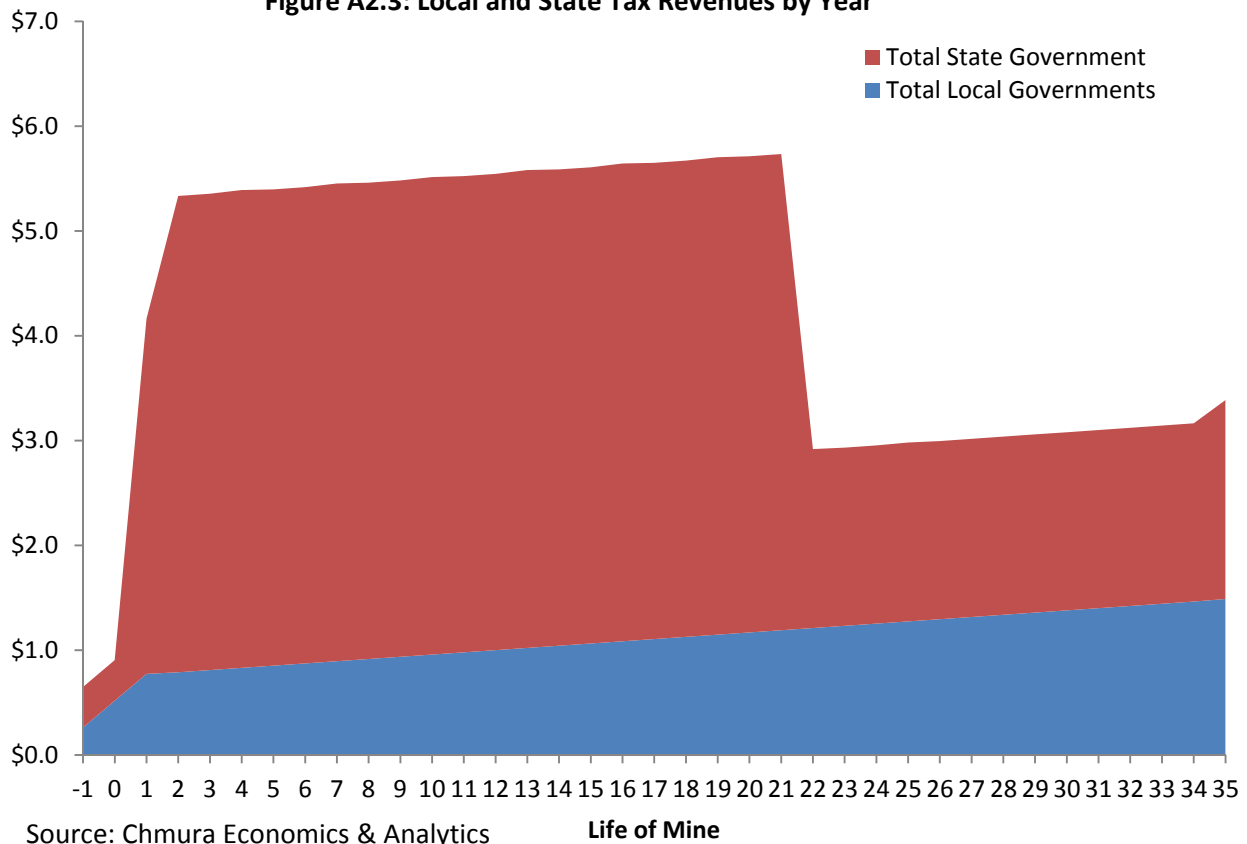


Source: Chmura Economics & Analytics

A2.5. Fiscal Impact Summary

Figure A2.3 shows the summary tax revenue by year (including capital expenditures, mining and milling operations, and reclamation spending). The cumulative state and local tax revenues during the life of the mine can reach \$158.3 million. On an annual average basis, total state and local tax revenue is estimated to be \$4.3 million per year or approximately 33 percent greater than in the baseline scenario.

Figure A2.3: Local and State Tax Revenues by Year

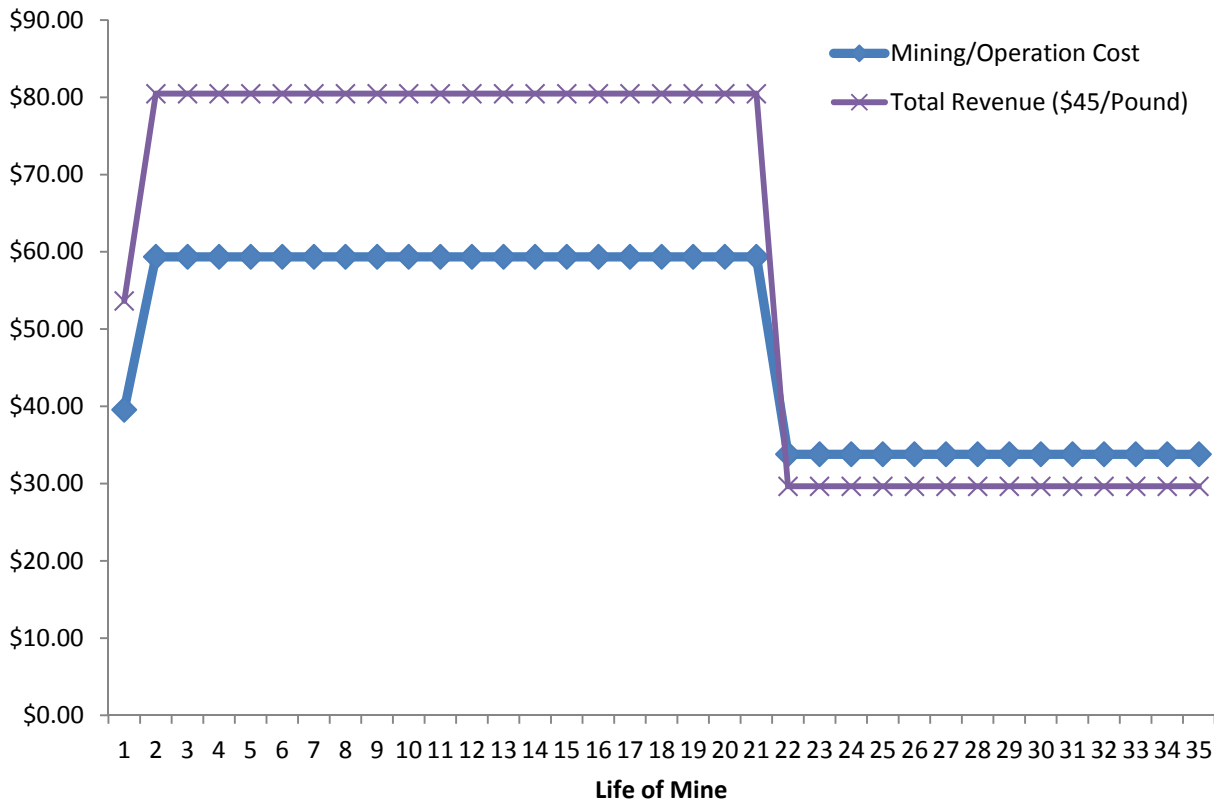


A3. Alternative Scenario: Low Uranium Price, Underground Mining

This section provides an estimate of the potential economic impact of underground mining under a low-price scenario. All assumptions are the same as in the baseline scenario except for the uranium price of \$45 per pound. In this low uranium price scenario, during the pillar extraction phase, the operating revenues cannot offset the operating costs of mining and milling operations, and the company will incur an operating loss. The company will have no incentive to continue mining and milling during this period and will sell the uranium for a loss. Under this scenario, Chmura assumes the company will continue operations only as long as it earns a profit. When the price is \$45 per pound, the company is likely to stop production after year 22. Additionally, Chmura assumes that the company will not dismantle mining and milling facilities immediately after year 22. The reason is that if the price of uranium rises above its break-even price point, the company would be inclined to resume production. However, Chmura’s analysis in this section still assumes that the life of mine is 35 years, so that annual average economic impacts are comparable with the baseline and other scenarios.²⁷⁷

²⁷⁷ If the LOM is changed to 22 years, the following conflicting situation will occur. The accumulative impacts of the project will be smaller than the baseline scenario, but the annual average impacts under the low-price scenario will be higher than the baseline scenario.

Figure A3.1: Projected Operational Revenue and Costs (\$ Million)



Source: Lyntek and BRS, Scoping Study and Cost

A3.1. Spending and Economic Impact of the Capital Spending

Under the low-price scenario, even though the company may stop production in year 22, the initial capital expenditure will have been spent, but the ongoing capital expenditures (the annual spending on equipment and tailings structure) will not proceed. As a result, the total capital expenditures made through the life of the mine will be less than in the baseline scenario.

Table 3.1 details the estimated economic impact of capital spending of the uranium mining and milling operations. During the life of the mine, capital spending will generate a total economic impact (including direct, indirect, and induced effects) estimated at \$129.2 million in the Chatham Labor Shed, which can support 1,339 jobs. Of the total economic impact, \$92.8 million will be from direct spending within the labor shed, which would support 982 direct jobs during the life of the mine.

Table A3.1: Economic Impact of Capital Spending: Low-Price Scenario

		Direct	Indirect	Induced	Total
Annual Average (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$2.5	\$0.4	\$0.6	\$3.5
	Employment	27	4	6	36
State of Virginia	Spending (\$ Million)	\$4.8	\$1.5	\$1.9	\$8.3
	Employment	45	11	18	73
Annual Average (Initial 3 years)					
Chatham Labor Shed	Spending (\$ Million)	\$17.9	\$3.4	\$3.9	\$25.2
	Employment	176	32	40	247
State of Virginia	Spending (\$ Million)	\$22.5	\$7.7	\$8.7	\$38.9
	Employment	189	54	80	323
Total (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$92.8	\$15.3	\$21.1	\$129.2
	Employment	982	144	213	1,339
State of Virginia	Spending (\$ Million)	\$111.4	\$34.8	\$44.8	\$191.0
	Employment	1,032	245	411	1,689

Source: Chmura Economics & Analytics and IMPLAN Pro 2009 (some numbers may not total exactly due to rounding)

The economic impact of capital spending in Virginia is larger than in the Chatham Labor Shed, as more businesses outside the labor shed also will benefit from the capital spending. During the life of the mine, it is estimated that the capital expenditures will generate a total impact of \$191.0 million in spending and support 1,689 jobs in Virginia.

A3.2. Economic Impact of Mining and Milling Operations

As in other scenarios, the operational costs and the number of jobs supported in the mining and milling operations remain unchanged and are not expected to vary with the price of uranium. However, starting in year 22, the mining and milling operations will not break even, so it is assumed that these operations will cease.

The total revenue of the milling and mining operations will depend largely on the price per pound of U₃O₈. Under a price of \$45 per pound, the annual revenue is likely to be \$80.5 million from years 2 to 21.

Table A3.2 details the estimated economic impact of the mining and milling operations under the low-price scenario. On an annual average basis, during the life of the mine, it is estimated that the mining and milling operations will generate a total economic impact (including direct, indirect, and induced effects) of \$61.8 million in the Chatham Labor Shed, which can support 337 jobs in the region. However, during the first 21 years, the economic impact is larger, with total spending amounting to \$103.0 million, which could support 561 jobs in the Chatham Labor Shed. The cumulative economic impact during the life of the mine is estimated to be \$2.2 billion and the support of 11,785 jobs in the Chatham Labor Shed.

Table A3.2: Annual Impact of Uranium Mining and Milling Operations: Low-Price Scenario

		Direct	Indirect	Induced	Total
Annual Average (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$47.5	\$4.3	\$10.0	\$61.8
	Employment	194	32	111	337
State of Virginia	Spending (\$ Million)	\$47.5	\$16.4	\$18.6	\$82.6
	Employment	194	235	265	694
Annual Average (Year 1 to Year 21)					
Chatham Labor Shed	Spending (\$ Million)	\$79.2	\$7.2	\$16.6	\$103.0
	Employment	324	53	184	561
State of Virginia	Spending (\$ Million)	\$79.2	\$27.4	\$31.0	\$137.6
	Employment	324	391	442	1,157
Total (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$1,662.9	\$151.3	\$348.6	\$2,162.8
	Employment	6,804	1,110	3,871	11,785
State of Virginia	Spending (\$ Million)	\$1,662.9	\$575.5	\$651.0	\$2,889.3
	Employment	6,804	8,211	9,281	24,296

Source: Chmura Economics & Analytics and IMPLAN Pro 2009 (some numbers may not total exactly due to rounding)

The economic impact of the mining and milling operations in the Commonwealth of Virginia is larger than in the Chatham Labor Shed, as more businesses outside the labor shed also will benefit from the mining and milling operations. During the life of the mine, the cumulative economic impact is estimated to be \$2.9 billion and support 24,296 jobs in the Commonwealth of Virginia.

A3.3. Spending and Employment Impact of Reclamation

Under the low-price scenario, operations discontinue at the pillar extraction phase, as the continuation of the operation would incur a loss to the owners of the Coles Hill site. When that occurs, all reclamation spending on additional tailings facilities will not be undertaken immediately. It is also assumed that the dismantling of the facilities will not occur until the management of the Coles Hill site determines the long-term price of uranium will be permanently below their break-even point, as the company has the incentive to keep the facility in an “idled” state in case the price of uranium will rise above the break-even point.

Table A3.3 details the estimated economic impact of the reclamation spending under the low price scenario. During the life of mine, it is estimated that the reclamation spending will generate a total economic impact (including direct, indirect, and induced effects) of \$4.4 million in the Chatham Labor Shed, which can support 49 jobs.

Table A3.3: Economic Impact of Reclamation: Low-Price Scenario

		Direct	Indirect	Induced	Total
Annual Average (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$0.1	\$0.0	\$0.0	\$0.2
	Employment	2	0	0	2
State of Virginia	Spending (\$ Million)	\$0.1	\$0.0	\$0.0	\$0.2
	Employment	2	0	0	2
Total (LOM)					
Chatham Labor Shed	Spending (\$ Million)	\$3.1	\$0.6	\$0.7	\$4.4
	Employment	36	6	7	49
State of Virginia	Spending (\$ Million)	\$3.8	\$1.2	\$1.7	\$6.8
	Employment	44	10	16	71

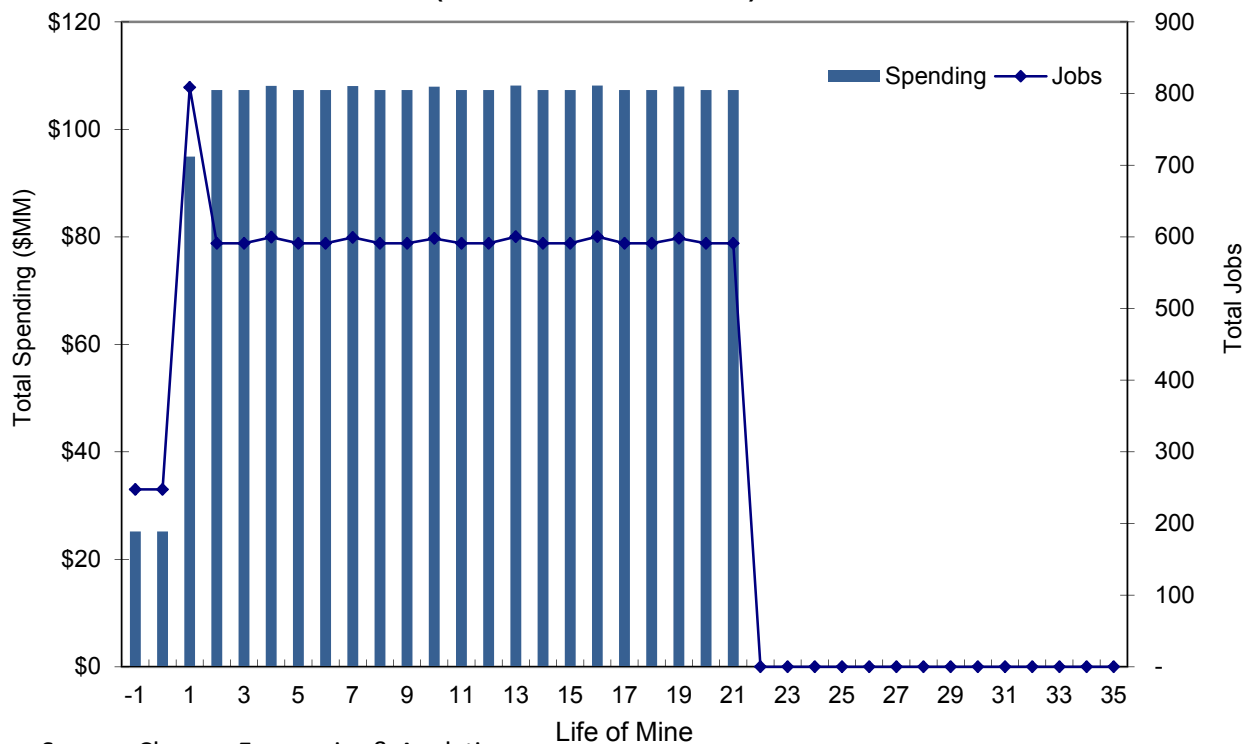
Source: Chmura Economics & Analytics and IMPLAN Pro 2009 (some numbers may not total exactly due to rounding)

The economic impact of reclamation spending in Virginia is larger than in the Chatham Labor Shed, as more businesses outside the labor shed also will benefit from the reclamation spending. During the life of the mine, it is estimated that reclamation spending will generate a total impact of \$6.8 million in spending and support 71 jobs in Virginia, when assuming a low-price scenario.

A3.4. Spending and Employment Summary

Since construction, operation, and reclamation spending will coincide, the economic impact of the uranium mining project in Virginia will fluctuate over time. In the first three years, the majority of economic impact will come from capital expenditures. Afterwards, the economic impact will come primarily from the mining and milling operations, with a small amount of impact from continuous capital expenditures, and some reclamation efforts. During the life of the mine, the cumulative economic impact (including direct, indirect and induced) is estimated to be \$2.3 billion and 13,173 jobs in the Chatham Labor Shed.

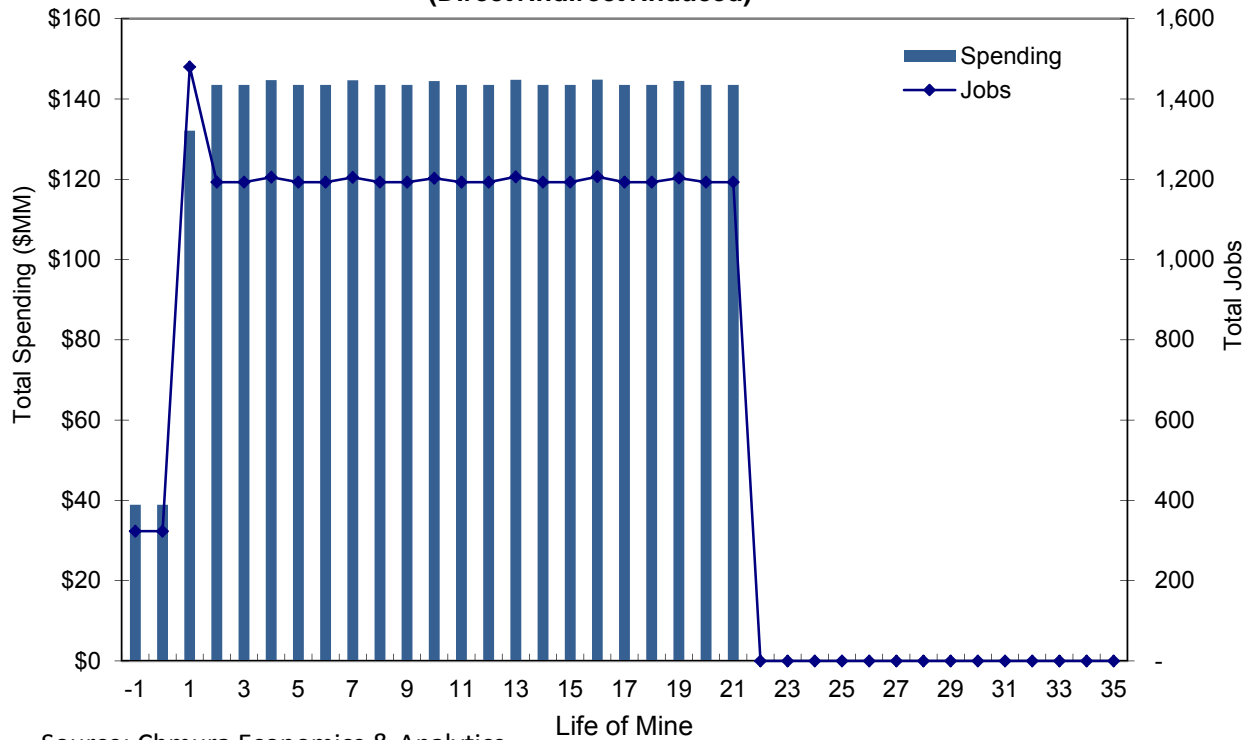
**Figure A3.2: Economic Impact Summary (Chatham Labor Shed)
(Direct+Indirect+Induced)**



Source: Chmura Economics & Analytics

The combined economic impact of the construction phase, mining and milling operations, and reclamation spending in Virginia is larger than in the Chatham Labor Shed, but they following a similar pattern. During the life of the mine, the cumulative economic impact (including direct, indirect and induced) is estimated to be \$3.1 billion dollars and 26,055 jobs in Virginia.

**Figure A3.3: Economic Impact Summary (Commonwealth of Virginia)
(Direct+Indirect+Induced)**

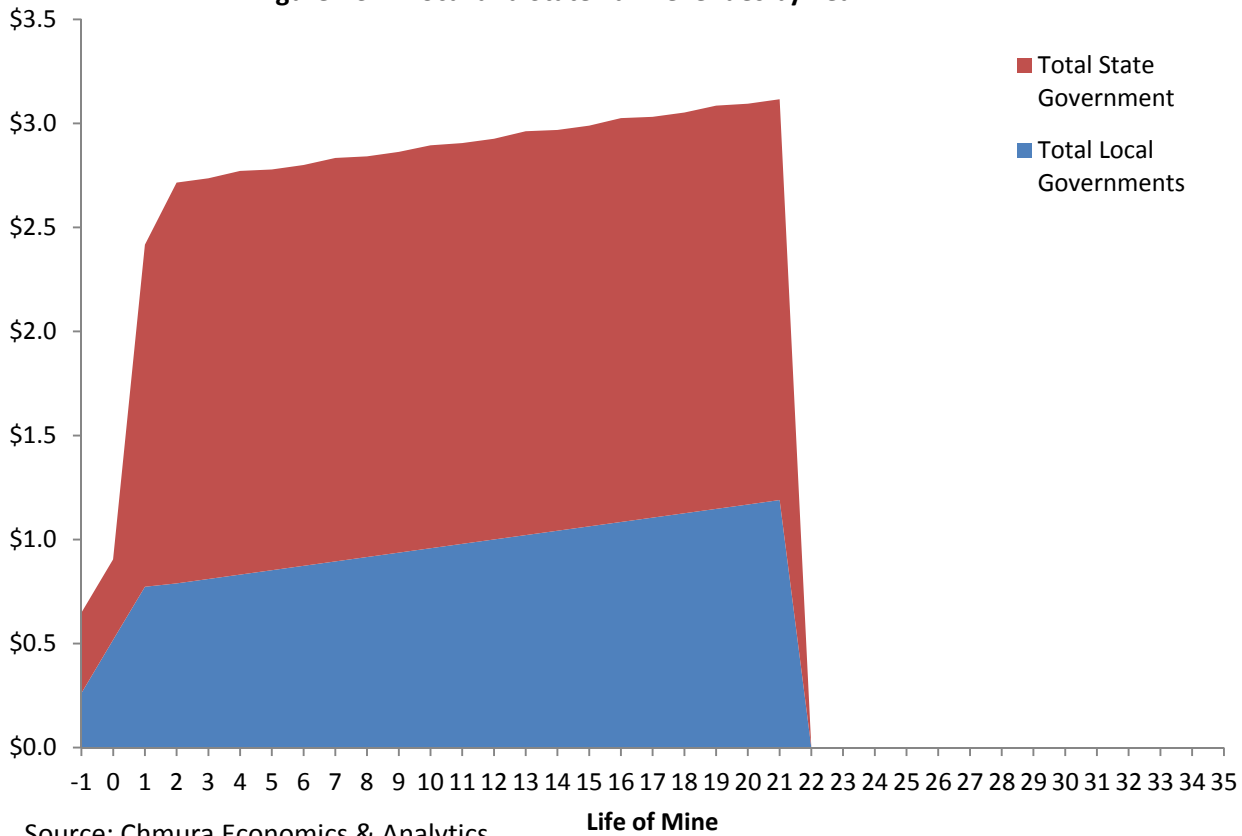


Source: Chmura Economics & Analytics

A3.5. Fiscal Impact Summary

During the life of the mine, the total accumulative tax revenues for state and local governments are estimated to be \$61.8 million, with \$41.0 million in state taxes and \$20.8 million in local taxes. It is possible that certain property taxes will be paid to the county even while production is shut down, but it is unlikely these receipts would reach the level of property taxes that would be paid under normal operations.

Figure A3.4: Local and State Tax Revenues by Year



Source: Chmura Economics & Analytics

A.4. Alternate Environmental Scenarios—Scenario 1

This section models the economic impact assuming no environmental degradation. This scenario assumes a “negligible” degree of environmental contamination and analyzes the implications in terms of public health, stigma effects, remediation spending, costs to other localities, and on the overall quality of life in the region. This alternate environmental scenario is described below:

Scenario 1: Negligible environmental impact. The qualities of air, water, noise, and soil are not materially altered from today’s baseline norms. This is the best-case scenario.

This scenario is identical to the baseline scenario in that there is no stigma effect on tourism, agriculture, private schools, and any other manufacturer. Public health is not impacted. In this scenario the stigma effects on real estate within a 2-mile radius are reduced by half. Also, the net benefit of all phases—construction, operations, and remediation—of the Coles Hill site is \$135.9 million per year. This yields a value of \$5.0 billion over the entirety of the Coles Hill operation.

The most favorable outcome for Virginia and the Chatham Labor Shed would be this environmental scenario coupled with a high price of uranium—\$75 per pound of yellowcake. Under this fortuitous set of circumstances, the Coles Hill site would generate \$168.2 million per year in economic value or more than \$6.2 billion in net economic value over its complete lifespan.

A.5. Alternate Environmental Scenarios—Scenario 3

This section models the economic impact assuming a greater degree of environmental degradation. This scenario assumes a “significant” degree of environmental contamination and analyzes the implications of this in terms of public health, stigma effects, remediation spending, costs to other localities, and on the overall quality of life in the region. This alternate environmental scenario is described below:

Scenario 3: Significant environmental impact in terms of the qualities of air, noise, or soil (but not water). At least in one of three areas (air, soil, or noise, but not water) contamination exceeds the limits set by current federal standards.

The benefits arising from the uranium mining and milling operation remain unchanged in the first two phases of its existence.²⁷⁸ The total construction spending of the project is estimated to be \$315.4 million over the life of the mine, measured in nominal dollars.²⁷⁹ Capital spending includes site development, equipment, construction (of mining, milling, and tailings structures), and soft costs such as permit fees and architecture and engineering fees. During the life of the mine, it is estimated that capital spending of the project will generate total economic impacts (including direct, indirect, and induced effects) of \$166.8 million in the Chatham Labor Shed, which can support 1,756 jobs.

The economic impact of capital spending in Virginia is larger than that in the Chatham Labor Shed because additional businesses outside the labor shed also will benefit from capital spending of the uranium project. During the life of the mine, it is estimated that capital expenditure will generate total impacts of \$243.0 million in spending and 2,192 jobs in Virginia.

Similarly, the estimated economic impact of the mining and milling operations will be the same as in the baseline scenario. On an annual average basis, during the life of the mine, it is estimated that the mining and milling operations will generate a total economic impact (including direct, indirect, and induced effects) of \$102.9 million in the Chatham Labor Shed, which can support 510 jobs in the region. Of the total economic impacts, \$79.2 million will be direct spending within the labor shed, and direct jobs amounting to 297 per year over the life of the mine. The indirect impact in the labor shed will total \$6.9 million and support 42 jobs per year during the life of the mine in mining and milling support industries, such as utilities and trucking services. The induced impacts in the labor shed during the life of the mine are expected to be \$16.8 million and 171 jobs per year, which will be concentrated in consumer service-related industries. The economic impacts of the mining and milling operations in the Commonwealth of Virginia are larger than those in the Chatham Labor Shed, as more businesses outside the labor shed also benefit from the mining and milling operations.

After accounting for increased annual infrastructure spending (\$0.29 million) and remediation spending (\$2.2 million—see following section or “Remediation Spending and Costs to Other Localities”), the total economic impact from the uranium mining and milling industry is \$138.4 million per year, which supports 1076 jobs in Virginia. But this positive economic impact has to be weighed against some potential costs that may be the result of the environmental degradation assumed in this scenario. These costs are addressed in the following sections.

²⁷⁸ Chmura utilizes the baseline price of \$60 per pound of yellowcake in this scenario.

²⁷⁹ All dollars in the economic impacts are measured in nominal terms. Source: Virginia Uranium Inc.

Stigma Effects on Housing, Agriculture, Tourism, and Private Schools:

In the baseline scenario, Chmura estimates that the approximately 175 properties within a 2-mile radius of the Coles Hill site would suffer a loss of 5 percent of their home values. Also, Chmura assumes the approximately 1,350 residences within a 5-mile radius would experience a negative stigma effect. Chmura further assumes—consistent with the relatively thin real estate market in the area—that the amount of loss is 8 percent of the home value. This results in an approximate \$20.5 million loss in real estate value.²⁸⁰ The corresponding loss in property taxes is \$106,000.²⁸¹ Chmura ascertains however, this loss will lessen over the period of five years once the uranium mining and milling operations is either shut down or constrains its environmental impact to air, soil, or noise to within federal norms. After five years, the stigma effect will remain the same as in the baseline scenario for an additional 10 years.

Given the assumption that the environmental impact from the Coles Hill site exceeds federal standards, Chmura considers that both the agricultural and tourism sector could suffer from negative stigma. Chmura calculates that this impact will be a 10 percent decline in the initial year, but this decline will gradually fade over a five-year period as remediation efforts take place.²⁸² The economic impact of this decline is significant. In the Chatham Labor Shed, the agricultural sector accounts for an annual economic contribution of \$409 million, while the tourism sector adds another \$306 million. A 10 percent loss in both agriculture and tourism would yield a total yearly economic loss to Virginia of roughly \$49 and \$70 million, respectively, and the loss of 1,429 jobs. While Chmura believes these sectors would eventually bounce back—assuming the mine and mill is either shut down or restores its environmental impact to federal norms—the five-year loss equals \$357 million in economic value.

In this scenario Chmura assumes that a private school, equivalent in size to Chatham Hall, permanently ceases operations. This represents an annual loss of \$17.4 million in economic value to the state of Virginia and the loss of approximately 197 jobs. Given that some of the private schools in the area have operated for more than 100 years, Chmura calculates the aggregate loss of a private school over a 50-year time horizon, which yields a total loss of \$870 million in economic value.

Tax losses from cessation of activities at a private school, reductions in the agriculture and tourism sectors, and the loss of some property taxes would be greater than the \$3.5 million in tax dollars generated by the industry.

Health Implications:

In the 1980s the EPA studied a number of active and inactive uranium mine sites by collecting soil and water samples and taking measurements at sites in four states (Colorado, New Mexico, Texas, and Wyoming). The information was used by the EPA to develop models for mines and mills regarding their average impact on public health. Using these models, in 1983 the EPA estimated the health effects to populations within 50 miles of each mine, and on a hypothetically 'most exposed' individual living one mile from an inactive surface and underground

²⁸⁰ This assumes a median home price of \$81,000 and one acre of land valued at \$3,000.

²⁸¹ Estimated Tax Rate: \$0.52 per \$100.

²⁸² Chmura assumes a complete 10 percent loss in year 1. This percentage declines to an 8 percent loss in year 2, a 6 percent loss in year 3, a 4 percent loss in year 4, and a 2 percent loss in year 5.

mine.²⁸³ The following table indicates the number of localities in relation to their distance from the mine site, and their corresponding population figures.

Table A5.1: Population estimates for a given distance from Coles Hill

Radius (miles)	Population	Number of Virginia Cities/Counties
1	<100 (estimate 70)	1
2	311	1
5	2,730	1
10	15,718	2
50	742,391	18

In 1989, the EPA conducted risk assessments for active underground uranium mines and surface uranium mines as well as for uranium milling operations.²⁸⁴ The table below summarizes their estimates of the public health risks associated with uranium mining as they relate to radionuclides and carcinogens.

Table A5.2 EPA Health Risk Model

	1-Mile Radius Maximum Exposed Individual	50-Mile Radius Average Exposed Individual
Inactive Surface	3.4 cases in 100,000	6.3 cases in 100,000,000
Inactive Underground	2.0 cases in 100,000	8.6 cases in 100,000,000
Active Surface	4.8 cases in 100,000	6.6 cases in 100,000,000
Active Underground	4.4 cases in 1,000	5.5 cases in 10,000
Mill Tailings Site	1.6 cases in 10,000	7 cases in 10,000,000

Most relevant to this study are the results from an active underground uranium mine and an active uranium mill. Calibrating these EPA estimates using two given population values, (within 1 mile and 50 miles of the site) Chmura

²⁸³ "Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining" V2 EPA 2007

²⁸⁴ "Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining" V2 EPA 2007

estimates that the affected population could see an additional 5.5 cases of cancer (presumably lung cancer) every year as result of the mine and milling operations. Please note that this is a speculative exercise, and Chmura is not qualified to conclude that increased cancer rates will be associated with the Coles Hill uranium mine and mill. Chmura is simply including the costs of these additional cases—as one of many assumptions—to be part of an alternative scenario. For this we can refer to the EPA 1989 estimates of the increase in cancer cases over a lifetime of exposure (approximately 75 years) for an underground mine and an operating uranium mill^{*285}

Table A5.3 Estimates of cancer cases per year

	Maximum Exposed Individual Lifetime Cases (75 years)	Average Exposed Individual Lifetime Cases (75 years)	Total Cases per Lifetime (approx 75 years)	Additional Cancer Cases Per Year
1 mile population =	70	0.32	409.2	5.5
50 mile population =	742,391			

Accordingly, Chmura has utilized these results to estimate the costs of treating the additional 5.5 cancer cases expected each year until the site had been remediated and returned to safe levels. The costs of treating these additional cancer cases—we presume them to be primarily lung cancer—is estimated to be \$178,200 per year. Chmura estimates these health-related costs linger 10 years after the Coles Hill site is closed. This estimate is based on research by the National Cancer Insitutue which shows that the cost of treating lung cancer is \$32,400 per patient per year in 2010.²⁸⁶ This analysis takes a narrow view of the “costs” associated with cancer treatment; for instance, lost productivity, emotional stress, and end of life arrangements are excluded. Similarly, this estimate does not include any potential costs associated with either the challenging of or payment to settle any civil suit that may result from claims of adverse health effects, if any, brought about by the operation of the Coles Hill uranium mine and mill. Thus this estimate is conservative and may underestimate the true costs of the increase in the number of cancer cases. Similarly, we did not model the cost of any increase in non-cancerous respiratory diseases, although at least one study suggest these types of diseases could occur with the same frequency of that of lung cancer.²⁸⁷

Remediation Spending and Costs to Other Localities

Chmura necessarily assumes that because the level of environmental impact has increased (it is characterized in this scenario as “significant”), so must the costs of remediation. In this case, Chmura utilizes the figures from a

²⁸⁵ *We utilize the EPA estimate for a “new technology” type mill tailings pile impoundment design.

²⁸⁶ “Projections of the Cost of Cancer Care in the United States: 2010–2020.” National Cancer Institute, 2011

²⁸⁷ “Exposure Pathways and Health Effects Associated with Chemical and Radiological Toxicity of Natural Uranium: A Review” Doug Brugge, et al., 2005.

1994 IAEA report that indicates the United States' average cost of remediation is about \$1.13 (\$1.73 adjusted for inflation) per ton of mill tailings.²⁸⁸ This IAEA conclusion is largely consistent with a later 2002 DOE study which concludes on average remediating a contaminated uranium site costs about \$42 million (\$55 million adjusted for inflation) per site.²⁸⁹ In the case of Coles Hill, because VUI estimates that they will produce about 26.7 million tons of tailings, the remediation efforts are estimated to cost \$46.2 million, which is more than three times what VUI currently plans to invest in site remediation. This remediation spending would generate approximately \$78.4 million in economic impact (direct, indirect, and induced), and because of this additional spending, the total annual economic impact of scenario 3 (\$138.2 million) is slightly above that of the baseline scenario (\$136.6 million).

Chmura further assumes that VUI will only be bonded for an amount equal to twice its estimated remediation spending estimate of \$14.9 million. Therefore, Chmura assumes that Virginia environmental agencies will fund any remediation efforts in excess of \$29.8 million.^{290 291} Given these assumptions, this will generate a one-time charge of approximately \$16.4 million, which state agencies will pay for using general tax revenues. Chmura further estimates that an additional 10 percent of this amount will need to be spent in total by nearby municipalities or counties for various issues relating to the remediation efforts. This one-time cost of \$1.6 million would most likely be borne by nearby downstream municipalities.

Summary & Net Economic Benefit

The net annual economic impact of this scenario would be roughly even at its worst, and the number of jobs destroyed could be negative for a period of time. The \$138.2 million in positive economic impact and 1,076 jobs would have to be weighed against the loss of property values (-\$20.5 million), a private school closure (-\$17.4 million), state remediation spending (-\$468,000), public health costs (-\$178,000), and a temporary but acute period of distress for the agriculture and tourism sectors (-\$119.1 million) and the total loss of 1,626 jobs statewide from all these sectors. At worst, this scenario could result in annual net losses of approximately 550 jobs and \$19.5 million.

However, depending on when this level of environmental degradation is realized, and if the Coles Hill site is able to bring its operations back within federally mandated environmental standards, the net accumulated economic value of the Coles Hill site may still be positive. For instance, if the Coles Hill site operates for 10 years, it will accrue \$138.4 million of value per year during that time frame for a total of \$1.384 billion. If operations cease at that point because environmental degradation is in excess of federal limits—as assumed in this alternate environmental scenario—the net accumulated economic loss will be approximately \$1.329 billion from the permanent loss of the private school²⁹², public health costs, and a five-year period of suppressed economic activity in the agriculture and tourism sectors coupled with losses in the local real estate market. Even after accounting for the loss in other sectors, the Coles Hill site would still bring a net accumulated economic value to the region of just over \$55 million^{*293}. Should the Coles Hill site operate the full 35 years before contamination reaches the levels assumed in scenario 3, the accumulated economic value would be \$3.792 billion.

²⁸⁸ “Planning and Management of Uranium Mine and Mill Closures” IAEA, May 1994

²⁸⁹ “Environmental Remediation of Uranium Production Facilities” IAEA/OECD, 2002

²⁹⁰ \$14.9 million x 2 = \$28.9 million.

²⁹¹ It is possible these costs could be passed off to Federal agencies, as the NRC typically takes possession of tailings sites, but these remediation costs most likely represent unfunded liabilities that will ultimately fall to taxpayers to fund.

²⁹² Chmura assumes the private school would have existed for at least another 50 years.

²⁹³ *This estimate does not employ a discount rate. A positive discount rate would raise this figure as the losses associated with the closure of the school are well in the future, while gains from the Coles Hill site are front-loaded.

A.6. Alternate Environmental Scenarios—Scenario 4

This section models the economic impact that assumes an even greater degree of environmental degradation. This scenario assumes a “severe” degree of environmental contamination and analyzes the implications of this in terms of public health, stigma effects, remediation spending, costs to other localities, and on the overall quality of life in the region. This alternate environmental scenario is described below:

Scenario 4: Severe environmental impact in terms of the qualities of air, water, noise, and soil. Contamination of both water and at least one other area (air, soil, or noise) exceeds the limits set by current federal standards. This is the worst-case scenario.

The benefits arising from the uranium mining and milling operation remain unchanged in the first two phases of its existence.²⁹⁴ The total construction spending of the project is estimated to be \$315.4 million over the life of the mine, measured in nominal dollars.²⁹⁵ Capital spending includes site development, purchase of equipment, construction of the mining, milling, and tailings structures, and soft costs such as permit fees and architecture and engineering fees. During the life of the mine, it is estimated that capital spending of the project will generate total economic impacts (including direct, indirect, and induced effects) of \$166.8 million in the Chatham Labor Shed, which can support 1,756 jobs.

The economic impact of capital spending in Virginia is larger than what the impact would be within the Chatham Labor Shed. This is from the benefit additional businesses throughout Virginia will receive from capital spending of the uranium project. During the life of the mine, it is estimated that capital expenditure will generate total impacts of \$243.0 million in spending and 2,192 jobs in Virginia.

Similarly, the estimated economic impact of the mining and milling operations will be the same as in the baseline scenario. On an annual average basis, during the life of the mine, it is estimated that the mining and milling operations will generate a total economic impact (including direct, indirect, and induced effects) of \$102.9 million in the Chatham Labor Shed, which can support 510 jobs in the region. Among the total economic impacts during the life of the mine, \$79.2 million will be direct spending within the labor shed, with direct jobs amounting to 297 per year. The indirect impact in the labor shed will total \$6.9 million and support 42 jobs per year in industries supporting mining and milling operations, including utilities and trucking services. The induced impacts in the labor shed are expected to be \$16.8 million and 171 jobs per year, which will be concentrated in consumer service-related industries. The economic impacts of the mining and milling operations in the Commonwealth of Virginia are larger than those in the Chatham Labor Shed, as more businesses outside the labor shed also benefit from the mining and milling operations.

After accounting for increased annual infrastructure spending (\$0.29 million) and remediation spending (\$3.5 million—see following section or “Remediation Spending and Costs to Other Localities”), the total economic impact from uranium mining and milling is \$139.9 million per year, which supports about 1091 jobs in Virginia. Still, this positive economic impact has to be weighed against some potential costs that may be the result of the environmental degradation assumed in this scenario. These costs are addressed in the following sections.

²⁹⁴ Chmura utilizes the baseline price of \$60 per pound of yellowcake in this scenario.

²⁹⁵ All dollars in economic impacts are measured in nominal terms. Source: Virginia Uranium Inc.

Stigma Effects on Housing, Agriculture, Tourism, Private Schools, and Manufacturing:

In the baseline scenario, Chmura estimated that the approximately 175 properties within a 2-mile radius would suffer a loss of 5 percent of their home values. In this scenario Chmura assumes the approximately 1,350 residences within a 5-mile radius would experience the negative stigma effect. Chmura further assumes a loss of 30 percent of each home's value. This results in approximately \$76.9 million in loss of real estate value,²⁹⁶ and the corresponding loss in property taxes is \$400,000.²⁹⁷ Chmura expects however, this loss to lessen over the period of five years after the uranium mining and milling operations is either shut down or remediation efforts are completed. After five years the stigma effect is assumed to be the same as in the baseline scenario for an additional 10 years.

Given the assumption that the environmental impact from the Coles Hill site exceeds federal standards, Chmura judges that both the agricultural and tourism sector could suffer from a negative stigma. Chmura determines that this impact will be a 20 percent decline in the initial year, but this loss will gradually fade over a five year period as remediation efforts take place.²⁹⁸ The economic impact of this decline in the Chatham Labor Shed is significant, since the agricultural and tourism sectors account for annual economic contributions of \$409 million and \$306 million, respectively. A 20 percent loss in both agriculture and tourism would yield a total yearly economic loss to Virginia of roughly \$80.1 and \$110.9 million, respectively, and the loss of more than 2,800 jobs. While Chmura estimates these sectors would eventually bounce back—assuming the mine and mill is either shut down or reverses its negative environmental impact—the five year loss is estimated at \$530 million in economic value.

In this scenario Chmura assumes that a private school equivalent in size to Chatham Hall permanently ceases operations. This represents an annual loss of \$17.4 million in economic value to the state of Virginia and the loss of approximately 197 jobs. Given that some of the private schools in the area have operated for more than 100 years, Chmura calculates the aggregate loss of a private school over a 50-year time horizon, which yields a loss of \$870 million in economic value.

In this scenario Chmura assumes that a manufacturer (whose industry is sensitive to water quality issues and employs approximately 400 individuals) permanently ceases operations. This represents an annual loss of \$400.8 million in economic value to the state of Virginia and the loss of approximately 1,581 jobs. Given that entry and exit is more common in the manufacturing realm than in the education sector, Chmura calculates the aggregate loss of the large manufacturer over a 25-year time horizon, which yields an economic loss of \$10.020 billion.

Tax losses from cessation of activities at a private school, reductions in the agriculture and tourism sectors, and the loss of some property taxes would be greater than the \$3.5 million generated by the industry.

Health Implications:

In the 1980s the EPA studied a number of active and inactive uranium mine sites by collecting soil and water samples and taking measurements at sites in four states (Colorado, New Mexico, Texas, and Wyoming). The information was used by the EPA to develop models for mines and mills regarding their average impact on public health. Using these models, in 1983 EPA estimated the health effects to populations within 50 miles of each mine,

²⁹⁶ This assumes a median home price of \$81,000 and one acre of land valued at \$3,000.

²⁹⁷ Estimated Tax Rate (\$0.52 per \$100 value)

²⁹⁸ Chmura assumes a complete 10 percent loss in year 1. This percentage declines to an 8 percent loss in year 2, a 6 percent loss in year 3, a 4 percent loss in year 4, and a 2 percent loss in year 5.

and on a hypothetically ‘most exposed’ individual living one mile from an inactive surface and underground mine.²⁹⁹ The following table indicates the number of localities in relation to their distance from the mine site, and their corresponding population figures.

Table A6.1: Population estimates for a given distance from Coles Hill

Radius (miles)	Population	Number of Virginia Cities/Counties
1	<100 (estimate 70)	1
2	311	1
5	2,730	1
10	15,718	2
50	742,391	18

In 1989, the EPA conducted risk assessments for active underground uranium mines and surface uranium mines as well as for uranium milling operations.³⁰⁰ The table below summarizes their estimates of the public health risks associated with uranium mining as they relate to radionuclides and carcinogens.

Table A6.2 EPA Health Risk Model

	1-Mile Radius Maximum Exposed Individual	50-Mile Radius Average Exposed Individual
Inactive Surface	3.4 cases in 100,000	6.3 cases in 100,000,000
Inactive Underground	2.0 cases in 100,000	8.6 cases in 100,000,000
Active Surface	4.8 cases in 100,000	6.6 cases in 100,000,000
Active Underground	4.4 cases in 1,000	5.5 cases in 10,000
Mill Tailings Site	1.6 cases in 10,000	7 cases in 10,000,000

Most relevant to this study are the results from an active underground uranium mine and an active uranium mill. Scenario 4 is identical to scenario 3, except that the additional risk of cancer cases for an active underground mine

²⁹⁹ “Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining” V2 EPA 2007

³⁰⁰ “Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining” V2 EPA 2007

and uranium mill for the maximum exposed person (4 in 1,000 and 1.6 in 10,000 respectively) is applied to the entire population of the 50-mile radius (742,291). This gives an estimated 3,385 additional cancer cases over a lifetime (approximately 75 years) which yields about 45 additional cancer cases per year, until the site is remediated and exposure to uranium and its byproducts returns to safe levels. The costs of treating these additional cancer cases—presumed to be primarily lung cancer—is estimated at \$1,458,000 per year. Chmura estimates these health-related costs to linger 10 years after the Coles Hill site is closed. This estimate is based on research by the National Cancer Institute which shows that the cost of treating lung cancer is \$32,400 per patient per year in 2010.³⁰¹ Again, this is entirely speculative, and Chmura can in no way conclude that increased cancer rates will definitely be associated with the Coles Hill uranium mine and mill. Chmura is simply including the costs of these additional cases—as one of many assumptions—to be part of an alternative scenario. This analysis takes a narrow view of the “costs” associated with cancer treatment—for instance, lost productivity, emotional stress, and end of life arrangements are excluded. Similarly, this estimate does not include any potential costs associated with either the challenging of or payment to settle any civil suit that may result from claims of adverse health effects, if any, brought about by the operation of the Coles Hill uranium mine and mill. Therefore, the estimate is conservative and may underestimate the true costs of the increase in the number of cancer cases. Similarly, we did not model the cost of any increase in non-cancerous respiratory diseases, although at least one study suggest these types of diseases could occur with the same frequency of that of lung cancer.³⁰²

Table A6.3 Estimates of cancer cases per year

		Maximum Exposed Individual Lifetime Cases (75 years)	Average Exposed Individual Lifetime Cases (75 years)	Total Cases per Lifetime (approx 75 years)	Additional Cancer Cases Per Year
50 mile population =	742,391	3,385.3		3,385.3	45.1

Remediation Spending and Costs to Other Localities

Chmura necessarily assumes that because the level of environmental impact has increased (it is characterized in this scenario as “severe”) so to must the costs of remediation. In this case, Chmura utilizes the figures from a more recent 2002 IAEA/OECD study that suggests the cost of remediating a site is greater than \$1.13 per ton of mill tailings.³⁰³ In this study, the IAEA and the OCED jointly determined that the costs of uranium clean-up was about

³⁰¹ “Projections of the Cost of Cancer Care in the United States: 2010–2020” National Cancer Institute, 2011

³⁰² “Exposure Pathways and Health Effects Associated with Chemical and Radiological Toxicity of Natural Uranium: A Review” Doug Brugge, et al., 2005.

³⁰³ “Environmental Remediation of Uranium Production Facilities” IAEA/OECD, 2002

\$2.90*³⁰⁴ (\$3.82 adjusted for inflation) per metric processed ton of mill tailings in the United States. In the case of Coles Hill, because VUI estimates that there is about 28.9 million U.S. tons of ore to be processed (approximately 26,303,000 metric tons,) the remediation efforts are estimated to cost \$76.2 million, which is more than five times what VUI currently plans to fund for site remediation. This remediation spending would generate approximately \$187.6 million in economic impact (direct, indirect, and induced), and because of this additional spending, the total annual economic impact of scenario 4 (\$139.9 million) is slightly above that of the baseline scenario (\$136.6 million).

Chmura further assumes that VUI will only be bonded for an amount equal to twice its estimated remediation spending estimate of \$14.9 million. Therefore, Chmura assumes that Virginia environmental agencies will fund any remediation efforts in excess of \$29.8 million.^{305 306} Given these assumptions, this will leave an approximately \$46.4 million one-time charge for state agencies to pay for with general tax revenues. Chmura further estimates that an additional 10 percent of this amount will need to be spent in total by nearby municipalities or counties for various issues relating to the remediation efforts. This one-time cost of \$4.6 million would most likely be borne by nearby downstream municipalities.

Summary & Net Economic Benefit

The net annual economic impact of this scenario would be roughly even at its worst, and the number of jobs destroyed could be negative for a period of time. The \$142.2 million in positive economic impact and 1,091 jobs would have to be weighed against the loss of property values (-\$76.9 million), a private school closure (-\$17.4 million), closure of a large manufacturer (-\$400.8 million), state remediation spending (-\$1.2 million), public health costs (-\$1.5 million), and a temporary but acute period of distress for the agriculture and tourism sectors (-\$191 million) and the total loss of more than 4,500 jobs statewide from all these sectors. Under the assumptions of this scenario, the annual economic losses are close to 5 times as large as the economic value the Coles Hill site provides, with the largest single factor being the loss of the large manufacturer.

Under this scenario, even if the Coles Hill site would operate for the full 35 years generating roughly \$5.1 billion in accumulated economic gain, the permanent loss of both the manufacturer (\$10.0 billion) and the private school (\$870 million), a period of diminished agriculture and tourism, accumulated loss in property values, and healthcare costs of more than \$11.7 billion would yield a net accumulated loss close to \$6.6 billion*.³⁰⁷ In the case where this level of environmental contamination was reached after the Coles Hill site had been operating only ten years, the net accumulated benefit would be \$1.4 billion and the net loss would top \$10.3 billion to Virginia.

³⁰⁴ This represents an average of the mine and mill site $(\$2.69 + \$3.10) / 2 = \$2.88$

³⁰⁵ $\$14.9 \text{ million} \times 2 = \29.8 million .

³⁰⁶ It is possible these costs could be passed off to Federal agencies, as the NRC typically takes possession of tailings sites, but these remediation costs most likely represent unfunded liabilities that will ultimately fall to taxpayers to fund.

³⁰⁷ *This estimate does not employ a discount rate. A positive discount rate would lower this figure as the losses associated with the closure of both the school and the manufacturer are well in the future, while gains from the Coles Hill site are front-loaded. However, the overall conclusion of a large net loss is not affected by the utilization of any reasonable discount rate.

A.7. Public Health and Environment

A.7.1. Case Studies of Denison Underground Mines

Denison Mines Corporation (TSX: DML; NYSE AMEX: DNN) is currently an investor in the Coles Hill project via a joint venture that Denison has in place with Virginia Uranium Incorporated. This partnership, together with the fact that Denison's CEO serves on the board of the joint venture, gives Chmura justification to assume that Denison will be the mining and milling partner if the Coles Hill project moves forward. However, VUI has not made any formal announcement that Denison will be a partner in the operational aspects of running the Coles Hill project at this time.

Denison's corporate structure is understandably complex, given its industry integration and global portfolio of exploration projects. Denison has its primary uranium interests in properties in northern Saskatchewan. The Company owns interests in two mills: 100% in White Mesa mill in Utah and 22.5% in McLean Lake mill in Saskatchewan. In addition to the milling of uranium, the Company also produces vanadium in the United States. The Company has global holdings in several countries at this time that it believes will provide future production in the years to come. Denison is also associated with the Uranium Participation Corporation (TSU:U) – primarily a financing and investment arm – and is involved in the environmental and decommissioning services through its division Denison Environmental Services (DES).³⁰⁸ It also maintains an office in Denver, Colorado, and some of its strategic holdings in the western United States are detailed in sections to follow.

Denison, if partnering with VUI on the mining and milling operations at Coles Hill, becomes relevant to this research because VUI is likely to look for an experienced partner in order to make Coles Hill a successful project. And, in keeping with the case study approach, Denison provides a very good cross-section of information with which to review. Denison, as it has in the past, is now currently defending its performance with various federal agencies. From Chmura's research, this is not unusual; nor does it make Denison a bad operator per se. However, using several incidents as case studies provides a better understanding of some of the issues that can occur with uranium mining and milling.

Chmura has selected 3 peer mines (underground) related to Denison, and has also reviewed 4 mines with international recognition (see Attachment 7.13).

A.7.1.1. CASE STUDY #1: "Arizona 1, Mohave County, Arizona"

Arizona 1, Mohave County, Arizona, is currently the only traditional underground uranium mine in operation in the United States, and is operated by Denison Mines (USA) Corp. It is currently the only traditional underground uranium mine operating in the United States at this time. The mine is approximately 10 miles north of the Grand Canyon, 12 miles from the Colorado River, and approximately 35 miles southwest of the town of Fredonia, Arizona. The mining of high-grade ore (0.58% U) began in December of 2009, utilizing the existing 1,252-foot deep two-compartment shaft, by long hole and shrinkage stoping methods. The mining rate is expected to be 335 tons per day with operations 4 days per week. Total production is expected to be 857,000 pounds U₃O₈. The ore is mined and trucked to a mill in Blanding, Utah – also owned by Denison and the only currently operating uranium mill in the United States – which is 315 miles from the mine.³⁰⁹ The proximity to the Grand Canyon and the Colorado River has created environmental and historic concerns. U.S. Interior Secretary Ken Salazar has proposed a 20-year

³⁰⁸ Please see: <http://www.denisonmines.com/Document/Details/3>.

³⁰⁹ Please see: http://azdailysun.com/news/local/state-and-regional/article_94ceacc4-005e-11df-8ee1-001cc4c03286.html.

moratorium on new mines. Five Arizona Native American tribes have voiced opposition to uranium mining near the Grand Canyon National Park. Opposition groups failed in U.S. District Court to stop the reopening of the mine.³¹⁰

Mining at Denison's Arizona 1 started in January 2010. In May 2010, however, the EPA determined the mine was operating illegally, as the company did not secure the necessary federal approval before ventilating the mine or testing for emissions. In June 2010, a court denied a Preliminary Injunction to suspend operations at the mine; environmental organizations had claimed that potential impacts on endangered species had not been considered. The mine is in operating status at the time of this research.

In 2010, EPA issued a 'notice of violation' to Denison for failing to notify EPA before it resumed mining operations. Denison had resumed mining at the site after twenty years of inactivity. EPA issued the violation because the authorization from a previous owner is not transferrable, in this case to Denison.³¹¹ The president of the company stated that he was working with regulators to address those issues. Later in 2010, the Arizona Department of Environmental Quality (ADEQ) found 38 possible mine safety violations at Arizona 1. The company is contesting the findings. The ore can be sold internationally and some will likely be shipped to South Korea for the Korea Electric Power Corp, which as of April 2009 owned 20% of Denison Mines.

Demographic Data

Coconino County, AZ (population 129,849) has a land area of 18,617 square miles while Pittsylvania County, Virginia (population 38,590) is only 971 square miles. The population density in the Danville-Martinsville MSA (where Coles Hill is located) is about 40 people per square mile; the population density in the Flagstaff MSA is about 7 people per square mile (where Arizona 1 is located), representing a significant difference in the order of magnitude (nearly 6 times). Flagstaff, AZ is the county seat for Coconino while Chatham is the county seat for Pittsylvania County. Flagstaff is the economic center for the metropolitan statistical area (MSA) while Danville is the center for the Danville-Martinsville MSA. The closest town to Arizona 1 is Fredonia, about 35 miles from the mine, and home to 1,000 residents.

Health Care

Arizona has 8 Level I Trauma Centers in the state. With 5 of them located in Phoenix, distance is an issue: Phoenix is 319.2 miles and 7 hours 26 minutes from Fredonia. There are only two Level I Trauma Centers in Arizona that are not in Phoenix:

- Scottsdale Healthcare – Osborn, AZ – a distance of 330.5 miles and 7 hours 27 minutes
- University Medical Center – Tucson, AZ – a distance of 436.3 miles and 9 hours 3 minutes

The closest Trauma Center is a Level II at Flagstaff Medical Center, which is 189.1 miles and 5 hours 44 minutes from Fredonia.³¹²

The closest "verified" burn center is the Arizona Burn Center at Maricopa Medical Center in Phoenix, a 19-bed specialized unit, that is approved (verified) by the American Burn Association (ABA) and the American College of Surgeons (ACS). It is also a Level I Trauma Center. However, the facility is 319.2 miles from Fredonia, so the 7

³¹⁰ Please see: <http://www.wise-uranium.org/upusaaz.html>.

³¹¹ The Associated Press: "EPA Says Ariz. Uranium Mine Operating Illegally," May 4, 2010.

³¹² Please see: <http://www.facs.org/trauma/verified.html>.

hours and 26 minutes it takes to drive from Fredonia to Phoenix would not be satisfactory; helicopter transport would be mandatory.

A.7.1.2. CASE STUDY #2: “The La Sal Complex, San Juan County, Utah”

The La Sal Complex, San Juan County, Utah consists of the Beaver Shaft, La Sal, and Snowball Mines that are connected underground to the Pandora Mine. The Beaver Shaft is situated on private land and both Snowball and La Sal are on Bureau of Land Management (BLM) land. Both the Beaver and La Sal mines began operation in 1970; all three (including Pandora) are owned by Denison Mines (USA) Corp, but Pandora is operated by Reliance Resources LLC of Moab, Utah. Denison requested that the three mines be considered as one and regulated as one; hence, its designation as a “complex.” The Beaver Shaft is less than one half mile from the town of La Sal and one of the mines’ vents is approximately one quarter of a mile from the center of town. As is typical, there are a number of other uranium mines in the general area.³¹³ An affiliated company, Laramide Resources, has filed its plan to reopen its La Sal mine. Laramide La Sal Inc. has filed its plan to reopen the La Sal #2 mine for uranium sampling “to confirm the geologic and metallurgic character of the mineral resource,”³¹⁴ although the mine was reclaimed in the 1980s. The ore would be sent to the Denison White Mesa mill for processing, which is 60 miles from the mine. Comments are due by June 6, 2011.³¹⁵ The WISE Uranium Project lists all three facilities (both mines and the mill) as currently “idle.”³¹⁶

Laramide Resources acquired the La Sal project in 2010 from Homestake Mining, a wholly owned subsidiary of Barrick Gold Corporation. The mine site is 60 miles from the White Mesa mill at Blanding, Utah – owned and operated by Denison Mines; the mill is one of only four permitted mills in the United States and the only one currently operating.³¹⁷

Laramide’s primary focus is its “flagship asset”: the Westmoreland Uranium Project in Queensland, Australia. Laramide “is a uranium development company offering low-cost, low-technical risk production in proven jurisdictions.” The company is headquartered in Canada. Westmoreland is one of the ten largest uranium deposits in Australia and only one of a few not under the control of a major mining company (Laramide refers to itself as a “junior mining company.”)³¹⁸ Denison, through its “Ore Buying Program,” enables small mines to have access to its milling operations.³¹⁹

Demographic Data

The closest town is La Sal, approximately 7 miles south of the mine site.³²⁰ The population in 2009 was 395. The land area is 45.84 square miles with a population density of 7.39 people per square mile in 2000.

³¹³ Please see the Denison 2010 Compliance Report:

http://www.uraniumwatch.org/lasalmines.ut/denison_subpartBannualreport_2010_lasalmines.110331.pdf.

and the Denison Plan of Operations Amendment: http://www.fs.fed.us/nepa/nepa_project_exp.php?project=34565

³¹⁴ Please see: <http://www.wise-uranium.org/upusaut.html#WHITEM>.

³¹⁵ Please see: http://www.blm.gov/ut/st/en/info/newsroom/2011/april/laramide_la_sal_plan.html.

³¹⁶ Please see: <http://www.wise-uranium.org/uouasa.html#ARIZONA1>.

³¹⁷ Please see: <http://www.wise-uranium.org/upusaut.html#LASALLAR>.

³¹⁸ Please see: <http://www.laramide.com/>.

³¹⁹ Please see: <http://www.wise-uranium.org/upusaut.html>.

³²⁰ Please see: <http://www.city-data.com/housing/houses-La-Sal-Utah.html>.

The White Mesa mill, wholly owned by Denison, is located 6 miles south of Blanding and employs about 125 people. The City of Blanding has a population of 3,375 and is also located in San Juan County. Median household income is \$37,212 and median resident age is 24.3 (for the state of Utah: 27.1).³²¹

San Juan County, Utah, has a population of 15,049 (21% urban; 79% rural) with a land area of 7,820 square miles and a population density of 2 people per square mile, which is extremely low. Median household income is \$33,915 and median resident age is 25.5.³²²

Uranium Mining and Milling

There are two mines at La Sal: La Sal and La Sal #2. The La Sal project was previously permitted in the late 1970s and has an existing 1,200 meter access drive which will allow a rapid start-up once permits are granted. La Sal #2 was actually reclaimed in the 1980s. Laramide has applied for a re-opening permit for ore “sampling” per its announcement on April 15, 2011. Both mines are currently listed as “idle” by the BLM. The sampling program calls for the removal of approximately 10,000 to 20,000 tons of ore that would be processed at Dennison’s White Mesa mill.³²³

The Blanding web site lists the manufacturing companies within the city; there are three, including Denison Mines USA Corp (with its White Mesa milling operation), and another company called Recapture Metals, Inc. that specializes in recycling gallium and other metals (the company was founded in 1986 in Blanding and has had Canadian connections since 1988, and owns 50% of a German-based gallium source). The Denison mill permanently disposes of remaining waste in the mill’s licensed tailings cells.³²⁴

The White Mesa mill itself has been controversial, sold several times, endured bankruptcy, and has been the subject of continued upset among three Native American tribes who lost their ceremonial and burial sites in order for the mill to be built on that land.

The U.S. Energy Information Administration reports on a number of uranium issues and included a table in its July 15, 2010 report that confirms the White Mesa mill was “operating – processing alternate feed” for the period from 2005 to 2007. The same report indicates the mill was “operating” during 2008 and 2009.³²⁵

Health Care

Three area hospitals provide service within a reasonable distance from La Sal:

- San Juan Hospital – 36 beds – Monticello, Utah – 15 miles
- Moab Regional Medical Center – 17 beds – Moab, Utah – 23 miles
- Community Hospital – 78 beds – Grand Junction, Colorado – 65 miles

³²¹ Please see: <http://www.city-data.com/city/Blanding-Utah.html>.

³²² Please see: http://www.city-data.com/county/San_Juan_County-UT.html.

³²³ Please see: https://www.blm.gov/ut/enbb/view_project.php?ProjectID=5957&sentinal=view.

³²⁴ Please see: <http://www.denisonmines.com/Document/Details/96>.

³²⁵ Please see: <http://www.eia.doe.gov/cneaf/nuclear/dupr/umills.pdf>.

Moab Regional is a “Critical Access Hospital,” a federal designation for a small rural hospital having fewer than 25 beds and is 50 miles from a tertiary care center. Community Hospital in Grand Junction is a Level IV Trauma Center.³²⁶

The closest Level I Trauma Center is the University of Utah Health Care Center Hospital, a 392-bed state-owned facility that is also a verified Burn Center. Located in Salt Lake City, Utah, it is 269.2 miles and 4 hours 43 minutes from La Sal.

A.7.1.3. CASE STUDY #3: “Elliot Lake” Ontario, Canada

The uranium sites of Elliot Lake, Ontario, Canada, currently are reclaimed and touted as a retirement community. The region has 10 tailings sites and 12 inactive underground uranium mining sites; mining began in the mid-1950s and the last mine was closed in 1992. Algoma (Ontario) became the world’s largest uranium find in 1953, but the mines of Elliot Lake produced low-grade uranium ore. The underground uranium mine with the longest continuous operation was the Denison Mine, which began in 1957 and closed in 1992; it produced 69 million tons (76 metric tons³²⁷) of ore. The mine site is approximately 12.5 km (7.8 miles³²⁸) from Elliot Lake; it has been rehabilitated and the tailings facility is monitored by an environmental services subsidiary of Denison. There are approximately a dozen other closed uranium mines in the area and ten tailings sites. The Elliot Lake uranium mines produced millions of tons of waste, suffered tailings dam failures, and contaminated the entire Serpent River.³²⁹ Denison Mines, Inc. and Denison Energy, Inc. found the decommissioning process of Elliot Lake to be somewhat contentious with the City of Elliot Lake concerning, in part, the information about the transfer of assets and the City’s contention that it did not have access to all the transaction reports. The Canadian Nuclear Safety Commission concluded that Denison was “qualified to carry out the activities that will be permitted under the proposed licenses.”³³⁰

Demographic Data

With the demise of the uranium industry, the city was forced to recreate itself and thus began promoting itself as a retirement community. In 1990, Elliot Lake was incorporated as a city. It is located in the Province of Ontario and the District of Algoma. The area is 269.5 square miles and the population is 11,549 (2006) with a density of 42.7. Population has been steadily declining since 1981. As of 2005, median age is 49.4 years and median income is \$20,111 in Canadian dollars (with the exchange rate as of 4/26/2011 being \$0.9546, median income would equal \$19,198 in U.S. dollars).³³¹

³²⁶ Please see: http://health.utah.gov/ems/trauma/trauma_centers.html.

³²⁷ 1 metric ton (tonne) = 1.10231131 tons.

³²⁸ 1 km = 0.621371192 miles.

³²⁹ Please see: <http://www.miningwatch.ca/en/elliott-lake-uranium-mines> and <http://nuclearsafety.gc.ca/eng/mycommunity/facilities/elliottlake/>.

³³⁰ Please see: <http://nuclearsafety.gc.ca/eng/commission/pdf/Decision-DenisonMines04-01-08-e.pdf>.

³³¹ Please see: <http://www.cityofelliottlake.com/en/cityhall/history.asp>.

Health Care

Health care in the Elliot Lake area is provided by St. Joseph's General Hospital, one of the 16-member institutions that comprise the Catholic Health Corporation of Ontario.³³² The hospital has 58 beds and the hospital staff and area physicians are supplemented by out-of-town specialists.³³³ Access to Level I trauma centers is less than ideal:

...many hospitals participate in initial trauma care, but definitive care is often provided at eight Level I or II referral trauma centers in major cities. The absence of helicopter transport in the province leaves a significant number of inhabitants of suburban communities outside 1-hour road travel catchment times, and the long distances in the province leave a substantial rural and remote population similarly vulnerable.³³⁴

The nearest Level 2 Trauma Center is St. Joseph's Health Centre in Sudbury, a 99-mile drive from Elliot Lake, and part of the same Catholic Health Corporation of Ontario as the hospital in Elliot Lake. Saskatchewan (nearly 1,500 miles away) has a Level 1 trauma center and is a city of over one million residents with a population density of only 4.3. Winnipeg (nearly 1,000 miles away) also has a Level 1 trauma center.

A.7.2. International Underground Uranium Mine Sites

There are several areas that are known for their uranium heritage, including:

- Yangiobod, Uzbekistan – built in the 1950s as a showpiece uranium mining town by the Soviets, it rivaled Moscow for food and clothing. At its boom time, the town had approximately 6,000 people; today's estimate is about 500. Uranium is no longer mined there, but interest has recently been shown by the Japanese. The town is described as run-down, but residents from Tashkent (the capital city with a population of over 2.1 million), are making the two-hour drive to Yangiobod for the cool summers and the snow skiing in the winter.³³⁵ The population of Uzbekistan is very young; about half the population was under nineteen years of age in 1990, which has led to a high population growth rate.
- Straz, Czech Republic – some 60 miles north of Prague, Straz was built for its mining operation, but the population totals only 4,200 people today. The area contains the largest known reserves of uranium in the European Union (at least 70,000 tons). The area is heavily polluted, and the Czech Republic's remediation efforts (which began in 1996) are expected to take 30 more years and cost around \$2.75 billion. During the cold war, forced labor was used to work the uranium mines and supply material to the Russians. Many residents are still employed by the uranium mining company, Diamo. Sensing opportunity, a joint venture called Urania (Australian and Czech) is exploring the old site.³³⁶
- Olympic Dam, Australia – this mine is believed to have the largest uranium resources in the world and is Australia's largest underground mine. Australia is the number three producer of uranium in the world. The mine employs 1,500 workers and 1,500 contractors. The town of Roxby Downs (about 10 miles south of the mine) was built to house the miners and has a population of about 4,000. It is often referred to as the most modern town of the outback and includes numerous leisure and community facilities. The town is

³³² Please see: <http://www.chco.ca/about/memberinstitutions.php>.

³³³ Please see: <http://www.cityofelliottlake.com/en/cityservices/stjosephshospital.asp>.

³³⁴ Please see: <http://www.sfu.ca/gis/schuurman/cv/PDF/accesstotraumasystems.pdf>.

³³⁵ Eurasianet.org, "Uzbekistan: Uranium Mining Town Draws Tashkent Glitterati," October 19, 2010.

³³⁶ The New York Times, "Fear Darkens Czech Uranium Mining Town," November 4, 2010.

unique in Australia; it is a joint venture between the state and the mining company. It opened in 1987.³³⁷ Unlike other countries (including the United States), Australia has never stopped actively exploring and mining uranium and other minerals.

- McArthur River, Saskatchewan Province, Canada – more uranium has been mined in Canada than any other country since the 1940s. In current annual production, Canada is currently in second place, having been overtaken by Kazakhstan in 2009.³³⁸ The third phase of this mine was opened in 1995 when McArthur was converted to an open-pit mine from an underground mine.³³⁹ In 2007 McArthur River Mining (MRM) formed a trust to provide approximately \$32 million to deliver long-term economic and social benefits to the Borrooloola region.³⁴⁰ McArthur is considered to be the world's largest high-grade uranium deposit.

A.7.2.1. CASE STUDY: Subjective QOL Determination – Andújar, Spain

The present paper describes a socioeconomic problem faced by the city of Andújar, Spain. This urban center is located in the province of Jaén in southern Spain with a population of about 40,000. The Andújar uranium mill (AUM) which started in 1959 was the source of employment for the city's population. Throughout the twenty years of operation, there was no problem with social acceptance of uranium issues. After closure of the facility in 1981, there was a growing awareness among the public on matters related to radiological protection, management of mill tailings, and environmental protection. The plan to decommission and rehabilitate the closed mill, which started in 1991, was the source of political debates and sensational journalistic reports that alarmed the population. A commission of the public was eventually formed to study, analyze, and discuss its opinions with Empresa Nacional de Residuos Radiactivos, S.A. (ENRESA), the government agency which is charged with the decommissioning program.

These initiatives have allowed the public to develop a better understanding of the project. It is to be emphasized, therefore, that such an activity (decommissioning and rehabilitation) should go hand in hand with informative and socioeconomic measures explaining exactly the environmental situation of the sites.

Within the framework of this new sensitivity, the citizens of Andújar themselves have, in an orderly and participative manner, requested and promoted actions aimed at restoring the site, going beyond the objectives sought by simple research activities or by requests from environmentalists. When in 1991 the first decommissioning and dismantling tasks had begun at the AUM, certain environmentalist associations and political parties attempted to use the closure and dismantling project to their own ends. Certain sensationalist views aired in the press centered on this issue, generating a sensation of some alarm among the population.

In short, two different perceptions of the matter may be identified:

- The first, adopted by the largest part of the population of Andújar and most of the political and social groups in the city, consisted in viewing the problem in its true dimension and of channeling

³³⁷ BHP Billiton, please see: <http://www.bhpbilliton.com/bb/ourBusinesses/baseMetals/olympicDam/aboutOlympicDam.jsp>

³³⁸ Please see: <http://www.world-nuclear.org/info/inf49.html>, updated March 2011.

³³⁹ Please see: http://www.mcarthurrivermine.com.au/phase3_overview.cfm.

³⁴⁰ Please see: http://www.mcarthurrivermine.com.au/community_benefitstrust.cfm.

efforts towards achieving the best possible solution, thus implying active cooperation with ENRESA.

- The second, adopted by a minority ignorant of the reality and history of the AUM, consisted of both magnifying the problem and comparing the risks involved with those popularly associated with nuclear power plants, thus taking advantage of the special sensitivity existing in Spain in relation to such facilities. The actions taken by those adopting this second standpoint served to create a specific view of the reality of the issue, at times through press editorials, questions to Parliament, and on other occasions by promoting wrong impressions and doubt among the members of the public with regard to questions such as general health or pollution of water supplies.

It was realized that this situation was not a suitable platform from which to undertake the scheduled task of environmental recovery. In order to correct it, it would be necessary to provide objective information on the works and to involve in the decommissioning and dismantling project all those who wished to participate, those who occupied posts of responsibility in the life of the city, and those who enjoyed a level of credibility among the population. To this end a Public Tracking Commission was set up as a channel for direct communications between ENRESA and the people of Andújar. The Commission encompassed political parties, business associations, unions, neighborhood associations, and institutions having responsibilities for environmental issues. The University of Cordoba acted as an independent consultant to the Commission.

The Commission analyzes the reports issued by ENRESA on the progress of the work and the radiological situation of the facility, and at the same time has powers to submit whatever initiatives it considers adequate in order to ensure better understanding among the members of the public of the tasks performed by ENRESA at the AUM.

The following are some of the contributions made:

- Organization of a program of visits to the AUM works
- Visits to certain installations of the UMTRA project in the United States (which are similar in characteristics to the AUM)
- Development of radiological protection courses for those members of the Tracking Commission who wish to widen their knowledge in this area and thus be in a position to analyze in greater depth the information supplied
- Periodic reporting to the media regarding the progress and evaluation of the works
- Organization of informative seminars aimed at different population groups

These initiatives have allowed the public to develop a better understanding of the project than would have been possible if ENRESA had not actively collaborated. Nevertheless there are still messages emanating from outside Andújar which, although no longer alarming its inhabitants, that attempt to portray the city in a negative light.³⁴¹

³⁴¹ Institutional and Social Participation by the City of Andújar in the Decommissioning and Dismantling of the Andújar Uranium Mill. J.A. ARCOS MOYA, Mayor of Andújar , Andújar, Spain.

Andújar has for many years enjoyed the benefit of a facility which provided employment and prosperity. Now, this installation has been closed, and it would be good that the activity that the mill previously undertook were compensated by new economic initiatives.³⁴²

A.7.3. PRIMER: Sampling of Agencies Involved in the Regulation of Uranium

- EPA (succeeding the Federal Radiation Council: 1959 – 1970)
 - National Pollutant Discharge Elimination System (NPDES)
- Nuclear Regulatory Commission (succeeding the Atomic Energy Commission) - 1974
- Department of Energy (succeeding the Energy Research and Development Administration) – 1977
 - Office of Legacy Management
- Department of the Interior
 - Office of Surface Mining
 - Bureau of Land Management
 - National Park Service
- Department of Agriculture
 - National Forest Service (1905)
- Navajo Nation
 - Navajo AMLRP/Uranium Mill Tailings Reclamation Act Department
 - Navajo Nation Division of Natural Resources
 - Navajo Nation Environmental Protection Agency (1995)
- Department of Labor (DOL)
 - CDC
 - MSHA
- Organization of Agreement States (38 total)
 - Council of State Governments
 - Suggested State Regulations for Control of Radiation
- Non-Agreement States (12 total)
- Individual State Departments of Environmental Quality

A.7.4. PRIMER: Sampling of Regulatory Acts Governing Uranium

- Atomic Energy Act (1954)
- Federal Guidance Documents (signed by the President; issued by EPA)
- Clean Air Act (1970)
 - Underground Uranium Mines
 - Department of Energy Facilities
 - Certain non-DOE Facilities
 - Elemental Phosphorous Plants
 - Radon from Phosphogypsum Stacks³⁴³

³⁴² Institutional and Social Participation by the City of Andújar in the Decommissioning and Dismantling of the Andújar Uranium Mill. J.A. ARCOS MOYA, Mayor of Andújar , Andújar, Spain.

- Operating Uranium Mill Tailings
- Radon Gas and Indoor Air Quality Research Act (1986)
- Energy Reorganization Act (1974)
- Indoor Radon Abatement Act (1988)
- Clean Water Act (1977)
- Safe Drinking Water Act (1974)
- Comprehensive Environmental Response, Compensation & Liability Act (1980)
- Superfund Amendments and Reauthorization Act (1986)
- National Oil and Hazardous Substances Contingency Plan
- Toxic Substances Control Act (1976)
- Resource Conservation and Recovery Act (1976)
- Federal Hazardous and Solid Waste Amendments (1984)
- Uranium Mill Tailings Radiation Control Act (1978)
- Solid Waste Disposal Act
- Energy Reorganization Act (1974)
- Nuclear Non-Proliferation Act (1978)
- Low-Level Radioactive Waste Policy Act (1980)
- West Valley Demonstration Project Act (1980)
- Nuclear Waste Policy Act (1982)
- Low-Level Radioactive Waste Policy Amendments Act (1985)
- Diplomatic Security and Anti-Terrorism Act (1986)
- Nuclear Waste Policy Amendments Act (1987)
- Solar, Wind, Waste, and Geothermal Power Production Incentives Act (1990)
- Energy Policy Act (1992)
- Surface Mining Control and Reclamation Act (1977)
- Abandoned Mine Land Program (1997)
- Federal Land Policy Management Act (1976)
- General Mining Law (1872)
- National Park Service Organic Act (1916)
- Navajo Reclamation Plan and Code
- Health Physics and Instrumentation Monitoring Plan

³⁴³ Phosphogypsum is the primary by-product of the wet-acid process for producing phosphoric acid from phosphate rock. It is largely calcium sulfate and has been given the name phosphogypsum. (Gypsum is the common name for hydrated calcium sulfate, a common building material.) Phosphate production generates very large volumes of phosphogypsum, which is stored in huge piles called "stacks" that cover hundreds of acres in Florida and other phosphate-processing states. Source: <http://www.epa.gov/radiation/neshaps/subpartr/about.html>.

A.7.5. Virginia's Climate

Few states have a more diverse climate than that of Virginia. The state has five different climate regions: the Tidewater, Piedmont, Northern Virginia, Western Mountain, and Southwestern Mountain regions. Some localities—Charlottesville, Lynchburg, and Warrenton, for example—have climate amenities such as long growing seasons and infrequent subzero temperature minimums, while winters on the northern Blue Ridge frequently produce bitterly cold temperatures like those of Chicago. Similarly, annual rainfall totals can vary from a sparse thirty-three inches typical of the Shenandoah Valley to more than sixty inches in the mountains of southwestern Virginia.

Virginia's climate results from global-scale weather patterns that are modified by the diverse landscape of the Commonwealth. While detailed discussion of the global-scale contribution is beyond the scope of this report, the state's landscape provides local controls primarily in three ways. First, the Atlantic Ocean and its river of warm water, commonly called the Gulf Stream, play a dominant role in differentiating Virginia's precipitation climate. Winter storms generally move or track from west to east and, in the vicinity of the east coast, move northeastward paralleling the coast and the Gulf Stream. This northeastern path results in part from the tendency of a storm to follow the boundary between the cold land and the warm Gulf Stream Waters. These storms grow rapidly as they cross the coast; and as they move northeastward, moisture-laden air from the storm crosses Virginia from both the east and northeast. The eastern slopes and foothills of the Blue Ridge Mountains are the prime recipients of this moisture. The great coastal storms of 1962, which are remembered primarily because of the high surf and storm surges along Virginia's coast, also produced record snowfalls along the northern section of the Blue Ridge Mountains.

The high relief of the Appalachian and Blue Ridge mountain systems also helps to control Virginia's climate. The influence here originates with the well-developed rainfall pattern that is evident along the great mountains of the western margin of North America. Great quantities of rain fall on these western slopes as moist air from the Pacific Ocean flows eastward, rises, condenses, and precipitates. As the air flows down over the eastern slopes, however, little rain falls and a rain shadow pattern results. Along the Appalachian and Blue Ridge Mountains of western Virginia, this airflow is sometimes from the west and sometimes from the east. When the flow is from the west, the New River and Shenandoah River valleys are in the rain shadow of the Appalachian Mountains; when the airflow is from the east, they are in the shadow of the Blue Ridge Mountains. As a result, both the New River and the Shenandoah River valleys are the driest portions of the state. Regions of equally low rainfall are rare in the eastern United States (although common along the eastern margins of the great plains of the central United States).

The third important local control on climate is the state's complex pattern of rivers and streams, which drains the precipitation that falls and modifies the pattern of moist airflow from which the precipitation falls. These river systems drain the Commonwealth's terrain in all four geographical directions. In far southwestern Virginia, the Clinch and Holston rivers drain south into North Carolina and Tennessee. The New River drains westward into the Ohio River, while the Shenandoah River drains northward into the Potomac. Finally, the Roanoke, James, York, and Rappahannock rivers drain eastward through the Piedmont and into the Tidewater area. The air that flows across Virginia flows either up these river valleys or over the crests of the mountains and down into the valleys. With a southerly flow of air, for example, moist air would move up the Holston River drainage course, and rainfall would increase up the valley with increasing elevation. However, this same southerly airflow would be downhill into the New River drainage course, and on toward the Ohio River basin. This downward flow of air is not conducive to rainfall.

Virginia's wide variety of agricultural products marks the economic benefits of its climate diversity. The close quarters of dissimilar climatic zones also has its costs (sic) have their costs), because the boundaries between zones are not fixed and the year-to-year constancy of conditions is rare. A climate condition typical of one region

might in a given year extend outward into another area. As an example, low rainfall levels typical of the Shenandoah Valley's thirty-three inches per year may extend eastward across the Blue Ridge, out across the Piedmont, and into the Tidewater region. In such a case, drought, crop failure, and economic losses like those of this past summer may be extensive.

A.7.6. Weather Systems

Much of Virginia's rainfall results from storms associated with warm and cold fronts. As mentioned, these storms generally move from west to east, and in the vicinity of the east coast, move northeastward. While a very large number of specific storm histories and storm tracks can occur and a great diversity of precipitation patterns can result, not all are equally common. Storms are most frequently observed to move parallel to the Appalachian or the Blue Ridge Mountains, the coastal zone, and the Gulf Stream, all of which have a northeastward trend, or to move parallel to the Great Lakes and the Ohio River Valley. When storms cross the east coast well to the south of Virginia and move offshore, the heaviest rain usually falls in southeastern Virginia. When these storms become very intense or when they closely skirt the coastline, the strong up-slope winds result in heavy rainfalls on the Blue Ridge. Frequently, frontal storms tracking along the Ohio Valley move across southern Pennsylvania and off the New Jersey coast; as such storms approach the coast, great quantities of moist air flow inland and then southward into Virginia.

When sufficient cold air invades Virginia from the west and northwest, frontal storms may cause heavy snowfalls. Two of the state's most dramatic frontal snowstorms of recent years occurred during the Christmas holidays of 1966 and 1969. In both cases, the Storm tracked along the Gulf and the east coasts and crossed over the Tidewater area; a strong eastward and northeastward flow brought moist air across the state, overriding cold air from the west. While heavy snows are common in the Piedmont region, the coastal areas during an average winter do not have major snowstorms, and heavy winter snows usually are confined to the mountainous areas of the state. As remarkable as it may seem, some of the heaviest snowfalls in the eastern United States occur in the Appalachians of West Virginia, just a few miles west of Highland County, Virginia. More than 2,500 millimeters (100 inches) fall annually in this area; but Virginia, being in West Virginia's snow shadow, receives only a fraction of this amount.

While heavy snowfalls usually result from frontal storms, hurricanes are created by a different weather pattern. Hurricanes and tropical storms are intense cyclones formed within the deep, moist layers of air over warm, tropical waters. Unlike frontal storms, which derive much of their energy from the great temperature contrasts on either side of fronts, hurricanes and tropical storms derive most of their energy from the warm ocean surface. Tropical storms over the low-latitude oceans generally move from east to west. As they move westward, they are displaced farther and farther to the north. Eventually, they enter the westerly airstreams of the mid-latitudes, and then recurve north and eastward. In the vicinity of Virginia, these tropical storms move in a general northeasterly track, like frontal storms; and as they move along this route, they intensify. Those storms that reach an intensity indicated by sustained winds of at least seventy-two miles an hour are classified as hurricanes.

Hurricanes and tropical storms that cross Virginia, including those immediately offshore, occur most frequently in early August and September and rarely appear before June or after November. During the month of September, anywhere from 10 to 40 percent of Virginia's rainfall comes from hurricanes and tropical storms. When Hurricane Camille, Virginia's most notable hurricane of recent times, passed through the state in 1969, upwards of 840 millimeters (33 inches) of rain fell on the eastern slopes of the Blue Ridge in Nelson County and caused record floods along the James River.

Before the turn of the century, hurricane and tropical storm passages across Virginia were relatively common, averaging one per year. From 1905 to 1920, however, a hurricane struck, on the average, only one year in every five. The frequency then increased to about three hurricanes in a five-year period before decreasing again in the 1960s and 1970s. The reasons for these variations are as yet unknown.

Thunderstorms, which occur in all months of the year, are most common in the deep, moist, warm air of tropical origin that is typical of summer. In Virginia, days with thunderstorms are recorded at commercial and military airports. Over the last two decades the state has averaged one thunderstorm day a decade in January, compared with nine thunderstorm days a month in July. Thunderstorm days are most frequent in southern Virginia, particularly in the far southwestern section, while northern Virginia experiences the least number of such storms.

Thunderstorms are also most likely to occur during the warmest part of the day, with 4:00 p.m. the most probable time of occurrence. In Roanoke, for example, thunderstorms occur ten times more frequently at 4:00 p.m. than at 10:00 a.m. and five times more frequently at 4:30 p.m. than at 7:00 p.m. In Norfolk, thunderstorms are also most frequent at 4:00 p.m., remaining common there until about midnight. Thunderstorms produce complex patterns of rainfall, such that areas of heavy rain may be next to areas with little or no rain.

Table A.8.1 Virginia Long-Term Average Temperature and Precipitation (1895-1998)³⁴⁴

Month	Maximum° F	Minimum° F	Average° F	Precipitation (Inches)
Jan	45.8	26.0	35.9	3.13
Feb	47.7	26.7	37.2	3.08
Mar	56.9	34.1	45.5	3.86
Apr	67.1	42.7	54.9	3.29
May	75.8	52.2	64.0	3.99
Jun	82.9	60.2	71.5	3.69
Jul	86.1	64.3	75.2	4.31
Aug	84.6	63.2	73.9	4.14
Sep	79.2	57.0	68.1	3.50
Oct	69.2	45.0	57.1	3.36
Nov	57.8	35.4	46.6	3.21
Dec	47.8	28.0	37.9	3.18
Annual	66.7	44.6	55.7	42.70

³⁴⁴ , “Virginia’s Climate” University of Virginia Climatology Office Newsletter, Bruce P. Hayden and Patrick J. Michaels.

Pittsylvania County, Virginia's largest county in land area (approximately 1,000 square miles), is located in the southern part of the state's Piedmont Plateau, along the North Carolina state line. The county was formed in 1767 from a portion of Lunenburg County and named for William Pitt, Earl of Chatham. By 1800, both the Towns of Danville and Chatham had been chartered. Leaf tobacco, textiles, timber, and agricultural produce have been the county's principal economic activities.

Most of the county has gentle to moderately rolling terrain, but there are some hilly areas along the Dan, Roanoke, Sandy, and Banister Rivers. Land elevations vary from 350 feet upwards to 2,000 feet. The Dan River originates in southern Virginia and meanders across the Virginia-North Carolina State line four times within Pittsylvania County. The Roanoke River forms the northern boundary of the county and includes Smith Mountain Lake and the Leesville Reservoir. The Banister River, with its headwaters in southwestern Pittsylvania County, drains much of the area.

Upland soils are predominantly deep, well-drained, and gently sloping, with a medium-textured surface above red clay subsoils of the Cecil, Madison, Appling, and Enon series. Floodplains are composed of deep alluvial soils of the Hiwassee, Turbeville, and Congaree series (Commonwealth of Virginia, 1973). Pittsylvania County has a mild climate with an average annual temperature of about 59 degrees Fahrenheit and an average precipitation of 44 inches per year.

Floodplain lands are largely used for agriculture, forestry, and a small number of residences. The Dan River floodplain includes the City of Danville sewage treatment plant. There is also some development along Fall Creek. The water plant for the Town of Hurt is located in the Roanoke River floodplain. Low-lying areas of Pittsylvania County are subject to periodic flooding from the Roanoke, Dan River Reach 1, Dan River Reach 2, Dan River Reach 3, Sandy, Banister, and Pigg Rivers and their tributaries. The most severe floods caused by the rivers are usually the result of heavy rains from tropical storms or major weather fronts, while floods caused by creeks usually result from local thunderstorms. Major floods in the county occurred in 1912, 1937, 1940, 1944, 1945, and 1972. The August 1940 flood is the maximum flood on record of the Roanoke, Pigg, Dan River Reach 1, Dan River Reach 2, Dan River Reach 3, and Sandy Rivers. Dan River Reach 1, Dan River Reach 2, and Dan River Reach 3 had a maximum flow of 75,000 cubic feet per second (cfs) and a stage of 400.6 feet at the USGS Danville gage. Sandy River had a flow of 23,000 cfs and stage of 475.2 feet measured at the USGS gage approximately 5.8 miles upstream from its mouth at the City of Danville. The 1940 flood approximated the one-percent annual chance (100-year) flood on both rivers. The highest flood on record of the Roanoke River also occurred in August 1940 when the river crested at 543 feet at the USGS gage (U.S. Department of the Interior, 1969). The 1940 flood of the Roanoke River would approximate the 0.2 percent annual chance (500-year) flood in Pittsylvania County due to the effect of upstream reservoirs built since that time. The 1940 flood was slightly less than the one-percent annual chance flood of the Dan and Pigg Rivers and somewhat greater than the one-percent annual chance flood of the Sandy River. The maximum flood on record of the Banister River occurred in September 1944 and approximated the one-percent annual chance flood.³⁴⁵

The June 1972 flood from Tropical Storm Agnes approximated the 2 percent annual chance (50-year) flood along the Dan River. Damage was primarily to farms. The destruction of crops, livestock, equipment, and buildings was

³⁴⁵ Federal Emergency Management Agency Flood Insurance Study, Preliminary, Sept. 30, 2009, Flood Insurance Study Number #51143cv000A.

estimated to be \$1.1 million. Severe flooding and subsequent damage also occurred in September 1996, due to Hurricane Fran, resulting in a disaster declaration for the city by President Clinton.³⁴⁶

Owing to Virginia’s diverse climate, enjoying four distinct seasons, weather changes are frequent and can be intense. The counties surrounding Coles Hill continue to experience strong seasonal thunderstorms which generate high winds, ranging in strength up to 75 knots (86.308 miles per hour). While tornadoes are not a predicted norm for the area, isolated occurrences have caused major property damage and one such storm resulted in a fatality on April 27, 2011 near Nathalie (Halifax County). Estimates by the National Weather Service rated the tornado as an EF-2, with winds of approximately 120-125 mph, and a swath of destruction measuring 350 yards wide by 8½ miles long. The fatality occurred less than 20 miles from the proposed mine and mill complex.

A sample of extreme weather events (damaging winds, usually related to thunderstorms, frontal advances, etc.) by location (the writer measured their proximities to Coles Hill) in Pittsylvania County compiled by the National Climatic Data Center of the U.S. Department of Commerce include:

Table A.8.2 Sample of Extreme Weather Events in the Vicinity of Coles Hill

Location	Date	Wind Speed	Time of Day	Distance from Coles Hill
Chatham	3 March 2003	60 knots (69.047 mph)	6:30 PM	6.5 miles SE
Hurt	9 May 2003	75 knots (86.3 mph)	3:33 PM	14 miles north
Hurt	9 May 2003	65 knots (74.8 mph)	4:15 PM	14 miles north
Countywide	12 June 2003	70 knots (80.555 mph)	12:30 PM	Countywide
Chalk Level	28 May 2010	55 knots (63.2 mph)	6:50 PM	3 miles north
Keeling	16 July 2010	50 knots (57.5 mph)	3:03 PM	11 miles south
Whittle(s)	18 July 2010	50 knots (57.5 mph)	3:30 PM	5 miles west
Sheva	20 July 2010	50 knots (57.5 mph)	3:44 PM	2.3 miles SE
Keeling	25 July 2010	50 knots (57.5 mph)	5:35 PM	11 miles south
Blairs	25 July 2010	50 knots (57.5 mph)	5:45 PM	14 miles south
Blairs	29 July 2010	50 knots (57.5 mph)	4:59 PM	14 miles south
Riceville	22 Sept. 2010	60 knots (69 mph)	5:55 PM	6.3 miles east

³⁴⁶ Federal Emergency Management Agency Flood Insurance Study, Preliminary, Sept. 30, 2009, Flood Insurance Study Number #51143cv000A.

While there are no measurable patterns to the random events listed above (other than afternoon hours), nor any attempt to establish the same, it is apparent that thunderstorms and attendant high winds are fairly common and probable in the area of study and in that region of Virginia. That being the case, any mining and milling operation would have to be engineered, constructed, and maintained with Virginia's specific weather trends in mind. Uranium waste piles in Moab, Utah, for example, do not contend with the frequency and amount of moisture, frequent thunderstorms, and attendant wind that a Southside Virginia operation must contend with to protect the area's environs and inhabitants from radiation dangers. The large Atlas milling operation site closed since 1984 (formerly The Uranium Reduction Company) in Moab, for example, is located at approximately 4,025 feet (high desert) along the Colorado River, and the area receives on average only 9.01 inches of rain and 9.8 inches of snow annually as contrasted with Chatham, Virginia, at 663 feet, which averages 43.7 inches of rain and 9.9 inches of snow annually.

A.8. Social Impacts

A.8.1. Material Changes Affecting Virginia Uranium

The legal entities that comprise mining operations and investment partnerships are fairly complicated and challenging to follow; Virginia Uranium is no different.

By its incorporation in Canada, as with any other country of incorporation, certain regulatory filings are required. In Canada, one of these filings is referred to as "Form 51-102F3 Material Change Report" and Chmura has reviewed quite a few of these, dating from the year 2000. Similar to the State Corporation Commission (SCC) in Virginia, or the Securities Exchange Commission (SEC) for the United States, an organization called "Industry Canada" performs similar informational and regulatory functions for companies operating in Canada.³⁴⁷

In the case of Virginia Uranium, Chmura used the Material Change Reports, together with the Company's own newsletters and various news articles, to derive understanding of the three entities outlined above. The current operating company ("Resources") involved numerous transactions – some of what is believed to be the more significant of these are detailed below:³⁴⁸

- Troymin Resources Ltd. entered into option agreements with Kennecott Canada Exploration, Inc. in December 1966.
- Santoy Resources Ltd. and Troyman Resources Ltd. created a new company called Santoy Resources Ltd. in April 2003. (The press release termed the event an "amalgamation" which gives some indication of the various assets and partnerships that are created.) Troyman had ownership interest in assets that Santoy wanted to pursue: Nickel-Copper-Platinum Group Metal properties in Quebec, Alaska, and in Mexico.
- Santoy Resources Ltd. acquired 1,000,000 shares of Boss Power Corporation, increasing its 35.8% ownership to 37.18% in October 2007. Boss Power was the 100% owner of the Blizzard uranium mine, a well-known historically reported uranium resource. Santoy announced that it will not seek control of Boss.
- Santoy Resources Ltd. proposed a \$5 million private placement in November 2007 for the purposes of advance exploration on the Company's uranium exploration portfolio in Saskatchewan, Manitoba, in the Otish Mountains of Quebec, and the Central Mineral Belt in Labrador.

³⁴⁷ Please see: <http://www.ic.gc.ca/eic/site/ic1.nsf/eng/home>.

³⁴⁸ Please see: www.Sedar.com for information on Material Change Reports for Canadian firms.

- Santoy Resources Ltd. and its 50% joint partner, Mega Uranium Corp, announced the results of its drilling at Mustang Lake and Bruce River Properties in the Central Mineral Belt of Labrador in February 2008. Because of the poor results from the initial drillings, Santoy elected not to participate in the next phase of the program, but to focus its efforts on its 100%-owned properties.
- Santoy Resources Ltd. and its 50:50 Joint Venture partner, Wescan Goldfields, Inc. announced in March 2008 its progress on the exploration of six individual project areas, five of which are in the Athabasca Basin, Saskatchewan.
- Santoy Resources Ltd. announced in March 2008 the commencement of a drilling program at its 100%-owned Burbidge Lake uranium project near Key Lake Mine in northern Saskatchewan.
- Santoy Resources Ltd. announced in April 2008 that the news release by British Columbia Minister for State for Mining has negatively impacted the value of Santoy's equity investment in Boss Power Corp.
- Santoy Resources Ltd. announced in June 2008 that its 50:50 joint venture drill program, with Mega Uranium Ltd. on the Mustang Lake in the Central Belt of Labrador had produced positive indications. Mega Uranium Ltd. is the operator.
- Santoy announced in August 2008 that it has entered into an Option Agreement with Xemplar Energy Corp. to acquire up to 100% interest in 1,241 claims in the Otish Basin, Quebec.
- Santoy announced in December 2008 the signing of a Letter of Intent with two private companies whereupon Santoy will acquire all of the shares of Virginia Uranium Ltd., a private Yukon corporation, in exchange for shares in Santoy at the ratio of 6 shares of Santoy for one share of Virginia Uranium Ltd. Virginia Uranium Ltd. currently holds a 12% minority interest in VA Uranium Holdings, Inc., a Yukon corporation. Virginia Uranium Holdings owns 100% of Virginia Uranium Inc., a Virginia corporation and controls the development and operating rights of the Coles Hill uranium property. Santoy is pleased with this transaction as it gives it "a significant position in a uranium project situated in a stable political location. At the same time, (Virginia Uranium Ltd.) shareholders will gain diversification and will benefit from Santoy's exploration properties." The acquisition complements Santoy's portfolio of uranium exploration properties.
- Santoy announced in February 2009 the formal business combination agreement, which is scheduled to close in July 2009 and will combine Santoy and Virginia Uranium.
- Santoy announced in July 2009 the completion of the first tranche of private placement financing (in the approximate amount of \$2 million). A second and final tranche of \$2 million is scheduled to be completed next week. A portion of this proposed financing will be applied to Santoy's equity position in VA Uranium Holdings, Inc.
- Santoy announced in July 2009 the completion of the business combination of Santoy and Virginia Uranium Ltd. After closing, Santoy will have approximately 54,377,279 common shares outstanding, will have changed its name to Virginia Energy Resources, Inc., and will hold a 20.8% interest in VA Uranium Holdings, Inc.
- Santoy announced on July 23, 2009 that it had completed its business combination with privately held Virginia Uranium Ltd. and changed its name to Virginia Energy Resources Inc., had consolidated its issued share capital to approximately 54,377,279 common shares outstanding, and will hold a 20.8% interest in VA Uranium Holdings, Inc. (which is expected to increase to 22.2%). The new company will change its trading symbol on the TSX Venture Exchange from SAN to VAE.
- In the same July 23, 2009 release, the new board of directors for the combined Santoy/Virginia Uranium business was announced. The board would consist of 7 directors – 3 from Virginia Uranium and 5 from Santoy – with Walter Coles, Sr. serving as Chair and Norm Reynolds serving as CEO, replacing Santoy CEO Ron Netolitzky, who will remain active on the new board.
- The executive team for the combined company will consist of Norm Reynolds, President and CEO; Walter Coles, Jr., Executive Vice President; Karan Allan, CFO; and Mike Cathro, VP of Exploration.
- Virginia Energy Resources announced on September 16, 2009 the completion of a 7-week exploration program on its Otish Basin properties in north-central Quebec and signed an agreement to acquire

- nearby Strategis property from Big Red Diamond Corporation, consisting of 10 claim blocks at the Proterozoic Otish basin. The acquisition terms require Virginia to pay \$50,000 on signing and to issue \$180,000 shares in stock within four months of signing. Big Red agrees to finance an approved work program at the Strategis property.
- The majority of Virginia's 2009 program was directed toward defining drill targets on four properties under option from Xemplar Energy Corporation. As part of the agreement with Xemplar, Virginia issued 600,000 post-consolidation shares in July 2009. In order to complete the acquisition of a 60% interest in the properties, Virginia must expend \$1.5 million on exploration prior to the second anniversary of the agreement (July 2010) – approximately \$1.3 million has already been spent to date. Upon completion of that work commitment, Virginia has the choice of initiating a 60% Virginia – 40% Xemplar joint venture in which Xemplar will be carried for the first \$1 million in expenditures, or Virginia can deliver 1.2 million post-consolidation shares to obtain 100% interest in the property.
 - Virginia announced on October 5, 2009 the results of re-sampling the historic drill core from the early 1980s on 3 prospects on its Peribonka property in the Otish Basin of north-central Quebec. The results confirm analogous findings to the nearby deposits of Strateco Resources Inc. and Abitex Resources Inc. The 3 successful prospects are: Lac du Castor, Lac Tion, and Lac Tete.
 - Virginia announced on October 28, 2009 the re-sampling of the historic drill core, Peribonka Uranium Property, Otish Basin, Quebec. The terms by which Virginia could earn its 100% interest in the Strategis property from Big Red were outlined in the September 16, 2009 Material Change Report (above).
 - Virginia announced on January 15, 2010 that it was exercising its option for 100% interest in the Otish, Quebec uranium property. The terms were announced in a previous Material Change Report (above). The parcel includes 4 claim blocks: Lorenz, Trident, Cigare, and Peribonka. To complete its acquisition, Virginia will deliver 1.2 million common shares to Xemplar.
 - Virginia announced on February 3, 2010 in a Material Change Report that Virginia Energy was to increase its equity in the Coles Hill Uranium Deposit; however, no details were given in the report. The report focused primarily on the Commonwealth's studies in conjunction with the moratorium, President Obama's 2010 State of the Union address, and Governor McDonnell's 2010 State of the Commonwealth address, whereupon energy issues were highlighted.
 - Virginia announced on March 16, 2010 the closing of the final tranche of a \$400,000 private placement. A total of 333,333 shares were issued at a price of \$0.30 per share for a total gross proceed of \$100,000. The funds will be allocated to the uranium exploration in the Athabasca Basin of Saskatchewan and the Otish Basin, Quebec properties.
 - Virginia announced on April 9, 2010 that Golden Band Resources Inc. will buy back Virginia's (formerly Santoy's) 8% interest in several of Golden Band's advanced gold exploration projects in northern Saskatchewan. The acquisition will result in Golden Band again owning 100% of these properties. Golden Band will pay to Virginia \$750,000 cash and 7,500,000 common shares at a deemed price of \$0.40 per share to extinguish a further \$3,000,000 repurchase price. Virginia agreed to a \$250,000 reduction in the cash payment. It is noted that Golden Bank and Virginia have two common directors.
 - Virginia announced on May 19, 2010 that it would acquire 4 million shares of VA Uranium Holdings from a company controlled by Norman Reynolds (a director and officer of Virginia) in exchange for 4,400,000 shares of Virginia. This transaction will increase Virginia's interest in VA Uranium Holdings from 26.2% to 29%. After completion of the 2010 funding agreement, Virginia will hold a 31.2% interest in the Coles Hill deposit via VA Uranium Holdings.
 - Virginia announced on October 18, 2010 that results of its preliminary economic assessment indicates outstanding profitability potential for the Coles Hill uranium project in Virginia. Part of the study included an evaluation of mining types: open-pit or underground; analysis recommended underground (although open-pit was not precluded). Note that this Material Change Report was the first to list Walter Coles, Jr. as President and CEO, replacing Norm Reynolds.

- Virginia announced on November 2, 2010 that it has granted 5,100,000 stock options to officers, directors, employees, and consultants of the company. The options are set for a period of 5 years and will allow the holder of the stock option to purchase at a price of \$0.37.
- Virginia announced on November 9, 2010 that Sprott Resource Corp. agreed to join Virginia as Strategic Partners in the Coles Hill Uranium Project. Sprott will acquire a 19.9% stake in VA Uranium Holdings to become a new strategic partner. Virginia has 90 days to exercise a preemptive right to invest into VA Uranium Holdings on the same terms as Sprott in order to maintain its 28.5% ownership position in Coles Hill through VA Uranium Holdings. Sprott will invest approximately C\$6 million (Canadian Dollars) of new funding into the project. Also, certain shareholders of VA Uranium Holdings have committed to exchanging shares of VA Uranium Holdings for shares in SRC so that SRC will attain a 19.9% participation level in VA Uranium Holdings. Virginia fully anticipates that it will invest approximately C\$2 million to maintain its 28.5% ownership stake in the project.
- Virginia announced on November 11, 2010 a \$5 million syndicated private placement led by Cormark Securities Inc. and including Bayview Capital Partners, Ltd. and Dundee Securities Corp. The underwriters have agreed to purchase 12,500,000 common shares at a price of \$0.40. The underwriters also have the option to purchase up to an additional 1,875,000 common shares for additional gross proceeds of up to \$750,000 at the price of \$0.40 per share. This Material Change Report contained a notice: “NOT FOR DISSEMINATION IN THE UNITED STATES OR FOR DISTRIBUTION TO U.S. WIRE SERVICES...”
- Virginia announced on November 25, 2010 that it had acquired the 2,000,000 shares of VA Uranium Holdings from a company (Marmot LLC) controlled by Norm Reynolds, a director and officer of the company in exchange for the issuance of 2,200,000 common shares of Virginia. (See announcement May 19, 2010 above – the transaction was half of what was originally reported.) The transaction increases the Company holding in Virginia Uranium from 28.5% to 29.9%. Following this transaction, Mr. Reynolds continues to hold 3,279,600 common shares of Virginia representing 4.1% of the company’s shares and Marmot holds 2,200,000 common shares representing 2.8% of the company’s shares.
- Virginia announced on December 2, 2010 a \$2 million private placement. The purpose was to raise up to \$2 million for stock sold at a price of \$0.50 per share. Funds will be allocated to advancement of the Company’s uranium exploration properties in the Otish Basin and the Athabasca Basin.
- Virginia announced on December 13, 2010 the closing on a bought deal financing. As previously announced in November 2010, a syndicate of underwriters led by Cormark Securities Inc. on behalf of a syndicate including Bayfront Capital Partners, Ltd. and Dundee Securities Corp. After closing on its option and paying the underwriters a 6% commission, the Company received gross proceeds of \$5,750,000 which will be invested in VA Uranium Holdings, Inc. for exploration on the Company’s Saskatchewan properties and general corporate expense.
- Virginia announced on December 16, 2010 the completion of the \$2 million private placement. In the same press release, the ‘About Virginia Energy Resources, Inc.’ section read as follows: “Virginia Energy Resources, Inc. is a uranium development and exploration company. The Company holds a 29% stake in the advanced stage Coles Hill uranium project in Virginia. Additionally, the Company is pursuing active exploration programs in the Athabasca Basin on its Murphy River and Hatchet River uranium properties, which are held in a 50-50 Joint Venture with Denison Mines Ltd., and its 100%-owned uranium in the Otish Basin of Quebec. The Company is also a 37% shareholder of Boss Power Corporation.”
- Virginia announced on December 21, 2010 its approval of geophysics and drilling for the Virginia-Denison Hatchet Lake Joint Venture Property in the Athabasca Basin. It is anticipated that “low-cost open-pit mining” will be used.
- Virginia announced on May 30, 2011 that it was proceeding with the Otish Basin drill program utilizing the \$2 million private placement funds (see above). In the same report, the Company announced that it

found it necessary to restate its financial results for 2009 and 2010. Further, the report states: “The Company remains well financed to pursue its corporate goals with \$3.2 million of cash and a stock portfolio with a current market value of \$7.2 million. Virginia Energy Resources owns approximately 30% of VA Uranium Holdings, Inc. and has a pre-emptive right to provide ongoing financing for the Coles Hill uranium project. As of March 31, 2011, VA Uranium Holdings held US\$10.4 million (U.S. dollars) of cash and equivalents. As a result, VA Uranium Holdings is also considered well-financed to advance the Coles Hill uranium project both from a political and technical perspective.”

- o No further Material Change Reports are listed on SEDAR past May 30, 2010.
- o An “Early Warning Report” was issued April 7, 2010 that Pinetree Capital Ltd (TSX: PNP) had made and planned to make investments in Virginia Energy Resources Corp that could result in its holdings of approximately 10% of Virginia.

A.8.2. Explanation of the Company’s Structure

The company – “Virginia Uranium” as it has come to be commonly known – is actually a complex organization, with two Canadian companies and one Virginia company that holds the Coles Hill property. A description of the three companies is as follows:

(NOTE: Chmura has selected the abbreviated names (which will likely differ from acronyms in other studies and reports) and these abbreviations may best explain the function of the particular company and help distinguish it from the others.)

1. VIRGINIA URANIUM INC. (“Uranium”)

“Uranium” controls the mineral rights, surface rights, and leasehold development and operating rights on the Coles Hill uranium property.

Overview

Founded in 2007, “Uranium” is a Virginia corporation and is based in Chatham, Virginia (231 Woodlawn Heights, Chatham, VA 24531). The company is privately held. “Uranium” has 100% equity interest in the Coles Hill uranium deposit.³⁴⁹ “Uranium” states the “majority interest in the company will continue to reside with Virginians so that the Commonwealth and its residents will forever benefit by this unique opportunity.”³⁵⁰

Material Issues

The “Uranium” website states that 78% is to be owned by the Coles and Bowen families, 12% by private investors (31 Virginia Investors), and 10% by employees, management, and directors.³⁵¹

Board of Directors

Walter Coles, Sr. is chairman of “Uranium.”³⁵²

2. VA URANIUM HOLDINGS INC. (“Holdings”)

“Holdings” is the holding company for its 100% owned subsidiary, Virginia Uranium, Inc.

³⁴⁹ Form 51-102F3, Material Change Report, dated February 3, 2010.

³⁵⁰ Please see: <http://www.virginiauranium.com/ownership.php>.

³⁵¹ Please see: <http://www.virginiauranium.com/ownership.php>.

³⁵² Summer 2009 Issue of “The Coles Hill Progress,” published by Virginia Uranium, Inc.

Overview

Founded in 2007, “Holdings” is a Yukon corporation and is based in Chatham, Virginia.³⁵³ “Holdings” owns 100% of “Uranium.” The Coles Family and the neighboring Bowen Family retained a 73% ownership in “Holdings”, and “Resources” is taking a 20.8% ownership in “Holdings.”

Material Issues

Sprott Resources Corp. acquired a 19.9% stake in “Holdings” to become a new strategic partner in the Coles Hill Uranium Project.³⁵⁴ Sprott is a Canadian firm (trading on the TSX as SCP), whose primary purpose is to invest and operate in natural resources such as uranium.

Board of Directors

The president and CEO of Sprott is a member of the “Holdings” board. Walter Coles, Sr. is chairman of “Holdings.”³⁵⁵ The majority of the shares are privately held.

3. VIRGINIA ENERGY RESOURCES INC. (“Resources”)

“Resources” is actively involved in pursuing uranium deposits owned by the former Santoy Resources Ltd. and building relationships to bring additional resources (financial and operational) to support the development of Coles Hill uranium deposit in Pittsylvania County, Virginia.

Overview

Formerly known as Santoy Resources Ltd., the company was a Canadian-based, publicly-owned company and traces its roots to 1993 in Alberta. “Resources” is the result of a July 21, 2009 merger between Virginia Uranium Ltd. and Santoy Resources Ltd. and is now based in Vancouver, B.C. (675 West Hastings Street, Suite 611, Vancouver, BC, CA, V6B 1N2). It is traded on the Toronto Stock Exchange (TSX) as VAE. Upon the merger, the company decided to use the new name of Virginia Energy Resources Inc.

Material Issues

Denison Mines Corp is a diversified Canadian corporation that owns just over a 22% stake in “Holdings” and is publicly traded on the TSX (as “DML”) and on both the NYSE and the AMEX (as “DNN”).³⁵⁶ Denison is a 50/50 partner with “Holdings” in another Joint Venture established with Santoy. Denison has a successful operations history in the United States of both its mining and milling facilities.

Board of Directors

The president and CEO of Denison Mines Corp. is a member of the “Resources”³⁵⁷ board. Walter Hughes, Sr. is Chairman of the Board. Walter Hughes, Jr. succeeds Norm Reynolds as President and CEO.³⁵⁸

³⁵³ Please see: <http://investing.businessweek.com/businessweek/research/stocks/private/snapshot.asp?privcapId=38013695>

³⁵⁴ Material Change Report, Form 51-10253, dated November 9, 2010.

³⁵⁵ Please see: <http://investing.businessweek.com/businessweek/research/stocks/private/person.asp?personId=39192478>.

³⁵⁶ Fall/Winter 2009 Issue of “The Coles Hill Progress,” published by Virginia Uranium, Inc.

³⁵⁷ Please see: <http://www.denisonmines.com/home/home>.

A.8.3. Summary of Virginia Uranium Positioning Strategy

What began with the ownership of land and mineral rights for the Coles Hill uranium project has grown (see Attachment 8.3) into a three-company integrated group (“Uranium,” “Holdings,” and “Resources”). Our synopsis of the four most significant strategic transactions for the Coles Hill project are as follows:

1. Denison Joint Venture Provides Progress Report

Santoy Resources issued a progress report from information provided by its 50/50 Joint Venture partner, Denison Mines Corp., for three of its four Athabasca Basin, Saskatchewan properties. (Santoy field crews are working the fourth property, Riou River, outside of the Joint Venture. The three Joint Venture projects are: Murphy Lake, Hatchet Lake, and Fond du Lac River.³⁵⁹

NOTE: Prior to the merger/acquisition between Santoy and Virginia Uranium, Santoy entered into a 50/50 Joint Venture with Denison, an experienced mining and milling company and the only company currently performing underground mining in the United States (Arizona 1 – see previous discussion – in Section A.7.1.1) and owning its milling operations (White Mesa – see previous discussion). As mentioned in the overview discussion of Virginia Energy Resources on the TSX Venture Exchange (VAE) on August 18, 2011:

“The Company is well financed...The Company explores on its own account and in joint venture with industry partners. The JV approach is a reflection of the high risk involved in exploration ventures, and is used as a method of increasing our exposure to discoveries while committing less funding...The management team behind the new company is comprised of highly experienced technical and financial professionals with a history of success in the discovery, development and operation of...uranium mines...[The Company’s] most important asset is an approximate 30% stake in the giant Coles Hill, Virginia uranium deposit. Through a first right of refusal on future financings, [the Company] has the option to increase this investment as the project advances.”³⁶⁰ (emphasis added)

2. Preliminary Economic Assessment Indicates Outstanding Profitability Potential for the Coles Hill Uranium Project in Virginia

While the state legislature considers the regulatory issues related to uranium mining, the on-site management team of Virginia Uranium, Inc. [privately held] will continue to advance the project from a technical perspective, as well as nurturing a favorable environment for local and national acceptance for the project. Virginia Energy Resources (TSX.V: VAE) is the largest single outside shareholder in Virginia Uranium Holdings, Inc. Virginia Uranium Holdings, Inc. owns 100% of Virginia Uranium, Inc. By the end of 2010, VAE’s indirect interest in the Coles Hill uranium project is expected to exceed 30%.³⁶¹

3. Santoy Merges with Virginia Uranium

³⁵⁸ Material Change Report, Form 51-102F3, dated May 19, 2010.

³⁵⁹ Santoy Resources Ltd., News Release dated October 3, 2007.

³⁶⁰ Please see: <http://www.santoy.ca/s/Home.asp>.

³⁶¹ Form 51-102F3, Material Change Report, October 18, 2010.

Issuer announces the signing of a Letter of Intent (“LOI”) between Santoy and two private companies pursuant to which Santoy will acquire all the shares of Virginia Uranium Ltd. (“Limited”), a private Yukon corporation, in exchange for shares in Santoy...The Coles Hill uranium deposit is considered to be one of the largest undeveloped uranium deposits in the United States...It is contemplated that the Company [Santoy] will change its name to reflect the significance of the transaction to the Company...Santoy is pleased to proceed with this transaction as it gives the Company a significant position in a uranium project situated in a stable political location. At the same time, Limited [Virginia Uranium] shareholders will gain diversification and will benefit from Santoy’s exploration properties. The acquisition complements Santoy’s portfolio of uranium exploration properties in the Athabasca Basin of Saskatchewan, the Otish Mountains in Quebec and the Central Mineral Belt of Labrador. The Company is also the largest shareholder of Boss Power Corp. which owns the Blizzard uranium deposit in British Columbia.³⁶²

NOTE: Santoy acquires Virginia Uranium, retains the Virginia name, and makes clear that Coles Hill is the chief asset of the Company. In the merger, the Company retains its 50/50 Joint Venture with Denison Mines (a mining operator).

4. Sprott Resources Corp. agrees to join Virginia Energy as Strategic Partners in Coles Hill Uranium Project

Virginia Energy Resources Inc. [“Resources”] is a uranium development and exploration company. The company holds a 28.5% stake in the advanced stage Coles Hill uranium project in Virginia [via “Holdings”]. Additionally, the company is pursuing active exploration programs in the Athabasca Basin on its Murphy River and Hatchet River uranium properties, which are held in a 50-50 Joint Venture with Denison Mines Ltd., and its 100%-owned uranium properties in the Otish Basin of Quebec. The company is also a 32.7% shareholder of Boss Power Corporation. Virginia Energy Resources Inc. trades on the Toronto Venture Stock Exchange under the symbol VAE.³⁶³

NOTE: Following the merger, the Company was able to announce a partnership with Sprott Resources Corp. - a highly diversified investor in the natural resources sector (from livestock feed to gold). Per the June 30, 2011 quarterly financial report, Sprott held total assets exceeding CAD\$611 million. Income was up substantially over the same quarter in 2010 – more than quadrupled – largely due to increases in oil and gas revenue.³⁶⁴ Sprott’s CEO stated, “We look forward to providing the financial and strategic support necessary to see this project through to success.”³⁶⁵ The Company’s CEO stated, “The Sprott organization is recognized globally as one of the most astute investors in the natural resource space. Their investment is a tremendous vote of confidence in the project management team, as well as the positive fundamental outlook for the industry.”³⁶⁶

Chmura’s findings indicate that the company has entered into a partnership with Denison Mines – a significant player in the uranium mining and milling industry –with a focus on the underground mining technique (not open-pit or in-situ leaching). Denison, as was noted earlier, is a Canadian-based subsidiary of the Lundin Group, which is publicly traded, and owns 12 companies with operations in more than 30 countries. Denison is very experienced in

³⁶² Form 51-102F3, Material Change Report, December 22, 2008.

³⁶³ Form 51-102F3, Material Change Report, November 9, 2010.

³⁶⁴ Please see: <http://www.sprottresource.com/Docs/Financial%20Reports/Q2-2011-fs.pdf>

³⁶⁵ Virginia Energy Resources Inc., News Release dated November 9, 2010, Marketwire.

³⁶⁶ Virginia Energy Resources Inc., News Release dated November 9, 2010, Marketwire.

the underground mining of uranium and in the milling process; in fact, Denison is the 100% owner of the White Mesa milling operation (near Blanding, Utah), which currently is the only operating mill in the United States. Denison announced in 2009 the “best discovery of uranium in 20 years” – the Phoenix Deposit – of which it owns a 60% share. It also owns the Arizona 1 mine, in Mohave County, Arizona, near the Grand Canyon and the Colorado River, which is the only underground uranium mine operating in the United States at the present time. On May 4, 2011, Denison announced it had secured a 58% interest in White Canyon Uranium Ltd. for its Daneros uranium mine in San Juan County, Utah, presently under construction.

A.8.4. Selected Public Opinion Polling Post-Fukushima

- ABC News/Washington Post Poll (April 14-17, 2011; margin of error 3.5):
 - Building more nuclear power plants at this time – 33% favor; 64% oppose; 3% unsure (as compared to a survey in April of 1983 with 27% favor; 65% oppose; 8% unsure – and the highest opposition from a survey in May of 1986 with 19% favor; 78% oppose; 3% unsure)
 - Building a nuclear power plant within 50 miles of your home – 30% favor; 67% oppose; 3% unsure (this question was not asked in previous surveys)
 - Nuclear power plants are generally safe – 53% safe; 43% unsafe; 4% unsure (as compared to a survey in May of 1986 with 42% safe; 53% unsafe; 5% unsure)
 - Confidence of nuclear power in the United States following the Japanese disaster – 6% more; 42% less; 51% unaffected; 1% unsure (obviously, the question was not asked previously)
- CNN/Opinion Research Corporation Poll (April 9-10, 2011; margin of error 3.5):
 - Confidence that the federal government could prevent another oil spill as big as the one in the Gulf of Mexico – 7% very; 34% somewhat; 29% not very; 28% not at all; 1% unsure (as compared to a survey May 21-23, 2010 – 7% very; 30% somewhat; 31% not very; 31% not at all; 1% unsure)
- AP/GfK Roper Public Affairs & Corporate Communications Poll (March 24-28, 2011; margin of error 4.2):
 - Building more nuclear power plants at this time – 39% favor; 60% oppose; 1% unsure (as compared to a survey November 17-29, 2009 – 49% favor; 48% oppose; 3% unsure)
 - Likelihood of nuclear emergency like Japan in U.S. – 14% extremely; 15% very; 36% somewhat; 26% not too; 9% not at all (obviously, this question was not asked previously)
 - Confidence in U.S. government to handle such an emergency – 9% extremely; 18% very; 41% somewhat; 19% not too; 13% not at all (again, this question was not asked previously)
- Gallop Poll (March 25-27, 2011 – margin of error 4%):
 - View toward nuclear power to help solve the country’s energy problems – 46% necessary; 48% dangers too great; 6% unsure (as compared to a survey May 18-20, 2001 – 49% necessary; 46% dangers too great; 5% unsure)
 - Safety of nuclear power plants in the United States. – 58% safe; 36% not safe; 6% unsure (this question was not asked previously)
- CBS News Poll (March 18-21, 2011 – margin of error 3%):
 - Overall view of nuclear power benefits vs. risks – 47% outweigh risks; 38% do not; 15% unsure
 - Building more nuclear power plants to generate electricity – 43% approve; 50% disapprove; 7% unsure (as compared to a survey in July 2008 – 57% approve; 34% disapprove; 9% unsure)
 - Approve of building a nuclear power plant in your community – 35% approve; 62% disapprove; 3% unsure (as compared to a survey in June 2001 – 40% approve; 55% disapprove; 5% unsure)

- Concern that a major accident might occur at a nuclear power plant in the United States. – 31% very concerned; 34% somewhat; 26% not very; 8% not at all; 1% unsure
- Safety of nuclear power plants operating in the United States – 69% safe; 22% not safe; 9% unsure
- Federal government adequately prepared to deal with a major nuclear accident in the United States – 35% prepared; 58% not prepared; 7% unsure
- Concern that radiation from Japan could harm people living in the United States. – 17% very concerned; 32% somewhat; 29% not very; 22% not at all
- Fearful of a nuclear accident in the United States after the accident in Japan – 44% more fearful; 53% not more fearful; 3% unsure.
- CNN/Opinion Research Corporation Poll (March 18-20, 2011 – margin of error 3%):
 - Generally approve or disapprove of nuclear energy to produce electric power – 57% approve; 42% disapprove; 1% unsure
 - Favor building more nuclear power plants in this country – 46% favor; 53% oppose; 1% unsure (as compared to a survey in March 19-21, 2010 – 50% favor; 47% oppose; 3% unsure)
 - Shut down or continue to operate existing nuclear power plants in this country – 27% shut down; 68% continue to operate; 4% unsure
 - Building a new nuclear power plant in your community – 39% acceptable; 60% unacceptable; 1% unsure
 - Willing to pay more for electricity in order to reduce the nation’s dependence on nuclear power – 38% willing; 60% not willing; 3% unsure
 - Overall safety of nuclear power plants – 28% very safe; 51% somewhat safe; 20% not so safe; 1% unsure
 - Overall safety of nuclear power plants close to oceans or earthquake areas – 12% very safe; 42% somewhat safe; 45% not very safe; 1% unsure
 - Confidence in the federal government’s ability to handle the situation if a nuclear power plant experienced severe damage – 18% a great deal; 49% moderate; 24% not much; 9% none at all
 - Likelihood of radiation from Japan reaching the United States – 14% very likely; 39% somewhat likely; 23% somewhat unlikely; 23% very unlikely; 1% unsure
 - Likelihood of radiation from Japan reaching the area where you live – 5% very likely; 17% somewhat likely; 18% somewhat unlikely; 60% very unlikely
 - Energy sources for future energy needs – Solar Power: 88% more; 11% less; 0% unsure; Wind Power: 83% more; 17% less; 1% unsure; Natural Gas: 70% more; 29% less; 1% more; Coal – 43% more; 56% less; 1% unsure; Nuclear: 42% more; 57% less; 1% unsure; Oil: 28% more; 71% less; 1% unsure
- Pew Research Center Survey (March 17-20, 2011 – margin of error 4%):
 - Promoting the increased use of nuclear power – 39% favor; 52% oppose; 8% undecided (as compared to a survey in May 6-9, 2010 – 45% favor; 44% oppose; 11% undecided)
 - Safety of U.S. nuclear power plants compared to Japan – 24% safer; 10% less safe; 53% about the same; 1% none are safe; 12% unsure.
- Fox News Poll (March 14-16, 2011 – margin of error 3%):
 - Safety of nuclear power as an energy source – 51% yes; 40% no; 9% unsure (as compared to June 17-18, 2008 – 53% yes; 34% no; 13% unsure)
 - Support for using nuclear power in U.S. following Japan situation – 19% much less likely; 18% somewhat less likely; 60% not made a difference; 3% unsure
- USA Today/Gallup Poll (March 15, 2011 – margin of error 4%):
 - Construction of nuclear power plants in the United States – 44% favor; 47% oppose; 9% unsure

- Effect of events in Japan on thoughts of nuclear disaster in the United States – 39% a lot more concerned; 31% a little more concerned; 27% not more concerned; 3% unsure
- CBS News Poll (August 20-24, 2010 – margin of error 3%):
 - Confidence that BP will fairly compensate those affected by the oil spill in the Gulf – 10% very; 34% somewhat; 31% not very; 22% not at all; 3% unsure (as compared to a survey in July 9-12, 2010 – 8% very; 32% somewhat; 33% not very; 25% not at all; 2% unsure)
 - Environmental recovery from oil spill – 20% maybe never; 71% eventually; 5% not all that severe; 4% unsure)
 - Economic recovery from oil spill – 16% maybe never; 79% eventually; 4% not all that severe; 1% unsure)
- AP/GfK Poll (August 11-16, 2010 – margin of error 4.5%):
 - Approval of the way BP is handling the oil spill in the Gulf – 33% approve; 66% disapprove; 1% neither; 1% unsure (as compared to June 9-14, 2010 – 15% approve; 83% disapprove; 0% neither; 1% unsure)
 - Effect of federal government's actions in response to the oil spill – 32% better; 25% worse; 41% no real impact; 3% unsure (as compared to June 9-14, 2010 – 18% better; 25% worse; 56% no real impact; 2% unsure)
 - Confidence in eating seafood from the areas of the Gulf oil spill – 5% extremely confident; 7% very confident; 33% somewhat; 24% not too confident; 31% not confident at all
 - Confidence of safe swimming at beaches in the areas of the Gulf oil spill – 4% extremely confident; 9% very confident; 30% somewhat confident; 26% not too confident; 29% not confident at all
- ABC News/Washington Post Poll (July 7-11, 2010 – margin of error 3.5%):
 - Rate the federal government's overall response to the oil spill in the Gulf – 4% excellent; 30% good; 32% not so good; 33% poor; 1% unsure
 - Rate the BP oil company's overall response to the oil spill in the Gulf – 2% excellent; 17% good; 31% not so good; 48% poor; 1% unsure
 - Severity of the oil spill on the environment – 68% major disaster; 28% serious problem; 3% not too serious
 - Should the federal government pursue criminal charges against BP and the other companies involved – 56% should; 34% should not; 6% depends; 4% unsure
- Fox News/Opinion Dynamics Poll (June 29-30, 2010 – margin of error 3%):
 - Approval of BP handling of the oil spill in the Gulf – 19% approve; 73% disapprove; 8% unsure
 - Approval of federal government handling the oil spill in the Gulf – 24% doing all it can; 69% could be doing more; 7% unsure
 - Could BP be doing more to stop the leak and clean up the damage in the Gulf – 23% doing all it can; 70% could be doing more; 7% unsure
- Marist College Marist Poll (June 17-24, 2010 – margin of error 3.5%):
 - BP handling of the oil spill in the Gulf – 17% approve; 83% disapprove; 1% unsure
- Gallup Poll (June 19-20, 2010 – margin of error 4%):
 - BP handling of the oil spill in the Gulf – 16% approve; 76% disapprove; 8% unsure
- CNN/Opinion Research Corporation Poll (June 16, 2010 – margin of error 4%):
 - BP handling of the oil spill in the Gulf – 13% approve; 87% disapprove; 0% unsure
 - Federal government handling of the oil spill in the Gulf – 25% approve; 74% disapprove; 1% unsure
 - Create a fund of billions of dollars to compensate workers and businesses that would be paid by BP but administered by a neutral party – 82% approve; 18% disapprove
 - Increase the amount of federal regulation of the oil industry – 68% approve; 31% disapprove; 1% unsure

- File criminal charges against employees and executives at BP – 53% approve; 46% disapprove; 1% unsure
- Trust to improve the situation in the Gulf – 32% BP; 54% Federal government; 2% equal; 12% neither
- What SHOULD be BP's priority: clean up and pay damages or protect the company and make a profit – 92% clean up; 7% make a profit; 1% unsure
- Best guess as to what BP's priority WILL be – 32% clean up; 67% make a profit; 1% unsure
- USA Today/Gallup Poll (June 11-13, 2010 – margin of error 4%):
 - Favor Congress passing new legislation to regulate energy output to reduce global warming – 56% favor; 40% oppose; 4% unsure
 - Responsibility of BP to pay for losses even if it drives the company out of business – 59% pay for all, even if it goes out of business; 38% pay what it can while remaining viable; 3% unsure
 - Should BP or the federal government be in charge of the oil spill – 45% federal government; 49% BP; 6% unsure
- Pew Research/National Journal Congressional Connection Poll (June 10-13, 2010 – margin of error 4%):
 - Priority for establishing U.S. energy policy – 37% low energy prices; 56% protect the environment; 8% unsure
 - Comprehensive bill that provides tougher efficiency standards for buildings and major appliances – 78% favor; 17% oppose; 5% unsure
- ABC News/Washington Post Poll (June 3-6, 2010 – margin of error 3.5%):
 - Address country's energy needs by building more nuclear power plants – 49% support; 46% oppose; 5% unsure (as compared to a May 31 to June 3, 2001 poll – 46% support; 51% oppose)
 - Blame for the oil spill: Weak federal regulations – 35% great amount; 20% good amount; 31% just some; 10% none at all; 4% unsure; Inadequate enforcement of existing regulations – 40% great amount; 22% good amount; 25% just some; 8% none at all; 4% unsure; Unnecessary risks taken by BP and drilling partners – 55% great amount; 18% good amount; 17% just some; 6% none at all; 4% unsure
 - Oil spill as an isolated incident or reflection of a broader problem with offshore drilling – 46% isolated incident; 49% broader problem; 4% unsure

A.8.5. Regulatory Theory and Practice

Lifting the moratorium on uranium mining and permitting uranium mining and milling in Virginia could put the Commonwealth in the uranium regulation business.

“We are asking much of regulation when we ask that it follow the guide of competition. As Americans, we have set up a system that indicates we have little faith in economic planning by the government. Yet, we are asking our regulators to exercise the judgment of thousands of consumers in the evaluation of our efficiency, service, and technical progress so that a fair profit can be determined. Fair regulation is now, and always will be, a difficult process. But it is not impossible.”³⁶⁷

³⁶⁷ Ralph M. Besse, from “The Regulation of Public Utilities,” by Charles F. Phillips, Jr., June 1988.

In his book, "The Regulation of Public Utilities," Charles F. Phillips, Jr. summarizes the goals, procedures, and theories of public utility regulation as follows:

As the American economy has developed, the regulatory process has become extremely complex... Consider, for example, criticisms of current regulation. There are three distinct conceptions of the central problem confronting modern regulation. The first... is economic. Regulation has failed to pursue economic efficiency as the appropriate objective. Instead, regulators appear to be primarily concerned with questions of fairness and justice, and with the welfare of the industries they regulate. The second... is political. Regulation has failed to be responsive to the whole spectrum of legitimate interest group pressures. The third... is administrative. Regulation has failed because of the delays and costs inherent in case-by-case decision making. Each [failure] calls for different prescriptions. But of greater importance is the multiplicity of goals and their inherent conflicts.³⁶⁸

Again, Phillips goes on to say:

"... They are not problems of right and wrong, for which there is only one right solution... Regulation involves the human adjustment of resources to accomplish humanly established ends. Regulation is limited and guided both by what we want and by what we are willing to give in order to get what we want... [Regulation] can be just as purposeful and tight and firm as we care to make it. The point is that regulation and regulatory policies must be *made*; they are not revealed to us, nor do we discover them."³⁶⁹

These regulations, in the case of the uranium industry, need to address both short-term and long-term risks to public health and the environment. This was emphasized by one Utah official in a public meeting on a permitting issue for the White Mesa uranium mill.

The SER... states that Cell 4B has been designed to provide "reasonable assurance" that radiological hazards will be suitably controlled for 1,000 years, to the extent reasonably achievable, and in any case for at least 200 years. So we have "reasonable assurance" to the extent that suitable control is "reasonably achievable." What does this vague language mean over the long-term? The public, the licensee, and the DRC do not really know. The tailings will remain on White Mesa in perpetuity, that is, forever. Therefore impacts from 200 to 1,000 years are short-term impacts, not long-term impacts, given the time that the tailings will continue to release radon and will be a radioactive and hazardous material requiring physical and regulatory control for as long as there are individuals and entities capable of exercising that control. Eventually the liners will break down, eventually the tailings cover will erode, and eventually the tailings and the associated radioactive and non-radioactive contaminants will disperse into the air, water, and soils. Any evaluation of the long-term impacts of the proposed licensing action must address the potential impacts of the dispersion of the tailings from natural forces over the thousands and millions of years that the tailings will remain in place.³⁷⁰

³⁶⁸ "The Regulation of Public Utilities," by Charles F. Phillips, Jr., June 1988, page 193.

³⁶⁹ "The Regulation of Public Utilities," by Charles F. Phillips, Jr., June 1988, page 194.

³⁷⁰ Utah Division of Radiation Control, "Public Participation Summary," for the Modification to the Ground Water Discharge Permit and the Amendment to the Radioactive Materials License at Denison Mines White Mesa Uranium Mill, June 14, 2010.

A.8.6 Application of Cumulative Prospect Theory to differences in attitudes toward the Coles Hill Site

After having reviewed the various environmental scenarios and provided estimates of the potential net positive or negative economic value the Coles Hill may bring, the theories of Nobel Prize recipient Daniel Kahneman may help explain how reasonable people may come to view the Coles Hill site very differently. Kahneman and his research partner, Amos Tversky, demonstrated through a series of experiments, surveys, papers, and books that people do not react to the world on purely rational basis, and when faced with choices involving uncertainty, people sometimes exhibit risk aversion (making choices to minimize risk or loss) and other times are risk-seeking (willing to gamble despite the prospect of losses).^{371, 372, 373, 374}

Kahneman's research shows that when faced with an uncertain outcome from an endeavor that could result in either a large potential gain or a large potential loss, people overwhelmingly become risk averse.³⁷⁵ Compared to the typical economic assumption of strict rationality, people tend to over-weight the prospect of a catastrophic loss even if the probability of this large loss is very small. Kahneman and Tversky's research found that people tend to over-weight small probabilities and under-weight moderate and high probabilities. Extremely likely but still uncertain outcomes are often treated as if they were certain; this is typically referred to as the *pseudocertainty effect*. Consequently, changes in the likelihood of very low probability outcomes have a greater impact on people's preferences than comparable changes in the middle of the probability range. This is typically called the *ratio-difference principle* or *subproportionality*, whereby the impact of any fixed positive difference between two amounts increases with their ratio.³⁷⁶

Precisely because the Coles Hill site offers a moderate probability for a large gain—if the environmental and health risks are managed well—as well as a small probability of an even greater potential loss—if the worst case of environmental contamination comes to pass—Kahneman's cumulative prospect theory can be used to model thresholds of the likelihood of the different scenarios whereby the “average” person would be either positively predisposed to the Coles Hill uranium operation or opposed to it.

These simulations are based on a number of assumptions both in terms of basic preferences toward “risk aversion” as well as with arbitrary estimates as to likelihood that either environmental scenario 1, 2, or 3 would be realized. These assumptions will be detailed below. Therefore the conclusions are speculative. Nonetheless, a threshold was found ranging between 5 and 14 percent—depending on varying assumptions of how long the Coles Hill site would operate before the environmental contamination came to pass—for the probability of scenario 4 at which point the hypothetical person would be neutral towards the project. This leads to the conclusion that should a

³⁷¹ "Prospect theory: An analysis of decisions under risk" Kahneman, D.; Tversky, A. *Econometrica* 47 (2): 263–291 (1979).

³⁷² *Judgment Under Uncertainty: Heuristics and Biases*, Kahneman, D., Slovic, P., & Tversky, A. New York: Cambridge University Press (1982).

³⁷³ *Thinking, Fast and Slow*, Daniel Kahneman, publisher: Farrar, Straus and Giroux (October 25, 2011).

³⁷⁴ "Advances in prospect theory: Cumulative representation of uncertainty" Tversky, Amos; Daniel Kahneman *Journal of Risk and Uncertainty* 5 (4): 297–323 (1992).

³⁷⁵ "Advances in prospect theory: Cumulative representation of uncertainty" Tversky, Amos; Daniel Kahneman *Journal of Risk and Uncertainty* 5 (4): 297–323 (1992).

³⁷⁶ "Rational Choice and the Framing of Decisions" A. Tversky & D. Kahneman *The Journal of Business*, Vol. 59, No. 4, Part 2: *The Behavioral Foundations of Economic Theory*. (Oct., 1986), pp. S251-S278.

person's perception of the likelihood of scenario 4 becoming reality be greater than 14 percent, then they would likely be opposed to the Coles Hill uranium operation. However, if they perceive the probability of a worst-case scenario to be under 5 percent then they would be positively pre-disposed to the Coles Hill operation. Those who perceive the probability of scenario 4 occurring to be between 5 and 14, their ultimate attitude toward the site would be dependent on how quickly they judged the environmental degradation would take place.

Contamination realized after:	Perception of Probability of Occuring				Certainty Equivalent	Expected Attitude
	Scenario 1	Scenario 2	Scenario 3	Scenario 4		
10 Years	1.0%	61.3%	30.7%	7.0%	-0.137972	Negative
	1.0%	62.0%	31.0%	6.0%	-0.049139	Negative
	1.0%	62.7%	31.3%	5.0%	0.0672392	Positive
20 Years	1.0%	59.3%	29.7%	10.0%	-0.125038	Negative
	1.0%	60.0%	30.0%	9.0%	-0.052853	Negative
	1.0%	60.7%	30.3%	8.0%	0.0201836	Positive
30 Years	1.0%	57.3%	28.7%	13.0%	-0.074276	Negative
	1.0%	58.0%	29.0%	12.0%	-0.019213	Negative
	1.0%	58.7%	29.3%	11.0%	0.0694537	Positive
35 Years	1.0%	55.3%	27.7%	16.0%	-0.060196	Negative
	1.0%	56.0%	28.0%	15.0%	-0.014427	Negative
	1.0%	56.7%	28.3%	14.0%	0.0616742	Positive
Assumptions						
Net Accumulated Value Scenario 1					\$5.030 billion	
Net Accumulated Value Scenario 2					\$4.995 billion	
Net Accumulated Value Scenario 3 w/ contimination at 10 years					\$0.055 billion	
Net Accumulated Value Scenario 3 w/ contimination at 20 years					\$1.439 billion	
Net Accumulated Value Scenario 3 w/ contimination at 30 years					\$2.823 billion	
Net Accumulated Value Scenario 3 w/ contimination at 35 years					\$3.792 billion	
Net Accumulated Value Scenario 4 w/ contimination at 10 years					\$-10.386 billion	
Net Accumulated Value Scenario 4 w/ contimination at 20 years					\$-8.987 billion	
Net Accumulated Value Scenario 4 w/ contimination at 30 years					\$-7.588 billion	
Net Accumulated Value Scenario 4 w/ contimination at 35 years					\$-6.609 billion	
Cumulative Prospect Theory Calculator						
Martin Sewell <mvs25@cam.ac.uk>						
Based on Tversky and Kahneman (1992)						
Power for gains, α					0.88 (0.88 in T&K)	
Power for losses, β					0.88 (0.88 in T&K)	
Loss aversion, λ					2.25 (2.25 in T&K)	
Probability weighting parameter for gains, γ					0.61 (0.61 in T&K)	
Probability weighting parameter for losses, δ					0.69 (0.69 in T&K)	