REPORT OF THE
SPECIAL RECLAMATION FUND
ADVISORY COUNCIL

February 1, 2016

EXECUTIVE SUMMARY

The Special Reclamation Fund Advisory Council (the "Council") was established by the Legislature in 2001 in order to ensure the effective, efficient and financially stable operation of the Special Reclamation Fund (the Fund). (W.Va. Code § 22-1-17). According to W.Va. Code § 22-1-17 the Council shall consist of eight members, including the Secretary of the Department of Environmental Protection or his or her designee, the Treasurer of the State of West Virginia or his or her designee, the Director of the National Mine Land Reclamation Center at West Virginia university and five members to be appointed by the governor with the advice and consent of the Senate.

The Fund is designated by the Legislature for the reclamation and rehabilitation of lands subject to permitted surface mining operations and abandoned after 1977, where the bond posted is insufficient to cover the cost of reclamation. The Fund is presently funded by a tax of 27.9 cents per ton of clean coal mined in West Virginia. From this revenue, funds based on a tax rate of 15 cents per ton are being paid into the Special Reclamation Water Trust Fund (SRWTF), while coal tax revenues based on 12.9 cents per ton are being paid into the Fund. According to W.Va. Code § 22-3-11**, "**Beginning with the tax period commencing on July 1, 2009, and every two years thereafter, the special reclamation tax shall be reviewed by the Legislature to determine whether the tax should be continued: *Provided,* That the tax may not be reduced until the Fund and SRWTF have sufficient moneys to meet the reclamation responsibilities of the state established in this section."

The SRWTF was created "for the purpose of assuring a reliable source of capital to construct, operate, and maintain water treatment systems on forfeited sites." (W.Va. Code § 22-3-11).

The Secretary of the Department of Environmental Protection is required to conduct formal actuarial studies every two years and conduct informal reviews annually on the Fund and SRWTF. The Council is also required to make a report to the Legislature every year on the financial condition of the Fund. (W.Va. Code § 22-1-17). The report is to include: "A recommendation as to whether or not any adjustments to the special reclamation tax should be made considering the cost, timeliness and adequacy of bond forfeiture reclamation, including water treatment [and] a discussion of the council's required study issues."

In accordance with the statutory requirements, the Council submits the following:

1. **Recommendation**: The Council recommends that the present 12.9 cent per ton tax dedicated to the Fund remain in force and that the tax dedicated to the SRWTF remain at 15 cents per ton. Additional recommendations by the Council can be found in the body of this report on page 26.
2. **Study issues**: Pursuant to W.Va. Code §22-1-17, the Council is also required to "Identify and define problems associated with the special reclamation fund." The Council conducted multiple studies during 2015 to better assess the current and future financial condition of the funds and to expand water treatment efforts to a watershed basis in order to enhance water quality on a watershed basis rather than site-by-site.

   Studies conducted during the 2015 report period include:

   a. 2015 Consensus Coal Production Forecast for West Virginia.
   b. Actuarial Review of the West Virginia Department of Environmental Protection Special Reclamation Fund and Water Trust Fund.
   c. Alternative Enforcement Evaluation by DEP.
   d. Watershed Scale Approaches to AMD Remediation: Martin Creek and Sandy Creek.

Findings of these studies are outlined in the body of the report.

BACKGROUND ON THE SPECIAL RECLAMATION FUND

Article 1, Chapter 22 of the Code of West Virginia was amended by the West Virginia Legislature in 2001, creating an eight member Special Reclamation Fund Advisory Council (the "Council") with the responsibility of ensuring the effective, efficient and financially stable operation of the Special Reclamation Fund. The legislation establishing the Council also increased the tax on clean coal mined in West Virginia, from three to seven cents per ton (the "Continuing Tax"), and levied an additional seven cents per ton (the "Temporary Tax"), to be deposited into the Fund. The revenues of the Fund were designated to pay for reclamation on post-1977 bond-forfeited sites.

The 2001 legislation provided for the Temporary Tax to be in effect for thirty-nine months. As a result of a 2005 actuarial report finding that the expiration of the Temporary Tax would result in nearly immediate insolvency of the Fund, the Temporary Tax was

extended by the Legislature in 2005, for an additional eighteen months. A 2007 actuarial study commissioned by the Council found that the failure to extend the Temporary Tax again would result in insolvency of the Fund. Accordingly, in 2008 the Legislature, through SB 751, created the SRWTF and enacted a temporary, twelve month tax of 7.4 cents which was to be allocated between the Fund and a SRWTF. Twelve and nine-tenths cents was dedicated to the Fund and 1.5 cents was deposited into the SRWTF. An updated actuarial study in 2008 concluded that terminating the temporary tax would result in insolvency within a few years. In response, in the 2009 legislative session, the Legislature amended W.Va. Code § 22-3-11 to remove the expiration date for the Temporary Tax and provided instead for biennial review of the Tax by the Legislature. (Acts of the Legislature 2009, chapter 216).

Based upon projections under the 2011 Actuarial Valuation performed by Pinnacle Actuarial Resources, Inc. the Fund was found to be sufficiently funded under the existing 12.9 cent tax. However, the Council was concerned that as the SRWTF began making payments for water capital and ongoing water treatment in Fiscal Year 2019, as projected, the SRWTF would fall into a deficit position in the second year of operation-2020." (2011 Actuarial Valuation, page 3). Declining coal production projected by the 2011 Consensus Coal Production Forecast and the significant increase in water treatment costs resulting from court rulings in two cases are contributing factors in the projected insolvency of the SRWTF. Accordingly, in 2012 the Legislature increased the special reclamation tax to 27.9 cents per ton, 15 cents of which was to be deposited into the SRWTF.

Based upon projections under the 2013 Actuarial Valuation performed by Pinnacle Actuarial Resources, Inc. the Fund was projected to be over 100 percent funded using a 20-year cash flow basis and 95.7 percent funded using a 35-year cash flow basis. The SRWTF was (and is today) accumulating 15 cents per ton coal tax revenue and interest and was projected by the 2013 Actuarial Valuation to be 150.4 percent funded using a 20-year cash flow basis and 89.9 percent funded using a 35-year cash flow basis.

Membership Status of the Special Reclamation Fund Advisory Council

Currently Mike Sheehan serves as the member representing the Cabinet Secretary of the DEP. Carolyn Atkinson serves as the member representing the Treasurer of the State of West Virginia. Dr. Paul Ziemkiewicz serves as the member representing the Director of the

National Mine Land Reclamation Center at West Virginia University. Christine Risch, Marshall University, Center for Business and Economic Research, serves as the Actuary/Economist member. Bill Raney serves as the member representing the interests of the coal industry. John Morgan serves as the member representing the interest of environmental protection organizations. Ronald Pauley serves as the member representing the interests of coal miners. The SRFAC member representing the interests of the general public is currently vacant.

FINANCES OF THE SPECIAL RECLAMATION FUND & THE SRWTF

This section of the Report to the Legislature outlines the financial status of the Fund for calendar year 2015 and provides comments regarding the future financial position of the Fund. The three key factors that have the most effect on the adequacy of the Fund are the coal production levels in West Virginia, the risk of future forfeitures, and the cost of reclaiming existing and future bond-forfeited sites. Each of these factors are addressed in the attached reports included in Appendix B.

To summarize the data and analysis that follow, it should be noted that the Fund will cover all costs for both land reclamation and water treatment through June 2018. Starting in July 2018, the SRWTF will begin covering the cost for water treatment—both water capital costs and ongoing water treatment costs.

As of December 31, 2015 the Fund has accumulated assets of $78.4 million while the SRWTF has accumulated $64 million in assets, a 32% increase over 2014 SRWTF values. Increased revenues for the SRWTF are attributed to the tax increase in 2012 as well as the improved investment strategy which was initiated in 2013 as described below.

In May of 2013, following numerous discussions between DEP personnel and members of the Investment Management Board and the Board of Treasury Investments, the Council was updated on various investment options and made the following recommendations:

The first recommendation is two parts:

1. That the current balance of the Water Quality (WQ) Trust Fund and all additional revenue of the WQ Trust Fund through Fiscal Year (FY) 2018 be

invested in the Investment Management Board (IMB) fixed income pool until FY 2019.

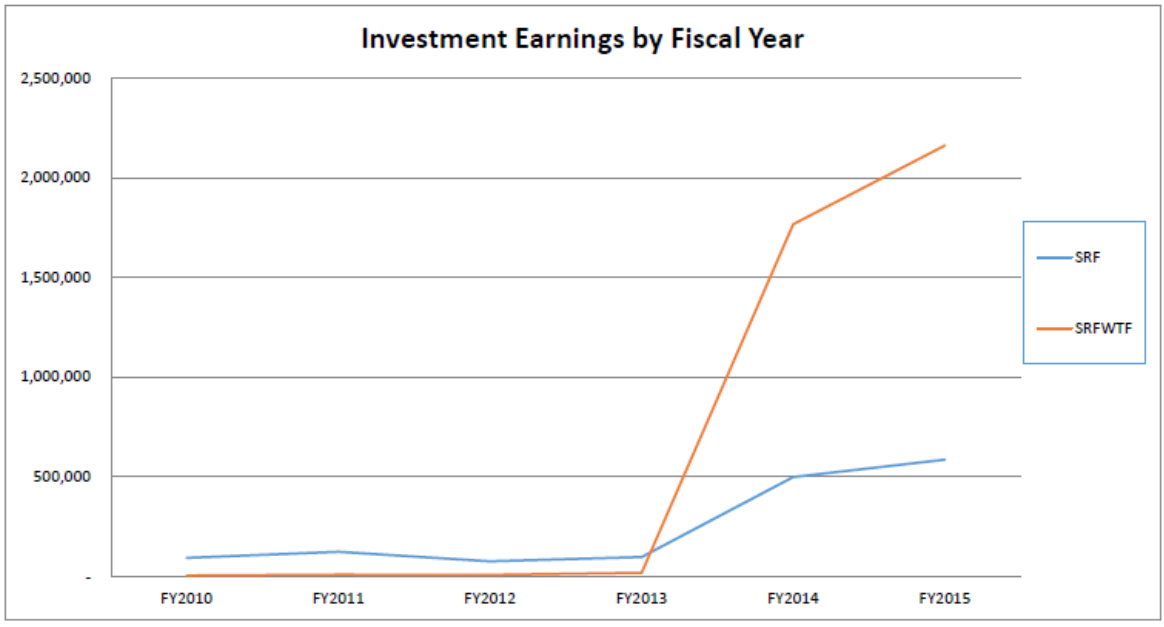
2. That DEP develop plans to maximize the return on investment for future WQ Trust revenue.

The second recommendation is also two parts:

1. That the current balance of the Special Reclamation (SR) Fund be invested in the West Virginia (WV) short term bond pool with the exception of $5 million, which should remain in the WV money market pool.
2. That DEP develop plans to maximize the return on investment for future SR Fund revenue.

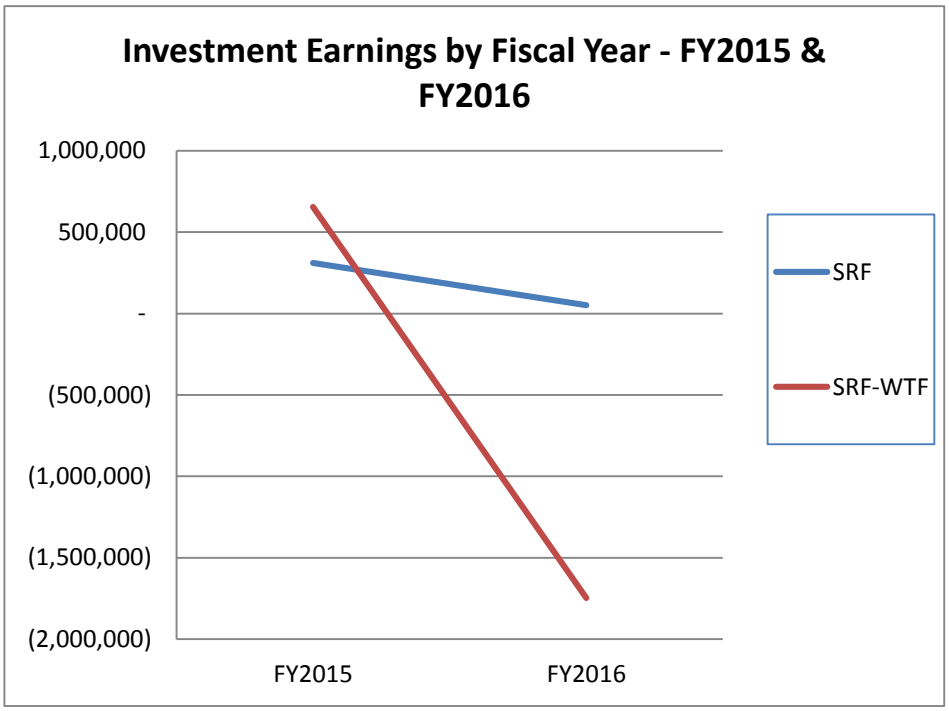
In October of 2013 the balance of $28 million from the SRWTF was transferred to the Investment Management Board Fixed Income Pool.

In June of 2013, with the exception of $5 million, the balance of the Fund was transferred to the WV Short Term Bond Pool. The following charts depict the results of the new investment strategies.



	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
SRF	92,735.26	123,398.29	75,108.74	96,824.83	498,000.98	585,398.73
SRFWTF	4,106.07	8,815.85	7,295.33	18,187.93	1,766,397.41	2,162,079.10

Figure 1



	FY2015	FY2016
SRF	$311,599.75	$51,255.74
SRF-WTF	$654,156.76	$(1,746,125.66)

Figure 2

Based on the 2015 Actuarial Study, the Fund is projected to fall to a low of $51.5 million in 2018. This is due to paying for all reclamation cost for both land and water as well as operation and maintenance cost associated with water treatment. The Fund then slowly recovers to $187.5 million by the end of the twenty year study period, at which point an $8.2 million liability is projected to remain. The SRWTF is expected to accumulate approximately $120 million by 2018 before it begins to support water reclamation costs in 2019. Afterwards, the SRWTF continues to show gains until it reaches $289.8 million by the end of the twenty year study period and a $110.5 million liability is projected to remain. Both funds combined are projected to total approximately $477.3 million at the end of the twenty year study period and a total liability of $118.7 million will remain.

The previous figures represent the actuary's central estimate. However, since the coal tonnage fees represent the bulk of the revenues to the Funds the study also looked at two adverse scenarios in which the coal tonnage fee collections were 10% and 25% below

anticipated coal tonnage fee collections every year. The study then used statistical techniques to determine the potential for deviation of actual numbers from the central estimate and calculated confidence levels for 75th, 90th, and 95th percentiles of loss. As can be seen in the following table a surplus remained for the Funds under each of these scenarios.

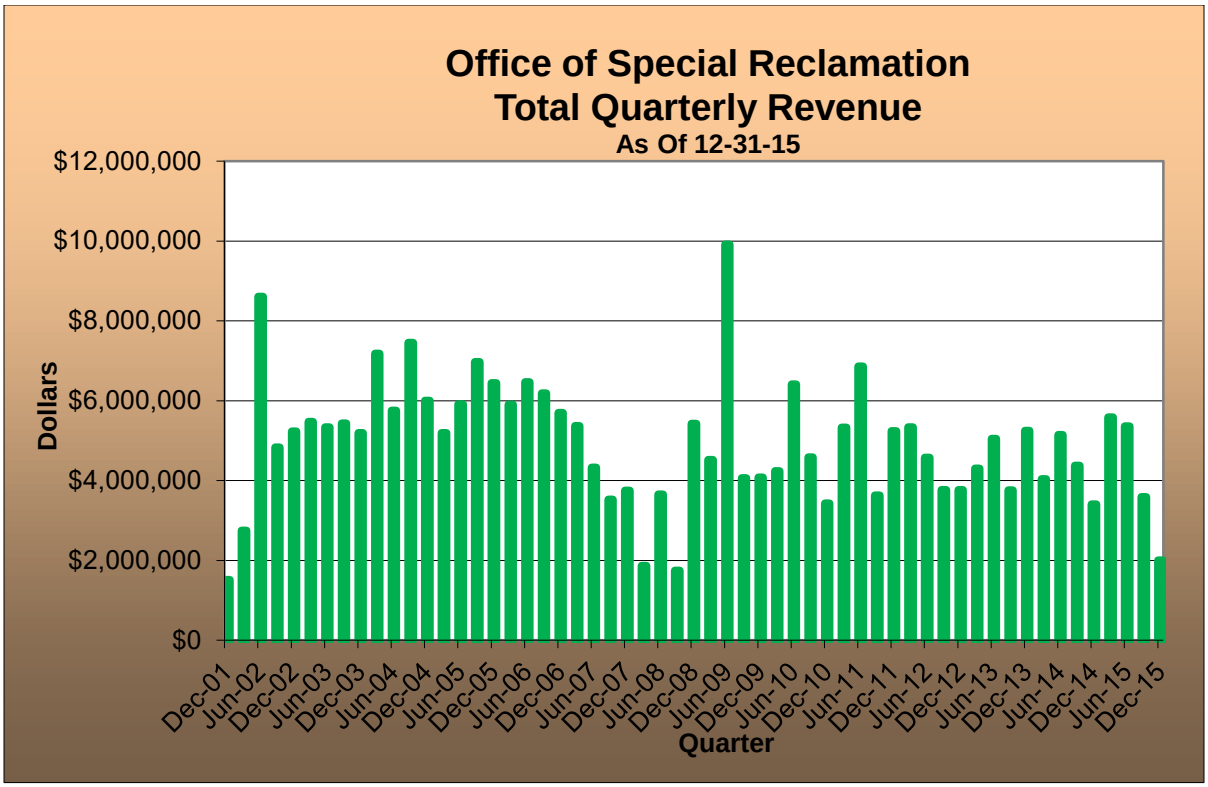
Table 1

Ending Fund Balance Year-End 2035

	Loss Scenario			
Revenue Scenario	Central	75th Percentile	90th Percentile	95th Percentile
Central	477,331,353	460,063,494	425,028,127	393,405,869
10% Adverse	400,318,543	383,050,684	348,015,318	316,393,060
25% Adverse	306,732,063	289,464,204	254,428,838	222,806,579

Since 2001, despite a very aggressive reclamation schedule, the Fund has been serving the people of West Virginia well through providing for the reclamation of bond-forfeited sites. At the time of the initial legislation in 2001, there were 392 forfeited permits requiring reclamation, including 122 requiring water treatment. Since passage of that legislation, an additional 195 permits have forfeited as well, bringing the total to 587 permits requiring reclamation. Of those, work has been completed on 481 permits. With regard to water treatment, the Fund is treating water at 143 sites and has an additional 54 sites under review or construction. As of December 31, 2015, the Fund has accumulated cash and investments totaling $78.4 million, while the SRWTF had accumulated $64 million.

Graphic summaries of the status of the Funds are outlined in the following figures.


Office of Special Reclamation
Total Quarterly Revenue
As Of 12-31-15
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
Dollars
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
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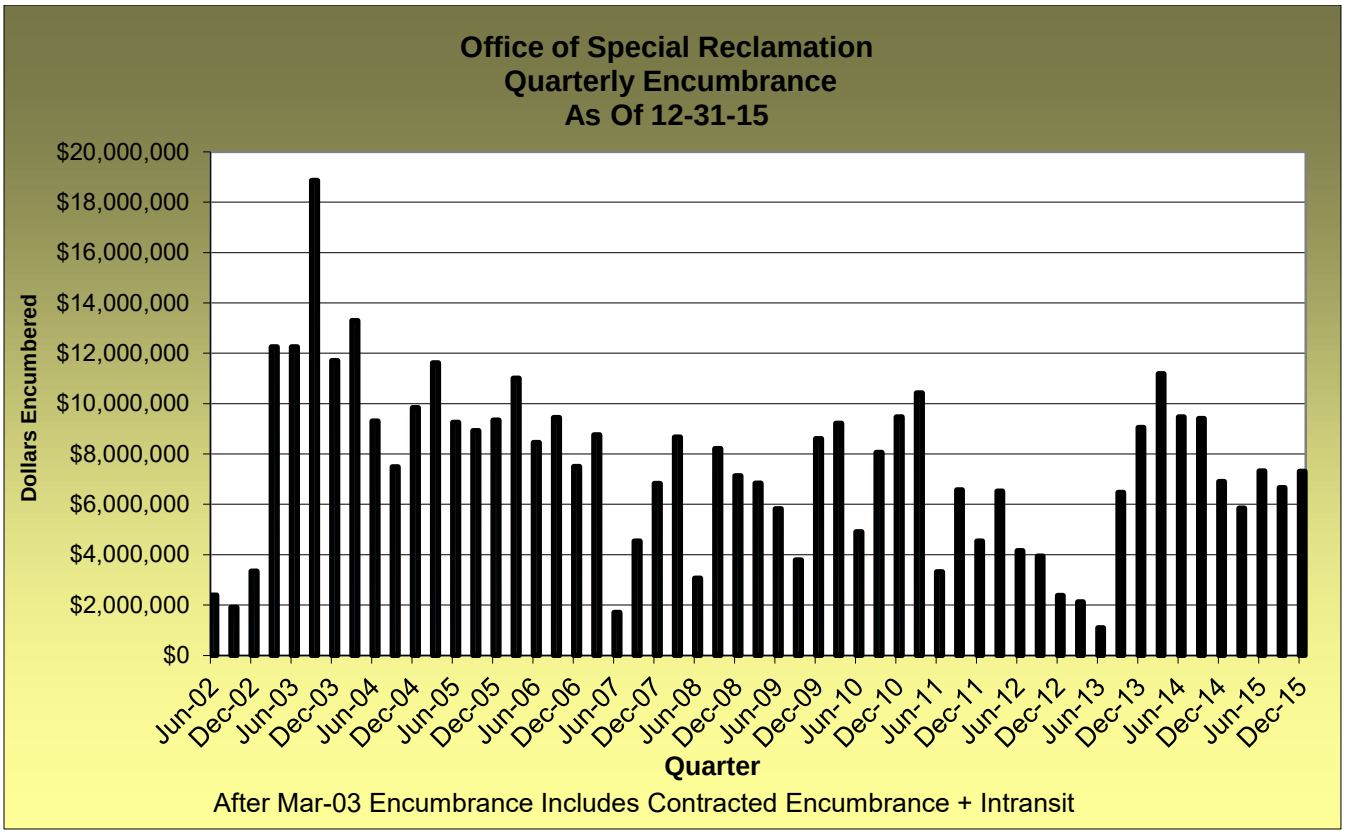
Quarter

Figure 3


Office of Special Reclamation
Quarterly Encumbrance
As Of 12-31-15
Dollars Encumbered
$20,000,000
$18,000,000
$16,000,000
$14,000,000
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
Jun-02
Dec-02
Jun-03
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Quarter
After Mar-03 Encumbrance Includes Contracted Encumbrance + Intransit

Figure 4

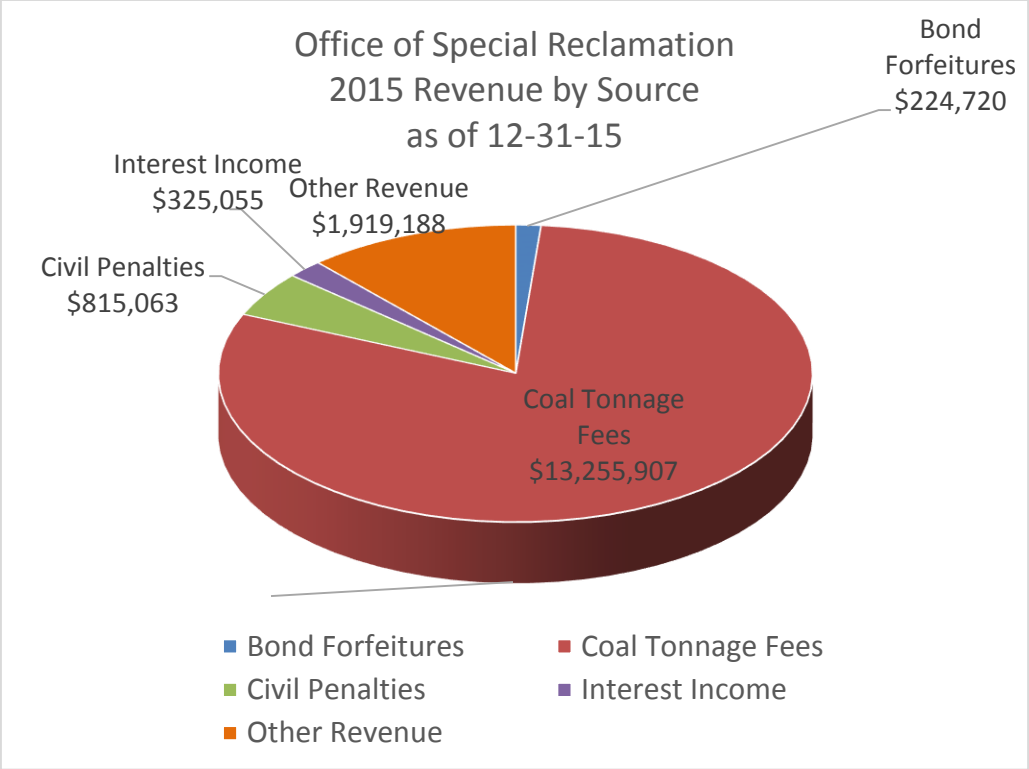

Figure 5

Water Treatment Funding

The current main funding mechanism for bond-forfeited sites is the 27.9 cent tax per ton of clean coal mined. In 2008, the Legislature authorized, but did not separately fund, the SRWTF. In reliance on the SRWTF statutory authorization, beginning in July 2008, coal tax revenues based on a tax rate of 1.5 cents per ton were being paid into the SRWTF. In addition, coal tax revenues based on 12.9 cents per ton were being paid into the Fund. In 2012 the Legislature increased the amount dedicated to the SRWTF to 15 cents per ton, but based on the funded status of the Fund at the time the Fund remained at 12.9 cents per ton. Unless modified in response to future legislation, for budgeting and analysis purposes, the DEP plans to continue paying all costs for both land and water reclamation work out of the Fund through FY 2018. Funding the water reclamation and treatment from the Fund will allow the SRWTF to build up assets, although it is not anticipated to remain solvent without future continuing funding. The current balance in the SRWTF is $64 million as of December 31, 2015. The Council is continuing to look at alternatives for water treatment funding.

Increased water capital cost and water treatment cost are the result of two identical lawsuits filed against the DEP. In 2011 and 2012 the DEP entered into separate consent decrees with the northern and southern district courts respectively. As will be discussed later in this report, the DEP is now required to apply for and obtain NPDES permits for all the sites included in Attachment A of the consent decrees plus an additional 21 sites which were included in an earlier lawsuit, for a total of 192 sites. DEP estimated that it will cost approximately $35.5 million to bring bond forfeiture sites into compliance with the more stringent water quality based effluent limits. Additionally, DEP estimates that it will cost approximately $6.7 million to operate and maintain these treatment systems on an annual basis.

Additional Charges to the Fund Due to NPDES Requirements

Due to NPDES requirements, the DEP has been faced with charging more expenditures to the Fund. These include:

- Realty – Land and/or easement purchases have been necessary to expand existing or new water treatment sites outside permit boundaries. The following are costs associated with expansion of sixteen (16) sites where additional land was needed to ensure compliance with the more stringent water quality based effluent limits (WQBEL):
    - Surveying - $204,260
    - Appraisals - $83,596
    - Appraisal reviews - $6,700
    - Cost of Timber - $23,187
    - Recording fees - $244.5
    - Easement purchases - $62,156
- Hiring private consulting engineers – To meet the requirements of the consent decree and in an attempt to maintain the land reclamation schedule, the DEP has been compelled to hire private engineering consulting firms to complete designs for projects that have historically been done in-house. As of the date of this report thirteen (13) contracts have been awarded at a total cost of

$3,031,313 and one (1) additional contract has been prepared for bids. DEP estimates that contractual design increases project cost by 10 to 12%.

- Increased staff – As a result of having to apply for and obtain NPDES permits at all bond forfeiture sites now and into the future, the DEP has found it necessary to incorporate an NPDES permitting section into the Office of Special Reclamation (OSR - The office responsible for reclamation of land and waters for bond forfeited sites). Four new staff members consisting of one (1) program manager and three (3) engineering technicians have been added to fulfil the NPDES requirements for the OSR. This is an additional charge to the Fund of approximately $156,864/year for salaries alone.
- NPDES permitting fees:
    - Application fees - $1,000/application. As of the date of this report the DEP has applied for 166 NPDES permits equating to $166,000
    - Modification fees - $500/mod. As of the date of this report the DEP has submitted 49 modifications equating to $24,500.
    - Annual fees - $1000/permit. As of the date of this report the DEP has 148 permits approved equating to $148,000
- Water sampling related to permit applications – As of the date of this report, the DEP has spent approximately $30,202 in laboratory cost for additional water analysis required for NPDES applications.

New DEP Policy Relevant to the Fund

Effective May 21, 2014 the DEP has implemented a new policy establishing a standard procedure the DEP will follow to terminate the State's jurisdiction over bond-forfeited former mining sites (Special Reclamation Sites). With a decision that the Special Reclamation Site has satisfied the applicable performance standards, DEP will terminate jurisdiction over the subject Special Reclamation Site. The new policy limits the vulnerability of the State, and consequently the Fund, by reducing the possibility of lawsuits pertaining to damages unrelated to former mining practices or reclamation practices, i.e. due to recreation, timbering, oil & gas, etc., as well as any changes to environmental laws taking effect after reclamation of the subject Special Reclamation Site. The DEP will retain

jurisdiction of Special Reclamation Sites, or portions thereof, that are necessary for the effective treatment of mine discharges emanating from the subject Site.

Litigation

1. The Fund through FY 2018 and the SRWTF starting in FY 2019 has acquired liability for additional water treatment as a result of lawsuits filed against the DEP, as described below.

Identical complaints were filed in the Northern and Southern District Courts, Civil Actions No. 07-cv-87 (the "Northern District Case") and No. 2:07-0410 (the "Southern District Case"), assigned to Judge Irene Keeley and Judge John T. Copenhaver, Jr., respectively. Both cases were styled *West Virginia Highland Conservancy and West Virginia Rivers Coalition v. Randy C. Huffman, Secretary, West Virginia Department of Environmental Protection.*

The two suits alleged that the West Virginia Department of Environmental Protection (DEP) had violated, and continues to violate, the federal Clean Water Act (the Act) by failing to obtain West Virginia National Pollutant Discharge Elimination System (WV/NPDES) permits when the Division of Land Restoration reclaims and treats water at bond forfeited sites as directed by state law. The Northern District Case named 18 specific bond forfeited sites and the Southern District Case named 3 sites.

On March 26, 2009, the Northern District Court entered summary judgment in favor of Plaintiffs in the Northern District Case, and granted a permanent injunction. The injunction requires DEP to apply for, process, and issue WV/NPDES permits to itself for the discharge into waters and streams of pollutants from the eighteen bond-forfeited, coal mining sites at issue in the case, whose reclamation the agency is required to manage. DEP appealed this decision to the United States Court of Appeals for the Fourth Circuit ("Fourth Circuit Court of Appeals"). By order dated November 8, 2010, the Fourth Circuit Court of Appeals affirmed the Northern District Court's ruling.

Similarly, a motion for summary judgment in the Southern District Case was granted by Order dated August 24, 2009. The Southern District Court found that the Secretary of the DEP was "in violation of the National Pollutant Discharge Elimination System permitting requirements of the Clean Water Act." The Southern District Court ordered the Secretary to

"apply for, and obtain, NPDES permits for all sites at issue in this action," and the parties subsequently submitted a joint stipulation agreeing to the same injunctive relief and timeframes for compliance set forth in the Northern District litigation. The Southern District Court entered final judgment August 31, 2010.

On January 11, 2010, the same Plaintiffs (West Virginia Highlands Conservancy and West Virginia Rivers Coalition) and the Sierra Club submitted a letter giving DEP notice of their intent to sue DEP regarding discharges from 131 additional bond forfeited sites on the same legal basis as the previous suits. Based on the outcome of the previous litigation, DEP engaged in settlement negotiations with the Plaintiffs and reached agreement regarding the permitting of the 21 sites in the previous litigation and the additional 131 sites. In August 2011, the Plaintiffs filed two new suits regarding the additional sites, *West Virginia Rivers Coalition, et al v. Huffman*, Civil Action No. 1:11-cv-118 (N.D. W.Va.), and *West Virginia Rivers Coalition, et al v. Huffman*, Civil Action No. 2:11-cv-524 (S.D. W.Va.), and lodged a proposed Consent Decree with both courts. The Northern District Court entered the Consent Decree on October 12, 2011. The Southern District Court entered the Consent Decree February 10, 2012. A list of all bond forfeited sites at issue in all four suits is attached to the Consent Decree as Attachment A. As required by the Consent Decree on July 2, 2012 DEP submitted a Final Treatment Cost Report to Plaintiffs and SRFAC, in which DEP determined the capital cost and annual operating and maintenance costs for water discharges from each bond forfeiture site to meet applicable water quality based effluent limitations. The DEP estimates these costs will amount to $35.5 million for one-time capital construction costs and over $6 million in annual operations and maintenance costs.

The Consent Decree resolves all four suits filed by the Plaintiffs regarding bond forfeited sites. The Consent Decree requires DEP to obtain WV/NPDES permits for all 21 bond forfeiture sites cited in the initial litigation by September 1, 2011. Thereafter, DEP will issue draft WV/NPDES permits for 50 additional sites by the end of each calendar year, beginning in 2012. By December 31, 2015 the Consent Decree requires DEP to issue draft WV/NPDES permits for all bond forfeited sites listed in Attachment A of the Consent Decree and for sites that were in existence on the date the Decree was executed. Thereafter, the DEP

shall exercise its best judgment on the timing of issuance of draft permits for sites forfeited after the execution of the consent decree.

Note: *The final draft permit was issued December 10, 2015.*

2. A third case presents potential for future litigation, should the legislature not adequately fund the Fund and SRWTF. *West Virginia Highlands Conservancy v. Secretary Salazar, DOI*, Civil Action No. 2:00-1062 (S.D. W.Va.). The West Virginia Highlands Conservancy (WVHC) had filed a motion with the U.S. District Court for the Southern District of West Virginia to reopen the case and schedule further proceedings on the grounds that the recommendations of the Special Reclamation Advisory Council were not being followed with regard to funding the Special Reclamation Fund. Based upon the Legislature's extension of funding through the Continuing and Temporary taxes, the case was placed on the court's inactive docket as of May 2008; however, the court allowed the possibility of a renewed motion if the Legislature does not continue to provide sufficient monies for the Fund to remain solvent.

In March 2011, the WVHC moved once again to have the litigation reopened alleging continuing problems with the Fund. A status conference was held on August 5, and the court ordered the filing of a joint status report. On August 25, 2011, the WVHC and the Defendants filed a joint status report with the court. The WVHC stated that the court should not delay reopening the case until the new actuarial report and Advisory Council recommendations are issued, whereas the Defendants recommended that it was premature for the court to reopen this matter prior to the close of the 2012 legislative session.

On March 30, 2012, a status conference call was conducted by the Court. In light of the enactment of Senate Bill 579 that increased the special reclamation tax from 14.4 cents to 27.9 cents per ton of clean coal mined, the Plaintiff acknowledged that it would move to withdraw its Second Motion to reopen and refile it to address the changed circumstances that have occurred since the filing of its motion to reopen.

On April 2, 2012, the WVHC filed its Motion to withdraw its Second Motion to reopen this case with the Court. On August 5, 2012, the Court issued an Order granting the Plaintiff's Motion to withdraw its Second Motion. In addition, the Court granted the WVHC leave to

file an additional motion to explain deficiencies that remain, notwithstanding the recent revenue increase in the Special Reclamation Fund.

This case remains open, so the District Court can address any issue that may arise regarding the State's ABS.

Study Issues

1. 2015 Consensus Coal Production Forecast for West Virginia

The West Virginia Consensus Coal Production Forecast is a combined production forecast comprised of four component forecasts. A consensus approach to forecasting seeks the "wisdom of crowds" in producing an expectation for output from the coal industry. The Consensus Forecast is used in planning analysis to provide the best expectation of tax to be collected for mandatory reclamation activities conducted through the Special Reclamation Fund and the Special Reclamation Water Trust Fund.

The report describes recent historical coal production trends for the State of West Virginia including the individual industries that comprise the major segments of demand. Each of the component forecasts used to form the Consensus Forecast; Energy Information Administration (EIA), Energy Ventures Analysis (EVA), Marshall University Center for Business and Economic Research (CBER), and West Virginia University Bureau for Business and Economic Research (BBER) is then described, with information about assumptions and resulting projected levels of production for West Virginia. The process used to produce the Consensus is also described, including the weightings applied to each of the component forecasts. The West Virginia Consensus Coal Production Forecast is calculated for the years 2015 through 2035.

A significant change to the 2015 Consensus Coal Forecast is the addition of the WVU long-term forecast. This increases the number of long-term forecasts to four from three, and lowers the weights of the component forecasts. The EIA maintains the highest share of the consensus due to historical accuracy of its forecasts, but its share of the consensus is lower than in the last two years.

The component models within the consensus forecast incorporate a wide range of possible levels of West Virginia coal production over the next 20 years. These varying levels of forecasted coal production illustrate the impact of various supply variables and uncertainty

over whether the continuation of recent trends will or will not continue. The consensus reduces uncertainty by combining the forecasts into one aggregate projection where West Virginia coal production continues to decline through 2018, recovers slightly for a couple years, and then declines slowly through 2035.

The 2015 West Virginia Consensus Coal Forecast figures are higher than the 2014 Consensus. A primary reason for this is lower coal prices, which in some models are an indication of lower production costs and more competitive supply from Appalachian producers as higher cost mines have closed. The EIA and EVA models both project higher production for West Virginia than in the prior forecast, while the CBER model projects lower production. The following Table is a comparison of component forecast and 2013 – 2015 consensus forecast.

Table 2

West Virginia Coal Production (million tons)							
Year	2015 Forecasting Group				2015 Consensus	2014 Consensus	2013 Consensus
	EIA	EVA	CBER	WVU			
2015	108.4	109.9	105.7	103.9	107.2	106.9	113.9
2016	105.9	104.7	103.6	98.2	103.4	101.4	112.2
2017	102.9	101.9	101.5	99.9	101.7	103.0	113.5
2018	103.1	105.5	99.5	101.5	102.7	103.3	108.7
2019	107.5	108.3	97.5	103.3	104.8	102.4	105.6
2020	107.1	109.2	95.4	104.7	104.9	101.5	105.4
2021	105.8	110.4	93.4	104.8	104.4	100.9	104.8
2022	103.9	110.4	91.4	104.7	103.4	100.7	106.6
2023	102.1	111.7	89.4	105.1	102.8	100.0	107.6
2024	101.7	113.2	88.2	104.9	102.8	99.9	107.2
2025	101.9	111.9	87.6	104.7	102.4	99.2	106.3
2026	100.8	113.2	87.0	104.5	102.2	98.2	106.3
2027	99.6	113.8	86.3	104.0	101.7	98.1	106.1
2028	98.5	114.4	85.7	103.0	101.2	97.1	105.4
2029	98.3	114.8	85.1	102.2	100.9	97.1	105.0
2030	99.0	114.9	84.5	101.6	100.9	96.5	104.4
2031	98.8	115.0	83.9	100.5	100.5	96.3	103.5
2032	99.9	116.2	83.3	99.8	100.9	95.1	101.9
2033	98.9	114.8	82.7	98.6	99.8	94.2	99.6
2034	95.4	114.9	82.0	97.3	98.3	93.7	99.0
2035	94.7	114.0	81.4	95.6	97.3	91.6	97.3

The full report can be found in Appendix B.

2. Actuarial Review of the West Virginia Department of Environmental Protection Special Reclamation Fund and Water Trust Fund.

Taylor & Mulder, Incorporated ("T&M") was contracted by the DEP to conduct an actuarial review of its loss reserves as of June 30, 2015. The report contains a summary and conclusions along with a description of their analysis underlying their conclusions.

Specifically, T&M was asked by the WVDEP to conduct an actuarial analysis to include within its scope the following tasks:

- A valuation in accordance with applicable actuarial standards of practice promulgated by the Actuarial Standards Board of the American Academy of Actuaries that will determine the Program's fiscal soundness;
- An evaluation of the present (June 30, 2015) assets and liabilities of the Special Reclamation Program for a minimum of 20 years, including an annual table illustrating those assets and liabilities for underground versus surface mine permits, small versus large permits (based on bond amounts or acreage) and permits for tipples, preparation plants, and impoundments and illustrating land and water liabilities separately;
- An evaluation of the prospective assets and liabilities of the Special Reclamation Program for a minimum of 20 years, including a table illustrating estimates of underground versus surface mine permits, small versus large permits (based on bond amounts or acreage) and permits for tipples, preparation plants, and impoundments and illustrating land and water liabilities separately, including the funded status of the Water Trust Fund ("WTF") as well as the Special Reclamation Fund ("SRF");
- A table that combines the findings of the two previous tasks;
- An analysis and discussion of the ability of the Program to support long term and/or perpetual liabilities; and,
- A one page executive summary of conclusions with references to the body of the report.

This is a "closed" valuation of the Funds' liabilities insofar as it considers only liabilities arising from permits that have already been issued. The estimated liabilities

account for current known reclamation projects as well as anticipated permit revocations on permits issued prior to June 30, 2015. Anticipated income is also linked to permits issued by June 30, 2015 without regard to future permits issued.

The Actuary's projections of revenues and expenses to the Funds imply that the Funds will experience financial solvency on a cash basis through 2035, and will therefore be capable of supporting the current liabilities over the long term. It should be noted, however, that the investment income for the SRWTF for each fiscal year was based on an assumption of a 5.5% yield. The investments for the SRWTF are managed by the West Virginia Investment Management Board (IMB) and have shown some significant losses in recent quarters. The assumption of the 5.5% yield is based on expected long term returns.

Note: *The IMB fund targets a return of 5.5%. However, the final fund balance will depend on the actual return earned over the projection period, which could be higher or lower than 5.5%. Because of the length of the projection period, the final balance is sensitive to changes in the rate of return. As such, this investment yield represents an important risk to the fund.*

By comparison, the 2013 analysis projected the Fund to dip into a slight negative balance in 2018 prior to disengaging from covering the liabilities of the SRWTF in 2019. The discrepancies between the two analyses may be described as follows:

The 2015 actuarial analysis uses an inherently different modeling methodology compared to what was used in previous actuarial studies performed for the SRF. A primary difference between the approaches is the use of regression modeling in the current study compared to use of historical averaging in prior studies. The studies also differ in the extent to which historical data is relied on for projections related to expected new forfeits. Some of the units of estimation are also different, as the current approach is based on costs per permit while prior approaches were based on costs per acre.

The current analysis uses a series of generalized linear models to estimate the magnitude of future reclamation costs. Models are based on variables identified as having explanatory power to predict rates of forfeiture or costs of reclamation. Each variable has a coefficient that quantifies its contribution to forfeitures and costs. Model results are based on a maximum likelihood approach that assigns a probability of a particular estimate being the

most likely result. Costs are estimated per permit, as a function of selected variables, and then multiplied by the projected number of forfeits.

Both current and past actuarial approaches utilized much of the same historical data at the permit level, including age, type, size, location, bond amounts, and actual incurred costs for land and water reclamation. In addition to this data, the current approach also incorporates industry variables such as the price of coal and the price of crude oil, as well as additional SRF data such as initial reclamation cost estimates, as opposed to just actual incurred costs. The current study thus explicitly includes some of the factors influencing forfeiture and cost trends whereas in prior studies such factors are not quantified with respect to SRF cost and forfeiture data.

The two approaches differ somewhat in the inclusion of historical data determined to be useful. For example, previous studies focused more on the status of permits (active, inactive and phased release) while the current study places more emphasis on the location of permits (northern vs. southern West Virginia). Another difference regards water treatment cost estimates used for projected reclamation resulting from new forfeits. In the 2013 actuarial study future water treatment liabilities were based on DEP's projected costs whereas the current cost projections rely solely on historical cost patterns identified by the actuary.

Both actuarial approaches are "closed" valuations that only consider liabilities associated with permits that have already been issued. Both studies also rely on the assumption that historical trends will continue, in terms of overall rates of forfeiture and in the relationships between forfeitures and expenditures.

The 2015 report can be found in Appendix B.

3. Alternative Enforcement Evaluation by DEP.

The DEP continues to re-examine previous bond forfeitures to determine whether there are any persons or entities who may have liability for some or all of the Special Reclamation Fund's reclamation and water treatment costs from whom the DEP could pursue cost recovery. Initially, the DEP identified the twenty largest Special Reclamation liabilities and referred these to OSM for assistance in investigating and identifying persons who controlled the companies which forfeited these bonds. OSM has provided the DEP with

preliminary results for the first two of its investigations. The DEP has assigned legal counsel from its Office of Legal Services to review these preliminary investigations to determine whether any person/entity identified is worth pursuing. As investigations are conducted, the DEP will also be providing feedback to OSM to help OSM perform work that will be of the greatest value to the DEP.

In 2015, WVDEP permittees holding approximately 900 permits commenced bankruptcy cases in West Virginia. The WVDEP has and continues to actively monitor each of these bankruptcy proceedings, taking appropriate and aggressive steps as necessary both in the regulatory and bankruptcy forums to ensure that the permit holders transfer the permits to capable and responsible operators or take other steps to reclaim the sites in accordance with the permits. In 2015, WVDEP has taken an active role in the chapter 11 cases of Alpha, Patriot, James River, Walter, and Xinergy. Those efforts continue in the ongoing chapter 11 cases of Alpha, James River, Walter, and Xinergy, as well as in connection with the resolution reached in the Patriot bankruptcy in October 2015. In addition, WVDEP's efforts have secured substantial financial and other commitments to help ensure full reclamation and water treatment on the affected permitted sites. In particular, WVDEP negotiated a $50 million settlement relating to 140 of the Patriot permits not transferred to continuing mine operator, Blackhawk Mining. The settlement consisted of the immediate issuance of a $12.5 million letter of credit as additional collateral securing those reclamation obligations, as well as the commitment by Blackhawk Mining to provide an additional $7.5 million of in-kind reclamation on the West Virginia permitted sites it left behind. In addition, Virginia Conservation Legacy Fund, the entity that took over the reclamation obligations on those permits, has also pledged as collateral to the WVDEP a substantial portion of its cash flow from ongoing operations and settlement that are estimated to reach as much as $30 million. WVDEP also negotiated a substantial settlement with Alpha, which has posted a $15 million letter of credit and provided an additional $24 million in super priority claims in its bankruptcy case to back roughly 15% of its self-bonded reclamation obligations. WVDEP continues to work closely with Alpha to further reduce its self-bonded obligations as Alpha works to bond all its reclamation obligations upon the conclusion of its bankruptcy proceedings. In 2015, the WVDEP also reached a settlement of its litigation with Appalachian Fuels that resulted in the provision by the Appalachian Fuels bankruptcy trustee

of an additional $1.75 million to fund reclamation on the three former Appalachian Fuels permits that WVDEP revoked and forfeited in 2014. For calendar year 2015 approximately $757,000 has been paid from Special Reclamation Fund accounts for outside legal costs associated with bankruptcy proceedings of coal mining permittees. At the start of 2016, another large coal permittee, Arch Coal (with 169 permits in West Virginia), filed for chapter 11 bankruptcy. WVDEP will be actively involved in this case, as it has been in all the others.

4. Watershed Scale Approaches to AMD Remediation: Martin Creek and Sandy Creek.

As was discussed earlier in this report, the DEP is now required to obtain NPDES permits for all of its water treatment facilities on former mining sites that have had their permits revoked and bonds forfeited. In some instances this will only lead to DEP discharging compliant waters into streams that are significantly impaired by pre-law acid mine drainage (AMD). Therefore, the DEP is pursuing an alternative NPDES permitting structure for bond forfeiture water treatment sites within the Martin Creek and Sandy Creek watersheds that will result in a large scale benefit by treating in-stream rather than on a site-by-site basis, thereby addressing both pre-law and post-law AMD problems which will ultimately restore the streams biological integrity.

In-stream treatment is a proven approach to addressing AMD problems on a watershed wide basis. Success has been evident as early as 1994 when DEP's Abandoned Mine Land Program (AML), in cooperation with the Department of Natural Resources (DNR), installed a lime doser and a Limestone Drum Station on the Blackwater River. The continuous application of alkalinity from the doser and limestone fines, which are generated by the constant grinding motion of the limestone inside the drums as they turn, resulted in restoration of twelve miles of the Blackwater River. The in-stream approach was proven once again in 1995 when AML, again in cooperation with the DNR, initiated the Middle Fork River Limestone Sands Dumping Project that restored thirty eight miles of the Middle Fork River to the point where trout were reintroduced in 1996. The latest example of this type of success is the Three Forks Creek Watershed Restoration Project which was a combined effort between AML, West Virginia University's Water Research Institute (WRI), and the Save the Tygart Watershed Group. Pre-law mining degraded four major tributaries

of Three Forks Creek to the point that it was so impaired it was mostly devoid of aquatic life. In 2010, prior to initiating in-stream treatment, the DEP conducted benthic macro-invertebrate and fish surveys at four locations along the main stem of Three Forks Creek. Results of this survey found diminished macro-invertebrate populations at all four locations, and one fish that was caught less than a half mile from the confluence of the Tygart Valley River.

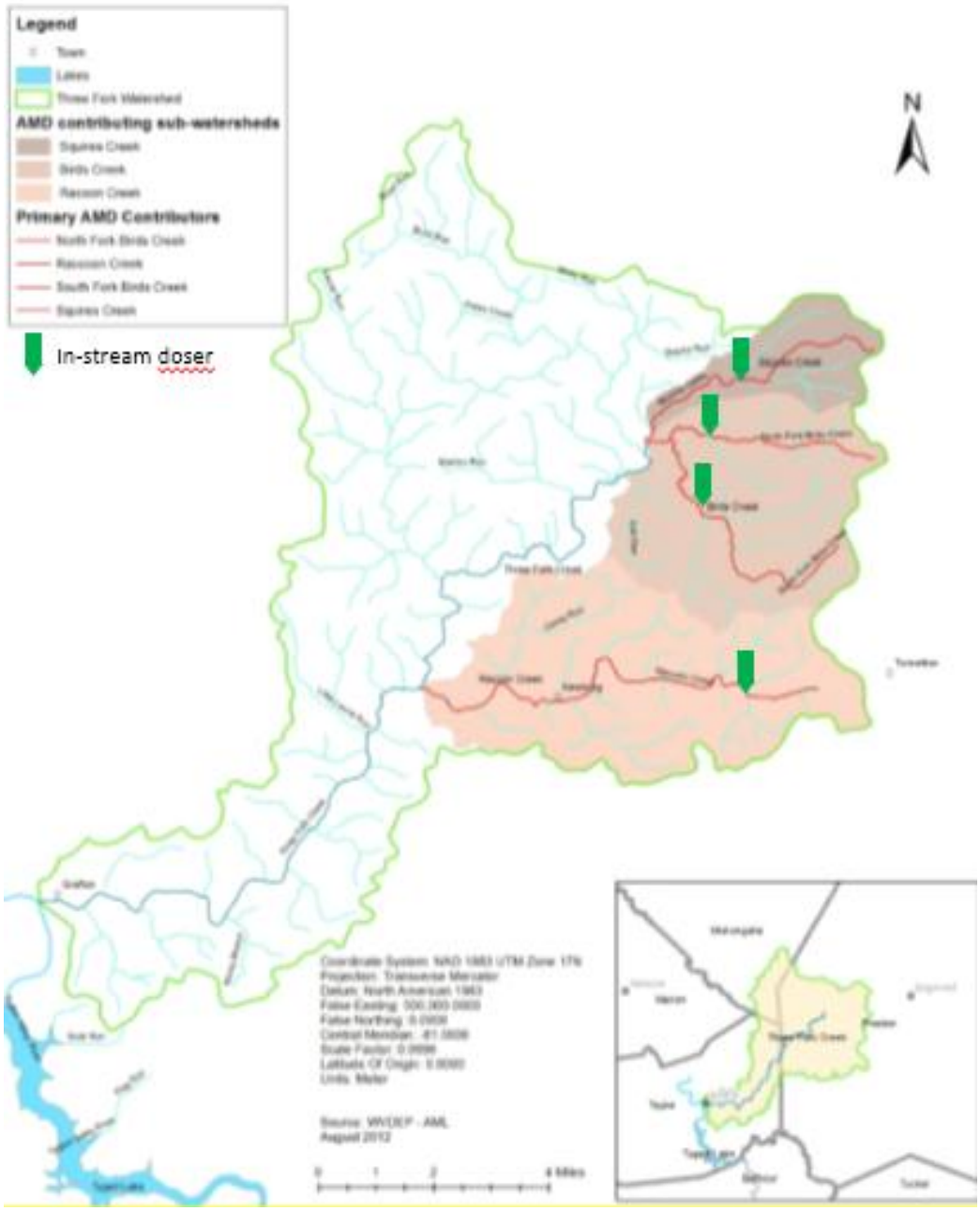

Figure 6 In-stream dosers on Three Fork Creek

Then in 2010, AML installed in-stream dosers on the four tributaries contributing AMD to Three Forks Creek. In 2012 the surveys were repeated at the same four locations. Macro-invertebrate populations improved significantly but the fish population exploded to over 1,600 fish representing 21 species of predator and prey, and numerous young fish were captured indicating that natural reproduction was taking place within the watershed.

Figure 7 In-stream doser on South Fork of Birds Creek

The DEP has been treating mine drainage on forfeited mine sites within the Three Forks Creek watershed as early as 2001. Six active treatment sites[1], consisting of eight lime dosers, and 3 passive treatment systems have been constructed at nine bond forfeiture sites within the watershed, and DEP now has eleven NPDES outlets. The DEP has spent approximately $2.7 million for the construction of these facilities and to date O&M cost have surpassed $2 million, over two hundred and sixteen thousand dollars on an annual basis, and as the results of the 2010 macro-invertebrate and fish surveys indicate - there were no biological improvements.

[1] An active treatment site is one in which a chemical neutralizing agent, such as lime or sodium hydroxide, is added directly to the AMD at the source. By comparison a passive treatment system is one in which the AMD passes through a neutralizing media, such as limestone, or a structure that enhances metals precipitation such as a wetland or settling pond.

The DEP is in the process of applying for a variance that would enable the Special Reclamation Program to treat in-stream in lieu of at-source treatment. To accomplish this the DEP is working collaboratively with the USEPA to develop a watershed based NPDES permitting structure from within the framework of the Clean Water Act. DEP treatment sites within the watershed where the variance is applied would be covered by the watershed-based NPDES permit, and the DEP would be required to meet certain in-stream water quality limits at a pre-determined stream location. The reasoning behind this approach is to enable DEP to use its' money more wisely and accomplish more by treating in-stream, thereby addressing pre and post-law AMD problems at comparable cost to what is currently being spent by treating at-source. In other words, if DEP is spending $200,000 on an annual basis at certain bond forfeiture AMD treatment sites within a particular watershed, that $200,000 could be used to place in-stream dosers at strategic locations within the watershed to restore stream miles on a watershed basis, rather than discharging compliant water into "dead" streams.

The DEP has entered into a contractual agreement with WRI to conduct studies in two watersheds, Martin Creek and Sandy Creek, where a variance may be applied. The purpose of these studies is to provide the DEP with data to guide future management decisions on the placement of dosers to treat these two watersheds on a watershed level. The agreement is provided in Appendix B.

2016 SRFAC Study Issues

- Review of DMR database.
    - Longevity of permits
    - Status of permits

Special Reclamation Fund Advisory Council Recommendations to the Legislature

Based upon conclusions drawn from information included in this report, the Council makes the following recommendations to the Legislature:

The Council recommends that the present 12.9 cent per ton tax dedicated to the Fund remain in force and that the tax dedicated to the SRWTF remain at 15 cents per ton. The Council further recommends that the State Legislature form a panel to examine the elements of our State code that result in uncontrolled liabilities, how other states deal with such issues

and finally to propose a State legislative initiative to rationalize water quality regulation to meet the conditions of the Federal Clean Water Act while adding rationality and certainty to the process.

The Council recommends that the Legislature continue to examine the implications of the recent court rulings and subsequent lawsuit settlements on the Special Reclamation Fund, Abandoned Mine Lands, and voluntary efforts by citizen-led watershed groups to address historic mining-reclamation related liabilities. The Council further recommends that the Legislature examine the mine reclamation and bonding programs of other states and as implemented in Tennessee by the federal Office of Surface Mining in order to determine if the statute and regulations creating the Fund and SRWTF in West Virginia have inappropriately structured SMCRA to assume long-term CWA liabilities. The Council further recommends the Legislature examine the separate and distinct authorities of the Clean Water Act (CWA) in assessing the eligibility of future forfeitures for transfer of liabilities to the SRWTF. The Council is concerned about default transfer of water treatment liability to the SRWTF when opportunities exist to pursue responsible parties under the CWA per the requirements of an NPDES (CWA Section 402) permit.

As a partial alternative to fully funding the SRWTF through a future increase in the tax, the Special Reclamation Fund Advisory Council recommends that, if possible, the Legislature commit a portion of excess coal severance tax or other revenues to the SRWTF, so it can begin to build value and help offset the cost of future water reclamation and ongoing treatment.

The Council would like to recognize the DEP for their conscientious management of the Fund and the SRWTF and their efforts in minimizing the impacts of bankruptcies to the Funds.

Special Reclamation Fund Advisory Council
Annual Report to the Legislature
February 1, 2016

Randy C. Huffman, Secretary DEP
Ex Officio
Designee: Michael Sheehan
Director, Division of Land Restoration
601 57th Street
Charleston, WV 25304

John D. Perdue, Treasurer
Designee: Carolyn Atkinson
Deputy Treasurer for Unclaimed Property
WV State Treasurer's Office
One Players Club Drive
Charleston, WV 25311

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National Mine Land Reclamation Center
WVU – NRCCE Building
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John S. L. Morgan
Morgan Worldwide
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Lexington, KY. 40508

Bill Raney, President
West Virginia Coal Association
Northgate Business Park
P.O. Box 3923
Charleston, WV 25339

Ronald Pauley
50 Sunset Drive
Sumerco, WV 25567

Christine M. Risch
Director of Resource & Energy Economics
Marshall University
Center for Business & Economic Research
One John Marshall Drive
Huntington, WV 25755-0003

Poling, Carla K

From: Ronald Pauley <rl.pauley@yahoo.com>
Sent: Monday, February 01, 2016 5:16 PM
To: Poling, Carla K
Subject: Re: SRFAC ann rep signature page

I am on my way to NC I can give you or Mike permission by this email or can scan tomorrow morning

Sent from Yahoo Mail for iPhone

On Monday, February 1, 2016, 4:59 PM, Poling, Carla K wrote:

Please continue to sign and forward this signature page.
Thank you
Carla

-----Original Message-----
From: Atkinson, Carolyn [mailto:carolyn.atkinson@wvsto.com]
Sent: Saturday, January 30, 2016 12:09 PM
To: Paul Ziemkiewicz <pziemkie@wvu.edu>; John S. L. Morgan (jmorgan@morganworldwide.com) <jmorgan@morganworldwide.com>
Cc: Poling, Carla K <Carla.K.Poling@wv.gov>
Subject: Re: SRFAC ann rep signature page

John,

I have signed and attached. Please see instructions below. Thanks!

Carolyn

From: Paul Ziemkiewicz <pziemkie@wvu.edu>
Sent: Friday, January 29, 2016 4:56 PM
To: Atkinson, Carolyn
Cc: Poling, Carla K
Subject: SRFAC ann rep signature page

I haven't heard from Carolyn and it is getting late, so to keep this moving, I've signed and am sending it to Carolyn for her signature. Carolyn, please send next to John Morgan.
Thanks
pfz

Attached is the signature page for the 2015 SRFAC annual report for your signature.
Carolyn, if you will please sign and scan it to Paul and on down the list.
Christy, you should be the last one to sign and then scan the completed document back to me to include in the report.

Appendices for 2015 SRF Advisory Council Annual Report
(All Appendices as of 12-31-15)

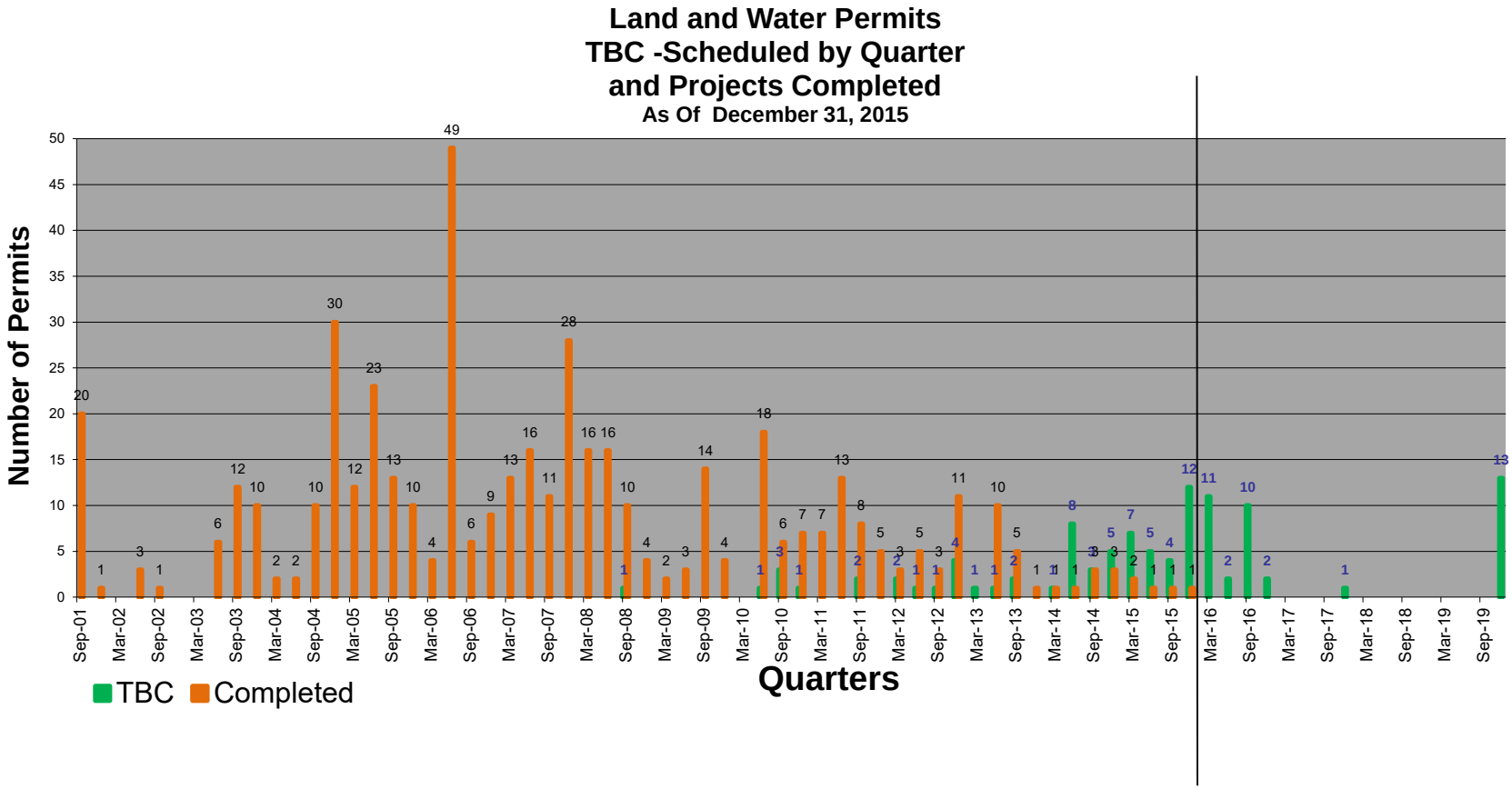
A. OSR Graphs:

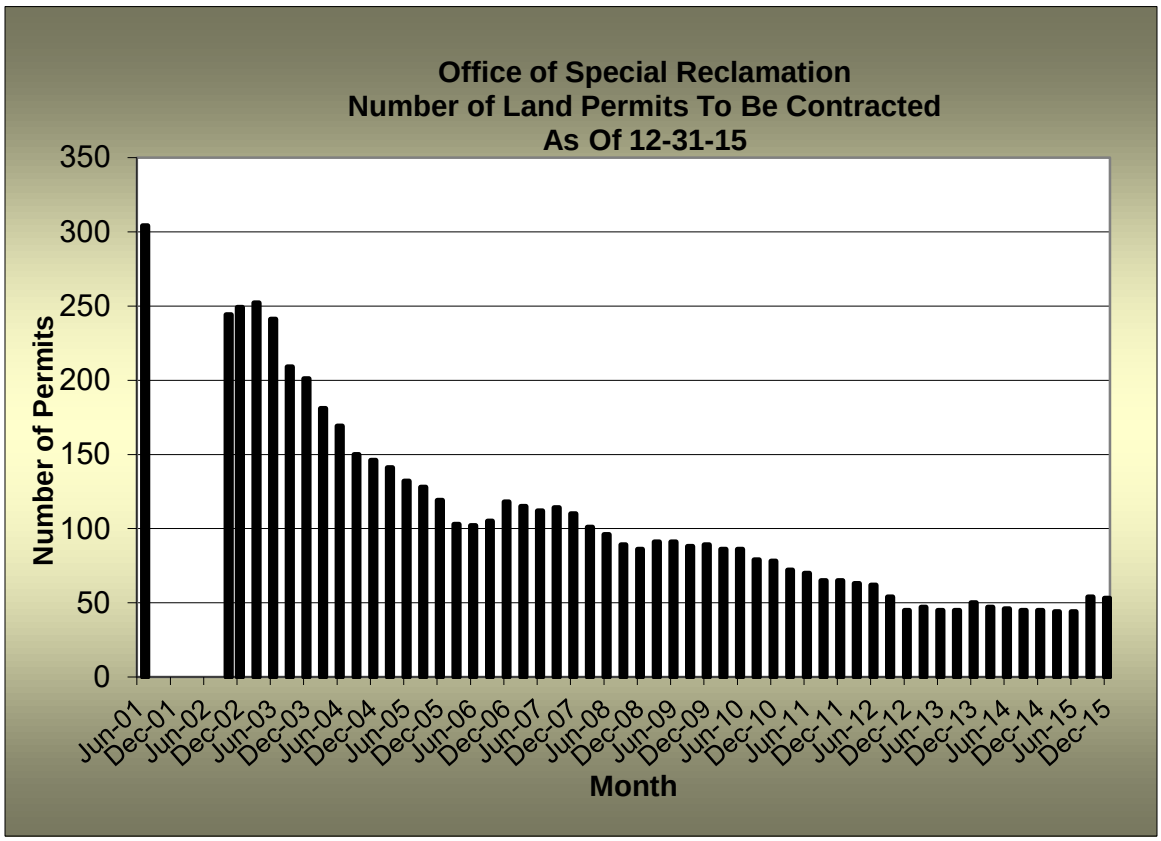
Land and Water Permits Scheduled by Quarter and Projects Completed
Land Permits To Be Contracted
Land Liabilities To Be Contracted
Permits Forfeited Since 6-30-01
Reclamation Projects Started Since 6-30-01
Contract Dollars Encumbered
Cash Balance
Total Revenue
Revenue Collected by Source: Bonds, Civil Penalties, Tax

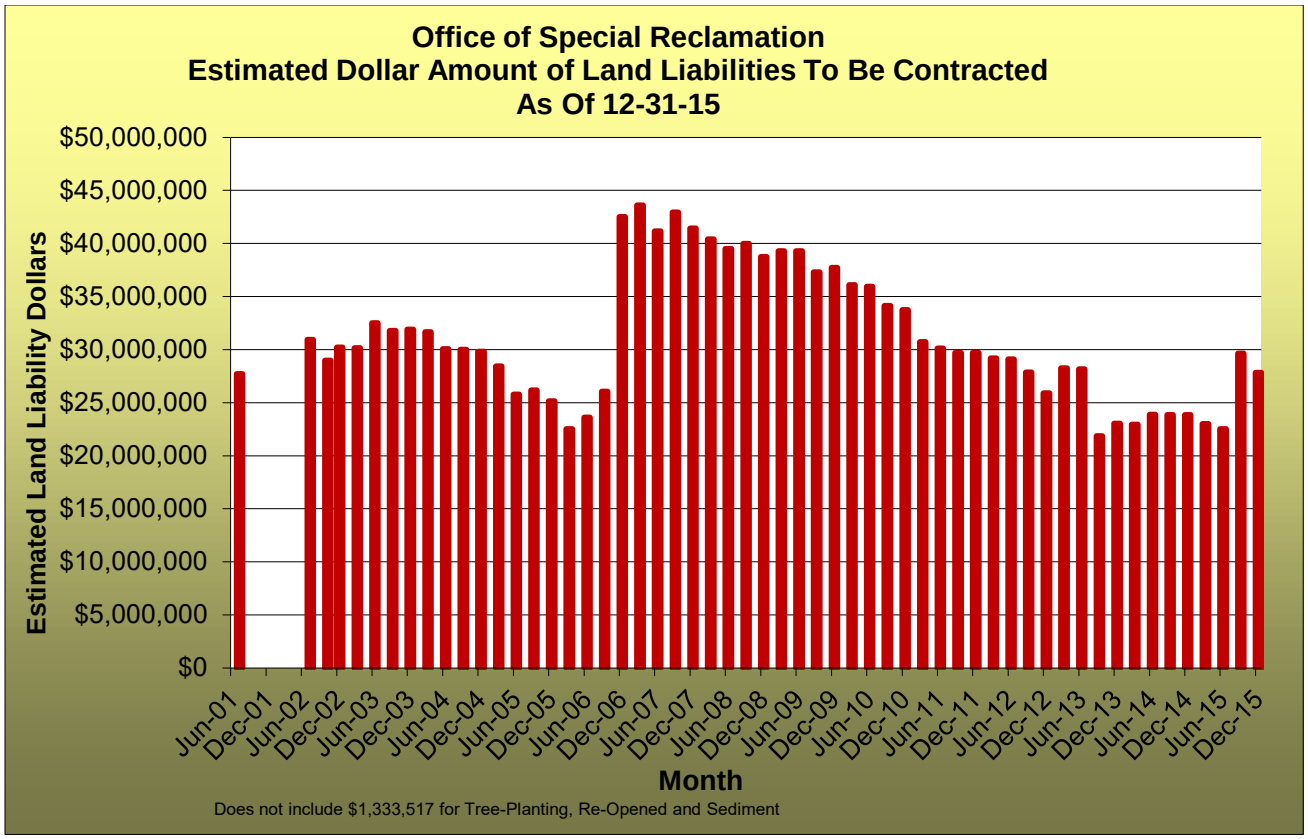
B. Reports Commissioned by the Council

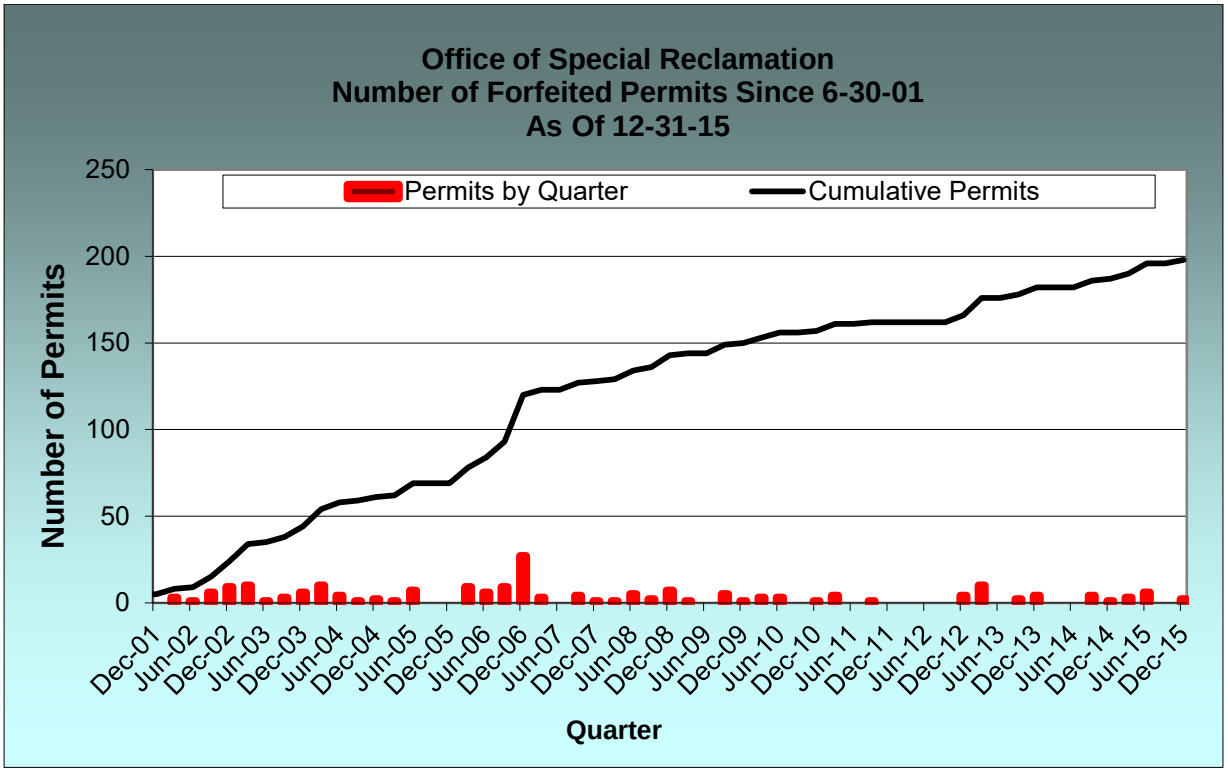
- **a.** 2015 Consensus Coal Production Forecast for West Virginia
- **b.** Actuarial Review of the West Virginia Department of Environmental Protection Special Reclamation Fund and Water Trust Fund
- **c.** Alternative Enforcement Evaluation by DEP
- **d.** Watershed Scale Approaches to AMD Remediation: Martin Creek and Sandy Creek
    i. Wv342 4dec15.pptx - Martin Creek AMD Treatment Project, Early Results

Appendix A


Land and Water Permits
TBC -Scheduled by Quarter
and Projects Completed
As Of December 31, 2015
Number of Permits
Quarters
TBC
Completed


Office of Special Reclamation
Number of Land Permits To Be Contracted
As Of 12-31-15
Number of Permits
350
300
250
200
150
100
50
0
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
Dec-10
Jun-11
Dec-11
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Month


Office of Special Reclamation
Estimated Dollar Amount of Land Liabilities To Be Contracted
As Of 12-31-15
Estimated Land Liability Dollars
$50,000,000
$45,000,000
$40,000,000
$35,000,000
$30,000,000
$25,000,000
$20,000,000
$15,000,000
$10,000,000
$5,000,000
$0
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
Dec-10
Jun-11
Dec-11
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Month
Does not include $1,333,517 for Tree-Planting, Re-Opened and Sediment


Office of Special Reclamation
Number of Forfeited Permits Since 6-30-01
As Of 12-31-15
Permits by Quarter
Cumulative Permits
Number of Permits
250
200
150
100
50
0
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
Dec-10
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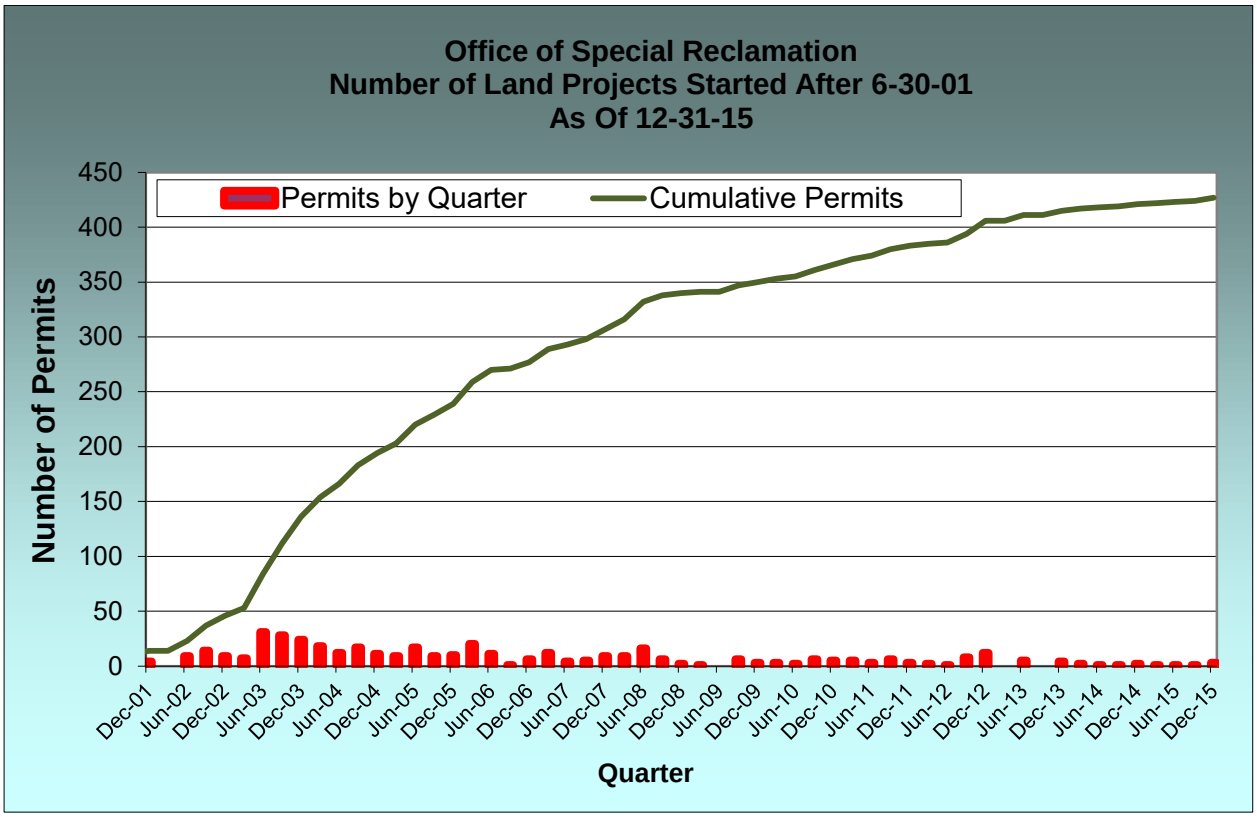
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Quarter


Office of Special Reclamation
Number of Land Projects Started After 6-30-01
As Of 12-31-15
Permits by Quarter
Cumulative Permits
Number of Permits
450
400
350
300
250
200
150
100
50
0
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
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Jun-10
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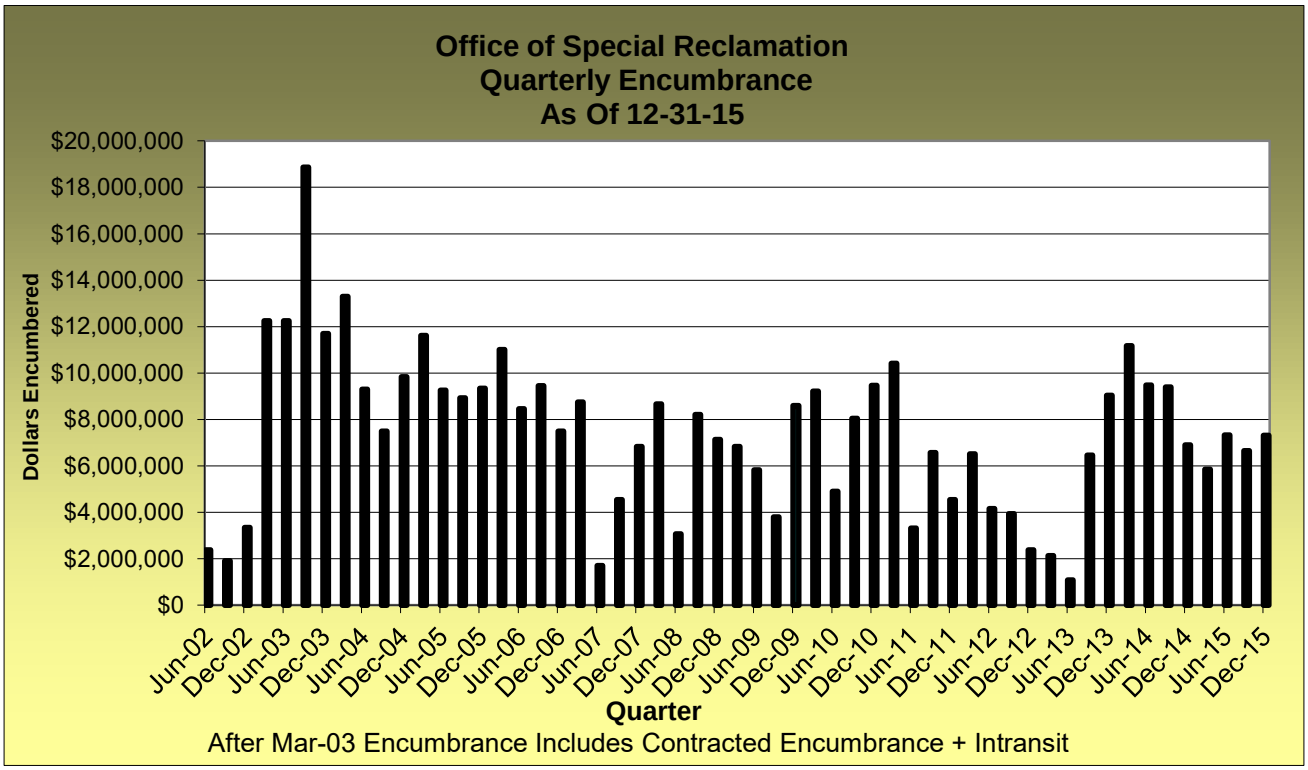
Jun-11
Dec-11
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Quarter


Office of Special Reclamation
Quarterly Encumbrance
As Of 12-31-15
Dollars Encumbered
$20,000,000
$18,000,000
$16,000,000
$14,000,000
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
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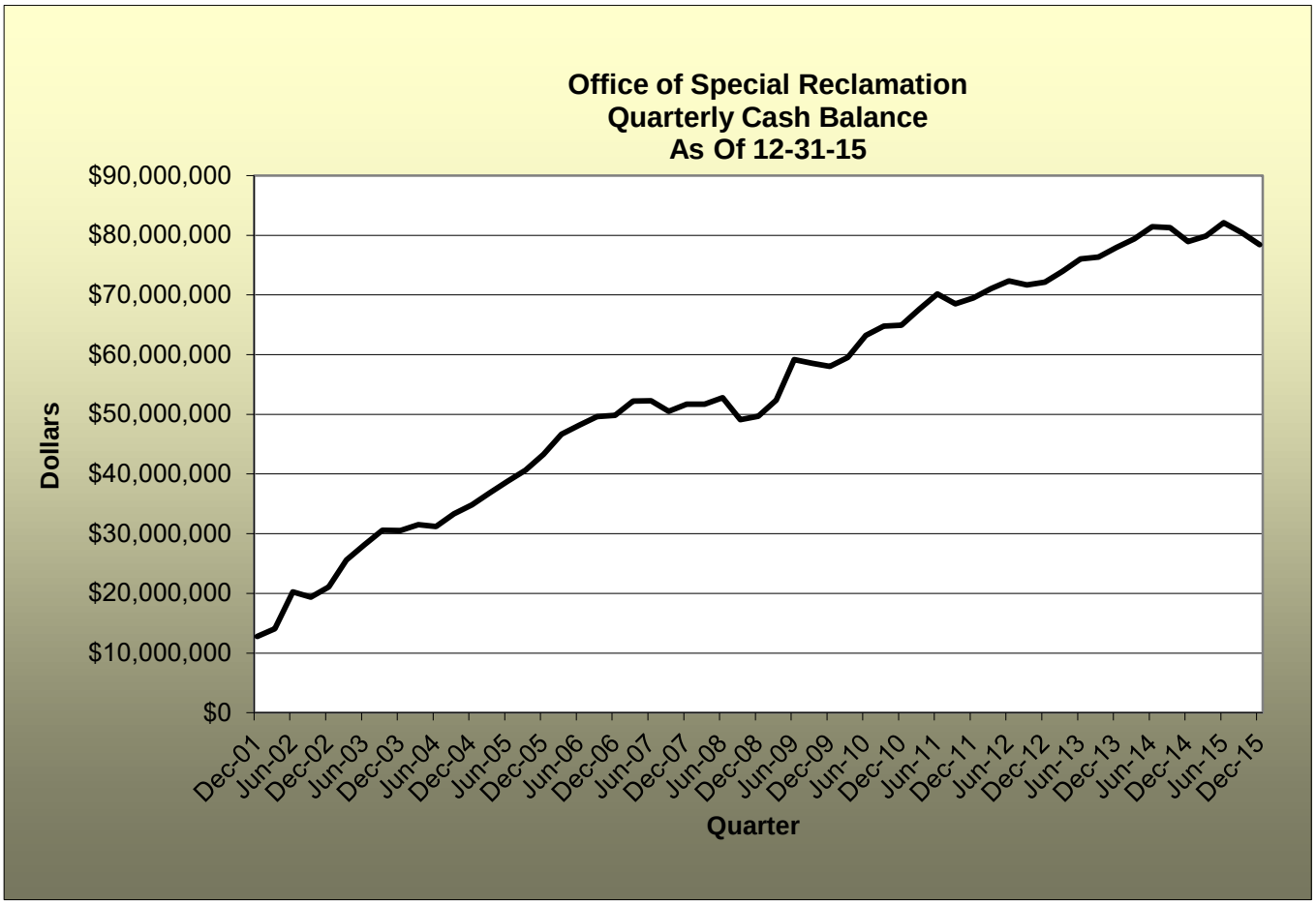
Dec-09
Jun-10
Dec-10
Jun-11
Dec-11
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Quarter
After Mar-03 Encumbrance Includes Contracted Encumbrance + Intransit


Office of Special Reclamation
Quarterly Cash Balance
As Of 12-31-15
Dollars
$90,000,000
$80,000,000
$70,000,000
$60,000,000
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
$0
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
Dec-10
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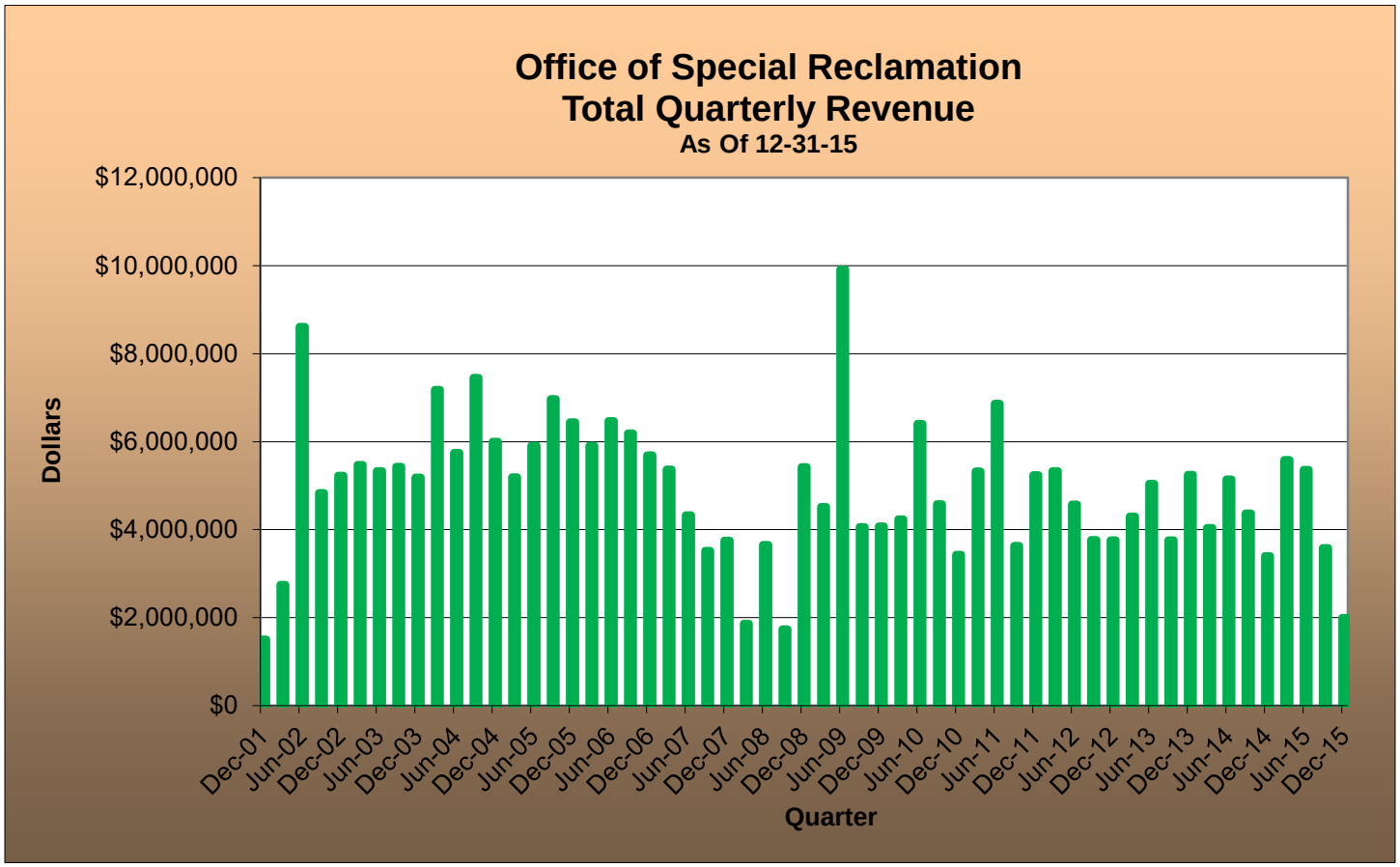
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Quarter


Office of Special Reclamation
Total Quarterly Revenue
As Of 12-31-15
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
Dollars
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
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Dec-12
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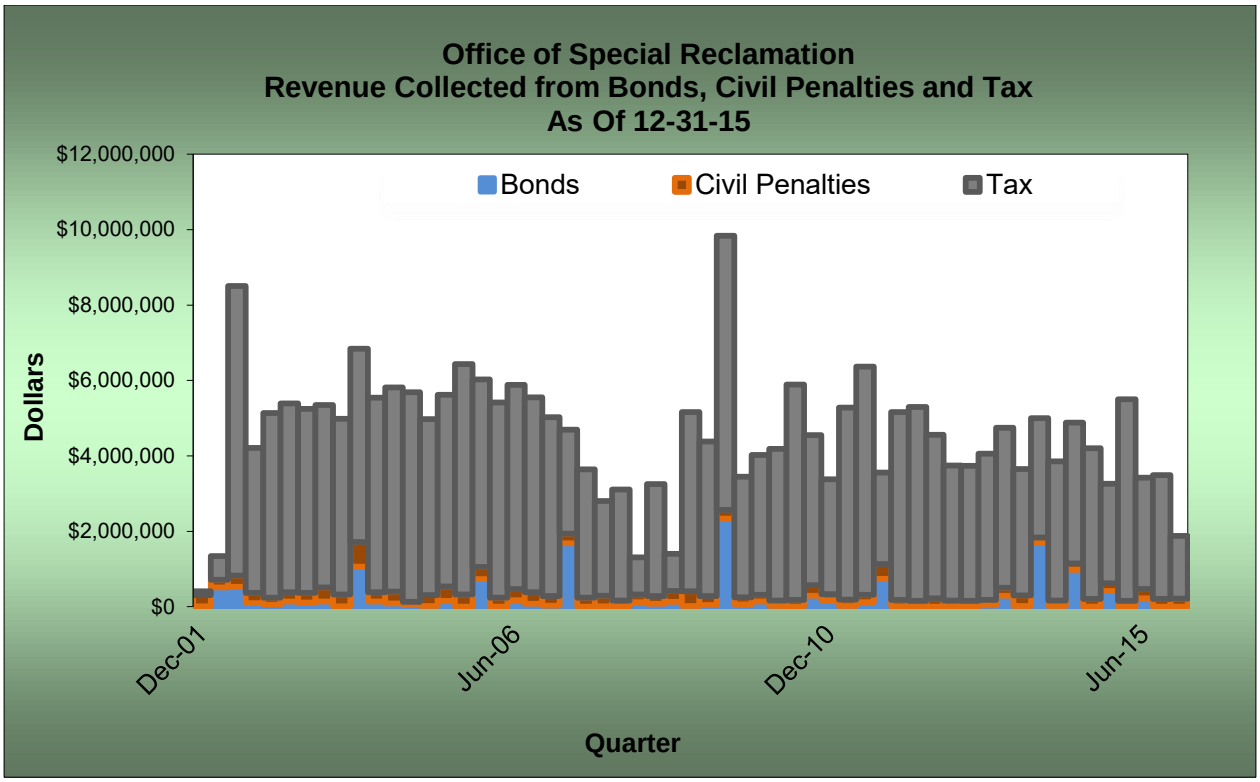
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Quarter


Office of Special Reclamation
Revenue Collected from Bonds, Civil Penalties and Tax
As Of 12-31-15
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
Dollars
Bonds
Civil Penalties
Tax
Dec-01
Jun-06
Dec-10
Jun-15
Quarter

Appendix B

Consensus Coal Production Forecast for West Virginia: 2015

Prepared for:

Special Reclamation Fund Advisory Council,

West Virginia Department of Environmental Protection

Date:

July 8, 2015

CBER
CENTER FOR BUSINESS AND ECONOMIC RESEARCH

Consensus Coal Production Forecast for West Virginia: 2015

Authors:

Christine Risch, Director of Resource and Energy Economics

Jennifer Shand, PhD, Director
Alicia K. Copley, Research Assistant

Center for Business and Economic Research
Marshall University

907 Third Avenue
Huntington, West Virginia 25701

Phone: (304) 528-7201

Disclaimer:

The contents of this report reflect the views of the authors who are responsible for the accuracy of the data presented herein. The views expressed in this report are those of the authors and do not reflect the official policy or position of Marshall University or its governing bodies. The use of trade names, if applicable, does not signify endorsement.

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Consensus Coal Production Forecast for West Virginia: 2015

Introduction

The West Virginia Consensus Coal Production Forecast is a combined production forecast comprised of four component forecasts. A consensus approach to forecasting seeks the "wisdom of crowds" in producing an expectation for output from the coal industry (Armstrong 2001). The Consensus Forecast is used in planning analysis to provide the best expectation of tax revenues to be collected for mandatory reclamation activities conducted through the Special Reclamation Fund and the Special Reclamation Water Trust Fund.

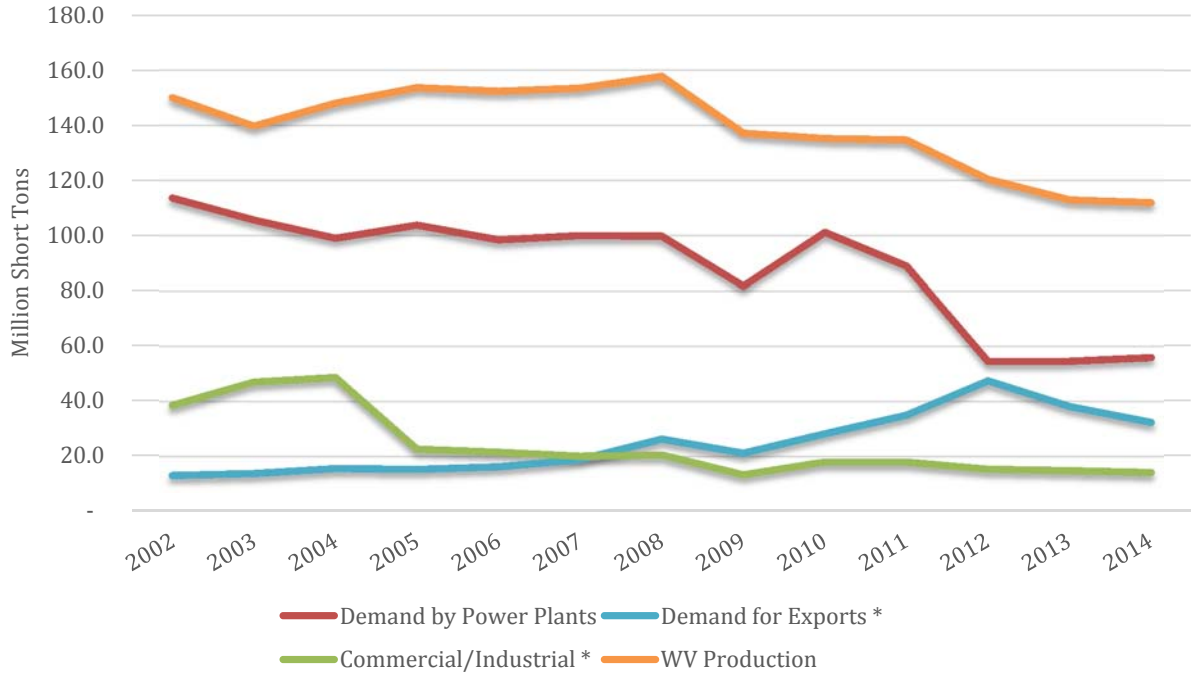
This report describes recent historical coal production trends for the State of West Virginia including the individual industries that comprise the major segments of demand. Each of the component forecasts used to form the Consensus Forecast is then described, with information about assumptions and resulting projected levels of production for West Virginia. The process used to produce the Consensus is also described, including the weightings applied to each of the component forecasts. The West Virginia Consensus Coal Production Forecast is calculated for the years 2015 through 2035.

Overview

West Virginia coal production for 2014 was around 112 million tons (EIA 2014),[1] a decline of about one percent from the 113 million tons produced in 2013. This decline reflects various trends and events within the coal industry's primary markets: power generation, exports and industrial demand. Recent demand trends with preliminary and estimated sector-level data for 2014 are shown below.

[1] 111.9 million tons is the Energy Information Administration's revised 2014 production value based on the final 2014 value published by MSHA (clean coal production reported on MSHA Form 7000-2). The West Virginia Office of Miner's Health, Safety and Training reports 2014 production of 122.6 million tons, but this is not exclusively clean coal which is the final production volume.

Figure 1: Historical West Virginia Coal Production and Components of Demand



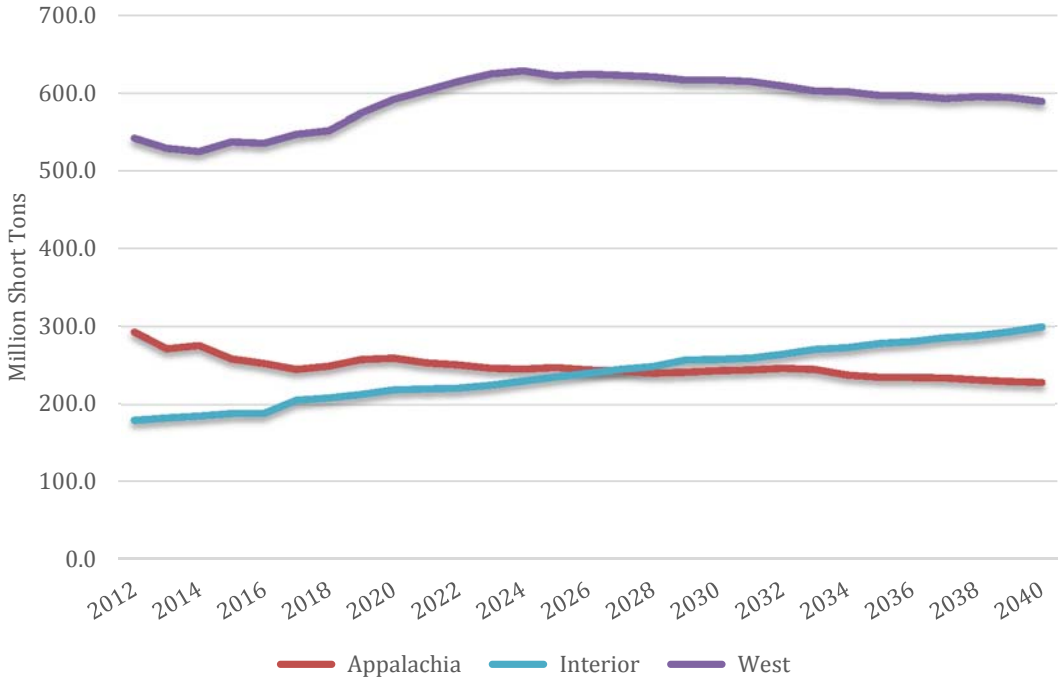
Source: (EIA 2015). Asterisked (*) 2014 volumes estimated by MU CBER. Other 2014 figures are preliminary by EIA.

Future demand for West Virginia coal depends on several variables including the price(s) paid by gas-fired electrical generators for natural gas in the region, the longevity and annual capacity factors of the coal-fired power plants that will continue to burn coal from the State, the rate of economic growth of countries that import West Virginia coal and the nature of compliance with existing and pending environmental regulations.

The Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2015 base case model forecasts Appalachian coal production to decline steadily through 2040, with some stability in the 2017 to 2020 time period. As shown in the following figure, Interior[2] coal production is projected to increase and to surpass Appalachian production in the mid-2020s.

[2] Arkansas, Illinois, Indiana, Iowa, Kansas, Western Kentucky, Louisiana, Mississippi, Missouri, Oklahoma, and Texas.

Figure 2: EIA Forecasted Coal Production, by Region



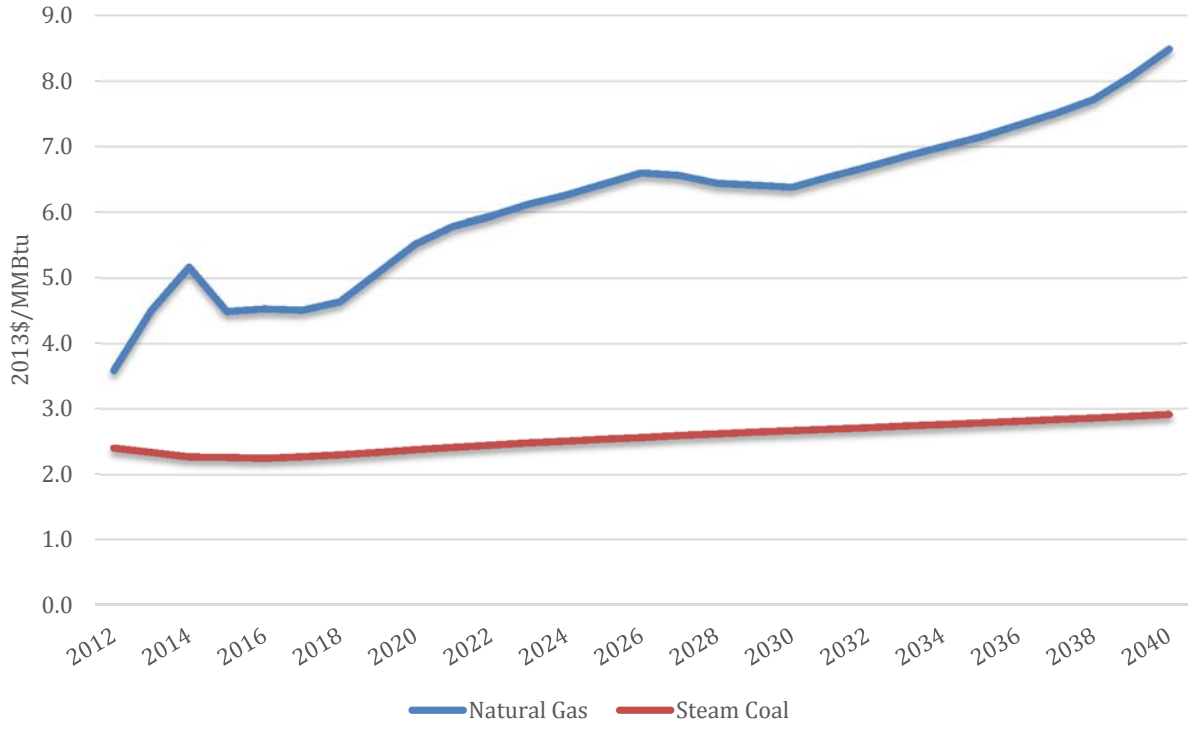
Source: (EIA 2015)

The Electricity Sector

Preliminary power plant fuel receipts data for 2014 published by the EIA indicates that demand for West Virginia-produced coal by the electricity sector increased slightly in 2014, to about 55.6 million tons, compared to about 55 million tons in 2013 (EIA 2015). Natural gas prices rose in 2014, with the average U.S. price for the electric power sector increasing to $5.19/mcf from $4.49/mcf in 2014 (EIA 2015).

The price of natural gas affects utilization of coal-fired power plants, and thus the amount of coal burned by those plants. Higher natural gas prices in 2014 made coal-fired generation somewhat more competitive than in 2013. In its AEO 2015 Reference Case analysis, the EIA continues to project gas prices delivered to the power generation sector to increase at a faster rate than coal prices.

Figure 3: Forecasted Natural Gas & Coal Prices to Electricity Sector

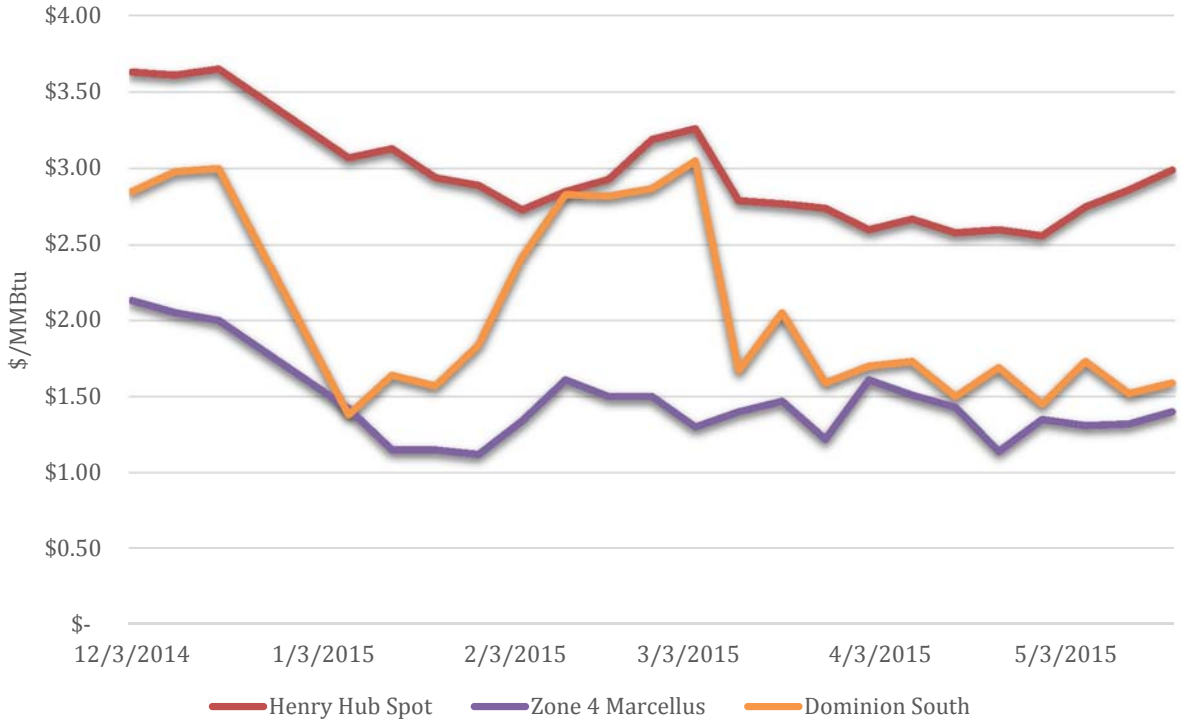


Source: (EIA 2015)

Although the expectation remains that a rise in the relative price of natural gas will moderate declines in coal demand, abundant gas production from the Marcellus play has resulted in particularly low gas prices in the Marcellus area. West Virginia coal competes in the same electricity market as Marcellus gas and is thus impacted by these prices.

Marcellus-area prices frequently trade at a discount to the Henry Hub price, the national benchmark for natural gas. Figure 3 below shows some recent prices for Zone 4 Marcellus gas, a hub in northeast Pennsylvania, and Dominion South, a hub in southwest Pennsylvania. Both of these sub-regions have recently traded at one-half of the Henry Hub price. Other Marcellus hubs, on pipeline systems with the ability to reject Gulf Coast gas, trade at higher prices closer to Henry Hub as noted by EIA's *Today in Energy* (EIA 2014). The continuing build out of pipelines in the region will allow more gas to get to market. These expansions, along with pending activation of the Cove Point LNG export terminal in 2017 (Dominion 2015) and possible reversal of pipelines that have historically brought gas to the northeast, will change the pricing dynamic of regional gas.

Figure 4: Select Marcellus Area vs. Henry Hub Gas Prices



Source: (EIA 2014 and 2015)

Coal-fired power plants in the eastern U.S. continue to close in order to comply with Environmental Protection Agency (EPA) air quality regulations. Closures to date in 2015 have included the Phil Sporn, Kanawha River and Kammer power plants in West Virginia (Appalachian Power Closes 3 West Virginia coal-fired plants 2015). The units at these plants were built in the 1950s and originally had a combined nameplate capacity of around 2,300 MW (EIA 2015).

As it is customary to only simulate the impact of existing rules, the potential impact of the EPA's proposed Clean Power Plan is not considered in any of the component forecasts that make of the West Virginia Consensus Forecast. Other policy changes, such as the June 2015 remand of the EPA MATS rule by the U.S. Supreme Court, are also not incorporated.

EIA analysis of the Clean Power Plan projects resulting declines in consumption of coal for power generation, although the decline only continues through 2024, with lower overall levels of demand through 2040. After 2024, demand for coal-fired generation is projected to rise due to increased demand for electricity, rising natural gas prices and increased renewable capacity, which causes higher utilization of existing coal plants. The southeastern United States region is projected to account for 75% (117 million tons) of the total decline in demand for coal in 2040 compared to the AEO2015 Reference case (EIA

2015). Appalachian coal production in the Base Policy case is 46 million tons (19%) lower by 2024 compared to its Annual Energy Outlook (AEO) 2015 Reference case.

West Virginia University's (WVU) Bureau for Business and Economic Research (BBER) projects an 18 percent decline in production, with the majority of that decline from Northern West Virginia mines due to the concentration of that production for the power gen market (West Virginia University BBER 2015).

According to the EPA, the final Clean Power Plan rule will be released in summer of 2015. States then have one to three years to submit compliance plans, depending on whether a single-state or multi-state approach is utilized and if an extension if requested. The beginning of the CPP compliance period is proposed for summer of 2020 (EPA 2015).

The Industrial Sector

As shown in Figure 1 (page 5) demand for coal by the industrial sector (coke plants and self-generating manufacturers, including coal-fired combined heat and power plants) continues a slow and steady decline. EIA's national-level projections still forecast only a slight decline in industrial demand for coal through 2040, at an annualized rate of 0.1 percent, although overall energy consumption by the sector is projected to grow at a rate of 0.7 percent per year (EIA 2015). All the decline is projected to be from reduced demand from domestic coke plants, with growth in coal usage expected from other industrial users. However, due to announced conversions to natural gas as a primary fuel source by some self-generating customers of West Virginia coal it is still possible that industrial demand for West Virginia coal could decline more quickly than the nation.

Domestic demand for coke continues to shrink as imports capture a growing share of the U.S. steel market. According to data published by the U.S. Department of Commerce International Trade Administration (ITA) imports of steel mill products reached a high of four million metric tons in October 2014 and January 2015, double the maximum levels seen in 2009 (ITA 2015). In addition, unit value for U.S. imports of steel products have been declining since 2011, which suppresses domestic prices. These trends are believed to be caused by excess capacity in the global steel industry, especially in Asia, which has led to overproduction and surges of exports (Stewart, et al. 2014).

Exports

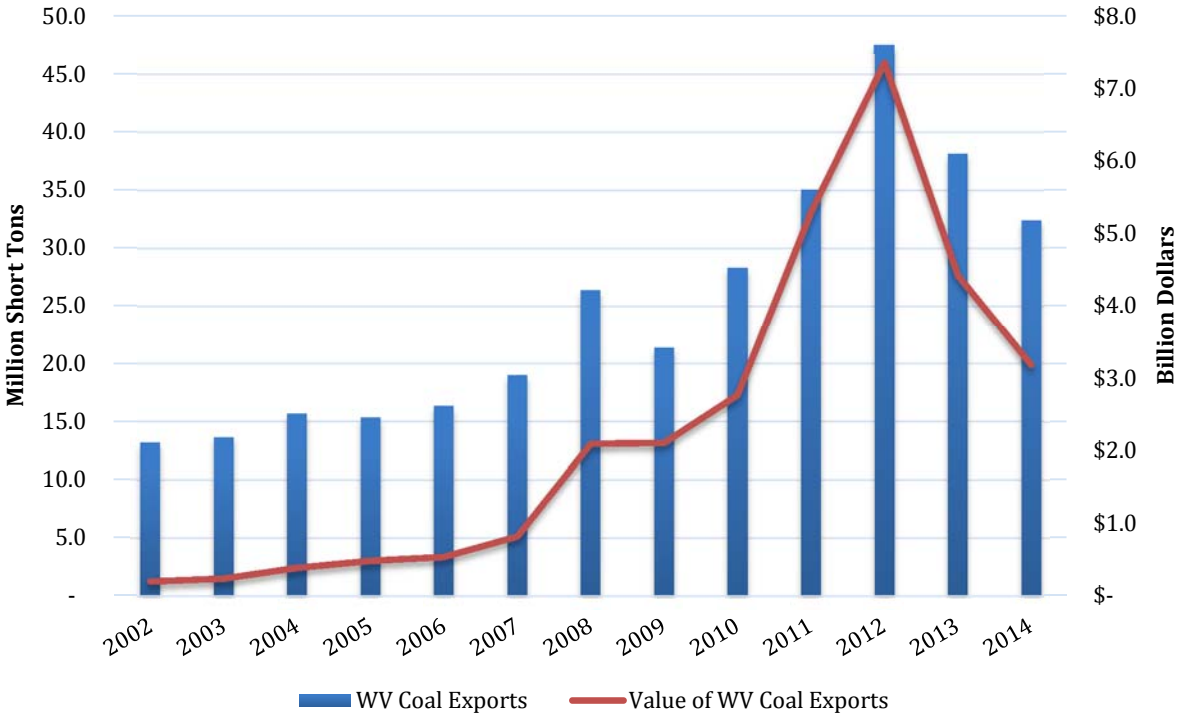
The nation's coal exports fell again in 2014, to 97 million short tons, down from approximately 118 million short tons in 2013.[3] The EIA AEO 2015 Reference Case projects total US coal exports to grow by 35% between 2014 and 2035, with 2015 being the lowest year of the forecast. Much of the growth is from increased exports of steam coal from mines

[3] 2014 data for coal export tonnage by U.S. state of origin has not yet been released. CBER estimates West Virginia's exports based on historical shares of total exports, value of coal exports and average export prices.

in the Interior and Western[4] regions, although coking coal exports are also projected to increase (EIA 2015).

West Virginia has consistent exports to many countries in Europe, South America, Africa and Asia. The value of coal exports from the state fell to $3.2 billion in 2014, from $4.4 billion in 2013. The top five importing countries by value were the Netherlands, Italy, Brazil, the United Kingdom and Ukraine (ITA 2015). The following graphic shows the value of West Virginia-based coal exports and associated tonnage from 2002 to 2014.

Figure 5: Value and Tonnage of West Virginia Coal Exports, 2002 to 2014



Source: (EIA 2015) (ITA 2015); 2014 Export tonnage estimated by CBER.

[4] Alaska, Arizona, California, Colorado, Montana, New Mexico, North Dakota, Utah, and Wyoming.

Component Forecasts

Energy Information Administration (EIA)

Publication: Annual Energy Outlook 2015

Date: April 2015

Forecast Horizon: 2014-2040

Region(s): Northern Appalachia, Central Appalachia

The EIA provides a forecast of coal production by region in its Annual Energy Outlook, projecting through 2040 (EIA 2015). This projection is generated using the National Energy Modeling System (NEMS). NEMS uses a market-based approach that balances energy supply and demand while considering regulations and industry standards.

The EIA's regional forecasts are adjusted to adapt these figures to forecast West Virginia coal production. The Northern Appalachia region includes Pennsylvania, Maryland, Ohio, and Northern West Virginia while Central Appalachia includes Virginia, Eastern Kentucky, Northern Tennessee, and Southern West Virginia. To forecast West Virginia coal production through 2035, the annual growth rate for Northern Appalachia is applied to historical production figures for Northern West Virginia and the annual growth rate for Central Appalachia is applied to Southern West Virginia figures.[5] Only the EIA Reference Case figures are used.[6]

Key Assumptions:

Macroeconomic Issues: The long-term macroeconomic projection from IHS Global Insight, Inc. is used in the EIA forecast. Real GDP growth averages 2.4% per year from 2013 to 2040.

Coal Prices: U.S. real minemouth prices are expected to increase from $37.20 per ton to $49.20 per ton in $2013 by 2040, reflecting the assumption that coal mining productivity will continue to decline. EIA expects Appalachian coal prices to also increase from $72.60 in 2013 to $102.9 by 2040.

[5] For more information on the adaptation of the EIA's forecasts, see Appendix A.

[6] The EIA presents six primary situations in the Annual Energy Outlook 2015: a Reference Case, a High Economic Growth Case, a Low Economic Growth Case, a High Oil Price Case, a Low Oil Price Case, and a High Oil and Gas Resource Case. The Reference Case was selected for the Consensus Forecast as a continuation of current trends, assuming known technology and technological/demographic trends.

Natural Gas Prices: Henry Hub[7] spot prices for natural gas averaged $3.73 per million Btu in 2013.[8] Prices are expected be lower in 2015 but rebound by 2020 with an average expected price of $7.85 per million Btu in 2040.

Electricity: U.S. electricity use is expected to increase by 0.8% annually from 2013 to 2040. One gigawatt (GW) of coal-fired capacity is expected to be added through the 2040 in comparison to 144 GW of natural gas capacity, 77 GW of renewable capacity, and 9 GW of nuclear capacity.

Industrial/Commercial: The industrial sector is expected to have a slight increase in coal consumption through 2028 compared to 2014 levels, after which usage is projected to decline. All of the decline is projected in metallurgical coal use (14 percent lower in 2040 than 2014). Other industrial use is projected to increase by about 12 percent from 2014 levels. The commercial sector is expected to maintain flat coal consumption throughout the forecast period.

Exports: National coal exports are expected to decrease through 2015 to a level of 82 million short tons, then increase over the remainder of the forecast horizon to 141 million short tons in 2040. This growth is primarily attributed to exports of steam coal from the Interior and Western regions.

Environmental: Current legislation and environmental regulations, for which implementing regulations were available at the end of October 2014, are considered in the forecast. (Some exceptions are made for laws that will take effect soon after the AEO 2015 is released.) Pending and proposed legislation, including the Clean Power Plan, are not included in projections. The EIA does model three different greenhouse gas cases with varying economy-wide CO_2 emissions prices under which coal production is significantly lower than its Base Case.

[7] The Henry Hub in Louisiana is the delivery point for the natural gas futures contract on the New York Mercantile Exchange.

[8] Henry Hub spot prices are listed in real dollars in 2013. Nominal prices from previous years are inflation-adjusted to the equivalent dollar value in the year 2013.

Results:

Table 1: EIA Annual Energy Outlook 2014 Adapted to West Virginia Production[9]

West Virginia Coal Production (million tons)				
Historical		Preliminary	Forecast	
2012	**2013**	**2014**	**2015**	**2016**
120.4	112.8	111.9	108.4	105.9
Forecast				
2017	**2018**	**2019**	**2020**	**2021**
102.9	103.1	107.5	107.1	105.8
Forecast				
2022	**2023**	**2024**	**2025**	**2026**
103.9	102.1	101.7	101.9	100.8
Forecast				
2027	**2028**	**2029**	**2030**	**2031**
99.6	98.5	98.3	99.0	98.8
Forecast				
2032	**2033**	**2034**	**2035**	
99.9	98.9	95.4	94.7	

[9] The preliminary total coal production number for 2014 (used here and in the following charts/figures) is reported as weekly and monthly data by the EIA and is based on mine-level data reported to the Mine Safety and Health Administration (MSHA).

Energy Ventures Analysis (EVA)

Publication: EVA Long-Term Forecast

Date: June 2015

Forecast Horizon: 2015-2040

Region(s): Northern Appalachia, Central Appalachia, West Virginia

EVA utilizes the Aurora XP Dispatch Model that calculates electricity generation by fuel type by developing the least cost generation situation that will meet power demand. All existing and planned generation capacity is included and the model can add or retire capacity as needed (Energy Ventures Analysis 2013).

Key Assumptions:

Macroeconomic Issues: GDP growth is expected to average 2.0 % per year through 2040.

Coal Prices: Coal prices for both Northern and Central Appalachia are expected to recover from the very low prices in 2015 although the recovery will take a number of years. By 2040, prices from both regions are expected to approach $60 per ton in real 2015 dollars and $90 per ton in nominal dollars.

Natural Gas Prices: Gas prices are expected to steadily increase through 2040 resulting in a price of close to $7 per MMBtu (2015$) in 2040.

Electricity: Growth in electricity demand is expected to average 0.7% per year through 2040. Demand for Appalachian coal by the electricity sector is projected to fall 27% between 2014 and 2040. With the retrofit of technologies, coal supply has become fungible meaning demand can switch between coal supply regions (e.g., Northern Appalachia and Illinois Basin) based upon the relative competitiveness of each. Future demand which is based upon an equilibrium analysis may shift between supply regions.

Industrial/Commercial: Non-coke industrial demand for Appalachian coal is projected to fall by about 40% between 2014 and 2040. Demand for metallurgical coal from Northern and Central (primarily) Appalachia during this same period is projected to fall by about 20%.

Exports: Steam coal exports from Northern and Central (primarily) Appalachia peaked in 2012 and are projected to decline by over 70% between 2014 and 2040. The decline reflects the relative lack of competitiveness of Central Appalachia coals in the global market. Steam coal exports overall are expected to increase if one or more announced

export terminals are built in the Pacific Northwest allowing competitive delivery of Powder River Basin coals into the Pacific market. Met coal exports from Northern and Central (primarily) Appalachia peaked in 2011 and are projected to decline by about 20% between 2014 and 2040. Compared to 2014, total Appalachian coal exports are projected to decline by 30% by 2040.

Environmental: The Cross-State Air Pollution Rule (CSAPR) went into effect January 1, 2015. The Mercury and Air Toxics Standards (MATS) went into effect April 2015 with a liberal one year extension. Section 316(b) of the Clean Water Act goes into effect with 2018 compliance for minor intake modifications and 2020 compliance for these requiring cooling towers. Coal Combustion Residuals (CCR) goes into effect by 2020. Conversion to dry ash handling is required by some. New landfills require lining. National Ambient Air Quality Standards (NAAQS) revisions will include fine particulate and ozone standards. SCR's will be required on all units for NOx. Regional haze compliance using Best Available Retrofit Technology will go into effect in 2020 excepting any announced settlements. Greenhouse Gas New Source Performance Standard is assumed to limit ability to add new coal-fired generation absent carbon capture and sequestration. No Federal program to reduce CO2 emissions on existing plants is assumed. Regional CO2 programs (i.e., RGGI and AB32) are assumed to continue.

Results:

Table 2: EVA Long-Term West Virginia Coal Production Forecast 2014

West Virginia Coal Production (million tons)				
Historical		Preliminary	Forecast	
2012	**2013**	**2014**	**2015**	**2016**
120.4	112.8	111.9	109.9	104.7
		Forecast		
2017	**2018**	**2019**	**2020**	**2021**
101.9	105.5	108.3	109.2	110.4
		Forecast		
2022	**2023**	**2024**	**2025**	**2026**
110.4	111.7	113.2	111.9	113.2
		Forecast		
2027	**2028**	**2029**	**2030**	**2031**
113.8	114.4	114.8	114.9	115.0
		Forecast		
2032	**2033**	**2034**	**2035**	
116.2	114.8	114.9	114.0	

Marshall University Center for Business and Economic Research (CBER)

Publication: CBER West Virginia Coal Production Forecast 2015

Date: June 2015

Forecast Horizon: 2014-2035

Region(s): West Virginia

The CBER forecast of West Virginia total coal production is an econometric model based on quarterly changes in total production from 1984 through 2013. The forecast model treats 2012 as a structural change in the coal market.[10] Data for the model are from EIA's monthly coal fuel receipts contained in Schedule 2 of Form EIA-923.[11] To create the initial short-term forecast, quarterly changes in total coal production were modeled with a vector autoregression (VAR) approach that explicitly accounted for the national price of exported coal and forecasted demand for West Virginia-sourced coal in regional power generation.[12] For years beyond 2023, the CBER forecast utilizes an autoregressive approach, which estimates future changes in total coal production based on historical patterns.

Key Assumptions:

Macroeconomic Issues: Moderate average annual GDP growth rates of about 2 to 2.5% per year, consistent with other macroeconomic forecasts.

Coal Prices: In the short-term, coal prices are expected to follow trends of the last decade, with increases exceeding that of general inflation. In the long-term prices increases are expected to be more modest.

Natural Gas Prices: Stable gas prices are expected in the short term. The planned addition of new natural gas capacity will also impact regional competitiveness in the near-term.

Electricity: Growth in electricity demand in the Eastern region of about 1.5% over the short term forecast horizon. Demand for West Virginia coal by the electricity sector in the Eastern region is expected to decline by 7.0% annually between 2014 and 2023.[13]

Industrial/Commercial: The conversion of former coal-fired self-generators to natural gas is expected to reduce industrial demand for West Virginia coal.

[10] Dummy variables were included in the model to identify 2012 which moderated the decline in forecasted values that otherwise result when weighting 2012 equally to the preceding years. See Hansen (2001) for a discussion of structural change as relating to U.S. Labor market trends. http://www.ssc.wisc.edu/~bhansen/papers/jep_01.pdf

[11] Form EIA-923 is available at http://www.eia.gov/electricity/data/eia923/.

[12] For more detail on the power generation demand model, see Appendix B.

[13] 7.0% is a compound annual rate.

Exports: Moderate growth in export markets for West Virginia coal is expected to mitigate some of the decline in demand from the regional power generation sector.

Environmental: Power plant closures due to non-compliance with MATS are expected to continue at a steady pace through 2016. West Virginia has already lost market share at plants that are soon to retire, causing some of these effects to occur prior to closure.

Results:

Table 3: CBER Long-term West Virginia Coal Production Forecast 2014

West Virginia Coal Production (million tons)				
Historical		Preliminary	Forecast	
2012	**2013**	**2014**	**2015**	**2016**
120.4	112.8	111.9	105.7	103.6
		Forecast		
2017	**2018**	**2019**	**2020**	**2021**
101.5	99.5	97.5	95.4	93.4
		Forecast		
2022	**2023**	**2024**	**2025**	**2026**
91.4	89.4	88.2	87.6	87.0
		Forecast		
2027	**2028**	**2029**	**2030**	**2031**
86.3	85.7	85.1	84.5	83.9
		Forecast		
2032	**2033**	**2034**	**2035**	
83.3	82.7	82.00	81.4	

West Virginia University Bureau for Business and Economic Research (BBER)

Publication: Coal Production in West Virginia: 2015-2035

Date: May 2015

Forecast Horizon: 2015-2035

Region: Northern West Virginia and Southern West Virginia

The WVUfbb BBER Coal Production Forecast is an econometric model analyzing demand and price data for West Virginia mines from 1985 through 2014. Historical data as well as U.S.-level forecasts published in EIA's Annual Energy Outlook 2015 and IHS Global Insight's April 2015 Forecast are used in the model. Region-specific variables are calculated by WVU BBER (West Virginia University BBER 2015).

Key Assumptions:

Macroeconomic Issues: Expected annual real GDP is 2.4% through the forecast horizon.

Coal Prices: The U.S. average price of coal is expected to reach $42 per short ton by 2035. Inflation-adjusted coal prices are also forecasted to increase in both Northern and Southern West Virginia.

Natural Gas Prices: Real natural gas prices to utilities are projected to increase 2% annually.

Electricity: The annual increase of electricity generation during the forecast horizon is expected at 1%. Coal and natural gas are forecasted to hold similar shares of electricity generation by 2035.

Industrial/Commercial: Industrial and commercial use of West Virginia coal is expected to decrease 23% by 2035.

Exports: 2012 is listed as an all-time peak for coal exports from West Virginia. Export levels are not expected to reach this level again through 2035.

Environmental: Only current legislation and environmental regulations not under legal dispute are considered in the forecast including MATS and the Clean-Air Interstate Rule (CAIR). Continuing retirement of coal plants is expected through 2016 to comply with MATS. The Clean Power Plan is not considered.

Results:

Table 4: WVU BBER West Virginia Coal Production Forecast 2014

West Virginia Coal Production (million tons)				
Historical		Preliminary	Forecast	
2012	**2013**	**2014**	**2015**	**2016**
120.4	112.8	111.9	103.9	98.2
		Forecast		
2017	**2018**	**2019**	**2020**	**2021**
99.9	101.5	103.3	104.7	104.8
		Forecast		
2022	**2023**	**2024**	**2025**	**2026**
104.7	105.1	104.9	104.7	104.5
		Forecast		
2027	**2028**	**2029**	**2030**	**2031**
104.0	103.0	102.2	101.6	100.5
		Forecast		
2032	**2033**	**2034**	**2035**	
99.8	98.6	97.3	95.6	

Consensus Forecast

The four long-term forecasts produced by EIA, EVA, CBER, and WVU are combined to create the Consensus Forecast for West Virginia Coal Production.[14] A weighted average is used to combine the four projections as follows (Armstrong 2001):

$$WV\ Coal\ Production_t = w_{EIA} * EIA\ Production_t + w_{EVA} * EVA\ Production_t + w_{CBER} * CBER\ Production_t + w_{WVU} * WVU\ Production_t$$

The weight (w_i) assigned to each forecast is based on the accuracy of past forecasts by that organization. All available forecasts for 2011 through present were evaluated for accuracy. For example, EIA's 2015 Annual Energy Outlook was assessed by considering the accuracy of its 2011, 2012, 2013, and 2014 projections.

Only recent years were evaluated due to the tumultuous macroeconomic conditions that appeared in late 2007 and 2008. Predictions for the first years of the time horizon were considered because accuracy is typically highest at the beginning of the forecast. Long-term accuracy was not considered in this weighting method due to the large potential for unpredictable macroeconomic conditions to affect annual error.

The error (e_i) of a forecast was determined using the following formula.

$$e_{i,t} = \frac{Forecast\ Production_{i,t} - Actual\ Production_t}{Actual\ Production_t}$$

The absolute value of the errors was averaged for each forecasting organization to remove the effects of under-estimation and over-estimation canceling each other. Since a new methodology was used by CBER in 2014, average error was calculated by evaluating the accuracy of the 2014 forecast and creating an in-sample forecast in 2015 and comparing these results to the actual values for 2011 through 2014.

Table 5: Average Absolute Errors

	Average Error
EIA	5.81%
EVA	7.26%
CBER	9.75%
WVU	8.19%

[14] For more information on the creation of consensus forecasts, see http://www.forecastingprinciples.com/paperpdf/Combining.pdf.

The weight given to each organization in the consensus was calculated as follows (Armstrong 2001):

$$w_i = \frac{\frac{1}{e_i}}{\sum_i \frac{1}{e_i}}$$

Using the following weights, the Consensus Forecast is calculated.

Table 6: Consensus Weights

	Weight
EIA	0.32
EVA	0.26
CBER	0.19
WVU	0.23

The results are shown below in table and figure format. The Consensus Forecast for West Virginia Coal Production shows production levels decreasing through 2017 and then remaining fairly steady though 2021. After 2021, production levels show a gradual and steady decreasing trend falling to 97 million tons of coal produced in 2035.

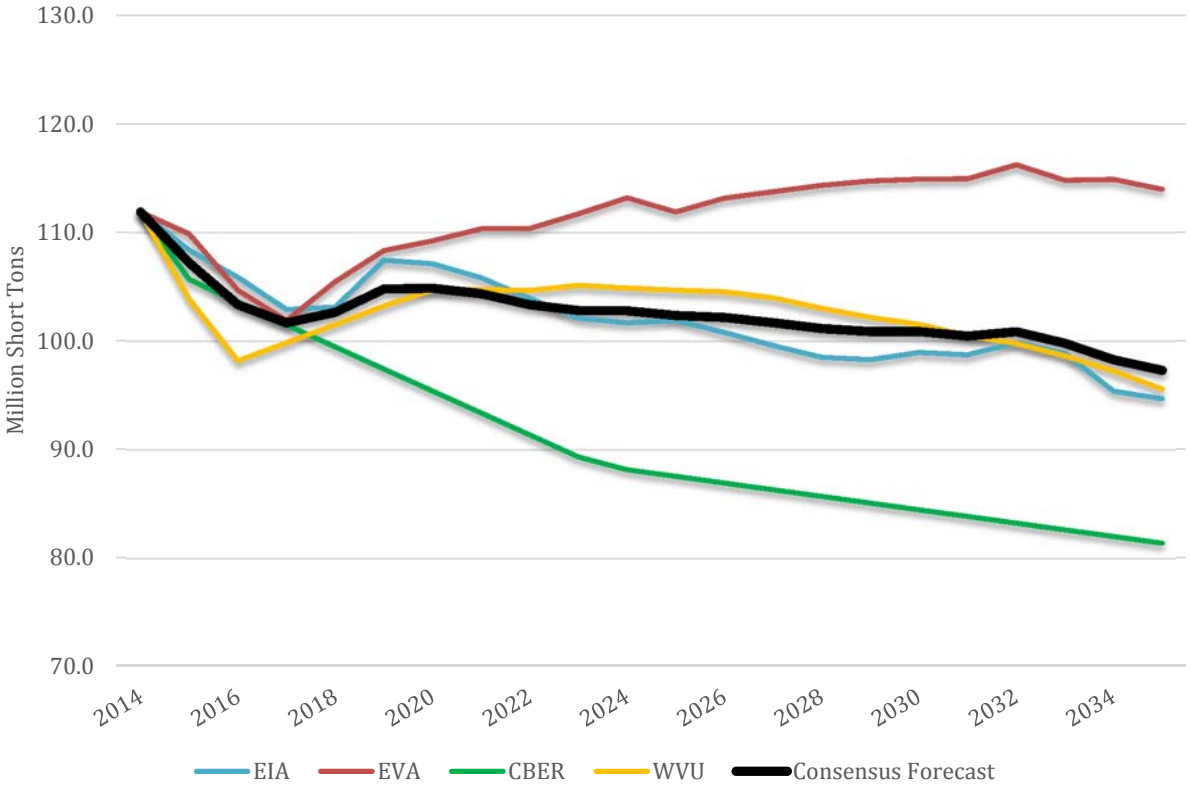
Table 7: Consensus Forecast for West Virginia Coal Production 2014

West Virginia Coal Production (million tons)				
Historical		**Preliminary**	**Forecast**	
2012	**2013**	**2014**	**2015**	**2016**
120.4	112.8	111.9	107.2	103.4
		Forecast		
2017	**2018**	**2019**	**2020**	**2021**
101.7	102.7	104.8	104.9	104.4
		Forecast		
2022	**2023**	**2024**	**2025**	**2026**
103.4	102.8	102.8	102.4	102.2
		Forecast		
2027	**2028**	**2029**	**2030**	**2031**
101.7	101.2	100.9	100.9	100.5
		Forecast		
2032	**2033**	**2034**	**2035**	
100.9	99.8	98.3	97.3	

Table 8: Comparison of Component Forecasts and 2013-2015 Consensus Forecasts

West Virginia Coal Production (million tons)							
Year	2015 Forecasting Group				2015 Consensus	2014 Consensus	2013 Consensus
	EIA	EVA	CBER	WVU			
2015	108.4	109.9	105.7	103.9	107.2	106.9	113.9
2016	105.9	104.7	103.6	98.2	103.4	101.4	112.2
2017	102.9	101.9	101.5	99.9	101.7	103.0	113.5
2018	103.1	105.5	99.5	101.5	102.7	103.3	108.7
2019	107.5	108.3	97.5	103.3	104.8	102.4	105.6
2020	107.1	109.2	95.4	104.7	104.9	101.5	105.4
2021	105.8	110.4	93.4	104.8	104.4	100.9	104.8
2022	103.9	110.4	91.4	104.7	103.4	100.7	106.6
2023	102.1	111.7	89.4	105.1	102.8	100.0	107.6
2024	101.7	113.2	88.2	104.9	102.8	99.9	107.2
2025	101.9	111.9	87.6	104.7	102.4	99.2	106.3
2026	100.8	113.2	87.0	104.5	102.2	98.2	106.3
2027	99.6	113.8	86.3	104.0	101.7	98.1	106.1
2028	98.5	114.4	85.7	103.0	101.2	97.1	105.4
2029	98.3	114.8	85.1	102.2	100.9	97.1	105.0
2030	99.0	114.9	84.5	101.6	100.9	96.5	104.4
2031	98.8	115.0	83.9	100.5	100.5	96.3	103.5
2032	99.9	116.2	83.3	99.8	100.9	95.1	101.9
2033	98.9	114.8	82.7	98.6	99.8	94.2	99.6
2034	95.4	114.9	82.0	97.3	98.3	93.7	99.0
2035	94.7	114.0	81.4	95.6	97.3	91.6	97.3

Figure 6: Component and Consensus Forecasts 2014 (million tons)



Summary

The 2015 West Virginia Consensus Coal Forecast figures are higher than the 2014 Consensus. A primary reason for this is lower coal prices, which in some models are an indication of lower production costs and more competitive supply from Appalachian producers as higher cost mines have closed. The EIA and EVA models both project higher production for West Virginia than in the prior forecast, while the CBER model projects lower production.

A significant change to the 2015 Consensus Coal Forecast is the addition of the WVU long-term forecast. This increases the number of long-term forecasts to four from three, and lowers the weights of the component forecasts. The EIA maintains the highest share of the consensus due to historical accuracy of its forecasts, but its share of the consensus is lower than in the last two years.

The EIA model projects total coal consumption in the U.S. electric power sector to be higher than in its AEO2014 analysis due to an increase in output from the remaining coal-fired

power plants, with the projected capacity factor for the U.S. coal fleet increasing from 60% in 2013 to 67% in 2016.[15] The relatively low operating costs of existing coal-fired units limit the decline in coal use in the EIA reference case model. The AEO2015 also projects lower prices and lower production for Appalachian coal through 2040 compared to AEO2014. All of the increased decline comes from Northern and Southern Appalachia, as Central Appalachian production is projected to be higher. Northern production is projected to be on average about 10 percent lower than the AEO2014 analysis, while Central production is projected to be about seven percent higher, even though productivity is still expected to decline more rapidly in Central Appalachia.

The EVA model projects West Virginia's share of both the Northern and Central Appalachian coal supply to grow over time. A 2015 change to this model was to increase the maximum economic life of coal power plants from 65 to 70 years, which results in increased coal usage for power generation over time.

The CBER model is influenced by inclusion of final 2013 production and demand data, which added another year of decline to historical trends. The addition of coal export prices to the model allows explicit incorporation of the impact of an additional market that was previously not analyzed.

The component models within the consensus forecast incorporate a wide range of possible levels of West Virginia coal production over the next 20 years. These varying levels of forecasted coal production illustrate the impact of various supply variables and uncertainty over whether the continuation of recent trends will or will not continue. The consensus reduces uncertainty by combining the forecasts into one aggregate projection where West Virginia coal production continues to decline through 2018, recovers slightly for a couple years, and then declines slowly through 2035.

[15] EIA AEO2015, Coal Market Module.

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Appendix A: EIA Forecasts for Northern and Southern West Virginia

The EIA forecasts coal production by region in its Annual Energy Outlook. Appalachia is split into three regions: Northern, Central, and Southern. For the purposes of this study, only the Northern and Central Appalachian regions are applicable. The Northern Appalachia region includes Pennsylvania, Maryland, Ohio, and Northern West Virginia while Central Appalachia includes Virginia, Eastern Kentucky, Northern Tennessee, and Southern West Virginia. Forecasts for these regions are adapted to Northern and Southern West Virginia production. EIA's forecasted annual growth rates for Northern and Central Appalachia are shown first.

Table 9: Growth Rates for Coal Production in Northern and Central Appalachia (EIA)

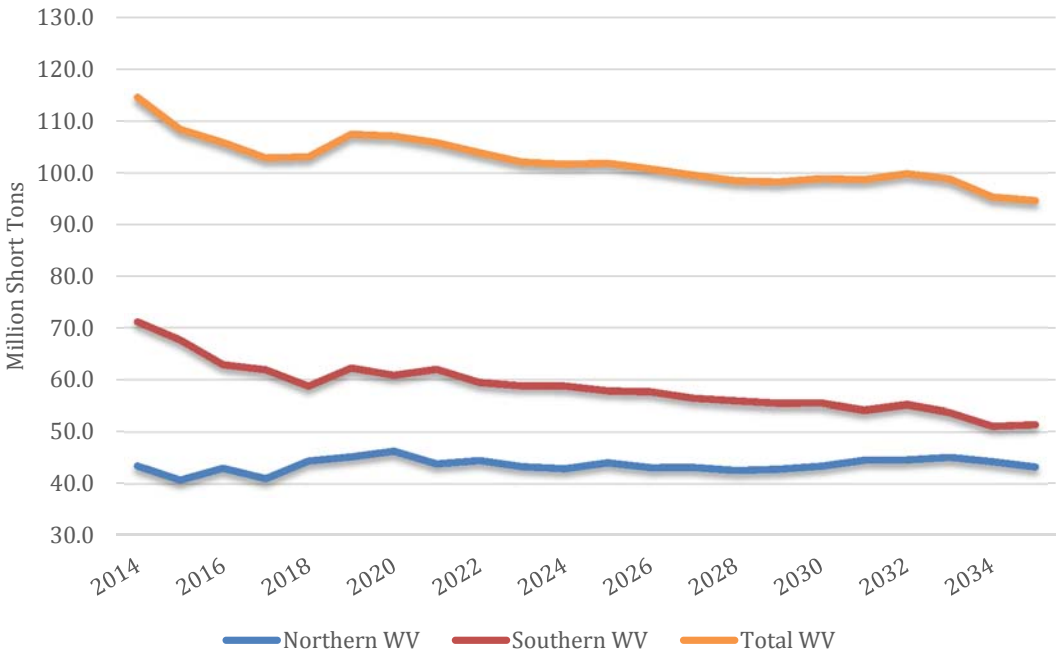
	2014	**2015**	**2016**	**2017**	**2018**
Northern Appalachia	2.5%	6.2%	5.6%	4.6%	8.2%
Central Appalachia	1.0%	-4.9%	-7.1%	-1.6%	-5.1%
	2019	**2020**	**2021**	**2022**	**2023**
Northern Appalachia	1.8%	2.3%	-5.2%	1.4%	-2.6%
Central Appalachia	6.0%	-2.3%	1.9%	-4.1%	-1.1%
	2024	**2025**	**2026**	**2027**	**2028**
Northern Appalachia	0.9%	2.7%	-2.1%	0.0%	-1.3%
Central Appalachia	0.0%	-1.6%	-0.3%	-2.1%	-0.9%
	2029	**2030**	**2031**	**2032**	**2033**
Northern Appalachia	0.6%	1.4%	2.6%	0.1%	1.1%
Central Appalachia	-0.9%	0.1%	-2.5%	2.0%	-2.7%
	2034	**2035**			
Northern Appalachia	-1.8%	-2.3%			
Central Appalachia	-4.9%	0.6%			

These regional growth rates are applied to historical West Virginia coal production data to achieve the State forecast. Growth rates for Northern Appalachia are used to project Northern West Virginia coal production, and rates for Central Appalachia are applied to Southern West Virginia. The calculated forecasts for Northern and Southern West Virginia are summed to produce the total West Virginia coal production.

Table 10: West Virginia Coal Production by Region (EIA)

	2014	2015	2016	2017	2018
Northern WV	43,466	40,753	43,040	41,046	44,427
Southern WV	71,113	67,643	62,861	61,880	58,710
Total WV	**114,579**	**108,395**	**105,900**	**102,926**	**103,137**
	2019	**2020**	**2021**	**2022**	**2023**
Northern WV	45,247	46,310	43,890	44,514	43,341
Southern WV	62,219	60,819	61,959	59,429	58,781
Total WV	**107,467**	**107,129**	**105,849**	**103,944**	**102,122**
	2024	**2025**	**2026**	**2027**	**2028**
Northern WV	42,945	44,093	43,182	43,189	42,623
Southern WV	58,760	57,821	57,637	56,419	55,913
Total WV	**101,705**	**101,914**	**100,819**	**99,608**	**98,535**
	2029	**2030**	**2031**	**2032**	**2033**
Northern WV	42,866	43,457	44,604	44,661	45,141
Southern WV	55,436	55,518	54,150	55,220	53,737
Total WV	**98,302**	**98,975**	**98,754**	**99,882**	**98,878**
	2034	**2035**			
Northern WV	44,312	43,297			
Southern WV	51,107	51,417			
Total WV	**95,419**	**94,714**			

Figure 7: West Virginia Coal Production by Region (EIA)



Appendix B: Power Generation Demand Forecast

To better understand the dynamics influencing total coal production for West Virginia, CBER analyzed data on West Virginia Coal consumed by power plants in the eastern region of the United States. The data for the analysis are from EIA's monthly fuel receipts data (EIA 2015), which have been aggregated into total quarterly fuel receipts of coal sourced from West Virginia for the period 2002-2013. Additional factors considered for the analysis include real natural gas prices and electricity demand (as indicated by average heating and cooling degree days in the region).

To construct the power generation demand forecast, CBER first projected electricity demand in the region, using coal-fired power plant capacity as a proxy. A key assumption is that capacity required to serve estimated electricity demand is irrespective of fuel type, and thus indicative of electricity demand generally. Using a vector autoregression model (VAR), CBER jointly forecasted the quarterly change in total fuel receipts for West Virginia-sourced coal and real natural gas prices, conditional on modest growth in electricity demand and treating the substantial decline observed in 2012 as a structural break in the coal market.[16]

[16] Dummy variables were included in the model to identify 2012 which moderated the decline in forecasted values that otherwise result when weighting 2012 equally to the preceding years.

Taylor&Mulder

Property and Casualty Consulting Actuaries

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015

December 2015

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December 31, 2015

Mr. Michael Sheehan
Assistant Director
West Virginia Department of Environmental Protection
Office of Special Reclamation
Michael.P.Sheehan@wv.gov

Dear Mr. Sheehan,

Enclosed is the actuarial review of the West Virginia Department of Environmental Protection ("WVDEP") Special Reclamation Fund and Water Trust Fund ("SRF" and "WTF", respectively, or collectively "the Funds") as of June 30, 2015.

The first section in the text of our report is the ***Executive Summary***. This section presents our conclusions and recommendations. It also describes the purpose and scope of our report, explains the distribution and use of our report, and provides the conditions and limitations underlying our work. This section of our report also includes the Background section which provides information about the Fund history.

The next section of the text of our report is the ***Actuarial Analysis*** that describes the sources of data, our overall methodology, the selection of factors and specific methodologies and considerations by line of business. It also describes the selection of ultimate losses. The ***Exhibits*** section of our report follows the text of the report and includes all of our analyses.

Please feel free to call if you have any questions regarding any aspect of our report.

Sincerely,

Daniel W. Lupton, FCAS, MAAA, MBA

Jane C. Taylor, FCAS, MAAA, JD
Enclosures

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015

Contents

Executive Summary

Purpose and Scope

Taylor & Mulder, Incorporated ("T&M") was requested by the West Virginia Department of Environmental Protection ("WVDEP") to conduct an actuarial review of its loss reserves as of June 30, 2015. This report contains our summary and conclusions along with a description of the analysis underlying our conclusions.

Specifically, T&M was asked by the WVDEP to conduct an actuarial analysis to include within its scope the following tasks:

- A valuation in accordance with applicable actuarial standards of practice promulgated by the Actuarial Standards Board of the American Academy of Actuaries that will determine the Program's fiscal soundness;
- An evaluation of the present (June 30, 2015) assets and liabilities of the Special Reclamation Program for a minimum of 20 years, including an annual table illustrating those assets and liabilities for underground versus surface mine permits, small versus large permits (based on bond amounts or acreage) and permits for tipples, preparation plants, and impoundments and illustrating land and water liabilities separately;
- An evaluation of the prospective assets and liabilities of the Special Reclamation Program for a minimum of 20 years, including a table illustrating estimates of underground versus surface mine permits, small versus large permits (based on bond amounts or acreage) and permits for tipples, preparation plants, and impoundments and illustrating land and water liabilities separately, including the funded status of the Water Trust Fund ("WTF") as well as the Special Reclamation Fund ("SRF");
- A table that combines the findings of the two previous tasks;

- An analysis and discussion of the ability of the Program to support long term and/or perpetual liabilities; and,
- A one page executive summary of conclusions with references to the body of the report.

Note: This is a "closed" valuation of the Funds' liabilities insofar as it considers only liabilities arising from permits that have already been issued. The estimated liabilities account for current known reclamation projects as well as anticipated permit revocations on permits issued prior to June 30, 2015. Anticipated income is also linked to permits issued by June 30, 2015 without regard to future permits issued.

This report presents the results of those analyses. This report was prepared by:

- Daniel W. Lupton, FCAS, MAAA, MBA, Vice President and Consulting Actuary.
- Jane C. Taylor, FCAS, MAAA, JD, Principal and Consulting Actuary,
- Evelyn Toni Mulder, FCAS, MAAA, FCA, Principal and Consulting Actuary

In accordance with the requirements of the Actuarial Standards of Practice in making statements of actuarial opinion, I provide the following statement:

> *I, Daniel W. Lupton, am Vice President and Consulting Actuary in the firm of Taylor & Mulder, Inc. I am a Fellow of the Casualty Actuarial Society in good standing and qualified to issue a Statement of Actuarial Opinion. I am also a Member of the American Academy of Actuaries.*

Conclusions

Overall Fund Liabilities

The following chart shows the projected liabilities for land reclamation costs, water capital costs, and maintenance and operations costs including cash flows through 2035:

West Virginia Office of Special Reclamation Actuarial Reserve Study as of June 30, 2015 Special Reclamation Fund and Water Trust Fund Combined			
	Current Liabilities	Prospective Liabilities	**Total Liabilities**
Land Reclamation Costs	35,889,399	14,281,004	50,170,403
Water Capital Costs	59,831,033	4,990,249	64,821,282
O&M Costs*	78,426,651	1,047,777	79,474,429
Administrative Expense	-	-	106,196,937
Total Liability	**174,147,083**	**20,319,031**	**300,663,051**

*O&M Costs are Operation and Maintenance Costs

Our analysis indicates that based on coal production forecasts and current coal tonnage fee revenues, we anticipate that the program will be capable of supporting its current liabilities over the long term. It should be noted that because this is a "closed" study, the above table does not include anticipated liabilities arising from permits issued after June 30, 2015.

Administrative expenses in the above table include employee benefits, contractual obligations, personnel services, and unclassified expenses other than reclamation costs. These administrative costs were projected based on anticipated reclamation costs over subsequent periods. This means that administrative cost projections include anticipated administrative costs required to reclaim lands associated with the current cohort of permits, but not those costs associated with permits that have not yet been issued.

A breakdown of the liabilities discussed above may be found in our Exhibits section, below, including breakdown by:

- Type of permit (i.e., underground versus surface) – Exhibits E-1, E-4, and E-7,
- Size of permit (permitted acres) – Exhibits E-2, E-5, and E-8,

- Location of permits (i.e., North, South, or Central West Virginia) – Exhibits E-3, E-6, and E-9,
- Current and prospective liabilities – Exhibits E-4 to E-6 and E-7 to E-9.

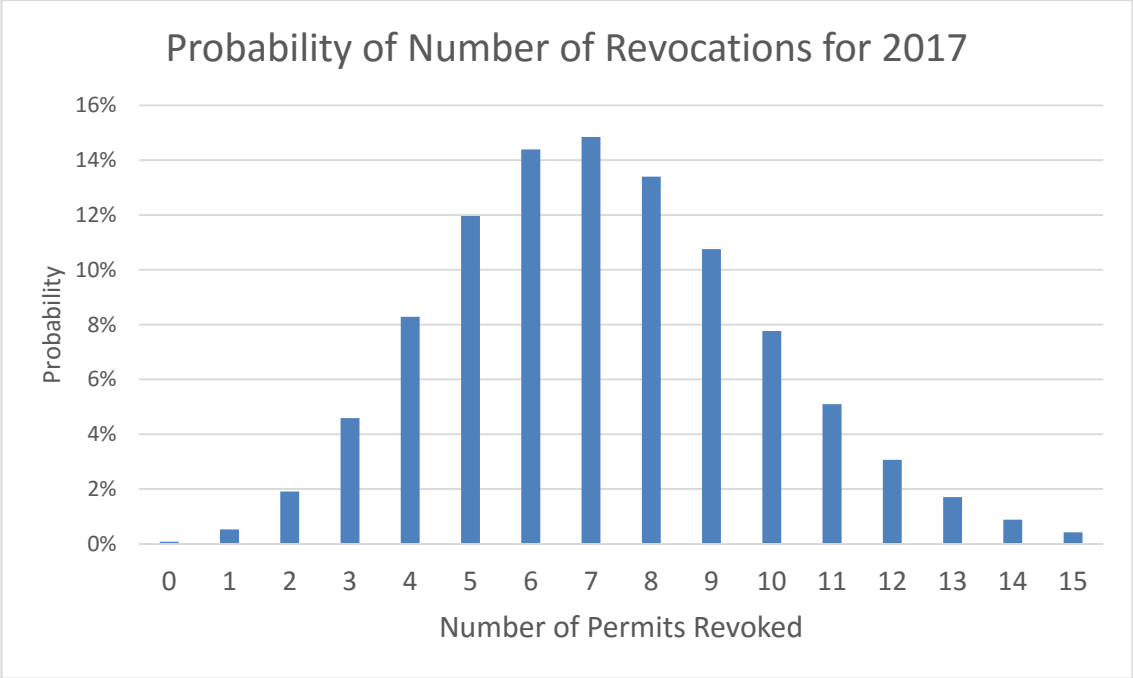
The following two sections describe particular aspects of Fund liability projections.

Prospective Permit Revocations

Prospective liabilities to the Funds include reclamation projects arising from currently issued permits that we anticipate will be revoked in the future. The following shows the projected mean number of permit revocations anticipated for 2016 through 2035:

West Virginia Office of Special Reclamation Actuarial Reserve Study as of June 30, 2015 Projected Permit Revocations by Calendar Year				
2016	**2017**	**2018**	**2019**	**2020**
10.0	7.2	6.1	5.7	5.4
2021	**2022**	**2023**	**2024**	**2025**
4.9	4.4	3.9	3.3	2.9
2026	**2027**	**2028**	**2029**	**2030**
2.5	2.1	1.8	1.6	1.3
2031	**2032**	**2033**	**2034**	**2035**
1.1	0.9	0.8	0.6	0.5

Regarding this table, it should be noted that these numbers represent the statistical expected value of the number of permit revocations. As an example, looking at the 2017 year, the probability distribution of anticipated revocations is as follows:



Therefore, the fractional number of permits anticipated to be revoked in 2017 in the table above represents the fact that the number of permits that will be revoked could be any number from 0 to 15, with different probabilities associated with each number[1]. In projecting anticipated future losses arising from these revocations, we allowed these values to vary according to similar probability distributions so as to test the likelihood of, and result of, having more or fewer than the average number of revocations.

The projected permit revocations from the current cohort of active permits anticipate several countervailing pressures that will influence future revocation rates. First, projected changes in the coal market influence the likelihood of bankruptcies that could lead to revocations. However, these revocations are moderated somewhat as bankruptcies can lead to acquisition of desirable permits by

[1] Technically speaking, the number of permits projected to be revoked in a given year could be any whole number from 0 to all the remaining permits. Practically, though, the probability drops off very quickly for higher revocations, making higher numbers virtually impossible. For instance, in the example year of 2007, there is only a 1-in-22,406 chance of 20 revocations. There is less than a 1-in-7,000,000 chance of 25 revocations.

third parties as part of liquidation proceedings, although it should be noted that less desirable permits may be more likely to face revocation after such liquidations. In addition, bankruptcies in one period appear to decrease the likelihood of bankruptcies in the subsequent period, all else held equal, in part because of changing competitive landscape and in part because companies that weather bad markets in one period are more financially secure and more able to weather bad future markets. This provides an explanation for the anticipated decline in revocation rates as the cohort of permits matures.

Permit revocations by location and by permit type may be found in Exhibit E-20. This breakdown of permit revocations was determined by analyzing historical revocations by permit type and location and including the effects of recent changes in these trends.

Projected liabilities arising from these permit revocations are based on the fitted distribution of historical reclamation costs. Both land and water reclamation costs exhibit “heavy-tailed” distributions that are well-modeled by log normal random variables. This means that small negative deviations from the median reclamation cost are as likely as larger positive deviations. In other words, reclamation costs have a propensity to be either fairly standard in size or else to “blow up,” depending on the nature of the reclamation.

Anticipated future reclamation expenses were based on making appropriate adjustments to historical distributions for changes in frequency or severity of reclamation costs over time as a result of changing conditions, particularly related to the size and nature of the revoked permits. These adjusted distributions were applied directly to the anticipated future reclamations using Monte Carlo simulation to generate 10,000 simulated scenarios for each future year for each expense type.

Confidence Levels of Losses

In addition to calculating a central estimate of the anticipated liabilities to the Funds, we used statistical techniques to determine the potential for deviation of actual numbers from our central estimate. This was accomplished through Monte Carlo simulation. The following chart shows a comparison of the central estimate to the 75th, 90th, and 95th percentiles of loss:

West Virginia Office of Special Reclamation Actuarial Reserve Study as of June 30, 2015 Special Reclamation Fund and Water Trust Fund Combined Comparison of Percentiles of Loss				
	Central	**75%**	**90%**	**95%**
Land Reclamation Cost	50,170,403	52,945,712	68,889,109	85,160,441
Water Capital Cost	64,821,282	64,745,307	72,489,077	82,453,404
O&M Cost	79,474,429	80,936,843	84,201,678	86,977,313
Administrative Expense	106,196,937	110,562,486	119,222,732	126,901,849
Total Liability	**300,663,051**	**309,190,348**	**344,802,595**	**381,493,007**

As an example of how to interpret these figures, our statistical simulations indicate that there is a 75% chance that land reclamation costs will be lower than $52.9 million. Similarly, there is a 90% chance that land reclamation costs will be lower than $68.9 million and a 10% chance that losses will be higher than that value.

Funds' Assets

In addition to projecting the Funds' liabilities, we also projected the Funds' assets. This was performed in the context of modeling future fiscal year cash flows. In addition to projecting future assets for the Funds, we reviewed potential adverse scenarios. The following chart shows anticipated revenues for each scenario over the period from 2016 to 2035:

West Virginia Office of Special Reclamation Actuarial Reserve Study as of June 30, 2015 Projected SRF and WTF Combined Revenues 2016-2035			
	Revenue	**10% Adverse**	**25% Adverse**
Bond Forfeitures	12,270,916	12,270,916	12,270,916
Civil Penalties	13,591,332	0	0
Coal Tonnage Fees	411,746,720	370,572,048	308,810,040
Interest Income	206,496,494	184,249,689	152,425,216
Total Revenue	**644,105,463**	**567,092,653**	**473,506,173**

Bond forfeiture revenues were based on anticipated forfeiture rates by permit location and mine type, combined with analysis of the median size of currently active permit bonds (by location and type). Civil penalties were calculated based on historical average civil penalties adjusted for the declining number of permits in the future. However, civil penalties were excluded as part of the adverse scenarios.

Coal tonnage fees were calculated based on anticipated changes in coal production in the larger market along with consideration of declines in performance on current permits over time compared to newly issued permits. A detailed description of the calculations underlying coal tonnage fee revenues to the Funds is provided as **Appendix B**, below. Because coal tonnage fees represented the bulk of the revenues to the Funds, we also looked at deterministic adverse scenarios in which coal tonnage fee collections were 10% or 25% below anticipated coal tonnage fee collections every year.

Investment income for the SRF for each fiscal year was based on an assumption of 0.653% yield on the West Virginia Short Term Bond Pool, multiplied by the prior year's Funds' balances. Likewise, investment

income for the WTF for each fiscal year was based on an assumption of a 5.5% yield[2]. The investments for the WTF are managed by the West Virginia Investment Management Board, and have shown some significant losses in recent quarters. The assumption of the 5.5% yield is based on expected long term returns.

Therefore, investment income is significantly reduced in the adverse scenarios because the anticipated the Funds' balances are smaller every year than under the anticipated scenario. Note that this calculation only includes investment income attributable to invested dollars associated with current permits and current and future liabilities arising from the current cohort of permits. Ending balances for the Funds associated with anticipated future permit issuances were not counted as part of this investment income.

Financial Projections

Our projections of revenues and expenses to the Funds imply that the Funds will experience financial solvency on a cash basis through 2035, and will therefore be capable of supporting the current liabilities over the long term. The following pages show a simplified version of our cash flow projections for the Special Reclamation Fund and Water Trust Fund on a combined basis for 2016 through 2035 followed by the same projections under the two adverse revenue scenarios:

[2] The IMB fund targets a return of 5.5%. However, the final fund balance will depend on the actual return earned over the projection period, which could be higher or lower than 5.5%. Because of the length of the projection period, the final balance is sensitive to changes in the rate of return. As such, this investment yield represents an important risk to the fund.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Combined Special Reclamation Fund & Water Trust Fund
Financial Projections through 2035

Fiscal Year	Total Income	Administrative Expense	Reclamation Expense	Total Expenses	Beginning Balance	Ending Balance
2016	37,193,255	8,294,748	15,832,535	24,127,283	142,125,409	155,191,381
2017	35,716,206	9,209,913	17,579,350	26,789,263	155,191,381	164,118,325
2018	35,939,342	9,826,614	18,756,473	28,583,087	164,118,325	171,474,580
2019	36,798,163	8,978,500	17,137,643	26,116,143	171,474,580	182,156,601
2020	36,278,231	6,894,063	13,158,989	20,053,052	182,156,601	198,381,780
2021	34,998,205	6,430,475	12,274,119	18,704,593	198,381,780	214,675,392
2022	34,100,242	5,985,142	11,424,094	17,409,236	214,675,392	231,366,397
2023	33,046,837	5,467,718	10,436,465	15,904,184	231,366,397	248,509,051
2024	32,330,818	4,992,091	9,528,616	14,520,707	248,509,051	266,319,163
2025	31,952,574	4,663,781	8,901,957	13,565,738	266,319,163	284,705,998
2026	31,177,215	4,332,021	8,268,712	12,600,733	284,705,998	303,282,480
2027	30,627,850	4,034,882	7,701,549	11,736,431	303,282,480	322,173,899
2028	30,017,039	3,736,632	7,132,266	10,868,898	322,173,899	341,322,041
2029	29,750,378	3,437,382	6,561,076	9,998,458	341,322,041	361,073,960
2030	29,614,023	3,313,987	6,325,547	9,639,534	361,073,960	381,048,448
2031	29,442,693	3,303,301	6,305,150	9,608,451	381,048,448	400,882,691
2032	29,344,651	3,302,628	6,303,865	9,606,493	400,882,691	420,620,849
2033	29,063,356	3,313,229	6,324,099	9,637,328	420,620,849	440,046,877
2034	28,500,533	3,329,261	6,354,701	9,683,962	440,046,877	458,863,447
2035	28,213,850	3,350,570	6,395,374	9,745,944	458,863,447	477,331,353
Remaining Liability		40,819,568	77,914,034	118,733,601		

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Combined Special Reclamation Fund & Water Trust Fund
Financial Projections through 2035
Revenue Reduced 10% & Civil Penalties Removed

Fiscal Year	Total Income	Administrative Expense	Reclamation Expense	Total Expenses	Beginning Balance	Ending Balance
2016	33,134,031	8,294,748	15,832,535	24,127,283	142,125,409	151,132,157
2017	31,809,858	9,209,913	17,579,350	26,789,263	151,132,157	156,152,752
2018	32,003,339	9,826,614	18,756,473	28,583,087	156,152,752	159,573,003
2019	32,769,816	8,978,500	17,137,643	26,116,143	159,573,003	166,226,677
2020	32,250,916	6,894,063	13,158,989	20,053,052	166,226,677	178,424,542
2021	31,078,212	6,430,475	12,274,119	18,704,593	178,424,542	190,798,160
2022	30,234,112	5,985,142	11,424,094	17,409,236	190,798,160	203,623,036
2023	29,251,898	5,467,718	10,436,465	15,904,184	203,623,036	216,970,750
2024	28,559,979	4,992,091	9,528,616	14,520,707	216,970,750	231,010,022
2025	28,166,706	4,663,781	8,901,957	13,565,738	231,010,022	245,610,990
2026	27,428,476	4,332,021	8,268,712	12,600,733	245,610,990	260,438,733
2027	26,891,250	4,034,882	7,701,549	11,736,431	260,438,733	275,593,552
2028	26,302,621	3,736,632	7,132,266	10,868,898	275,593,552	291,027,274
2029	26,016,763	3,437,382	6,561,076	9,998,458	291,027,274	307,045,579
2030	25,847,488	3,313,987	6,325,547	9,639,534	307,045,579	323,253,533
2031	25,646,434	3,303,301	6,305,150	9,608,451	323,253,533	339,291,516
2032	25,506,729	3,302,628	6,303,865	9,606,493	339,291,516	355,191,751
2033	25,204,699	3,313,229	6,324,099	9,637,328	355,191,751	370,759,123
2034	24,652,532	3,329,261	6,354,701	9,683,962	370,759,123	385,727,693
2035	24,336,795	3,350,570	6,395,374	9,745,944	385,727,693	400,318,543
Remaining Liability		40,819,568	77,914,034	118,733,601		

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Combined Special Reclamation Fund & Water Trust Fund
Financial Projections through 2035
Revenue Reduced 25% & Civil Penalties Removed

Fiscal Year	Total Income	Administrative Expense	Reclamation Expense	Total Expenses	Beginning Balance	Ending Balance
2016	28,556,266	8,294,748	15,832,535	24,127,283	142,125,409	146,554,392
2017	27,374,894	9,209,913	17,579,350	26,789,263	146,554,392	147,140,023
2018	27,505,393	9,826,614	18,756,473	28,583,087	147,140,023	146,062,328
2019	28,136,930	8,978,500	17,137,643	26,116,143	146,062,328	148,083,116
2020	27,586,630	6,894,063	13,158,989	20,053,052	148,083,116	155,616,694
2021	26,501,246	6,430,475	12,274,119	18,704,593	155,616,694	163,413,347
2022	25,683,771	5,985,142	11,424,094	17,409,236	163,413,347	171,687,881
2023	24,746,905	5,467,718	10,436,465	15,904,184	171,687,881	180,530,603
2024	24,046,510	4,992,091	9,528,616	14,520,707	180,530,603	190,056,406
2025	23,599,547	4,663,781	8,901,957	13,565,738	190,056,406	200,090,215
2026	22,865,038	4,332,021	8,268,712	12,600,733	200,090,215	210,354,520
2027	22,302,272	4,034,882	7,701,549	11,736,431	210,354,520	220,920,360
2028	21,698,125	3,736,632	7,132,266	10,868,898	220,920,360	231,749,587
2029	21,348,813	3,437,382	6,561,076	9,998,458	231,749,587	243,099,942
2030	21,098,988	3,313,987	6,325,547	9,639,534	243,099,942	254,559,395
2031	20,819,209	3,303,301	6,305,150	9,608,451	254,559,395	265,770,154
2032	20,585,498	3,302,628	6,303,865	9,606,493	265,770,154	276,749,159
2033	20,211,097	3,313,229	6,324,099	9,637,328	276,749,159	287,322,928
2034	19,620,072	3,329,261	6,354,701	9,683,962	287,322,928	297,259,037
2035	19,218,970	3,350,570	6,395,374	9,745,944	297,259,037	306,732,063
Remaining Liability		40,819,568	77,914,034	118,733,601		

The revenues and expenses in this projection are based on the revenues described above, as well as the current and prospective liabilities described above. However, it should be noted that the cash flows arising from liabilities in this chart will not exactly equal the expected total liabilities due to the time horizon over which the total liabilities are paid. For instance, the prospective liabilities of $20.3 million include some reclamation projects anticipated to begin on 2035 that may not be completed for several years.

Detailed versions of the above chart may be found in Exhibits E-10 through E-12. Exhibit E-13 shows the breakdown of payments by type for the Special Reclamation Fund and the Water Trust Fund over this time period.

As of June 30, 2015, approximately $65 million of project expenditures are scheduled to be paid by 2017. After discussions with the Council, we have anticipated a four year payment schedule. These scheduled payment amounts are reflected in the cash flow projections above.

Administrative expenses have historically been highly correlated with the level of reclamation activity and are projected to follow a similar pattern. As described in the **Fund Assets** section of this report, bond forfeiture revenues, civil penalties, and coal tonnage fees are anticipated to decline due to the closed nature of the study and due to anticipated declines in coal production from current permits over time.

The result of these projections is that the anticipated fund balance will tend to increase through 2035 based on our expected scenarios, leading to an ending fund cash balance in 2035 of $477.3 million for the Funds compared to a final remaining liability of $118.7 million at year-end 2035. This balance varies depending on actual coal tonnage fee collections and based on the size of losses, as shown in Exhibits E-14 through E-18. Exhibit E-19 compares anticipated ending fund balances against outstanding liabilities at year-end 2035 based on different revenue and loss scenarios.

Background

On August 3, 1977, Congress enacted the Surface Mining Control and Reclamation Act of 1977 ("the SMCRA") to encourage the reclamation of mined areas and return land and water resources to beneficial use. The SMCRA established a program for the regulation of mining permits and a program for reclaiming bond forfeiture sites. In West Virginia, reclamation of abandoned mine lands is performed by the West Virginia Department of Environmental Protection ("WVDEP") Office of Special Reclamation.

Funding for the reclamation of mined areas comes from bond forfeitures, coal tonnage fees, civil penalties, and interest income. The largest of these funding sources is coal tonnage fees. Coal tonnage fees of $0.15 per ton of coal mined are deposited in the Water Trust Fund ("WTF") and $0.129 per ton are deposited in the Special Reclamation Fund ("SRF"). Amounts from bond forfeitures go to the SRF.

Currently, all reclamation activities, including water treatment, are paid through the SRF. Assets from the WTF will remain dormant until 2019. Beginning in 2019, it will become possible to withdraw amounts from the WTF to pay for perpetual water treatment.

Report Distribution and Use

This report has been prepared for internal use by the management of the WVDEP and its board, its accountants, auditors, and attorneys, and the West Virginia legislature. The WVDEP is not authorized to include this report in any marketing or request for proposal solicitations. In addition, it should be understood that T&M consultants are available to respond to any questions by authorized third parties with respect to this report.

Conditions and Limitations

The analyses contained in this report were performed using accepted loss and loss adjustment expense reserving methods adjusted to the special needs of the WVDEP and in conformance with sound actuarial standards and principles. T&M introduced assumptions and judgments that we considered appropriate in the circumstances.

With regard to projections of ultimate values, it should be understood that the emergence and settlement of claims are subject to uncertainty. While we have used our best professional judgment in all instances, projections of future ultimate losses and loss expenses are inherently uncertain because of the random nature of claims occurrences. They are also dependent upon future contingent events and are affected by many additional factors.

WVDEP claim reserving procedures, current and perceived social and economic inflation, current and future court and jury attitudes, legislative changes affecting the WVDEP, improvements in technology, and many other economic, legal, political, legislative and social factors all can have significant effects on ultimate claim costs. Therefore, we cannot warrant that actual developments will not differ from current projections. Such differences could be upward or downward and could be significant.

In summary, the ultimate loss and loss adjustment expense levels estimated in this report are subject to potential variations in estimation due to:

(1) the fact that the ultimate liability of WVDEP is subject to the outcome of events yet to occur;

(2) the unanticipated changes in the legal, economic, legislative or claims adjudication environments;

(3) statistical fluctuation in losses around the estimated or expected values when all other factors remain constant; and

(4) the fact that the actual future loss and loss payment and reporting patterns may differ from those applied in the determination of the expected losses or there may be unanticipated changes in the loss and expense loss and expense payment and reporting patterns;

Accordingly no assurance can be given that future loss emergence will not deviate from the estimated ultimate loss and loss adjustment expenses. However, the ultimate loss and loss adjustment expense estimates were based on a reasonable application of generally accepted actuarial procedures and techniques applied to the information available.

We reviewed the information for overall reasonableness and consistency.

T&M relied without audit or verification on historical loss, loss adjustment expense, exposure data, and other information provided by the WVDEP and its employees. T&M has relied upon the data provided and on the oral and/or written statements made regarding the quality, accuracy, and completeness of the data and information supplied. Any inaccuracies or inconsistencies in the data could have a significant effect on the conclusions drawn.

Should any inaccuracies be found in the data, T&M should be notified immediately so that the analysis can be adjusted accordingly.

With regard to projections of estimated revenues, it should be understood that the revenue streams are subject to uncertainty similar to that experienced in modeling loss projections. While we have used our best professional judgment in all instances, projections of future revenues are inherently uncertain due to potential changes in technology, the implementation of environmental requirements, the introduction of alternative fuels, and changes in the economy among others. While T&M has used its best judgment in

selecting values and trends for each category of revenue, actual revenue collected is dependent upon unknown future events and may be affected by additional factors outside of WVDEP control.

The analysis in this report was limited to the loss and loss adjustment expense items noted in the scope of this project. This report does not include an examination of the assets of the WVDEP, nor did we form any opinion as to the value or validity of the assets. This report does not include a review or analysis of any income statement or other balance sheet items. This analysis with respect to loss and loss adjustment expense reserves is based upon the assumption that all reserves are backed by valid assets and that these assets reflect suitably scheduled maturities and/or sufficient liquidity to meet cash flow requirements.

This report is limited in scope to the estimate of the level of reserve adequacy at the evaluation date of the report. It also includes projections regarding cash flow of the operations of the WVDEP under certain narrow assumptions and conditions.

This report was prepared for use by persons technically competent in insurance financial matters. Persons receiving this report should be made aware of the availability of T&M personnel to answer questions and/or amplify on any matter addressed therein.

Appendix A: Actuarial Analysis

Sources of Data

Data was compiled from several sources. The following are the primary sources from which data was taken and how each data source was used:

- Special Reclamation Database: This database was provided by Michael Sheehan, Assistant Director of the Office of Special Reclamation. The database includes information pertaining to 1,955 historical and ongoing reclamation projects in the state, including site characteristics, land use information, anticipated and actual land and water reclamation costs (both individual capital expenditures and ongoing costs), and administrative costs. This database was used to model the severity of losses to the Funds.
- Permits database: This database was provided by Lewis Halstead, Deputy Director of Program Development for the WVDEP Division of Mining and Reclamation. This database includes data on 6,657 permits issued between 1961 and June 30, 2015, including the permit status, permit location and type, bond amount, and bonded acres. This database was used to model the frequency of permit revocations.
- U.S. Energy Information Administration ("USEIA") Data: Data was collected from the US Energy Information Administration for inclusion in frequency and revenue models. These data included coal price, coal tonnage, and crude oil price history and projections through 2040.
- 2015 Consensus Coal Forecast was also used for coal market history and projections.
- Special Reclamation Fund Expenditures: This database was provided by Scott Fairchild, Financial Reporting Specialist (II) for the WVDEP. This database includes SRF expenditures from July 1, 2005 to June 30, 2015 and was used to project future expenditures.
- Revenues for WTF and SRF: These databases were also provided by Scott Fairchild. These databases include all revenues to the Special Reclamation Fund and Water Trust Fund from July 1, 2005 to June 30, 2015. These databases were used to project future revenues to the Funds.

- Prior Actuarial Reports: These were provided by Mr. Sheehan to provide additional context for our projections.

Overall Methodology

Generalized Linear Models

Because of the nature of the data provided and the estimation of future liabilities and revenues, we determined that the use of generalized linear models would provide the most useful information about future frequency and severity.

A generalized linear model is a general form of a linear model. In a linear model, the variable under investigation (for instance, ultimate cost of land reclamation) is equal to a linear combination of several variables. As an example, one could employ the following as a linear model:

$$\begin{aligned} &Land\ Reclamation\ Cost \\ &\quad = Intercept + A \times Disturbed\ Acres + B \times Initial\ estimate + Error \end{aligned} \tag{1}$$

In this simple model, land reclamation costs estimated as being equal to a coefficient "A" multiplied by the number of disturbed acres at a reclamation site, plus another coefficient "B" multiplied by the initial estimate of the total land reclamation cost, plus a random error term that is assumed to be normally distributed. The error term represents the fact that there will be some portion of the total land reclamation cost that cannot be modeled because it varies randomly from reclamation to reclamation, contractor to contractor, day to day, etc.

The "intercept" term is simply a constant that accounts for the land reclamation cost if the initial estimate of liability is $0, or if the disturbed acres were listed as 0 in the database. Another way of thinking about this is that reclaiming 100 acres may not be exactly twice as expensive on average as reclaiming 50 acres because both projects would require some fixed overhead costs. These fixed overhead costs would be included in the "intercept" term because they do not vary with the number of acres, but they are important to include in the model.

Linear models, while useful, are quite rigid in terms of what they are able to model for a number of reasons. One reason is that they require the dependent variable (the land reclamation costs) to be a linear function of the independent variables (the number of disturbed acres and the initial liability estimate). For instance, suppose that for smaller reclamations, the initial liability estimate tends to be very close to the final ultimate liability at the site, but for larger reclamations, the initial estimate tends to be too large. In this case, the linear model will tend to underestimate the size of smaller reclamations or overestimate the size of large reclamations.

Generalized linear models address this issue and allow for more flexible models. Using the example above, a generalized linear model might look like the following:

$$Cost = f(Intercept + A \times Disturbed\ Acres + B \times Initial\ estimate) + Error \quad (2)$$

In this case, the land reclamation cost is a *function* of a linear combination of the variables, but it is not necessarily equal to that linear combination. For example, the function in this case might be an exponential function, yielding an equation such as:

$$Cost = e^{Intercept + A \times Disturbed\ Acres + B \times Initial\ estimate} + Error \quad (3)$$

Admittedly, it is not readily apparent from looking at the equation why this form is superior. However, it turns out that land reclamation costs are much more accurately modeled by an equation such as this than by a linear model.[3]

As a final note, it is useful to consider the interpretation of a linear model or a generalized linear model. For example, consider again equation (3), above. Clearly, the land reclamation cost estimate is proportional in some way to the disturbed acres and the initial estimate of the land liability. This proportion is dictated by the coefficients "A" and "B". For example, if A is greater than zero, then the ultimate cost increases as the disturbed acres increase. If B is less than zero, then a higher initial estimate may lead to a lower ultimate cost, holding all else equal.

However, it is important to note: care should be taken in interpreting the actual values of the coefficients. If one coefficient is larger than another, it is not necessarily indicative of that value being more important. For example, suppose that A is equal to 5 when we are modeling costs as a function of disturbed acres. If instead, we model costs as a function of *hundreds of acres*, then A will equal 0.05. The cost is still equally sensitive to a change in the number of acres, but the coefficient is much smaller. Therefore, it is important to consider the scale of the independent variables before concluding which variables are more "important" to a modeled value.

The following sections describe the specific models used for frequency, severity, revenues, and expenses.

[3] While it may not be visually apparent why the generalized linear model form proposed here is superior to the linear model, we do not mean to indicate that it is a mystery. This is actually a well-understood phenomenon from a mathematical perspective.

Frequency Model

The frequency of reclamations that are paid for by the SRF or WTF was modeled based on revocations of mining permits. Revocations each year were modeled as being Poisson-distributed according to the following equation:

$$N = e^{-0.542-0.005\times DY^2+0.003\times CP-2.672\times TYPC-2.822\times NYPC+0.583\times COPC+0.012\times DY^2\times TYPC} + Error \quad (4)$$

The variables used (and an interpretation) are as follows:

- DY: "Development Years" – this variable is equal to the number of years from the time a permit was issued to the projection period, minus 4. For instance, if we were projecting the likelihood of a permit being revoked in 2016 and if the permit were issued in 2010, this covers a period of seven years. Therefore, DY is equal to 3 (= 7 – 4). Note that if a permit is issued in 2010, then 2010 is development year 1.
- DY^2: "Development Years Squared" – this variable is the square of DY. The negative coefficient for this variable in the second term indicates that the likelihood of a permit being revoked declines modestly with the time that the permit has been active.
- CP: "Cohort Permits" – this variable represents the number of permits issued in each calendar year. For instance, 40 permits were issued in 2014 and 18 permits were issued in 2015. As a result, the likelihood that a permit issued in 2015 will be revoked is lower, all else equal, than a permit issued in 2014. This could be interpreted as implying that cohorts of mines compete more directly than mines from different years, so a larger cohort means greater competition, which could put mines out of business and lead to revocations. Alternatively, this could suggest that many new permits are requested during periods when coal is very attractive, but that these companies are not always prepared for changing economic conditions and may be more likely to lead to revocations. By contrast, the smaller number of permits issued in less attractive

markets are to a self-selected group of companies that have found a way to stay profitable despite difficult macroeconomic trends.

- TYPC: "Three Year Price Change" – this variable is the three-year running change in the price of coal (from the USEIA). The negative coefficient here indicates that if coal prices have been generally increasing, the likelihood of a revocation is much lower. If coal prices decline, however, the likelihood of a revocation may increase significantly.
- NYPC: "Next Year Price Change" – this variable tracks the subsequent year price change. The interpretation of this variable is that if projections of future coal markets look unattractive, mining companies are less likely to fight to prevent revocations, whereas if projections are favorable, companies may be more vigilant about staying in business for one more year so the business can turn itself around.
- COPC: "Crude Oil Price Change" – this variable tracks the most recent year of crude oil price changes. Crude oil prices drive fuel costs, which are a large source of expenditures for mining companies. As crude oil prices increase, profits will decline in the coal industry, leading to greater likelihood of revocations. A secondary effect is that increased crude oil prices raise prices in other industries, which will indirectly increase operating costs for coal mining (and thereby lead to higher probability of revocation).

The final term in the frequency model is an interaction term between the squared "Development Years" and the "Three Year Price Change" variable. The positive coefficient for this variable implies that older permits have a higher risk of revocation if the price of coal has been increasing than if the price has been decreasing. This could be a result of competition effects when the price of coal increases, generating more market entrants and putting pressure on older businesses.

Severity Models

Severity was divided into three components: land reclamation costs, water capital expenditures, and annual water treatment costs.

The equation for land reclamation costs is as follows:

$$Cost = e^{10.7+.002\times SLE+.164\times SRA-.372\times NS-.000087\times SLE\times SRA} + Error \quad (5)$$

The variable descriptions for this model are as follows:

- SLE: "Square-Root of Land Liability Estimate" – this variable is equal to the square root of the initial estimate for the total cost of land reclamation or, if there is no estimate, 0. The positive value of the coefficient implies that a higher initial estimate does correspond to a higher ultimate cost. However, it was determined that the square root of the land liability estimate was more predictive than the raw estimate. This implies that the ultimate cost of reclaiming mined land increases at a decreasing rate as the land liability estimate increases. It should be noted that the initial liability estimate of land reclamation costs is not updated as further information is gathered. Therefore, this variable was used both to fit the model and to project ultimate losses.
- SRA: "Square-Root of Reclaimed Acres" – this variable is equal to the square root of the number of acres reclaimed. Much like the "Square-Root of Land Liability Estimate" variable, the ultimate cost of land reclamation increases at a decreasing rate as the acreage to be reclaimed increases. This implies that as the size of reclaimed area increases, economies of scale somewhat attenuate the cost of reclamation. When fitting this variable, the square root of reclaimed acres was used, whereas when projecting ultimate results, the square root of disturbed acres was used to represent the anticipated number of acres that needed to be reclaimed at unfinished reclamation sites.

- NS: “North or South” – this variable is equal to “1” if the site is dealt with in the northern field office in Philippi and “0” otherwise. The negative coefficient on this variable indicates that northern reclamations tend to be less severe on average.

The final term in the regression is an interaction term between the square root of reclaimed acres and the square root of the initial land liability estimate. The coefficient for the interaction term is negative whereas the estimate for each of the variables separately is positive. This implies that there is some overlap between the size of the reclamation and the initial estimate. Because the initial estimate will tend to be higher if more acres need to be reclaimed, this factor essentially could be seen as separating out the effects of the acreage to be reclaimed and the initial estimate of the cost.

The model for water treatment capital costs is as follows:

$$Capital = e^{9.027+2.062\times AMD+0.0012*SWQE+0.0005\times SWQE\times NS+1.009*WCCEE} + Error \qquad (6)$$

The variables for this model are as follows:

- AMD: “Acid Mine Drainage” – this is a flag indicating that there is acid mine drainage detected at the site to be reclaimed. The positive coefficient implies that the capital costs associated with water treatment are (significantly) higher when acid mine drainage is present. It should be noted that roughly 10% of historical water capital expenditures to date have been on sites for which Acid Mine Drainage is listed as “N” in the special reclamation database.
- NS: “North or South” – this is the same as the land reclamation cost model, above. The negative coefficient implies that water capital costs tend to be lower in the north than in the southern part of the state.
- SWQE: “Square-Root Water Quality Capital Cost Estimate” – this variable, the square root of the initial estimate of capital costs for water treatment, is part of an interaction term along with the “North or South” variable. The positive coefficient on this variable indicates that the capital

cost associated with water treatment is higher when the estimate of water quality capital cost is higher. In the projection dataset, this value was replaced with the retrofit cost estimate (if it exists) or the initial water quality capital cost estimate (if the former does not exist).

- WCCEE: "Water Capital Cost Estimate Exists" – this is a flag indicating a value of "1" if a water capital cost estimate was made for a given site, and "0" otherwise. This enables the model to distinguish between sites with a water capital cost estimate of $0 and a site for which a water capital cost estimate had simply not been made.

Notably, the "AMD" and "WCCEE" variables in this model are not statistically significant. However, they were included in the model because their inclusion greatly reduced cross-validation error. Put another way, because of the small quantity of data available for analysis, it is difficult to be certain that the selected coefficient is exactly correct. However, the inclusion of these variables in the model greatly enhanced the model's ability to predict cases not used for fitting the model (reclamations the model had not as yet "seen").

The main focus behind the use of the initial water capital cost estimate (as opposed to the estimate of the cost of retrofitting a site) is to develop a relationship between liability estimates and the ultimate cost associated with those projects. As of June 30, 2015, relatively few sites requiring retrofitting had received notice to proceed with retrofits, so for many sites the cost of retrofit projects had not yet been reflected in the water capital dollars spent to date. The model adjusts for this by forming a relationship between cost estimates and ultimate costs. When projecting the ultimate cost associated with a site, we used the most recent appropriate estimate of the unpaid water capital costs associated with the site, thereby capturing the ultimate cost of retrofits based on the estimated costs.

The anticipated annual cost for Operation and Maintenance of water treatment is modeled by the following equation:

$$Annual\ Cost = e^{8.059 - 1.866 \times EWQAC + 0.590 \times HRC + 0.007 \times SAE \times NS + 0.004 \times SAE \times EWQAC} + Error \qquad (7)$$

The following are the variables used in this model:

- EWQAC: "Estimated Water Quality Abandonment Cost" – this variable is a true/false flag representing whether an abandonment cost estimate has been made or not. The negative coefficient implies that if an estimate has been made, the average annual cost tends to be smaller on average.
- HRC: "Hydrologic Region Code" – although the data was too sparse to determine the relative risk of different hydrologic region codes, the presence or absence of a hydrologic region code was positively associated with annual water treatment costs. The positive coefficient may be understood as showing that the presence of a hydrologic region code signifies a higher average cost.
- SAE: "Square-Root of Annual Cost Estimate" – this variable is equal to the square root of the estimate of annual costs. This variable interacts with NS (described below) and EWQAC. The positive coefficient implies that the absence of an annual cost estimate has a greater effect on the actual annual cost than does having an annual cost estimate of $0.
- NS: "North or South" – this variable is described above. This variable is included in an interaction term with the "Square-Root of Annual Cost Estimate" variable. The positive coefficient implies that annual costs increase as the annual cost estimate increases, but that this effect is greater in the north than in the south.

Much like the water capital cost model, the initial annual cost estimate was used in the model, but the most recent available annual cost estimate was used in the projection dataset. i.e., if retrofit was needed, then the post-retrofit annual O&M estimate was used while the initial estimate was used otherwise.

In addition to reviewing water treatment costs, we reviewed the anticipated length of time that annual water treatment would be required. Of the 796 reclamations that had start dates for water treatment, only 10 have "completed" status, meaning that water issues that had been discovered were resolved[4]. While the average time from initial revocation of a permit to completed status is 10.3 years, the average time that currently unfinished reclamations (involving water treatment) have been in progress is 20.7 years by the same measure.

We analyzed this data to determine the anticipated average time from permit revocation to completed water treatment. However, given the very limited number of sites with completed status, probabilistic analysis yields only the conclusion that the vast majority of water reclamation will result in perpetual water treatment projects without anticipated end dates[5]. As a result, we have included no abandonment costs in our projections of unpaid liabilities, but have instead assumed that water treatment will continue indefinitely for all affected sites.

Water cost projections, both for water capital expenses and for maintenance and operations expenses, were attenuated by a value equal to the probability that water reclamation would be required on sites that had not yet experienced water reclamation. For example, a site that has acid mine drainage would

[4] Note: this does not necessarily imply that water was treated and that treatment was "completed," only that water issues were identified and subsequently resolved.

[5] This is because the region of maximum likelihood for average duration of reclamation activities is dramatically left-skewed. This means that when calculating the maximum *a posteriori* ("MAP") estimate or the maximum likelihood estimate (MLE) of the anticipated duration of water reclamation activities, the result was well over 100 years for even strongly informative (i.e., highly biased) prior distributions. This analysis was undertaken with a variety of assumptions to ensure the robustness of the result. Practically speaking, although there may be some abandonment costs paid as part of the reclamations, they are likely to be sparsely distributed and are unlikely to have a material impact on the ultimate liabilities to the fund.

It should be further noted with respect to the anticipated duration of water reclamation activities that acid mine drainage was not a strong predictor of whether water treatment was needed. This is because many sites with negative AMD flags still had water treatment costs in the historical data. While it is possible that acid load will be attenuated with a half-life of approximately twenty years (per *Demchak J, Skousen J, McDonald LM. 2004. Longevity of acid discharges from underground mines located above the regional water table. J Environ Qual 33: 656-668*), this seems more likely to attenuate anticipated water treatment costs rather than water treatment longevity.

receive a factor of 1.0, whereas a site with unknown acid mine drainage might receive a factor of 0.50, representing the probability that water reclamation will be required on that site in the future. It should be noted that sites with no acid mine drainage received a very small probability that water treatment would be required in the future. This probability was based on the probability model reduced by a factor of 10, based on the fact that roughly 10% of water capital dollars to date had been spent on sites with no AMD.

The overall probability described above was modeled by assuming that the likelihood that construction of water treatment facilities is a Bernoulli random variable that is based on the year that the permit was revoked and the length of time since the permit was revoked. This allowed us to calculate the probability that reclamations that have not currently had water issues identified will require water reclamation in the future, as well as the probability that future revoked permits will require water reclamation at any point in the reclamation activity lifecycle.

The model used for calculating the probability of requiring water treatment is as follows:

$$P(Water\ Treatment) = e^{-117.333+0.2940YE+0.05614YR} \quad (8)$$

The following are the variables used in this model:

- YE: "Years Elapsed" – this variable represents the number of years since the year in which the permit was revoked until a year under investigation
- YR: "Year Revoked" – this variable represents the calendar year in which a permit is revoked

This model is used to determine the probability that water treatment will be needed in any given year. The total probability that water treatment will be required within the analysis time frame is then calculated by the formula:

$$W_{YR} = 1 - \prod_{YE=YR}^{YR+30} (1 - P_{YR,YE}) \quad (9)$$

Where W_{YR} is the total probability that a reclamation arising from a permit that revoked in YR will be identified in the future as requiring water treatment, and $P_{YR,YE}$ is the probability that water treatment will be identified as being required in year YE for a permit revoked in year YR.

Revenue Calculations

Anticipated coal tonnage fees were modeled by considering the anticipated change in Appalachian coal production per year as well as the effect of the "runoff" of permits (i.e., the reductions in production from old permits as newly issued permits replace old ones). The calculations underlying this analysis are provided as **Appendix B**, below.

Bond forfeitures revenues were determined by looking at the average bond size on the current cohort of permits and applying this value to future anticipated bond forfeitures.

Civil penalties were likewise anticipated to decline concomitant with the decline in production on the current cohort of permits.

Administrative Expense Calculations

Historical administrative expenses were provided to us for the years 2006 through June 30, 2015. Administrative expenses are defined as the sum of employee benefits, contractual obligations, personnel services, and other unclassified expenses.

For most years, administrative expenses highly correlated with reclamation costs. Therefore, administrative expenses were calculated based on the average administrative expenses per remediation expenses historically, multiplied by the current year remediation expenses.

Prospective Reclamation Cost Models

Prospective liabilities (i.e., liabilities associated with currently issued, unrevoked permits that are anticipated to be revoked in the future) were determined using curve fitting methodologies. Specifically, each component of reclamation costs (land reclamation, water capital cost, and operations and maintenance cost) were fitted to log normal distributions using the "method of moments" on log-scale data, and empirical percentiles of reclamation costs were compared to fitted percentiles to determine the quality of fit. In general, empirical percentiles of log-scale data appeared to closely match a normal distribution. This was consistent with severity models of current liabilities, which were based on assuming that severity was approximately log normally distributed.

Projections were therefore done on a per-permit level (not based on revoked acres, for example). Projections of all costs used in the cash flow analysis were trended forward based on anticipated inflation.

Given the relative size of future liabilities in comparison to current liabilities and the average duration of payments, it appears that further refinements of the future liability projections are unlikely to have a material impact on the anticipated total expense payments through 2035.

Model Development

Because of the relative sparseness of the data available for this study, there was extensive focus on proper model development.

Early models of frequency and severity were similar to their final forms. It was apparent early in the modeling process that a Poisson distribution was appropriate for frequency and a log normal distribution was appropriate for severity distributions. Besides providing greatly superior model performance, these models are consistent with actuarial research in a variety of areas.

Early models for this study were therefore fitted to historical data and selected on the basis of minimizing the Akaike Information Criterion ("AIC"). AIC measures the likelihood of the data with a penalty for model complexity. Therefore, all things equal, a parsimonious model will have superior (lower) AIC than a complex model that has similar predictive power.

For each model, a wide variety of variables were tested, and variables were excluded if the attendant factors were determined to not be statistically significant at the $p < 0.05$ level, with the notable exceptions mentioned above. In addition, variables were sought that had greater explanatory power. Explanatory power was measured both by the AIC and by a Pseudo-R^2 measure that was calculated as (1.0 – residual deviance / null deviance). This roughly corresponds to the amount of variation in the data that is explained by the model.

Subsequent refinements of the models involved minimizing 10-fold cross-validation ("CV") error. CV error is a rough estimate of the ability of the model to generalize to data that the model was not trained on. Starting with the basic model form, the data is split into ten "folds". We then fit the model ten times, each time leaving out one fold of data and fitting the model with the remaining nine folds. The estimation error (equal in this case to the mean squared error) is calculated for each fold, and the results for all ten fits are averaged.

During this process, some variables were identified as not being statistically significant that provided significant boosts to CV results. These variables were included in final models despite lacking in statistical significance as measured by other tests.

The following chart shows the Pseudo-R^2 value for each of the models:

West Virginia Office of Special Reclamation Actuarial Reserve Study as of June 30, 2015 Special Reclamation Fund and Water Trust Fund Combined		
Model	Pseudo-R^2	AIC
Frequency Model	52.2%	2,384
Land Reclamation Cost	55.4%	27,153
Water Capital Cost	45.6%	3,972
Water Operations & Maintenance Cost	51.6%	29,502

Note that AIC is relative to the sample size used in fitting the data. Therefore, because more data points were used to estimate the land reclamation costs and the water O&M costs, the associated AIC values were naturally higher.

It should be noted that the Pseudo-R^2 and AIC values are not a perfect reflection of the predictive value of the models. For instance, the Pseudo-R^2 will tend to be very high for models that are significantly over-fitted. Although the AIC has a modest penalty for model complexity, it might similarly allow for over-fitting of models.

From a Bayesian standpoint, a maximum likelihood ("MLE") model such as that used here is equivalent to the maximum *a posteriori* ("MAP") solution if the prior distributions of the parameters under investigation are relatively uninformative or flat in the area of maximum likelihood. Therefore, the model solutions used are likely to be optimal or near-optimal given the data and certain assumptions regarding the prior distribution of modeled parameters.

Appendix B – Coal Tonnage Fee Revenue Calculations

The Special Reclamation Fund and Water Trust Fund collect coal tonnage fee revenues based on the quantity of coal mined in West Virginia. Because of the closed nature of the study, when projecting coal tonnage fee revenues for the SRF and WTF into the future, it is important to consider only coal production related to the cohort of permits that had been issued as of the evaluation date of the study.

Coal tonnage fee revenues were calculated based on projected coal production in the state. This was performed separately for the northern and southern halves of the state, and separately for underground and surface mine types. For each type, coal production was projected by combining the effects of two trends:

1. Overall market trends in Appalachian coal production derived from USEIA data and the Consensus Coal Forecast
2. "Replacement Rate" – A factor representing the proportion of total coal production related to permits that had been issued as of the evaluation date of the study.

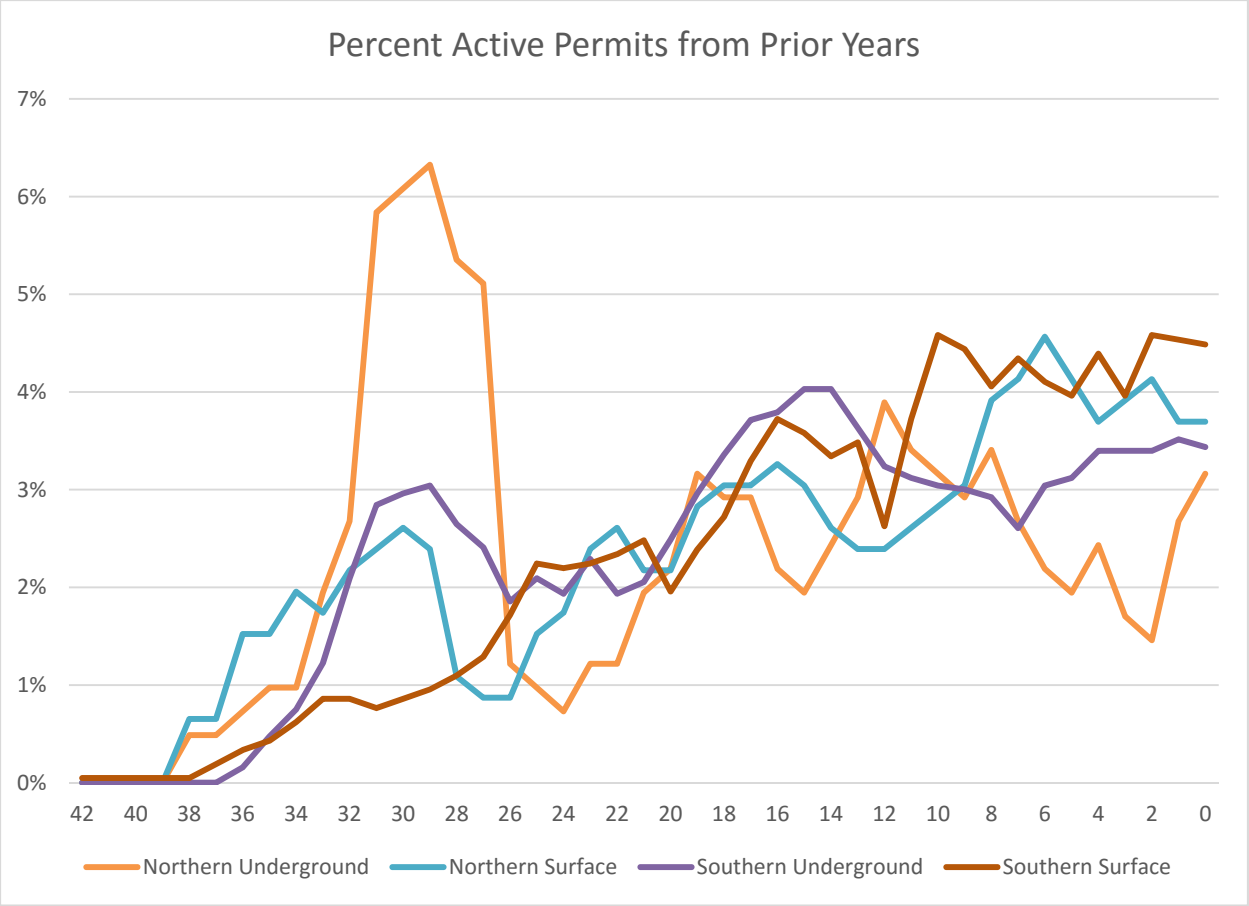
The first of these values is relatively straightforward. For example, if Appalachian coal production is anticipated to drop 2.2% from 2015 to 2016, then we apply a decrease of 2.2% to anticipated 2016 coal production. The use of this factor incorporates the anticipated changes in the overall coal market into the future.

The second of these trend factors is more complicated. By way of explanation, consider the following example: If we look at southern underground mines at year-end 2015, we anticipate seeing that about 3.5% of productive permits had been issued in 2015 and about 3.4% of productive permits in 2015 had been issued in 2014. Put another way, of the total production in 2015, 3.5% of that is attributable to permits that had been new that year, 3.4% to the prior year, and the balance (93.1%) spread across other prior years.

When we project the total coal production in 2016, we then anticipate that about 3.5% of that production will come from new permits that had been issued in 2016, and 3.4% of that production will result from permits that had been issued in 2015, and so on. These values will change with each successive year as old permits become inactive or revoked and as new permits are added, changing the total population of productive permits over time. Going back to the example, in 2016, 96.5% (i.e., 100% - 3.5%) of *total* coal production from southern underground mines in West Virginia would be attributable to permits that had been issued in years 2015 and prior. In 2017, this value declines to 93.1% (i.e., 100% - 3.5% - 3.4%), as now some of the overall coal production is attributable to permits issued in 2017, plus coal production attributable to permits issued in 2016. These successive values define the "replacement rate" by which old permits are replaced by new permits each year.

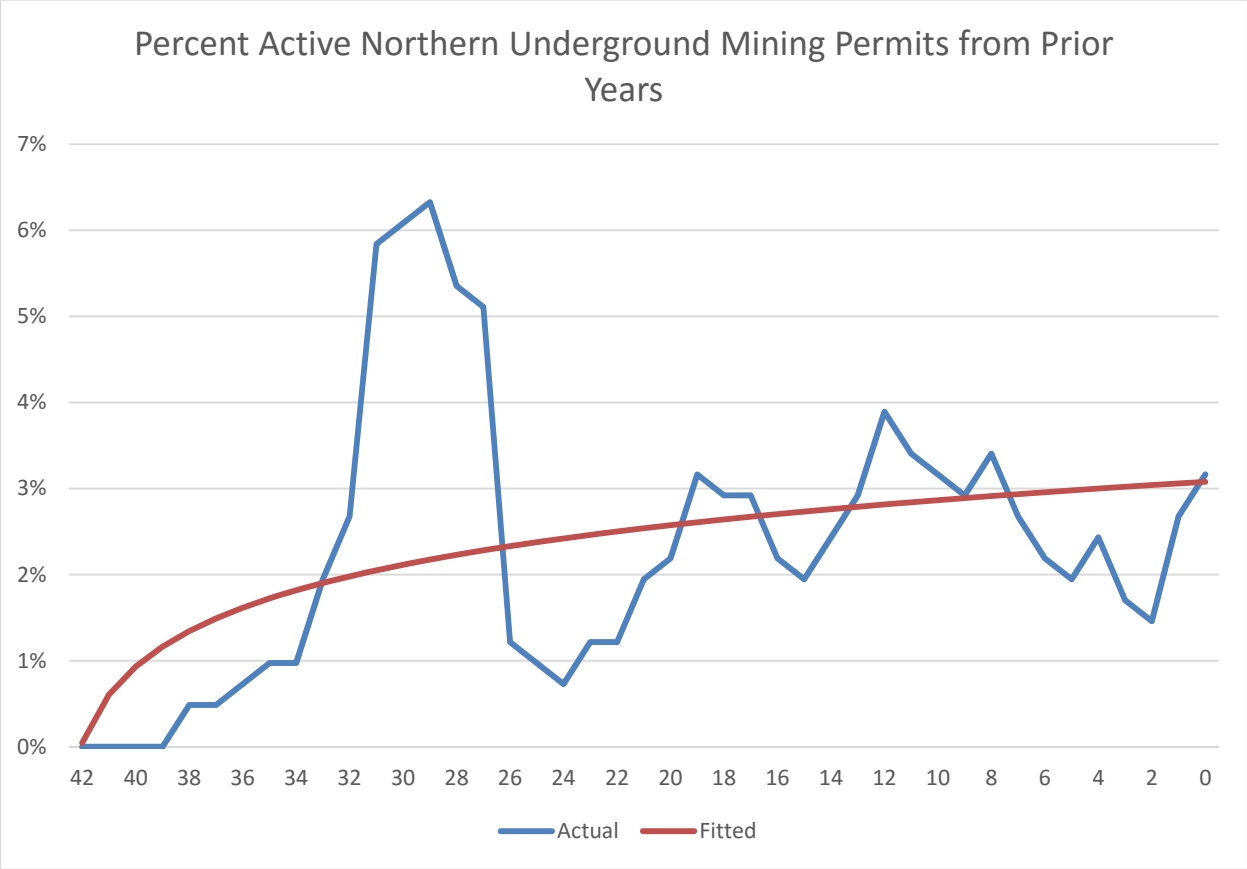
To calculate the replacement rate, for each mine location / type combination, we reviewed the number of active permits from each issuance year as of year-end 2010 through year-end 2014. These years were selected because they were the five most recent complete years of data. Five years were used to maximize responsiveness to recent changes while still providing adequate data on which to base projections.

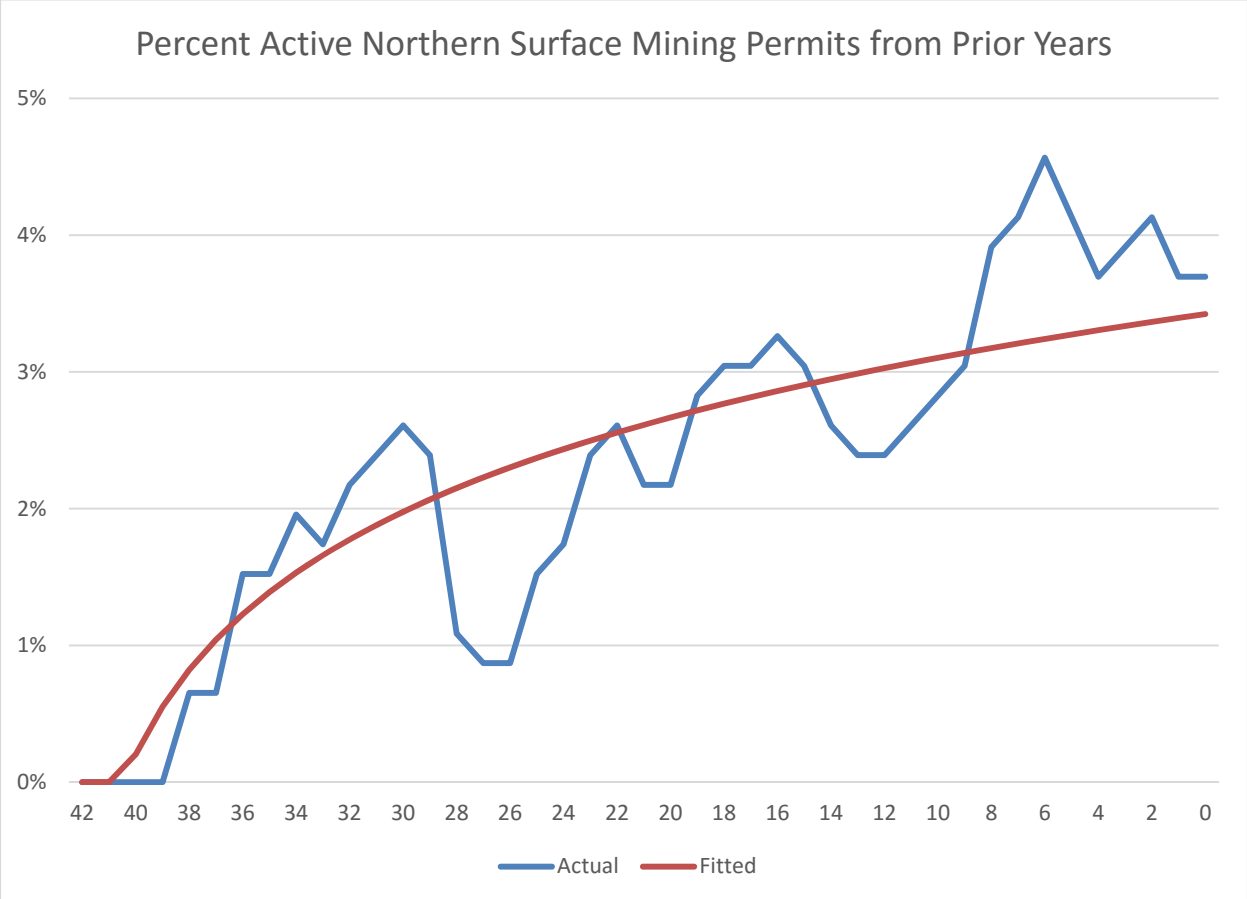
The active permits by year were then averaged across all five years. This allowed us to determine for each mine location / type combination what percentage of currently productive permits had been issued in the most recent year, the second most recent year, and so on. The following chart shows the average percent active permits from prior issuance years:

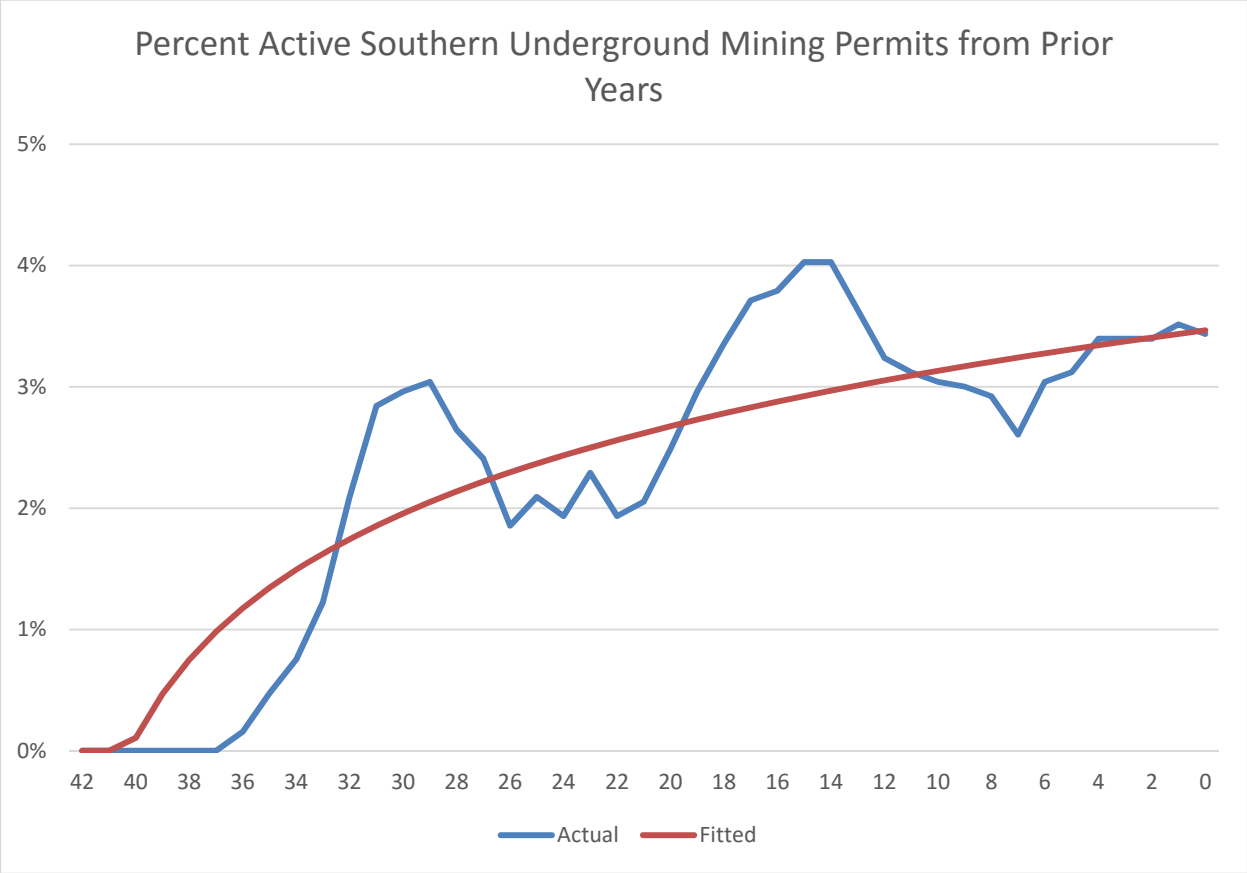


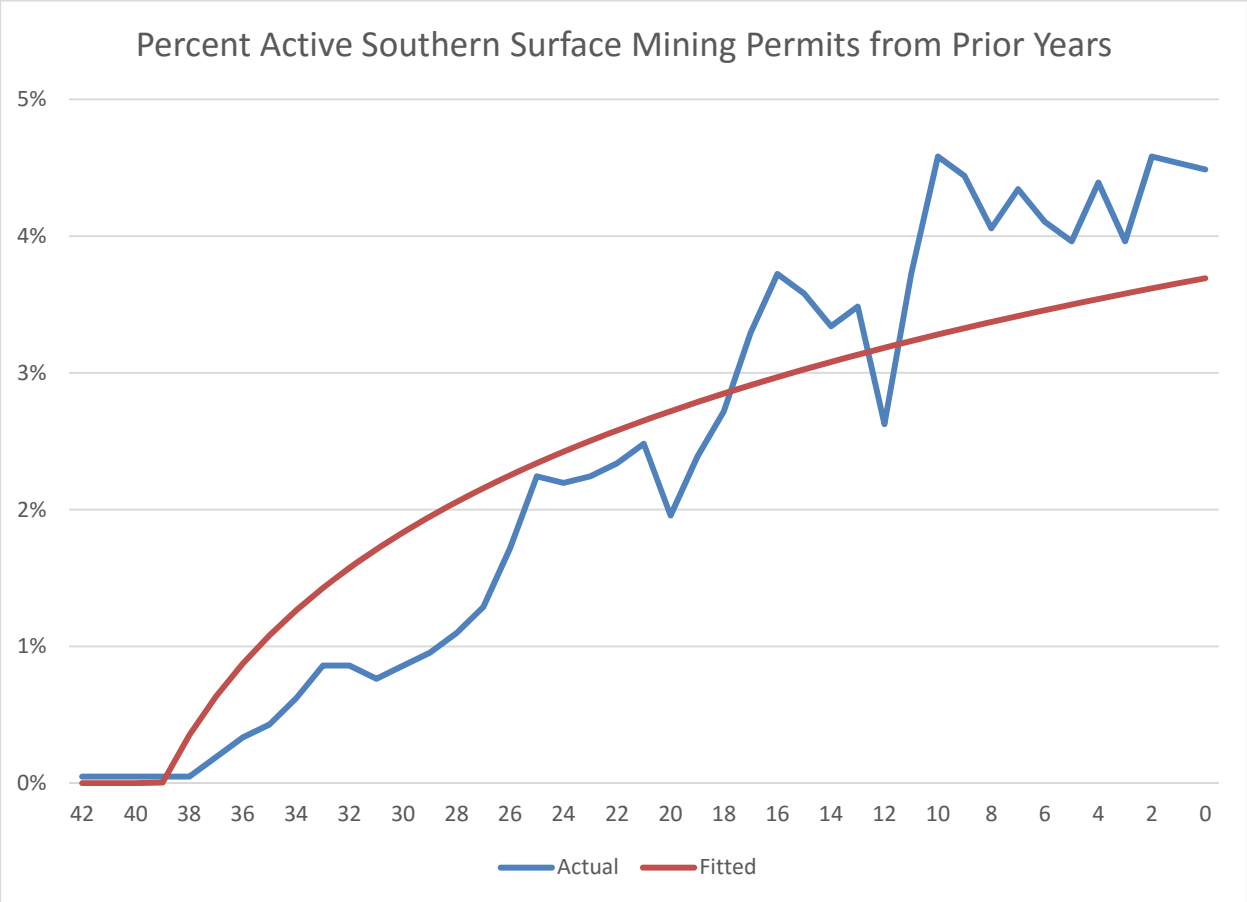
As an example, looking at northern underground mines at any given point in time, on average 3.2% of currently productive permits had been issued in the most recent issuance year, 2.7% of currently productive permits had been issued in the previous issuance year, and so on.

These raw values are somewhat volatile over time, particularly for northern underground mines, as a result of random variations in the number of active permits from year to year. To minimize the volatility of these percentages arising from random variations, we smoothed the values using logarithmic interpolation. The following four charts show the actual and fitted percentages of permits issued for each prior issuance year:


Percent Active Northern Underground Mining Permits from Prior Years
7%
6%
5%
4%
3%
2%
1%
0%
42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0
Actual
Fitted


Percent Active Northern Surface Mining Permits from Prior Years
5%
4%
3%
2%
1%
0%
42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0
Actual
Fitted


Percent Active Southern Underground Mining Permits from Prior Years
5%
4%
3%
2%
1%
0%
42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0
Actual
Fitted


Percent Active Southern Surface Mining Permits from Prior Years
5%
4%
3%
2%
1%
0%
42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0
Actual
Fitted

After projecting the effects of decline rate for each future year and applying anticipated changes in the overall coal market, we calculated the anticipated coal production by mine location and type for future years arising from the current cohort of issued permits.

It should be noted that these coal production totals were not used to directly calculate anticipated coal tonnage fee revenues (e.g., by multiplying by $0.129 per ton to determine SRF revenues). This is because the coal production numbers were obtained from USEIA data, and the total coal production from this source slightly mismatched the *implied* coal production determined by taking the historical coal tonnage fee revenues and dividing by the rate per ton of coal. The values were similar, but for the sake of consistency with actual coal tonnage fee revenues, we instead took historical revenues as a starting point and adjusted those revenues based on percent change in the coal production. For instance, if the coal production from the current cohort of permits was 5.5% lower in 2016 than in 2015, then the 2015 coal tonnage revenues were adjusted downward by 5.5% to determine the anticipated 2016 coal tonnage fee revenues. The revenues for the WTF were calculated by multiplying SRF revenues by $0.15/$0.129, representing the tax collection differences between the Funds.

The following page shows the anticipated coal production by mine type and location based on USEIA data.

Calendar Year	Coal Production Adjusted for Closed Nature of Study (Production Data from USEIA)									Percent Change From Prior Year
	Northern			Southern			Total			
	Underground	Surface	Total	Underground	Surface	Total	Underground	Surface	Total	
1994	43,702	5,614	49,316	67,977	44,483	112,460	111,679	50,097	161,776	
1995	40,726	5,388	46,114	69,303	47,580	116,883	110,029	52,968	162,997	0.8%
1996	40,274	5,637	45,911	75,311	49,211	124,522	115,585	54,848	170,433	4.6%
1997	37,056	5,746	42,802	79,467	51,474	130,941	116,523	57,220	173,743	1.9%
1998	39,236	5,382	44,618	77,954	48,572	126,526	117,190	53,954	171,144	-1.5%
1999	33,653	5,135	38,788	70,075	49,116	119,191	103,728	54,251	157,979	-7.7%
2000	32,281	5,319	37,600	66,158	54,498	120,656	98,439	59,817	158,256	0.2%
2001	32,753	5,418	38,171	66,798	57,447	124,245	99,551	62,865	162,416	2.6%
2002	28,683	5,350	34,033	59,235	56,810	116,045	87,918	62,160	150,078	-7.6%
2003	30,029	4,921	34,950	56,764	47,998	104,762	86,793	52,919	139,712	-6.9%
2004	36,082	4,564	40,646	54,851	52,497	107,348	90,933	57,061	147,994	5.9%
2005	37,590	5,037	42,627	53,419	57,603	111,022	91,009	62,640	153,649	3.8%
2006	36,074	6,324	42,398	48,554	61,421	109,975	84,628	67,745	152,373	-0.8%
2007	36,076	6,144	42,220	48,777	62,483	111,260	84,853	68,627	153,480	0.7%
2008	34,109	7,013	41,122	54,260	62,395	116,655	88,369	69,408	157,777	2.8%
2009	33,148	5,247	38,395	47,739	50,993	98,732	80,887	56,240	137,127	-13.1%
2010	37,302	4,004	41,306	47,242	46,671	93,913	84,544	50,675	135,219	-1.4%
2011	38,590	3,259	41,849	44,805	48,008	92,813	83,395	51,267	134,662	-0.4%
2012	39,445	2,045	41,490	41,024	37,911	78,935	80,469	39,956	120,425	-10.6%
2013	40,871	1,519	42,390	37,949	32,448	70,397	78,820	33,967	112,787	-6.3%
2014	41,498	1,542	43,040	38,531	32,945	71,476	80,028	34,488	114,516	1.5%
2015	38,907	1,446	40,353	36,125	30,889	67,014	75,032	32,335	107,367	-6.2%
2016	36,873	1,366	38,239	34,100	29,089	63,189	70,973	30,454	101,428	-5.5%
2017	34,637	1,278	35,915	31,899	27,145	59,044	66,536	28,423	94,958	-6.4%
2018	34,074	1,252	35,327	31,245	26,520	57,766	65,320	27,773	93,092	-2.0%
2019	34,060	1,247	35,306	31,091	26,319	57,410	65,151	27,565	92,716	-0.4%
2020	33,145	1,208	34,353	30,114	25,420	55,533	63,259	26,628	89,887	-3.1%
2021	31,222	1,133	32,355	28,227	23,756	51,983	59,449	24,890	84,339	-6.2%
2022	29,787	1,076	30,863	26,790	22,478	49,268	56,578	23,554	80,131	-5.0%
2023	28,172	1,013	29,185	25,201	21,074	46,275	53,373	22,087	75,460	-5.8%
2024	26,981	965	27,946	23,998	20,000	43,998	50,979	20,965	71,944	-4.7%
2025	26,133	930	27,063	23,105	19,185	42,290	49,238	20,115	69,353	-3.6%
2026	24,758	876	25,634	21,752	17,991	39,743	46,510	18,867	65,377	-5.7%
2027	23,594	830	24,424	20,591	16,961	37,552	44,185	17,791	61,976	-5.2%
2028	22,301	780	23,080	19,326	15,849	35,175	41,627	16,629	58,256	-6.0%
2029	21,373	742	22,115	18,384	15,006	33,390	39,757	15,748	55,505	-4.7%
2030	20,537	708	21,245	17,525	14,234	31,759	38,062	14,942	53,004	-4.5%
2031	19,625	672	20,297	16,606	13,415	30,021	36,231	14,086	50,318	-5.1%
2032	18,783	638	19,421	15,751	12,650	28,401	34,534	13,288	47,823	-5.0%
2033	17,683	595	18,279	14,686	11,721	26,407	32,369	12,317	44,686	-6.6%
2034	16,218	541	16,759	13,330	10,567	23,897	29,549	11,108	40,657	-9.0%
2035	15,100	499	15,598	12,273	9,657	21,930	27,372	10,156	37,528	-7.7%
2036	14,182	464	14,646	11,388	8,889	20,277	25,570	9,352	34,923	-6.9%
2037	13,248	428	13,676	10,499	8,122	18,621	23,747	8,550	32,297	-7.5%
2038	12,235	390	12,625	9,558	7,322	16,879	21,792	7,712	29,504	-8.6%
2039	11,274	355	11,629	8,670	6,569	15,239	19,944	6,924	26,868	-8.9%
2040	10,379	322	10,701	7,844	5,871	13,716	18,224	6,193	24,417	-9.1%

Exhibits

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Projected Unpaid Current & Prospective Liabilities to 2035 by Mine Type

(1)	(2)	(3)	(4)	(5)	(6)
Mine Type	Unpaid Land Reclamation Costs	Unpaid Water Capital Cost	Total Current Unpaid Losses	Unpaid O&M Water Expenses Through 2035	Total Unpaid Losses
Surface	27,549,348	44,161,013	71,710,361	46,336,966	118,047,327
Underground	10,386,253	11,649,748	22,036,002	19,308,449	41,344,451
Refuse Area	973,799	1,938,571	2,912,370	1,071,734	3,984,103
Prospect	163,001	430,727	593,727	323,407	917,135
Other	11,098,002	6,641,223	17,739,225	12,433,872	30,173,098
Total	50,170,403	64,821,282	114,991,685	79,474,429	194,466,114

Note: Column (4) = (2) + (3)
Column (6) = (4) + (5)
Dollars in this chart are real dollars and are not inflation adjusted.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Projected Unpaid Current & Prospective Liabilities to 2035 by Permit Size

(1)	(2)	(3)	(4)	(5)	(6)
Permit Acres	Unpaid Land Reclamation Costs	Unpaid Water Capital Cost	Total Current Unpaid Losses	Unpaid O&M Water Expenses Through 2035	Total Unpaid Losses
0 - 10	8,149,795	9,171,657	17,321,452	13,743,006	31,064,458
10 - 20	3,970,860	5,797,784	9,768,644	5,101,905	14,870,550
20 - 30	2,132,130	7,484,604	9,616,734	17,216,741	26,833,475
30 - 40	1,770,931	4,461,140	6,232,072	3,360,617	9,592,689
40 - 50	2,003,686	4,231,939	6,235,625	2,803,134	9,038,760
50 - 60	1,786,110	3,098,118	4,884,228	2,751,910	7,636,138
60 - 70	1,889,448	2,952,823	4,842,271	2,218,710	7,060,980
70 - 80	1,311,205	2,161,310	3,472,515	1,594,676	5,067,191
80 - 90	2,933,367	990,215	3,923,583	3,540,508	7,464,091
90 - 100	1,857,440	1,916,074	3,773,514	2,880,827	6,654,340
100 - 110	1,041,776	1,236,586	2,278,362	1,671,675	3,950,037
110 - 120	159,054	152,561	311,615	344,471	656,086
120 - 130	143,410	2,471,796	2,615,205	978,530	3,593,735
130 - 140	343,406	548,688	892,094	433,715	1,325,809
140 - 150	208,438	453,920	662,359	171,793	834,152
150 - 160	78,224	902,593	980,817	1,590,826	2,571,643
160 - 170	504,410	397,300	901,711	380,126	1,281,837
170 - 180	88,653	392,041	480,694	451,588	932,282
180 - 190	908,661	1,163,270	2,071,931	360,908	2,432,839
190 - 200	697,935	3,108,163	3,806,099	676,079	4,482,178
> 200	18,191,463	11,728,700	29,920,163	17,202,683	47,122,846
Total	50,170,403	64,821,282	114,991,685	79,474,429	194,466,114

Note: Column (4) = (2) + (3)
Column (6) = (4) + (5)
Dollars in this chart are real dollars and are not inflation adjusted.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Projected Unpaid Current & Prospective Liabilities to 2035 by Location

(1)	(2)	(3)	(4)	(5)	(6)
Office Location	Unpaid Land Reclamation Costs	Unpaid Water Capital Cost	Total Current Unpaid Losses	Unpaid O&M Water Expenses Through 2035	Total Unpaid Losses
North	19,863,884	35,125,578	54,989,462	63,822,208	118,811,671
South	16,654,354	19,659,368	36,313,722	10,298,564	46,612,287
Central	13,652,166	10,036,335	23,688,501	5,353,656	29,042,157
Total	50,170,403	64,821,282	114,991,685	79,474,429	194,466,114

Note: Column (4) = (2) + (3)
Column (5) calculated as anticipated annual O&M Expense multiplied by 20 years
Column (6) = (4) + (5)
Dollars in this chart are real dollars and are not inflation adjusted.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Projected Unpaid Current Liabilities to 2035 by Mine Type

(1)	(2)	(3)	(4)	(5)	(6)
Mine Type	Unpaid Land Reclamation Costs	Unpaid Water Capital Cost	Total Current Unpaid Losses	Unpaid O&M Water Expenses Through 2035	Total Unpaid Losses
Surface	21,502,671	42,048,106	63,550,778	45,893,330	109,444,108
Underground	5,040,981	9,781,936	14,822,916	18,916,274	33,739,190
Refuse Area	791,277	1,874,792	2,666,069	1,058,342	3,724,412
Prospect	163,001	430,727	593,727	323,407	917,135
Other	8,391,469	5,695,472	14,086,941	12,235,298	26,322,239
Total	35,889,399	59,831,033	95,720,432	78,426,651	174,147,083

Note: Column (4) = (2) + (3)
Column (5) calculated as anticipated annual O&M Expense multiplied by 20 years
Column (6) = (4) + (5)
Dollars in this chart are real dollars and are not inflation adjusted.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Projected Unpaid Current Liabilities to 2035 by Permit Size

(1)	(2)	(3)	(4)	(5)	(6)
Permit Acres	Unpaid Land Reclamation Costs	Unpaid Water Capital Cost	Total Current Unpaid Losses	Unpaid O&M Water Expenses Through 2035	Total Unpaid Losses
0 - 10	1,430,396	6,823,680	8,254,076	13,250,013	21,504,089
10 - 20	2,309,915	5,217,395	7,527,310	4,980,044	12,507,354
20 - 30	1,185,626	7,153,864	8,339,490	17,147,297	25,486,787
30 - 40	1,098,209	4,226,069	5,324,278	3,311,260	8,635,539
40 - 50	1,578,672	4,083,425	5,662,097	2,771,952	8,434,049
50 - 60	1,460,179	2,984,227	4,444,406	2,727,997	7,172,402
60 - 70	1,592,199	2,848,954	4,441,153	2,196,901	6,638,054
70 - 80	1,081,749	2,081,131	3,162,880	1,577,841	4,740,721
80 - 90	2,722,164	916,414	3,638,578	3,525,012	7,163,590
90 - 100	1,695,778	1,859,584	3,555,362	2,868,966	6,424,328
100 - 110	900,973	1,187,385	2,088,359	1,661,345	3,749,703
110 - 120	0	96,982	96,982	332,801	429,783
120 - 130	0	2,421,684	2,421,684	968,008	3,389,692
130 - 140	236,500	511,332	747,832	425,872	1,173,704
140 - 150	109,355	419,298	528,653	164,523	693,176
150 - 160	0	875,259	875,259	1,585,087	2,460,346
160 - 170	426,187	369,966	796,153	374,387	1,170,540
170 - 180	0	361,062	361,062	445,084	806,146
180 - 190	835,652	1,137,759	1,973,411	355,552	2,328,963
190 - 200	637,964	3,087,207	3,725,171	671,679	4,396,850
> 200	16,587,881	11,168,356	27,756,237	17,085,031	44,841,268
Total	35,889,399	59,831,033	95,720,432	78,426,651	174,147,083

Note: Column (4) = (2) + (3)
Column (5) calculated as anticipated annual O&M Expense multiplied by 20 years
Column (6) = (4) + (5)
Dollars in this chart are real dollars and are not inflation adjusted.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Projected Unpaid Current Liabilities to 2035 by Location

(1)	(2)	(3)	(4)	(5)	(6)
Office Location	Unpaid Land Reclamation Costs	Unpaid Water Capital Cost	Total Current Unpaid Losses	Unpaid O&M Water Expenses Through 2035	Total Unpaid Losses
North	16,298,849	33,879,838	50,178,687	63,560,647	113,739,334
South	11,602,801	17,894,191	29,496,991	9,927,939	39,424,930
Central	7,987,750	8,057,004	16,044,753	4,938,066	20,982,819
Total	35,889,399	59,831,033	95,720,432	78,426,651	174,147,083

Note: Column (4) = (2) + (3)
Column (5) calculated as anticipated annual O&M Expense multiplied by 20 years
Column (6) = (4) + (5)
Dollars in this chart are real dollars and are not inflation adjusted.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Projected Unpaid Prospective Liabilities to 2035 by Mine Type

(1)	(2)	(3)	(4)	(5)	(6)
Mine Type	Unpaid Land Reclamation Costs	Unpaid Water Capital Cost	Total Current Unpaid Losses	Unpaid O&M Water Expenses Through 2035	Total Unpaid Losses
Surface	6,046,677	2,112,906	8,159,583	443,636	8,603,219
Underground	5,345,273	1,867,813	7,213,085	392,175	7,605,261
Refuse Area	182,522	63,779	246,300	13,391	259,692
Prospect	-	-	-	-	-
Other	2,706,533	945,751	3,652,284	198,575	3,850,859
Total	14,281,004	4,990,249	19,271,253	1,047,777	20,319,031

Note: Column (4) = (2) + (3)
Column (6) = (4) + (5)
Dollars in this chart are real dollars and are not inflation adjusted.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Projected Unpaid Prospective Liabilities to 2035 by Permit Size

(1)	(2)	(3)	(4)	(5)	(6)
Permit Acres	Unpaid Land Reclamation Costs	Unpaid Water Capital Cost	Total Current Unpaid Losses	Unpaid O&M Water Expenses Through 2035	Total Unpaid Losses
0 - 10	6,719,399	2,347,977	9,067,376	492,993	9,560,369
10 - 20	1,660,946	580,389	2,241,334	121,861	2,363,196
20 - 30	946,504	330,740	1,277,244	69,444	1,346,688
30 - 40	672,722	235,071	907,793	49,357	957,150
40 - 50	425,014	148,514	573,528	31,183	604,711
50 - 60	325,931	113,891	439,822	23,913	463,735
60 - 70	297,249	103,869	401,118	21,809	422,927
70 - 80	229,456	80,179	309,635	16,835	326,470
80 - 90	211,203	73,801	285,005	15,496	300,501
90 - 100	161,662	56,490	218,152	11,861	230,013
100 - 110	140,802	49,201	190,003	10,330	200,334
110 - 120	159,054	55,579	214,633	11,670	226,303
120 - 130	143,410	50,112	193,522	10,522	204,044
130 - 140	106,905	37,356	144,262	7,844	152,105
140 - 150	99,083	34,623	133,706	7,270	140,976
150 - 160	78,224	27,334	105,557	5,739	111,296
160 - 170	78,224	27,334	105,557	5,739	111,296
170 - 180	88,653	30,978	119,632	6,504	126,136
180 - 190	73,009	25,512	98,520	5,357	103,877
190 - 200	59,971	20,956	80,927	4,400	85,327
> 200	1,603,582	560,344	2,163,926	117,653	2,281,578
Total	14,281,004	4,990,249	19,271,253	1,047,777	20,319,031

Note: Column (4) = (2) + (3)
Column (6) = (4) + (5)
Dollars in this chart are real dollars and are not inflation adjusted.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Projected Unpaid Prospective Liabilities to 2035 by Location

(1)	(2)	(3)	(4)	(5)	(6)
Office Location	Unpaid Land Reclamation Costs	Unpaid Water Capital Cost	Total Current Unpaid Losses	Unpaid O&M Water Expenses Through 2035	Total Unpaid Losses
North	3,565,035	1,245,740	4,810,775	261,562	5,072,337
South	5,051,553	1,765,177	6,816,731	370,625	7,187,356
Central	5,664,416	1,979,332	7,643,748	415,590	8,059,338
Total	14,281,004	4,990,249	19,271,253	1,047,777	20,319,031

Note: Column (4) = (2) + (3)
Column (5) calculated as anticipated annual O&M Expense multiplied by 20 years
Column (6) = (4) + (5)
Dollars in this chart are real dollars and are not inflation adjusted.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Combined Special Reclamation Fund & Water Trust Fund
Financial Projections through 2035 - Cash Basis

Fiscal Year	Bond Forfeitures	Civil Penalties	Misc	Coal Tonnage Fees	Interest Income	Total Income	Administrative Expenses	Reclamation Expenses	Total Expenses	Ending Balance
2006	902,077	1,199,276		21,659,819	1,712,329	25,473,501	4,571,459	11,982,688	16,554,147	49,492,188
2007	1,781,172	1,059,319		16,073,851	2,591,521	21,505,863	4,161,857	14,045,033	18,206,890	52,791,161
2008	206,040	855,750		9,415,063	2,222,615	12,699,469	4,770,862	6,591,630	11,362,492	54,128,138
2009	2,531,687	1,151,628		18,949,386	705,420	23,338,120	4,524,566	10,308,686	14,833,252	62,633,006
2010	223,140	688,062		18,563,773	96,841	19,571,817	4,525,561	10,290,348	14,815,909	67,388,914
2011	603,343	805,018		20,268,951	132,214	21,809,526	4,661,459	8,748,442	13,409,902	75,788,539
2012	752,610	940,571		18,840,145	82,404	20,615,730	5,297,098	11,130,132	16,427,230	79,977,039
2013	328,792	677,771	496,398	29,883,163	115,013	31,501,137	5,673,144	7,383,220	13,056,365	98,421,811
2014	2,710,492	734,975	298,349	30,159,866	2,264,398	36,168,080	6,472,171	6,201,223	12,673,395	121,916,496
2015	647,730	2,551,755	1,825	32,306,756	2,747,478	38,255,543	6,699,487	11,347,144	18,046,631	142,125,409
2016	1,831,355	1,007,382		30,518,431	3,836,088	37,193,255	8,294,748	15,832,535	24,127,283	155,191,381
2017	1,324,587	943,127		28,571,859	4,876,633	35,716,206	9,209,913	17,579,350	26,789,263	164,118,325
2018	1,112,417	924,593		28,010,370	5,891,962	35,939,342	9,826,614	18,756,473	28,583,087	171,474,580
2019	1,045,134	920,855		27,897,135	6,935,039	36,798,163	8,978,500	17,137,643	26,116,143	182,156,601
2020	981,970	892,753		27,045,779	7,357,729	36,278,231	6,894,063	13,158,989	20,053,052	198,381,780
2021	897,539	837,652		25,376,518	7,886,496	34,998,205	6,430,475	12,274,119	18,704,593	214,675,392
2022	800,187	795,865		24,110,583	8,393,606	34,100,242	5,985,142	11,424,094	17,409,236	231,366,397
2023	708,819	749,470		22,705,059	8,883,489	33,046,837	5,467,718	10,436,465	15,904,184	248,509,051
2024	610,663	714,551		21,647,185	9,358,419	32,330,818	4,992,091	9,528,616	14,520,707	266,319,163
2025	535,240	688,812		20,867,427	9,861,096	31,952,574	4,663,781	8,901,957	13,565,738	284,705,998
2026	455,042	649,324		19,671,149	10,401,700	31,177,215	4,332,021	8,268,712	12,600,733	303,282,480
2027	393,671	615,544		18,647,794	10,970,841	30,627,850	4,034,882	7,701,549	11,736,431	322,173,899
2028	335,607	578,596		17,528,444	11,574,392	30,017,039	3,736,632	7,132,266	10,868,898	341,322,041
2029	286,238	551,279		16,700,900	12,211,961	29,750,378	3,437,382	6,561,076	9,998,458	361,073,960
2030	243,610	526,439		15,948,376	12,895,597	29,614,023	3,313,987	6,325,547	9,639,534	381,048,448
2031	200,173	499,757		15,140,042	13,602,722	29,442,693	3,303,301	6,305,150	9,608,451	400,882,691
2032	165,447	474,975		14,389,260	14,314,969	29,344,651	3,302,628	6,303,865	9,606,493	420,620,849
2033	140,548	443,823		13,445,525	15,033,459	29,063,356	3,313,229	6,324,099	9,637,328	440,046,877
2034	112,329	403,803		12,233,146	15,751,254	28,500,533	3,329,261	6,354,701	9,683,962	458,863,447
2035	90,340	372,729		11,291,737	16,459,044	28,213,850	3,350,570	6,395,374	9,745,944	477,331,353
Remaining Liability							40,819,568	77,914,034	118,733,601	

Note: Projections do not include expenses or revenues arising from permits issued after 2015.
Remaining Liability includes remaining land reclamation costs, water capital costs, and 10 years of O&M costs, adjusted to 2035 dollars
Other dollar values shown are inflation-adjusted (nominal) dollars.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Special Reclamation Fund
Financial Projections through 2035 - Cash Basis

Fiscal Year	Bond Forfeitures	Civil Penalties	Misc	Coal Tonnage Fees	Interest Income	Total Income	Administrative Expenses	Reclamation Expenses	Total Expenses	Ending Balance
2006	902,077	1,199,276		21,659,819	1,712,329	25,473,501	4,571,459	11,982,688	16,554,147	49,492,188
2007	1,781,172	1,059,319		16,073,851	2,591,521	21,505,863	4,161,857	14,045,033	18,206,890	52,791,161
2008	206,040	855,750		9,415,063	2,222,615	12,699,469	4,770,862	6,591,630	11,362,492	54,128,138
2009	2,531,687	1,151,628		17,098,738	700,561	21,482,614	4,524,566	10,308,686	14,833,252	60,777,500
2010	223,140	688,062		16,639,204	92,735	17,643,142	4,525,561	10,290,348	14,815,909	63,604,733
2011	603,343	805,018		18,168,515	123,398	19,700,275	4,661,459	8,748,442	13,409,902	69,895,106
2012	752,610	940,571		16,876,736	75,109	18,645,026	5,297,098	11,130,132	16,427,230	72,112,901
2013	328,792	677,771	496,398	15,277,933	96,825	16,877,720	5,673,144	7,383,220	13,056,365	75,934,256
2014	2,710,492	734,975	298,349	13,949,645	498,001	18,191,462	6,472,171	6,201,223	12,673,395	81,452,324
2015	647,730	2,551,755	1,825	14,936,957	585,399	18,723,665	6,699,487	11,347,144	18,046,631	82,129,358
2016	1,831,355	1,007,382		14,110,673	536,305	17,485,714	8,294,748	15,832,535	24,127,283	75,487,789
2017	1,324,587	943,127		13,210,644	492,935	15,971,294	9,209,913	17,579,350	26,789,263	64,669,820
2018	1,112,417	924,593		12,951,031	422,294	15,410,336	9,826,614	18,756,473	28,583,087	51,497,069
2019	1,045,134	920,855		12,898,675	336,276	15,200,940	4,056,896	7,743,568	11,800,464	54,897,546
2020	981,970	892,753		12,505,038	358,481	14,738,242	2,487,787	4,748,543	7,236,330	62,399,458
2021	897,539	837,652		11,733,229	407,468	13,875,888	2,011,011	3,838,502	5,849,513	70,425,833
2022	800,187	795,865		11,147,904	459,881	13,203,837	1,502,743	2,868,349	4,371,092	79,258,579
2023	708,819	749,470		10,498,038	517,559	12,473,886	969,552	1,850,624	2,820,176	88,912,289
2024	610,663	714,551		10,008,913	580,597	11,914,725	713,733	1,362,333	2,076,066	98,750,948
2025	535,240	688,812		9,648,380	644,844	11,517,275	621,125	1,185,568	1,806,693	108,461,530
2026	455,042	649,324		9,095,263	708,254	10,907,882	540,048	1,030,812	1,570,860	117,798,552
2027	393,671	615,544		8,622,098	769,225	10,400,538	486,838	929,248	1,416,085	126,783,005
2028	335,607	578,596		8,104,549	827,893	9,846,645	437,546	835,162	1,272,708	135,356,942
2029	286,238	551,279		7,721,921	883,881	9,443,319	390,092	744,585	1,134,677	143,665,584
2030	243,610	526,439		7,373,980	938,136	9,082,166	345,709	659,869	1,005,578	151,742,172
2031	200,173	499,757		7,000,234	990,876	8,691,041	302,288	576,989	879,277	159,553,936
2032	165,447	474,975		6,653,099	1,041,887	8,335,408	261,791	499,692	761,484	167,127,860
2033	140,548	443,823		6,216,748	1,091,345	7,892,464	226,340	432,025	658,365	174,361,959
2034	112,329	403,803		5,656,186	1,138,584	7,310,902	193,197	368,762	561,959	181,110,902
2035	90,340	372,729		5,220,911	1,182,654	6,866,633	164,023	313,077	477,100	187,500,436
Remaining Liability							2,822,227	5,386,903	8,209,130	

Note: Projections do not include expenses or revenues arising from permits issued after 2015.
Reclamation Expenses starting in 2019 are shared with the Water Trust Fund.
Remaining Liability includes remaining land reclamation costs, water capital costs, and 10 years of O&M costs, adjusted to 2035 dollars
Other dollar values shown are inflation-adjusted (nominal) dollars.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Water Trust Fund
Financial Projections through 2035 - Cash Basis

Fiscal Year	Coal Tonnage Fees	Interest Income	Total Income	Administrative Expenses	Reclamation Expenses	Total Expenses	Ending Balance
2006	-	-	-			-	-
2007	-	-	-			-	-
2008	-	-	-			-	-
2009	1,850,648	4,859	1,855,506			-	1,855,506
2010	1,924,569	4,106	1,928,675			-	3,784,181
2011	2,100,436	8,816	2,109,252			-	5,893,433
2012	1,963,409	7,295	1,970,704			-	7,864,137
2013	14,605,229	18,188	14,623,417			-	22,487,555
2014	16,210,221	1,766,397	17,976,618			-	40,464,173
2015	17,369,799	2,162,079	19,531,878			-	59,996,051
2016	16,407,759	3,299,783	19,707,542	-	-	-	79,703,592
2017	15,361,214	4,383,698	19,744,912	-	-	-	99,448,504
2018	15,059,339	5,469,668	20,529,007	-	-	-	119,977,511
2019	14,998,460	6,598,763	21,597,223	4,921,605	9,394,075	14,315,679	127,259,055
2020	14,540,742	6,999,248	21,539,990	4,406,276	8,410,446	12,816,722	135,982,322
2021	13,643,289	7,479,028	21,122,317	4,419,464	8,435,617	12,855,081	144,249,558
2022	12,962,679	7,933,726	20,896,405	4,482,399	8,555,745	13,038,144	152,107,819
2023	12,207,021	8,365,930	20,572,951	4,498,167	8,585,841	13,084,008	159,596,762
2024	11,638,271	8,777,822	20,416,093	4,278,358	8,166,283	12,444,641	167,568,215
2025	11,219,047	9,216,252	20,435,298	4,042,656	7,716,389	11,759,045	176,244,468
2026	10,575,887	9,693,446	20,269,332	3,791,973	7,237,899	11,029,872	185,483,928
2027	10,025,696	10,201,616	20,227,312	3,548,044	6,772,302	10,320,346	195,390,894
2028	9,423,895	10,746,499	20,170,394	3,299,086	6,297,104	9,596,190	205,965,098
2029	8,978,978	11,328,080	20,307,059	3,047,290	5,816,491	8,863,781	217,408,376
2030	8,574,396	11,957,461	20,531,857	2,968,278	5,665,678	8,633,956	229,306,276
2031	8,139,807	12,611,845	20,751,653	3,001,013	5,728,161	8,729,174	241,328,755
2032	7,736,162	13,273,082	21,009,243	3,040,836	5,804,173	8,845,009	253,492,988
2033	7,228,777	13,942,114	21,170,891	3,086,888	5,892,074	8,978,962	265,684,917
2034	6,576,960	14,612,670	21,189,631	3,136,064	5,985,939	9,122,003	277,752,545
2035	6,070,826	15,276,390	21,347,216	3,186,547	6,082,298	9,268,845	289,830,917
Remaining Liability				37,997,341	72,527,130	110,524,471	

Note: Projections do not include expenses or revenues arising from permits issued after 2015.
Reclamation Expenses starting in 2019 are shared with the Special Reclamation Fund
Remaining Liability includes remaining land reclamation costs, water capital costs, and 10 years of O&M costs adjusted to 2035 dollars
Other dollar values shown are inflation-adjusted (nominal) dollars.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Combined Special Reclamation Fund & Water Trust Fund
Reclamation Expense Detail - Cash Basis

Fiscal	Payout of Current Liabilities				Payout of Prospective Liabilities				Total Reclamation Expenses			
Year	Land	Water	O&M	Total	Land	Water	O&M	Total	Land	Water	O&M	Total
2006												11,982,688
2007												14,045,033
2008												6,591,630
2009												10,308,686
2010												10,290,348
2011												8,748,442
2012												11,130,132
2013												7,383,220
2014												6,201,223
2015												11,347,144
2016	6,928,791	6,373,272	1,999,880	15,301,943	399,004	121,658	9,929	530,592	7,327,796	6,494,931	2,009,809	15,832,535
2017	7,755,349	6,743,284	2,205,273	16,703,906	653,174	204,526	17,744	875,444	8,408,524	6,947,809	2,223,017	17,579,350
2018	8,226,491	6,955,909	2,447,853	17,630,253	842,022	259,856	24,342	1,126,220	9,068,513	7,215,765	2,472,195	18,756,473
2019	6,746,266	6,309,196	2,738,436	15,793,899	997,302	315,120	31,322	1,343,744	7,743,568	6,624,316	2,769,759	17,137,643
2020	3,616,793	4,927,872	3,092,477	11,637,142	1,131,750	352,192	37,904	1,521,847	4,748,543	5,280,064	3,130,382	13,158,989
2021	2,626,396	4,478,879	3,532,846	10,638,122	1,212,105	379,486	44,406	1,635,997	3,838,502	4,858,365	3,577,252	12,274,119
2022	1,609,902	4,009,956	4,094,890	9,714,748	1,258,447	399,955	50,944	1,709,346	2,868,349	4,409,912	4,145,833	11,424,094
2023	589,369	3,520,485	4,594,466	8,704,321	1,261,255	413,455	57,435	1,732,145	1,850,624	3,933,940	4,651,901	10,436,465
2024	135,863	3,009,831	4,686,355	7,832,049	1,226,470	406,780	63,317	1,696,566	1,362,333	3,416,611	4,749,672	9,528,616
2025	38,431	2,477,342	4,780,083	7,295,855	1,147,138	389,978	68,986	1,606,102	1,185,568	2,867,320	4,849,069	8,901,957
2026	-	1,927,565	4,875,684	6,803,249	1,030,812	360,308	74,343	1,465,463	1,030,812	2,287,873	4,950,027	8,268,712
2027	-	1,376,446	4,973,198	6,349,644	929,248	342,798	79,860	1,351,905	929,248	1,719,244	5,053,058	7,701,549
2028	-	824,246	5,072,662	5,896,907	835,162	315,586	84,611	1,235,359	835,162	1,139,832	5,157,273	7,132,266
2029	-	263,708	5,174,115	5,437,823	744,585	289,436	89,233	1,123,254	744,585	553,143	5,263,348	6,561,076
2030	-	30,918	5,277,597	5,308,516	659,869	263,609	93,553	1,017,032	659,869	294,527	5,371,151	6,325,547
2031	-	9,807	5,383,149	5,392,957	576,989	237,565	97,639	912,193	576,989	247,373	5,480,788	6,305,150
2032	-	1,106	5,490,812	5,491,918	499,692	210,834	101,421	811,947	499,692	211,940	5,592,233	6,303,865
2033	-	238	5,600,629	5,600,867	432,025	186,117	105,090	723,233	432,025	186,355	5,705,719	6,324,099
2034	-	-	5,712,641	5,712,641	368,762	164,639	108,659	642,060	368,762	164,639	5,821,300	6,354,701
2035	-	-	5,826,894	5,826,894	313,077	143,394	112,009	568,481	313,077	143,394	5,938,903	6,395,374
Remaining Liability	(0)	17,426,225	58,268,939	75,695,164	744,564	354,214	1,120,091	2,218,870	744,564	17,780,439	59,389,031	77,914,034

Note: Remaining Liability includes remaining land reclamation costs, water capital costs, and 10 years of O&M costs, adjusted to 2035 dollars
Other dollar values shown are inflation-adjusted (nominal) dollars.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Combined Special Reclamation Fund & Water Trust Fund
Financial Projections through 2035 - Cash Basis
Revenue Reduced 10% & Civil Penalties Removed

Fiscal Year	Bond Forfeitures	Civil Penalties	Misc	Coal Tonnage Fees	Interest Income	Total Income	Administrative Expenses	Reclamation Expenses	Total Expenses	Ending Balance
2006	902,077	1,199,276		21,659,819	1,712,329	25,473,501	4,571,459	11,982,688	16,554,147	49,492,188
2007	1,781,172	1,059,319		16,073,851	2,591,521	21,505,863	4,161,857	14,045,033	18,206,890	52,791,161
2008	206,040	855,750		9,415,063	2,222,615	12,699,469	4,770,862	6,591,630	11,362,492	54,128,138
2009	2,531,687	1,151,628		18,949,386	705,420	23,338,120	4,524,566	10,308,686	14,833,252	62,633,006
2010	223,140	688,062		18,563,773	96,841	19,571,817	4,525,561	10,290,348	14,815,909	67,388,914
2011	603,343	805,018		20,268,951	132,214	21,809,526	4,661,459	8,748,442	13,409,902	75,788,539
2012	752,610	940,571		18,840,145	82,404	20,615,730	5,297,098	11,130,132	16,427,230	79,977,039
2013	328,792	677,771	496,398	29,883,163	115,013	31,501,137	5,673,144	7,383,220	13,056,365	98,421,811
2014	2,710,492	734,975	298,349	30,159,866	2,264,398	36,168,080	6,472,171	6,201,223	12,673,395	121,916,496
2015	647,730	2,551,755	1,825	32,306,756	2,747,478	38,255,543	6,699,487	11,347,144	18,046,631	142,125,409
2016	1,831,355	-		27,466,588	3,836,088	33,134,031	8,294,748	15,832,535	24,127,283	151,132,157
2017	1,324,587	-		25,714,673	4,770,598	31,809,858	9,209,913	17,579,350	26,789,263	156,152,752
2018	1,112,417	-		25,209,333	5,681,588	32,003,339	9,826,614	18,756,473	28,583,087	159,573,003
2019	1,045,134	-		25,107,422	6,617,261	32,769,816	8,978,500	17,137,643	26,116,143	166,226,677
2020	981,970	-		24,341,201	6,927,745	32,250,916	6,894,063	13,158,989	20,053,052	178,424,542
2021	897,539	-		22,838,866	7,341,807	31,078,212	6,430,475	12,274,119	18,704,593	190,798,160
2022	800,187	-		21,699,525	7,734,400	30,234,112	5,985,142	11,424,094	17,409,236	203,623,036
2023	708,819	-		20,434,553	8,108,526	29,251,898	5,467,718	10,436,465	15,904,184	216,970,750
2024	610,663	-		19,482,466	8,466,849	28,559,979	4,992,091	9,528,616	14,520,707	231,010,022
2025	535,240	-		18,780,684	8,850,782	28,166,706	4,663,781	8,901,957	13,565,738	245,610,990
2026	455,042	-		17,704,034	9,269,400	27,428,476	4,332,021	8,268,712	12,600,733	260,438,733
2027	393,671	-		16,783,015	9,714,564	26,891,250	4,034,882	7,701,549	11,736,431	275,593,552
2028	335,607	-		15,775,600	10,191,414	26,302,621	3,736,632	7,132,266	10,868,898	291,027,274
2029	286,238	-		15,030,810	10,699,715	26,016,763	3,437,382	6,561,076	9,998,458	307,045,579
2030	243,610	-		14,353,539	11,250,339	25,847,488	3,313,987	6,325,547	9,639,534	323,253,533
2031	200,173	-		13,626,038	11,820,224	25,646,434	3,303,301	6,305,150	9,608,451	339,291,516
2032	165,447	-		12,950,334	12,390,947	25,506,729	3,302,628	6,303,865	9,606,493	355,191,751
2033	140,548	-		12,100,973	12,963,178	25,204,699	3,313,229	6,324,099	9,637,328	370,759,123
2034	112,329	-		11,009,832	13,530,371	24,652,532	3,329,261	6,354,701	9,683,962	385,727,693
2035	90,340	-		10,162,563	14,083,892	24,336,795	3,350,570	6,395,374	9,745,944	400,318,543
Remaining Liability							40,819,568	77,914,034	118,733,601	

Note: Reclamation Expense projections do not include expenses arising from permits issued after 2015.
Remaining Liability includes remaining land reclamation costs, water capital costs, and 10 years of O&M costs, adjusted to 2035 dollars
Other dollar values shown are inflation-adjusted (nominal) dollars.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Combined Special Reclamation Fund & Water Trust Fund
Financial Projections through 2035 - Cash Basis
Revenue Reduced 25% & Civil Penalties Removed

Fiscal Year	Bond Forfeitures	Civil Penalties	Misc	Coal Tonnage Fees	Interest Income	Total Income	Administrative Expenses	Reclamation Expenses	Total Expenses	Ending Balance
2006	902,077	1,199,276		21,659,819	1,712,329	25,473,501	4,571,459	11,982,688	16,554,147	49,492,188
2007	1,781,172	1,059,319		16,073,851	2,591,521	21,505,863	4,161,857	14,045,033	18,206,890	52,791,161
2008	206,040	855,750		9,415,063	2,222,615	12,699,469	4,770,862	6,591,630	11,362,492	54,128,138
2009	2,531,687	1,151,628		18,949,386	705,420	23,338,120	4,524,566	10,308,686	14,833,252	62,633,006
2010	223,140	688,062		18,563,773	96,841	19,571,817	4,525,561	10,290,348	14,815,909	67,388,914
2011	603,343	805,018		20,268,951	132,214	21,809,526	4,661,459	8,748,442	13,409,902	75,788,539
2012	752,610	940,571		18,840,145	82,404	20,615,730	5,297,098	11,130,132	16,427,230	79,977,039
2013	328,792	677,771	496,398	29,883,163	115,013	31,501,137	5,673,144	7,383,220	13,056,365	98,421,811
2014	2,710,492	734,975	298,349	30,159,866	2,264,398	36,168,080	6,472,171	6,201,223	12,673,395	121,916,496
2015	647,730	2,551,755	1,825	32,306,756	2,747,478	38,255,543	6,699,487	11,347,144	18,046,631	142,125,409
2016	1,831,355	-		22,888,823	3,836,088	28,556,266	8,294,748	15,832,535	24,127,283	146,554,392
2017	1,324,587	-		21,428,894	4,621,412	27,374,894	9,209,913	17,579,350	26,789,263	147,140,023
2018	1,112,417	-		21,007,778	5,385,198	27,505,393	9,826,614	18,756,473	28,583,087	146,062,328
2019	1,045,134	-		20,922,851	6,168,945	28,136,930	8,978,500	17,137,643	26,116,143	148,083,116
2020	981,970	-		20,284,335	6,320,325	27,586,630	6,894,063	13,158,989	20,053,052	155,616,694
2021	897,539	-		19,032,388	6,571,319	26,501,246	6,430,475	12,274,119	18,704,593	163,413,347
2022	800,187	-		18,082,937	6,800,646	25,683,771	5,985,142	11,424,094	17,409,236	171,687,881
2023	708,819	-		17,028,794	7,009,292	24,746,905	5,467,718	10,436,465	15,904,184	180,530,603
2024	610,663	-		16,235,389	7,200,458	24,046,510	4,992,091	9,528,616	14,520,707	190,056,406
2025	535,240	-		15,650,570	7,413,737	23,599,547	4,663,781	8,901,957	13,565,738	200,090,215
2026	455,042	-		14,753,362	7,656,634	22,865,038	4,332,021	8,268,712	12,600,733	210,354,520
2027	393,671	-		13,985,846	7,922,755	22,302,272	4,034,882	7,701,549	11,736,431	220,920,360
2028	335,607	-		13,146,333	8,216,184	21,698,125	3,736,632	7,132,266	10,868,898	231,749,587
2029	286,238	-		12,525,675	8,536,901	21,348,813	3,437,382	6,561,076	9,998,458	243,099,942
2030	243,610	-		11,961,282	8,894,096	21,098,988	3,313,987	6,325,547	9,639,534	254,559,395
2031	200,173	-		11,355,031	9,264,005	20,819,209	3,303,301	6,305,150	9,608,451	265,770,154
2032	165,447	-		10,791,945	9,628,106	20,585,498	3,302,628	6,303,865	9,606,493	276,749,159
2033	140,548	-		10,084,144	9,986,404	20,211,097	3,313,229	6,324,099	9,637,328	287,322,928
2034	112,329	-		9,174,860	10,332,883	19,620,072	3,329,261	6,354,701	9,683,962	297,259,037
2035	90,340	-		8,468,803	10,659,827	19,218,970	3,350,570	6,395,374	9,745,944	306,732,063
Remaining Liability							40,819,568	77,914,034	118,733,601	

Note: Reclamation Expense projections do not include expenses arising from permits issued after 2015.
Remaining Liability includes remaining land reclamation costs, water capital costs, and 10 years of O&M costs, adjusted to 2035 dollars
Other dollar values shown are inflation-adjusted (nominal) dollars.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Combined Special Reclamation Fund & Water Trust Fund
Financial Projections through 2035 - Cash Basis
Approximate 75th Percentile of Losses

Fiscal Year	Bond Forfeitures	Civil Penalties	Misc	Coal Tonnage Fees	Interest Income	Total Income	Administrative Expenses	Reclamation Expenses	Total Expenses	Ending Balance
2006	902,077	1,199,276		21,659,819	1,712,329	25,473,501	4,571,459	11,982,688	16,554,147	49,492,188
2007	1,781,172	1,059,319		16,073,851	2,591,521	21,505,863	4,161,857	14,045,033	18,206,890	52,791,161
2008	206,040	855,750		9,415,063	2,222,615	12,699,469	4,770,862	6,591,630	11,362,492	54,128,138
2009	2,531,687	1,151,628		18,949,386	705,420	23,338,120	4,524,566	10,308,686	14,833,252	62,633,006
2010	223,140	688,062		18,563,773	96,841	19,571,817	4,525,561	10,290,348	14,815,909	67,388,914
2011	603,343	805,018		20,268,951	132,214	21,809,526	4,661,459	8,748,442	13,409,902	75,788,539
2012	752,610	940,571		18,840,145	82,404	20,615,730	5,297,098	11,130,132	16,427,230	79,977,039
2013	328,792	677,771	496,398	29,883,163	115,013	31,501,137	5,673,144	7,383,220	13,056,365	98,421,811
2014	2,710,492	734,975	298,349	30,159,866	2,264,398	36,168,080	6,472,171	6,201,223	12,673,395	121,916,496
2015	647,730	2,551,755	1,825	32,306,756	2,747,478	38,255,543	6,699,487	11,347,144	18,046,631	142,125,409
2016	1,831,355	1,007,382		30,518,431	3,836,088	37,193,255	8,601,079	16,417,243	25,018,322	154,300,343
2017	1,324,587	943,127		28,571,859	4,870,814	35,710,388	9,562,422	18,252,198	27,814,620	162,196,111
2018	1,112,417	924,593		28,010,370	5,879,410	35,926,790	10,210,915	19,490,006	29,700,921	168,421,980
2019	1,045,134	920,855		27,897,135	6,915,105	36,778,230	9,343,962	17,835,216	27,179,178	178,021,031
2020	981,970	892,753		27,045,779	7,305,158	36,225,660	7,198,271	13,739,645	20,937,916	193,308,775
2021	897,539	837,652		25,376,518	7,804,473	34,916,182	6,722,618	12,831,746	19,554,364	208,670,593
2022	800,187	795,865		24,110,583	8,281,452	33,988,087	6,262,876	11,954,216	18,217,091	224,441,589
2023	708,819	749,470		22,705,059	8,740,398	32,903,747	5,726,014	10,929,486	16,655,500	240,689,836
2024	610,663	714,551		21,647,185	9,183,816	32,156,215	5,230,564	9,983,799	15,214,363	257,631,688
2025	535,240	688,812		20,867,427	9,655,169	31,746,648	4,883,366	9,321,087	14,204,453	275,173,883
2026	455,042	649,324		19,671,149	10,164,715	30,940,230	4,529,906	8,646,422	13,176,328	292,937,785
2027	393,671	615,544		18,647,794	10,703,208	30,360,217	4,213,076	8,041,677	12,254,753	311,043,249
2028	335,607	578,596		17,528,444	11,276,468	29,719,115	3,895,558	7,435,616	11,331,174	329,431,191
2029	286,238	551,279		16,700,900	11,884,137	29,422,553	3,577,180	6,827,915	10,405,095	348,448,649
2030	243,610	526,439		15,948,376	12,538,296	29,256,722	3,442,523	6,570,890	10,013,413	367,691,957
2031	200,173	499,757		15,140,042	13,215,196	29,055,167	3,425,492	6,538,382	9,963,874	386,783,250
2032	165,447	474,975		14,389,260	13,895,658	28,925,340	3,419,217	6,526,404	9,945,621	405,762,969
2033	140,548	443,823		13,445,525	14,580,658	28,610,555	3,425,250	6,537,919	9,963,169	424,410,356
2034	112,329	403,803		12,233,146	15,263,107	28,012,386	3,437,170	6,560,672	9,997,843	442,424,899
2035	90,340	372,729		11,291,737	15,933,567	27,688,372	3,455,025	6,594,752	10,049,777	460,063,494
Remaining Liability							47,856,679	91,346,065	139,202,744	

Note: Reclamation Expense projections do not include expenses arising from permits issued after 2015.
Remaining Liability includes remaining land reclamation costs, water capital costs, and 10 years of O&M costs, adjusted to 2035 dollars
Other dollar values shown are inflation-adjusted (nominal) dollars.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Combined Special Reclamation Fund & Water Trust Fund
Financial Projections through 2035 - Cash Basis
Approximate 90th Percentile of Losses

Fiscal Year	Bond Forfeitures	Civil Penalties	Misc	Coal Tonnage Fees	Interest Income	Total Income	Administrative Expenses	Reclamation Expenses	Total Expenses	Ending Balance
2006	902,077	1,199,276		21,659,819	1,712,329	25,473,501	4,571,459	11,982,688	16,554,147	49,492,188
2007	1,781,172	1,059,319		16,073,851	2,591,521	21,505,863	4,161,857	14,045,033	18,206,890	52,791,161
2008	206,040	855,750		9,415,063	2,222,615	12,699,469	4,770,862	6,591,630	11,362,492	54,128,138
2009	2,531,687	1,151,628		18,949,386	705,420	23,338,120	4,524,566	10,308,686	14,833,252	62,633,006
2010	223,140	688,062		18,563,773	96,841	19,571,817	4,525,561	10,290,348	14,815,909	67,388,914
2011	603,343	805,018		20,268,951	132,214	21,809,526	4,661,459	8,748,442	13,409,902	75,788,539
2012	752,610	940,571		18,840,145	82,404	20,615,730	5,297,098	11,130,132	16,427,230	79,977,039
2013	328,792	677,771	496,398	29,883,163	115,013	31,501,137	5,673,144	7,383,220	13,056,365	98,421,811
2014	2,710,492	734,975	298,349	30,159,866	2,264,398	36,168,080	6,472,171	6,201,223	12,673,395	121,916,496
2015	647,730	2,551,755	1,825	32,306,756	2,747,478	38,255,543	6,699,487	11,347,144	18,046,631	142,125,409
2016	1,831,355	1,007,382		30,518,431	3,836,088	37,193,255	8,978,145	17,136,965	26,115,110	153,203,554
2017	1,324,587	943,127		28,571,859	4,863,652	35,703,226	10,044,278	19,171,939	29,216,217	159,690,562
2018	1,112,417	924,593		28,010,370	5,863,048	35,910,429	10,766,108	20,549,726	31,315,834	164,285,157
2019	1,045,134	920,855		27,897,135	6,888,092	36,751,216	9,923,192	18,940,815	28,864,007	172,172,366
2020	981,970	892,753		27,045,779	7,222,346	36,142,848	7,752,925	14,798,336	22,551,261	185,763,954
2021	897,539	837,652		25,376,518	7,664,109	34,775,817	7,288,660	13,912,174	21,200,834	199,338,937
2022	800,187	795,865		24,110,583	8,078,780	33,785,415	6,832,338	13,041,172	19,873,510	213,250,842
2023	708,819	749,470		22,705,059	8,470,812	32,634,161	6,287,071	12,000,399	18,287,470	227,597,533
2024	610,663	714,551		21,647,185	8,843,293	31,815,692	5,769,607	11,012,693	16,782,299	242,630,926
2025	535,240	688,812		20,867,427	9,241,831	31,333,310	5,392,721	10,293,315	15,686,036	258,278,200
2026	455,042	649,324		19,671,149	9,677,426	30,452,941	4,997,915	9,539,731	14,537,645	274,193,495
2027	393,671	615,544		18,647,794	10,141,848	29,798,857	4,648,260	8,872,330	13,520,590	290,471,763
2028	335,607	578,596		17,528,444	10,639,960	29,082,607	4,294,572	8,197,232	12,491,804	307,062,565
2029	286,238	551,279		16,700,900	11,172,043	28,710,459	3,940,903	7,522,169	11,463,072	324,309,953
2030	243,610	526,439		15,948,376	11,750,085	28,468,511	3,778,645	7,212,459	10,991,105	341,787,359
2031	200,173	499,757		15,140,042	12,349,205	28,189,177	3,738,452	7,135,741	10,874,193	359,102,343
2032	165,447	474,975		14,389,260	12,949,454	27,979,136	3,709,820	7,081,090	10,790,909	376,290,570
2033	140,548	443,823		13,445,525	13,551,667	27,581,563	3,696,175	7,055,046	10,751,221	393,120,912
2034	112,329	403,803		12,233,146	14,148,403	26,897,681	3,690,614	7,044,431	10,735,044	409,283,549
2035	90,340	372,729		11,291,737	14,729,808	26,484,614	3,692,330	7,047,706	10,740,036	425,028,127
Remaining Liability							117,532,994	224,340,192	341,873,186	

Note: Reclamation Expense projections do not include expenses arising from permits issued after 2015.
Remaining Liability includes remaining land reclamation costs, water capital costs, and 10 years of O&M costs, adjusted to 2035 dollars
Other dollar values shown are inflation-adjusted (nominal) dollars.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Combined Special Reclamation Fund & Water Trust Fund
Financial Projections through 2035 - Cash Basis
Approximate 95th Percentile of Losses

Fiscal Year	Bond Forfeitures	Civil Penalties	Misc	Coal Tonnage Fees	Interest Income	Total Income	Administrative Expenses	Reclamation Expenses	Total Expenses	Ending Balance
2006	902,077	1,199,276		21,659,819	1,712,329	25,473,501	4,571,459	11,982,688	16,554,147	49,492,188
2007	1,781,172	1,059,319		16,073,851	2,591,521	21,505,863	4,161,857	14,045,033	18,206,890	52,791,161
2008	206,040	855,750		9,415,063	2,222,615	12,699,469	4,770,862	6,591,630	11,362,492	54,128,138
2009	2,531,687	1,151,628		18,949,386	705,420	23,338,120	4,524,566	10,308,686	14,833,252	62,633,006
2010	223,140	688,062		18,563,773	96,841	19,571,817	4,525,561	10,290,348	14,815,909	67,388,914
2011	603,343	805,018		20,268,951	132,214	21,809,526	4,661,459	8,748,442	13,409,902	75,788,539
2012	752,610	940,571		18,840,145	82,404	20,615,730	5,297,098	11,130,132	16,427,230	79,977,039
2013	328,792	677,771	496,398	29,883,163	115,013	31,501,137	5,673,144	7,383,220	13,056,365	98,421,811
2014	2,710,492	734,975	298,349	30,159,866	2,264,398	36,168,080	6,472,171	6,201,223	12,673,395	121,916,496
2015	647,730	2,551,755	1,825	32,306,756	2,747,478	38,255,543	6,699,487	11,347,144	18,046,631	142,125,409
2016	1,831,355	1,007,382		30,518,431	3,836,088	37,193,255	9,269,157	17,692,432	26,961,589	152,357,075
2017	1,324,587	943,127		28,571,859	4,858,125	35,697,698	10,433,152	19,914,197	30,347,349	157,707,424
2018	1,112,417	924,593		28,010,370	5,850,098	35,897,479	11,223,078	21,421,963	32,645,041	160,959,863
2019	1,045,134	920,855		27,897,135	6,866,378	36,729,502	10,414,293	19,878,201	30,292,494	167,396,871
2020	981,970	892,753		27,045,779	7,150,331	36,070,833	8,240,401	15,728,802	23,969,203	179,498,501
2021	897,539	837,652		25,376,518	7,538,393	34,650,102	7,792,648	14,874,157	22,666,805	191,481,798
2022	800,187	795,865		24,110,583	7,894,254	33,600,889	7,344,721	14,019,180	21,363,901	203,718,786
2023	708,819	749,470		22,705,059	8,222,682	32,386,031	6,797,198	12,974,099	19,771,297	216,333,520
2024	610,663	714,551		21,647,185	8,527,340	31,499,739	6,263,079	11,954,603	18,217,681	229,615,577
2025	535,240	688,812		20,867,427	8,855,895	30,947,374	5,860,702	11,186,570	17,047,273	243,515,678
2026	455,042	649,324		19,671,149	9,220,217	29,995,732	5,428,427	10,361,468	15,789,895	257,721,515
2027	393,671	615,544		18,647,794	9,613,259	29,270,269	5,050,393	9,639,899	14,690,292	272,301,492
2028	335,607	578,596		17,528,444	10,038,752	28,481,399	4,663,787	8,901,967	13,565,754	287,217,136
2029	286,238	551,279		16,700,900	10,497,768	28,036,184	4,278,115	8,165,819	12,443,934	302,809,387
2030	243,610	526,439		15,948,376	11,002,183	27,720,609	4,089,236	7,805,298	11,894,534	318,635,462
2031	200,173	499,757		15,140,042	11,526,328	27,366,300	4,025,383	7,683,419	11,708,802	334,292,960
2032	165,447	474,975		14,389,260	12,049,733	27,079,416	3,973,561	7,584,504	11,558,065	349,814,311
2033	140,548	443,823		13,445,525	12,573,155	26,603,052	3,939,246	7,519,005	11,458,251	364,959,111
2034	112,329	403,803		12,233,146	13,088,824	25,838,103	3,915,374	7,473,440	11,388,815	379,408,399
2035	90,340	372,729		11,291,737	13,586,461	25,341,267	3,899,898	7,443,900	11,343,797	393,405,869
Remaining Liability							196,081,933	374,269,871.98	570,351,805	

Note: Reclamation Expense projections do not include expenses arising from permits issued after 2015.
Remaining Liability includes remaining land reclamation costs, water capital costs, and 10 years of O&M costs, adjusted to 2035 dollars
Other dollar values shown are inflation-adjusted (nominal) dollars.

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Combined Special Reclamation Fund & Water Trust Fund
Comparison of Ending Fund Balance to Ending Liability at Year-End 2035

Ending Fund Balance Year-End 2035

	Loss Scenario			
Revenue Scenario	Central	75th Percentile	90th Percentile	95th Percentile
Central	477,331,353	460,063,494	425,028,127	393,405,869
10% Adverse	400,318,543	383,050,684	348,015,318	316,393,060
25% Adverse	306,732,063	289,464,204	254,428,838	222,806,579

Remaining Liability Year-End 2035

	Loss Scenario			
Revenue Scenario	Central	75th Percentile	90th Percentile	95th Percentile
Central	118,733,601	139,202,744	341,873,186	570,351,805
10% Adverse	118,733,601	139,202,744	341,873,186	570,351,805
25% Adverse	118,733,601	139,202,744	341,873,186	570,351,805

Excess of Fund Balance over Remaining Liability Year-End 2035

	Loss Scenario			
Revenue Scenario	Central	75th Percentile	90th Percentile	95th Percentile
Central	358,597,751	320,860,749	83,154,942	(176,945,936)
10% Adverse	281,584,942	243,847,940	6,142,132	(253,958,746)
25% Adverse	187,998,462	150,261,460	(87,444,348)	(347,545,226)

Note: Dollar values shown are in 2035 dollars

West Virginia Office of Special Reclamation
Actuarial Reserve Study as of June 30, 2015
Combined Special Reclamation Fund & Water Trust Fund
Projected Mean Permit Revocations by Location and Type

	Northern		Southern			
Year	Underground	Surface	Underground	Surface	Other	Total
2016	2.0	4.4	0.9	1.2	1.4	10.0
2017	1.4	3.2	0.7	0.9	1.0	7.2
2018	1.2	2.7	0.6	0.8	0.9	6.1
2019	1.1	2.5	0.5	0.7	0.8	5.7
2020	1.0	2.4	0.5	0.7	0.8	5.4
2021	1.0	2.2	0.5	0.6	0.7	4.9
2022	0.9	1.9	0.4	0.5	0.6	4.4
2023	0.8	1.7	0.4	0.5	0.6	3.9
2024	0.7	1.5	0.3	0.4	0.5	3.3
2025	0.6	1.3	0.3	0.4	0.4	2.9
2026	0.5	1.1	0.2	0.3	0.4	2.5
2027	0.4	1.0	0.2	0.3	0.3	2.1
2028	0.4	0.8	0.2	0.2	0.3	1.8
2029	0.3	0.7	0.1	0.2	0.2	1.6
2030	0.3	0.6	0.1	0.2	0.2	1.3
2031	0.2	0.5	0.1	0.1	0.2	1.1
2032	0.2	0.4	0.1	0.1	0.1	0.9
2033	0.2	0.3	0.1	0.1	0.1	0.8
2034	0.1	0.3	0.1	0.1	0.1	0.6
2035	0.1	0.2	0.0	0.1	0.1	0.5
2036	0.1	0.2	0.0	0.0	0.1	0.4
2037	0.1	0.1	0.0	0.0	0.0	0.3
2038	0.0	0.1	0.0	0.0	0.0	0.2
2039	0.0	0.1	0.0	0.0	0.0	0.2
2040	0.0	0.1	0.0	0.0	0.0	0.1

WestVirginiaUniversity.
OFFICE OF SPONSORED PROGRAMS

October 27, 2015

Mr. Michael P. Sheehan
47 School Street, Suite 301
Philippi, WV 26416

RE: Watershed Scale Approach to AMD Remediation: Martin Creek and Sandy Creek

Dear Mr. Sheehan:

Transmitted herewith and recommended for your consideration is the original referenced proposal prepared by Paul Ziemkiewich of the West Virginia University National Research Center for Coal and Energy.

Questions of a programmatic nature should be directed to Dr. Ziemkeiwicz while administrative or financial matters should be addressed to Patricia Patteson in our Office of Sponsored Programs at (304) 293-3998 or email wvusponsoredprograms@mail.wvu.edu

Cordially,

Janet Boyles

Janet Boyles
Pre-Award Manager

JB/pp
cc: Paul Ziemkiewicz
File #15-876

PO Box 6845 | 886 Chestnut Ridge Road, Room 202
Morgantown, WV 26506-6845
304.293.3998 F 304.293.7435

Title of Proposal:	Watershed Scale Approach to AMD Remediation: Martin Creek and Sandy Creek
Submitted to:	WVDEP – Office of Special Reclamation
Submitted by:	West Virginia University
Federal or Entity Identification Number:	556000842
DUNS:	929332658
Institutional Address:	Office of Sponsored Programs 886 Chestnut Ridge Road PO Box 6845 West Virginia University Morgantown, WV 26506-6845
Telephone: **Facsimile:**	(304) 293-3998 (304) 293-7435
Project Director:	Paul Ziemkiewicz
Title:	Director
Department:	Environmental Technology
College: **Campus Address:**	National Research Center for Coal and Energy West Virginia University P.O. Box 6064 Morgantown, WV 26506-6064
Telephone:	(304) 293-6958
Amount Requested:	$500,000
Proposed Starting Date:	July 1, 2015
Proposed End Date:	December 31, 2016

Mary Jane Buckland

Mary Jane Buckland, Associate Director, Office of Sponsored Programs, West Virginia University

10/27/15

Date

Watershed Scale Approaches to AMD Remediation: Martin Creek and Sandy Creek

Project: WV 342

Submitted: June 30, 2015
Modification Submitted: October 16, 2015

Funds Awarded in August 2015 (OSP #15-876): $638,000
Funds Requested in Modification: $500,000
(modifications are underlined)

Total Funds Requested: $1,138,000

Submitted by the:
National Mine Land Reclamation Center at
West Virginia Water Research Institute
A program of the
National Research Center for Coal and Energy
at
West Virginia University
PO Box 6064
Morgantown, WV 26506

Introduction

A study completed by the National Mine Land Reclamation Center (NMLRC) for the West Virginia Department of Environmental Protection (WVDEP) Office of Special Reclamation demonstrated significant cost savings and projected increased environmental benefit by applying in-stream lime dosers at strategic locations within the stream system rather than using lime dosers to treat individual sources (Ziemkiewicz 2006). By utilizing portable dosers and placing them at strategic locations within the Martin Creek and Sandy Creek watersheds, the West Virginia Water Research Institute (WVWRI) proposes to identify optimal locations for permanent installation of in-stream dosers (Figure 1 and Figure 6). Water quality samples will be collected on a weekly basis at locations upstream of the dosers and at tributary mouths to monitor water quality conditions in response to the dosers.

Martin Creek:

Approximately 3.4 stream miles in the Muddy Creek drainage are impaired by acid mine drainage (AMD). The majority of the acid load comes from the Martin Creek sub watershed, including Fickey Run and Glade Run. According to the Lower Cheat River Watershed Based Plan (WBP), Fickey Run is impaired by two abandoned mine land (AML) and two bond forfeiture sites, while Glade Run is impaired by five AML and five bond forfeiture sites. Both Fickey Run and Glade Run flow into Martin Creek, which receives AMD from two AML sites before it joins Muddy Creek 3.2 miles above its confluence with the Cheat River. Approximately 0.7 miles above Martin Creek, Muddy Creek receives AMD from several AML sources originating from the Dream Mountain Ranch. Muddy Creek supports a quality cold water fishery upstream of Dream Mountain.

The purpose of this study is to provide the WVDEP with data to guide future management decisions on the placement of dosers to treat Martin Creek at a watershed level. This project will terminate as directed by WVDEP (or after one year) based on the success of the dosing trial.

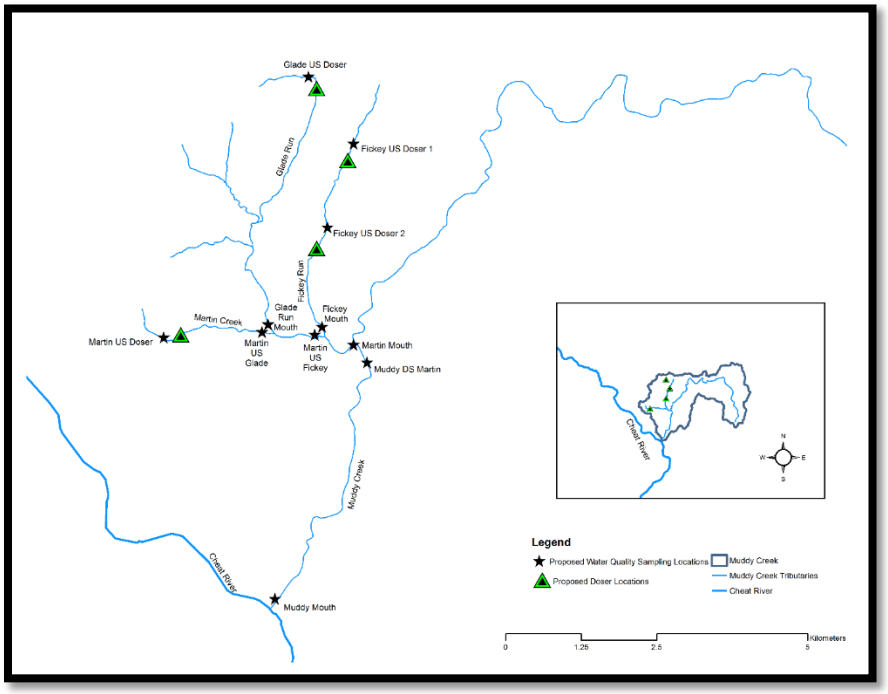


Figure 1. Proposed doser and water quality sampling locations in the Muddy Creek watershed.

Sandy Creek:

Sandy Creek is a subwatershed in the lower section of the Tygart Valley River basin (Figure 2). The Sandy Creek subwatershed drains over 90.3 square miles and flows into Tygart Lake (WVDEP 2003a). As per the 1982 Tygart Valley River Subbasin Abandoned Mine Drainage Assessment, Sandy Creek was identified as contributing 49.5% of the total acid load to the Tygart between Philippi, WV and the mouth at Fairmont, WV. Water quality data collected during the assessment found 9,325 lbs/day of acid being discharged into Tygart Reservoir from Sandy Creek (WVDEP 1987).

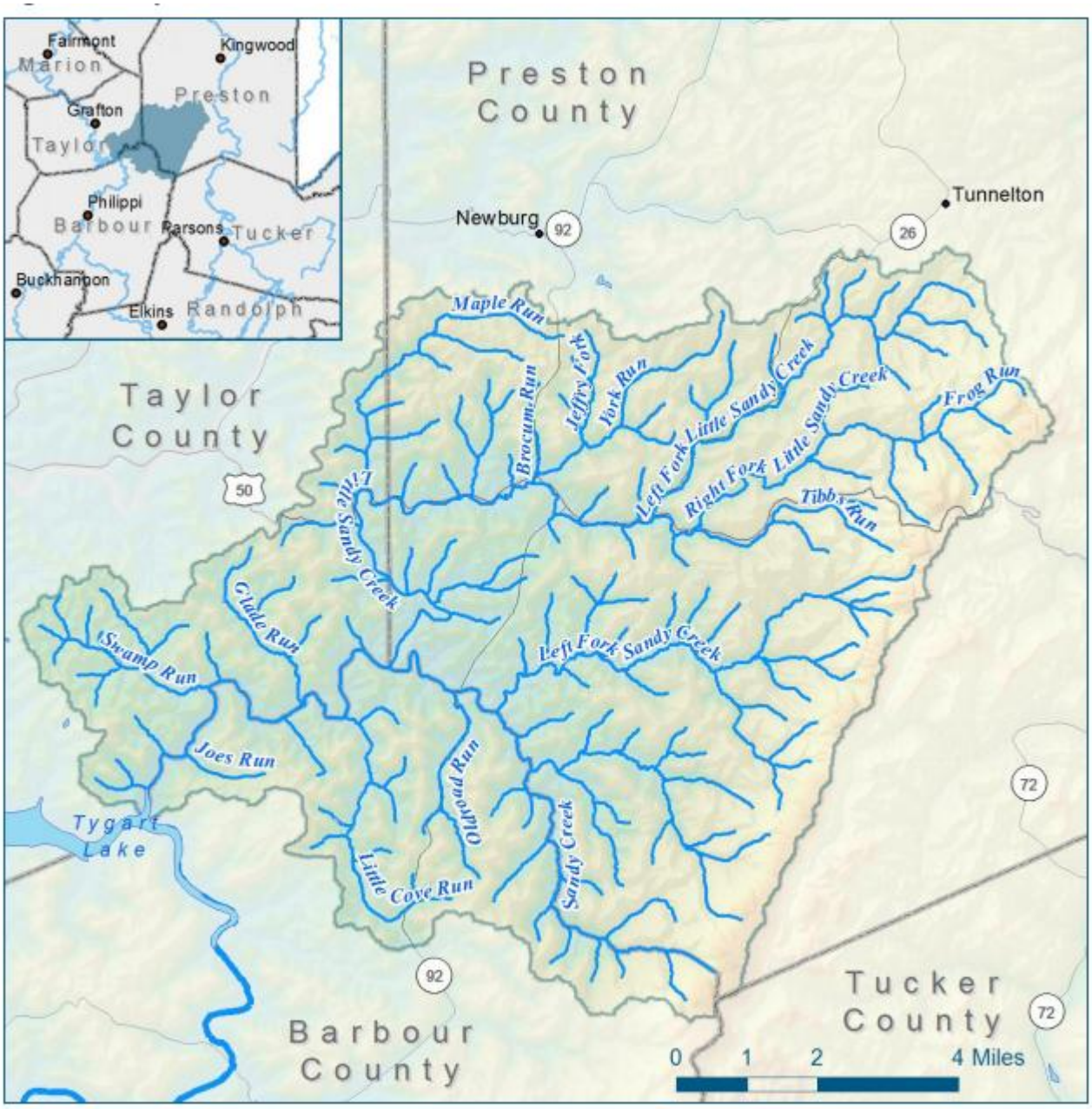


Figure 2. Sandy Creek watershed (WVDEP 2012)

As per West Virginia Department of Environmental Protection (WVDEP), multiple abandoned mine lands (AML) have been identified which discharge acid mine drainage into Left Fork Little Sandy Creek, Left Fork Sandy Creek, and Maple Run. Additionally, several bond forfeiture sites (BFS) within the watershed fall under WVDEP's Office of Special Reclamation (OSR).

The 2002 303(d) list identified impairment by iron, aluminum (total) and manganese (WVDEP 2003b) in the Sandy Creek watershed. Total maximum daily loads (TMDL) limits were developed in 2001. In 2003, the state water quality standard for aluminum changed from total to dissolved aluminum. In its 2004 list, WVDEP only maintained aluminum listings if dissolved aluminum data were available and those data indicated impairment (WVDEP 2004). Five of the six streams previously listed for total aluminum were delisted and the 2004 list only included Little Sandy Creek as impaired by dissolved aluminum. Table 1 lists streams, impairments and pollutants for the Sandy Creek watershed.

Table 1. Impaired streams in the Sandy Creek watershed (WVDEP 2012)

Stream	Impairments	Pollutants	TMDL?
Sandy Creek	Iron	Iron	Yes
	pH	Aluminum, iron, manganese	Yes
Glade Run	Iron	Iron	Yes
	pH	Aluminum, iron, manganese	Yes
Little Sandy Creek	Aluminum (d)	Aluminum (d)	No
	CNA-biological	Unknown	No
	Iron	Iron	Yes
	pH	Aluminum, iron, manganese	Yes
Maple Run	Iron	Iron	Yes
	pH	Aluminum, iron, manganese	Yes
Left Fork Little Sandy Creek	Iron	Iron	Yes
	pH	Aluminum, iron, manganese	Yes
Left Fork Sandy Creek	Iron	Iron	Yes

Source: WVDEP (2010a). Note: CNA=condition not allowable.

Background

In-stream dosing

Application of passive treatment technology at individual AMD sources has been the traditional restoration approach, primarily because state and federal funding sources have provided funding for installation. However, experience has shown that construction of passive treatment systems to treat individual sources can be expensive due to the large number, diffuse nature, and spatial distribution of AMD sources. Ideally, if it were physically possible to consolidate all or most AMD sources within a watershed and construct one large treatment system, as is the approach for municipal wastewater treatment, significant cost savings and environmental benefits would result at a much faster rate. A study completed by the NMLRC for the WVDEP demonstrated significant cost savings and projected increased environmental benefit by applying in-stream lime dosers at strategic locations within the stream system rather than using lime dosers to treat individual sources (Ziemkiewicz 2006).

Previous studies

(Martin Creek)

The Targeted Watershed Initiative (TWI) was completed in 2012 through a partnership with Friends of Cheat, NMLRC and the West Virginia University Division of Forestry and Natural Resources. The TWI included passive

treatment at three non-point AMD sources, active at-source treatment at one site, and active in-stream treatment along Fickey (Figure 3).

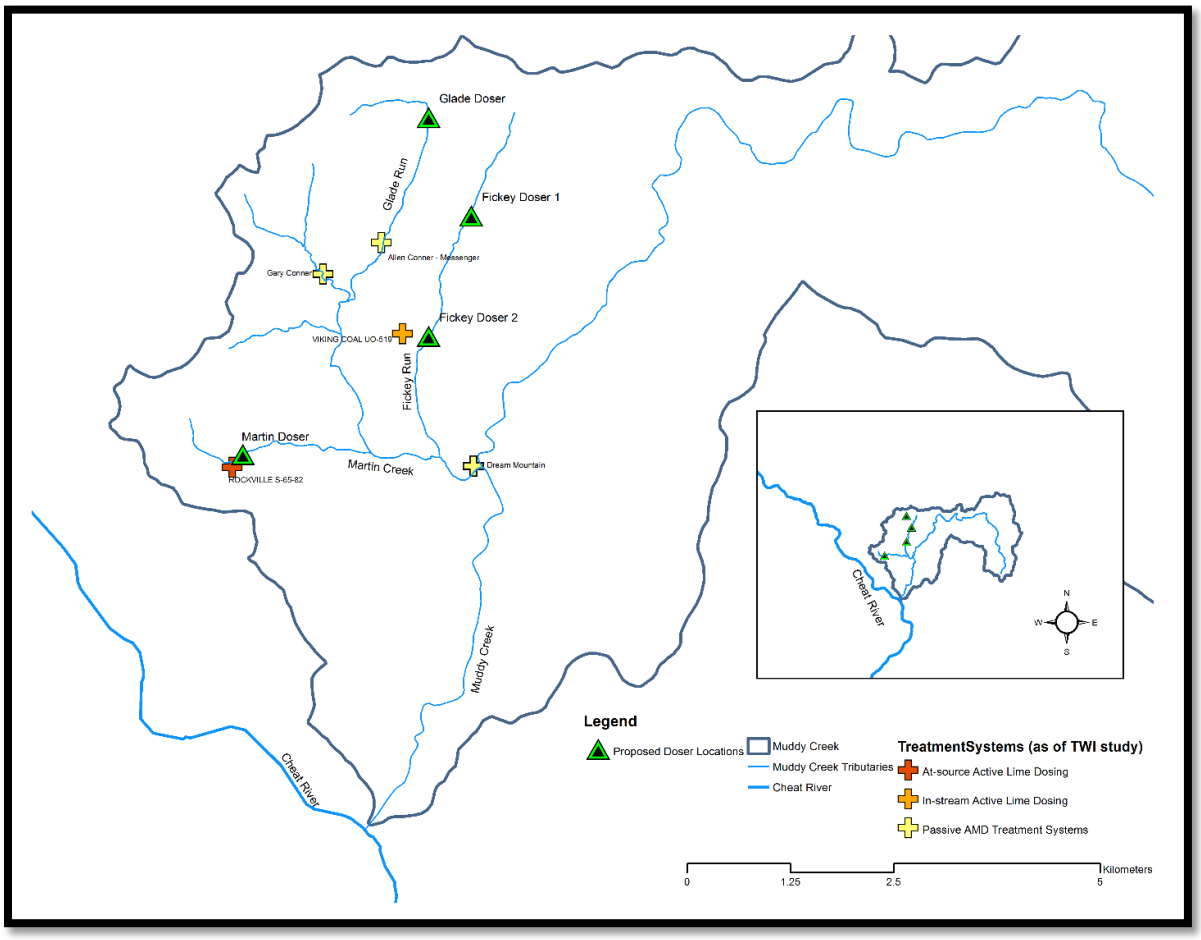


Figure 3. Proposed Doser locations and treatment locations from the TWI study.

In consideration of placement for in-stream dosers, recommendation on prior in-stream dosing on Fickey Run were noted form the TWI final report:

"The in-stream lime doser on Fickey Run planned to use the stream as a settling zone for precipitating metals and sludge. This treatment plan was not chosen because it was the best possible method to treat Fickey Run. The treatment plan was an attempt to compromise treatment strategies that were unavailable or not possible at the time of implementation. The further degradation of Fickey Run with sludge was justified because of expected watershed-wide improvements in water quality and biological health. Monitoring efforts were designed to detect the effects of in-stream dosing along the downstream gradient. Repeated observation and water quality results, however, showed that sludge associated with dosing was not contained in Fickey Run. Instead, increased turbidity and abundant amounts of sludge were found far downstream in Martin Creek, Muddy Creek and even in the Cheat River.

There are a couple of reasons for this finding. First, the position of the lime doser was not installed high enough in the watershed in order to leave enough distance for sludge to accumulate in Fickey Run. Also, the natural steep

gradient of Fickey Run downstream of the Viking Coal site discharge aids downstream transport of precipitates. Fickey Run is severely impaired by AMD. The stream is often cited as one of the most polluted streams in the state of West Virginia. In-stream dosing has facilitated the first stage of an active treatment of AMD, but it is clear that sludge management must be integrated into the overall restoration plan for situations like this."

Based on the recommendations from the TWI in-stream dosing along Fickey, we anticipate two dosers on Fickey Run will provide more efficient treatment and lessen the impact of "sludge" further downstream.

Sandy Creek

In 2012, a watershed-based plan (WBP) for the Sandy Creek of the Tygart Valley River was prepared by Downstream Strategies on behalf of the Save the Tygart Watershed Association and submitted to WVDEP. While the objective of the WBP is to secure 319 funds for treatment of impairment through passive treatment, the plan does suggest locations and justification for utilizing a limestone doser to address mine drainage impairment in the watershed. The WBP estimates 100% load reductions for iron, aluminum and manganese (assuming a 94% purity rating and 80% mixing efficiency, using an estimated 677 tons/year of quicklime) for a doser on the Left Fork Little Sandy (WVDEP 2012). Additionally, 100% load reductions for iron, aluminum and manganese are projected for a doser on Maple Run (with 94% purity rating, 80% mixing efficiency, using 120 tons/year of quicklime).

Note that while the WBP identified quick lime as the chemical of choice, this proposal includes using hydrated lime for in stream dosing.

Project Description

Task 1: Dosing Trials

Martin Creek

A systematic approach will be taken to determine effective placement of the dosers in the watershed. Initially, dosers will be placed:

- Headwaters of Fickey Run (Fickey Doser 1)
- Near Viking Coal on Fickey Run (Fickey Doser 2)
- Headwaters of Martin Creek (Martin Doser)
- Glade Run (Glade Doser)

The first doser to go into operation will be the Martin Doser. Review of weekly water quality analysis will assist in determining doser efficiency as each doser becomes operational. The objective is to improve water quality in Martin Creek in the most cost effective manner.

The proposed location of Fickey Doser 1 is anticipated to reduce one half to three quarters of acid load and dissolved iron (Fe d) during mid-low flows. Ideally, a significant portion of the metals will precipitate prior to reaching Fickey Doser 2 by placing Doser 1 further upstream on Fickey Run.

In review of the TWI data, Fickey Run shows the acid and Fe loads at around 45% upstream of Viking in the June sample and between 72 and 86% respectively in the July sample when the flow was much lower (Figure 4).

Note: FR US = Fickey Run Upstream Viking; FR DS = Fickey Run Downstream Viking; FR 900 = Fickey Run at 900 yards upstream mouth; FR 400 = Fickey Run at 400 yards upstream mouth; FR mouth = Fickey Run at mouth; acd calc = calculated acidity; Al d = dissolved aluminum; Fe d = dissolved iron; Q gpm = discharge in gallons per minute; tpy = tons per year.

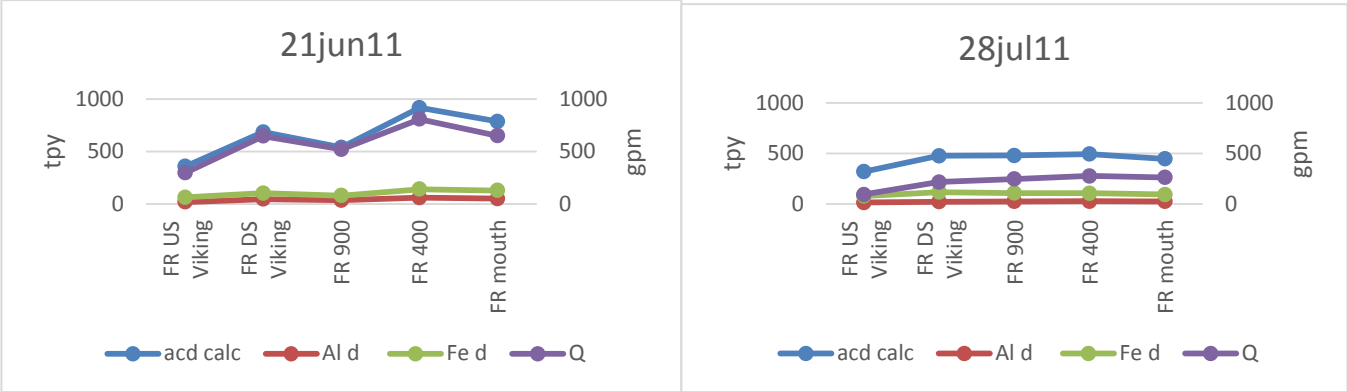


Figure 4. TWI water quality data at sampling locations along Fickey Run in June and July, 2011.

Sandy Creek

Proposed locations for the dosers, based on information in the WBP are shown in Figure 5.

- Maple Run (near Bethel Church Strip)
- Left Fork Little Sandy (near Kanetown)

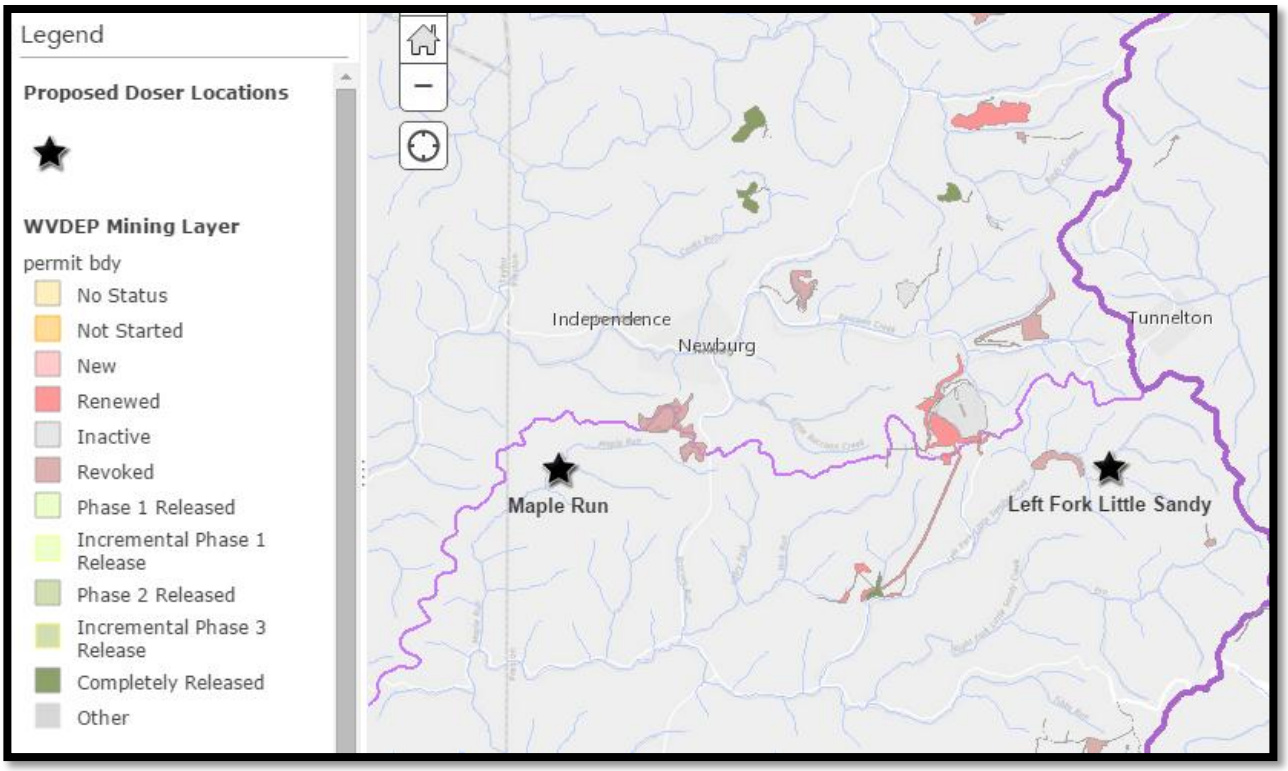


Figure 5. Proposed doser locations as per the WBP.

Site Access

Access to the sites by WVWRI will be covered through site access agreements secured with the landowners by WVDEP.

Site Preparation and Doser Installation

Site preparation (clearing, pad preparation, roads, etc.) will be provided by a licensed contractor in the state of West Virginia. Dosers will be loaned to WVWRI from WVDEP for the term of the project. All components will be installed on site by Aquafix Systems, Inc .

Doser Operation and Maintenance

WVWRI field technicians will be on site weekly for water quality monitoring and will provide visual assessments to the doser conditions and operations. Aquafix Systems, Inc. will provide maintenance and repairs if needed during the term of the project. Additionally, MS Controls will provide service to the automated control system, as necessary for the duration of the project.

Lime

WVWRI will contract with Aquafix Systems, Inc. to provide lime for the dosers.

Doser Removal

All modifications made to the dosers will be removed and the dosers will be returned to the same state of operation as they were at the beginning of the project. Dosers will be moved offsite by Aquafix Systems, Inc. to a location determined by WVDEP. Automated control systems (solar panels, etc) will be removed and provided to WVDEP at the conclusion of the project.

Task 2: Water Quality Sampling

Field parameters will include: temperature (°C), dissolved oxygen (ppm), specific conductance (µS/cm), and total dissolved solids (mg/L) using a YSI 556 multi-parameter probe (Yellow Springs Instruments, Yellow Springs, OH, USA), and turbidity via transparency tube. Stream discharge will be measured using the area-velocity technique with a Marsh-McBirney Flo-Mate 2000 flow meter (Marsh-McBirney, Frederick, MD). Additionally, grab water samples will be collected at each site and stored on ice until analysis at the National Research Center for Coal and Energy in Morgantown, WV. Parameters to be analyzed include: pH, alkalinity, acidity, conductivity, sulfates, and total suspended solids along with total and dissolved metals (iron, magnesium, aluminum, calcium, and manganese).

Martin Creek

Water quality samples will be collected on a weekly basis at 11 locations in the study area (Figure 1). Specifically, at locations upstream of the dosers and at the tributary mouths.

Additionally, an in-stream data logger near the route 26 bridge will record pH at 20 minute intervals and data will be downloaded weekly during water quality grab sample events.

Sandy Creek

Water quality samples will be collected on a weekly basis at 11 locations in the study area (Figure 6).

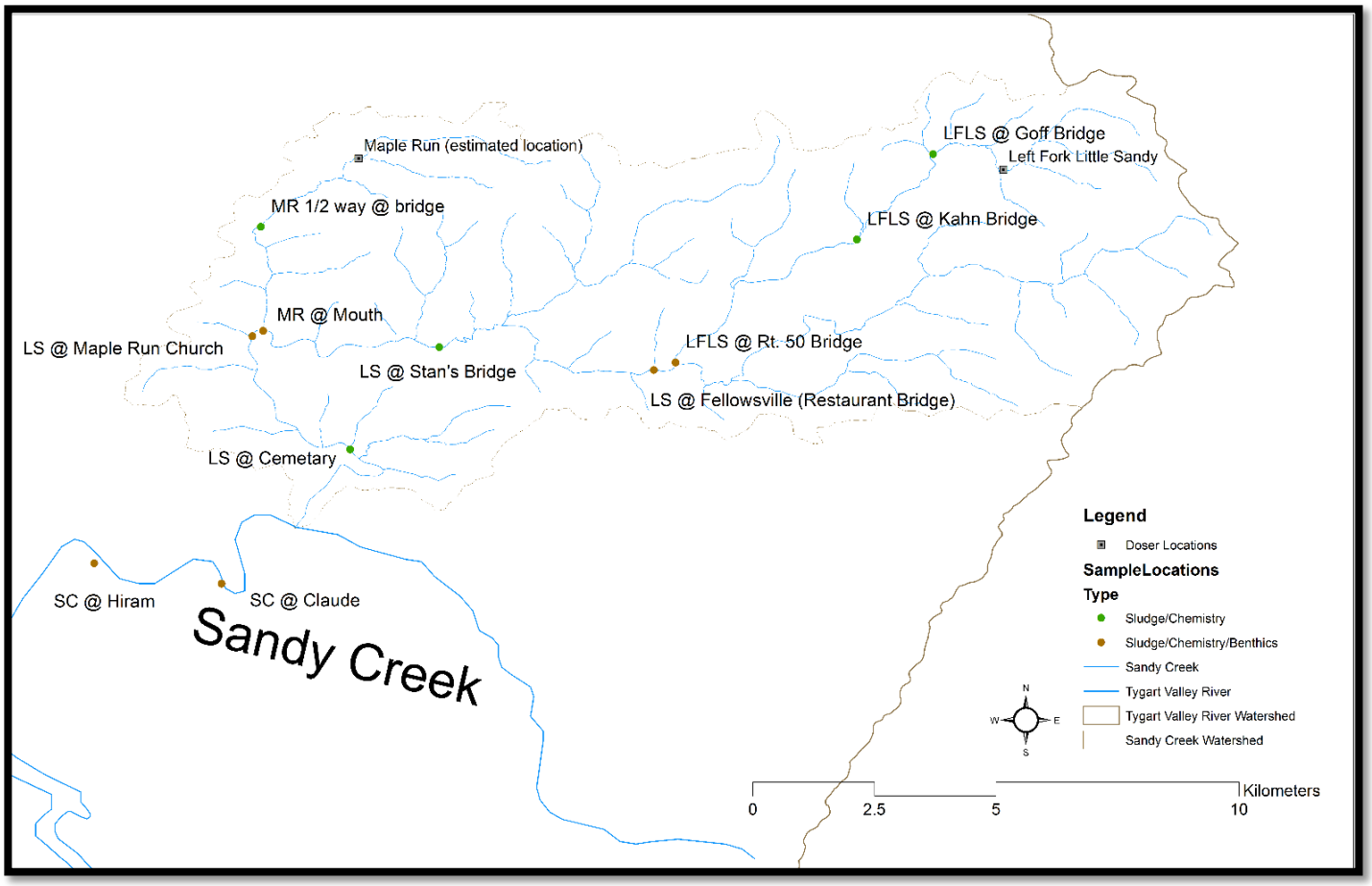


Figure 6. Proposed doser and water quality sampling locations in the Sandy Creek watershed. LFLS = Left Fork Little Sandy; LS = Little Sandy; MR = Maple Run; SC = Sandy Creek

Table 2. Sampling Locations. LFLS = Left Fork Little Sandy; LS = Little Sandy; MR = Maple Run; SC = Sandy Creek

Latitude	Longitude	Sampling Location	Type
39.35294	-79.791417	LFLS @ Kahn Bridge	Sludge/Chemistry
39.36874	-79.777315	LFLS @ Goff Bridge	Sludge/Chemistry
39.33022	-79.824979	LFLS @ Rt. 50 Bridge	Sludge/Chemistry/Benthics
39.32883	-79.82898	LS @ Fellowsville (Restaurant Bridge)	Sludge/Chemistry/Benthics
39.33306	-79.868683	LS @ Stan's Bridge	Sludge/Chemistry
39.33505	-79.903242	LS @ Maple Run Church	Sludge/Chemistry/Benthics
39.31414	-79.885152	LS @ Cemetary	Sludge/Chemistry
39.35528	-79.901667	MR 1/2 way @ bridge	Sludge/Chemistry
39.33605	-79.901244	MR @ Mouth	Sludge/Chemistry/Benthics
39.28934	-79.908948	SC @ Claude	Sludge/Chemistry/Benthics
39.29313	-79.932519	SC @ Hiram	Sludge/Chemistry/Benthics

Note: benthic surveys will be conducted independently by WVDEP at the six locations identified in Table 2.

Task 3: Sludge Monitoring

Sludge depth measurements will be determined by placing a graduated measuring rod in stream. Field technicians will then monitor sludge accumulation during weekly sampling events. Photos will also be taken to provide a visual assessment of sludge accumulation.

Martin Creek

Accumulation of sludge will be monitored at up to 10 locations (to be determined) throughout the study area.

Sandy Creek

Accumulation of sludge will be monitored at up to 11 locations (Table 2) throughout the study area.

Task 4: Reporting

Reports will be provided to WVDEP on a monthly basis in addition to a final report within 30 days of project completion.

Timeline

Martin Creek

WVWRI	
Contractor	
MS Controls	
Aquafix	

	2015						2016							
Task	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
Initiate service agreements														
Site preparation														
Building of components for dosers														
Installing dosers on sites														
Filling dosers with hydrated lime														
Doser maintenance														
Weekly water quality sampling														
Sludge monitoring														
Monthly reports														
Moving dosers														
Removing dosers from site														
Final report														

Sandy Creek

	2015			2016										
Task	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov
1. Dosing Trials														
2. Water quality sampling														
3. Sludge monitoring														
4. Reporting														

WVWRI	
MS Controls/Aquafix	

Note: The projected timelines may adjust in accordance to success of treatment.

Budget

Martin Creek

CATEGORY	TOTAL
SALARIES	**$ 26,027**
BENEFITS	**$ 5,759**
OTHER DIRECT COSTS	**$ 31,740**
NRCCE Laboratory	$ 25,740
Sampling Equipment	$ 6,000
SUBCONTRACTS	**$ 65,802**
WVU Research Corporation	$ 65,802
SERVICE AGREEMENTS	**$ 446,572**
Aquafix Systems, Inc	$ 146,540
MS Controls, Inc	$ 100,032
WV licensed contractor	$ 200,000
TRAVEL	**$ 4,100**
Field Sampling	$ 2,600
Conferences/Meetings	$ 1,500
TOTAL DIRECT COSTS	**$ 580,000**
DIRECT COSTS (F&A) @ 10%	**$ 58,000**
TOTAL	**$ 638,000**

Sandy Creek

CATEGORY	TOTAL
SALARIES	**$ 17,921**
BENEFITS	**$ 3,155**
OTHER DIRECT COSTS	**$ 36,264**
NRCCE Laboratory	$ 28,080
Sampling Equipment	$ 5,000
Field Sampling	$ 3,184
SUBCONTRACTS	**$ 49,005**
WVU Research Corporation	$ 49,005
SERVICE AGREEMENTS	**$ 347,000**
Aquafix	$ 297,000
MS Controls	$ 50,000
TRAVEL	**$ 1,200**
Conferences/Meetings	$ 1,200
TOTAL DIRECT COSTS	**$ 454,545**
DIRECT COSTS (F&A) @ 10%	**$ 45,455**
TOTAL	**$ 500,000**

DISCLAIMER: Please note that hourly rates are provided for informational purposes only. As an educational institution West Virginia University (WVU) does not account for faculty effort by the hour nor does the University pay employees an hourly rate. The University operates on a percentage of effort basis. Invoices will not include information related to hours and hourly rates. The University can provide hourly rates for informational purposes only, but this will not be backed up by time cards or confirmed in any audit.

Note: While a full year has been budgeted and scheduled; project may terminate at any time if treatment is deemed successful by WVDEP. Invoices will be submitted to WVDEP on a quarterly basis.

References

Friends of Cheat. 2012. Lower Cheat River Remediation Plan – Final Report. US EPA Targeted Watershed initiative.

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WVDEP. 2004. 2004 Integrated water quality monitoring and assessment report. Department of Water and Waste Management.

WVDEP. 2012. Sandy Creek of the Tygart Valley River Watershed-based plan. Prepared by Downstream Strategies on behalf of Save the Tygart Watershed Association.

Ziemkiewicz, P.F. 2006. Watershed-based versus at-source AMD treatment: costs and benefits. West Virginia Mine Drainage Task Force Symposium, Morgantown, WV.

Martin Ck AMD Treatment Project

Early results: 3 nov to 1 dec 15

Paul Ziemkiewicz
Melissa O'Neal
Water Research Institute
West Virginia University

BACKGROUND

- WVDEP/OSR currently treats bond forfeiture sites at source under NPDES permits:
  - For small discharges this is extremely expensive
  - Almost no environmental benefit

- WVDEP/OSR Seeks to demonstrate the effectiveness of in stream dosing to:
  - Recover more stream miles
  - Improve efficiency of SRF expenditures

IN STREAM DOSING

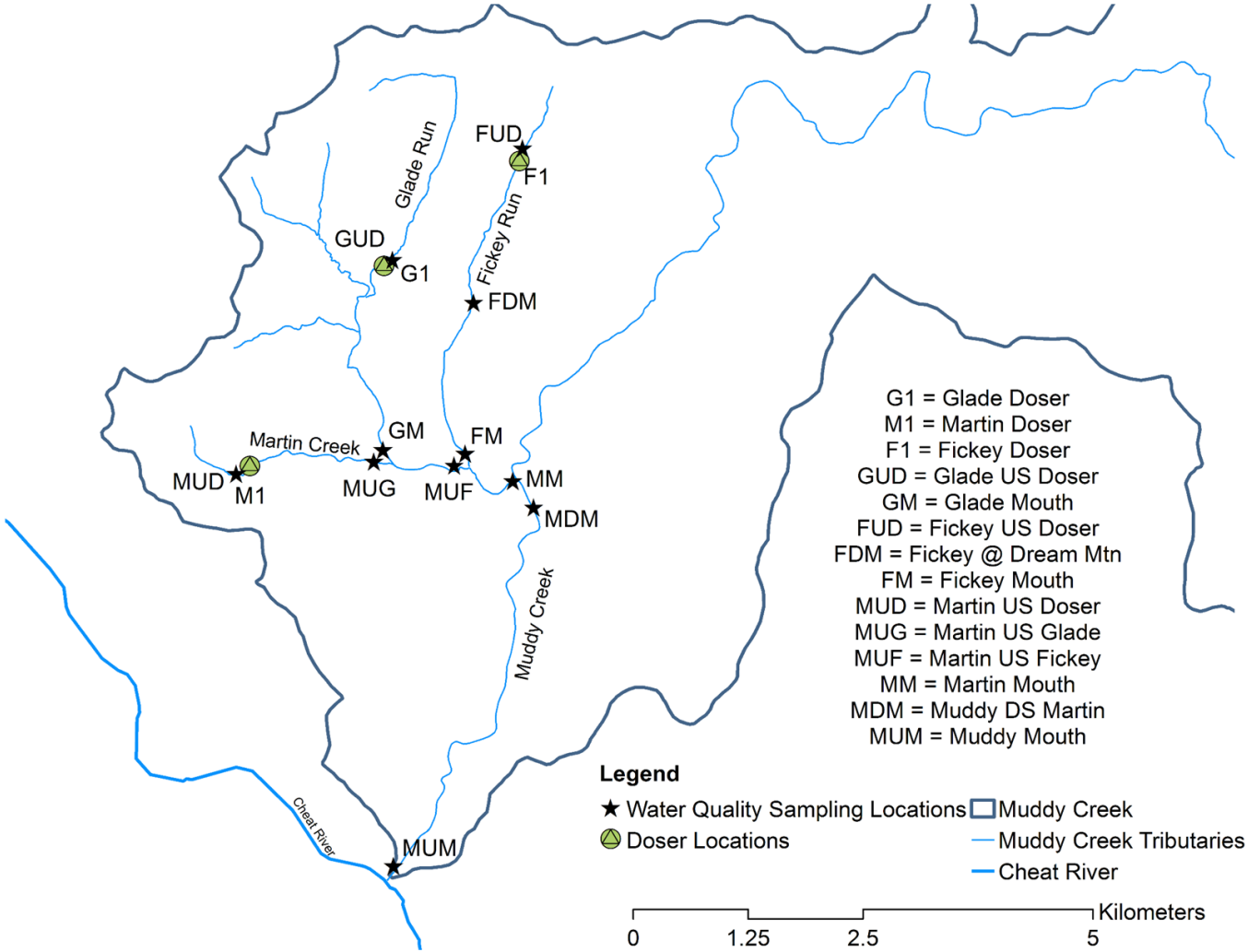
- Advantages
  - Many more stream miles recovered per dollar invested
  - Lower capX, opX
  - Alternative NPDES permitting
  - Easier to attract investors
- Disadvantages
  - Sludge deposition in streams
  - Length of sacrifice zone
  - Unknown downstream benefits for steep stream channels with high metal loadings-Fickey Run

PROJECT WV 342 OBJECTIVES

- Document stream mile recovery in worst case scenario: Martin Ck basin, Preston Co. WV
- Optimize doser configuration and dosing rates
- Avoid $1MM solutions to $100k problems

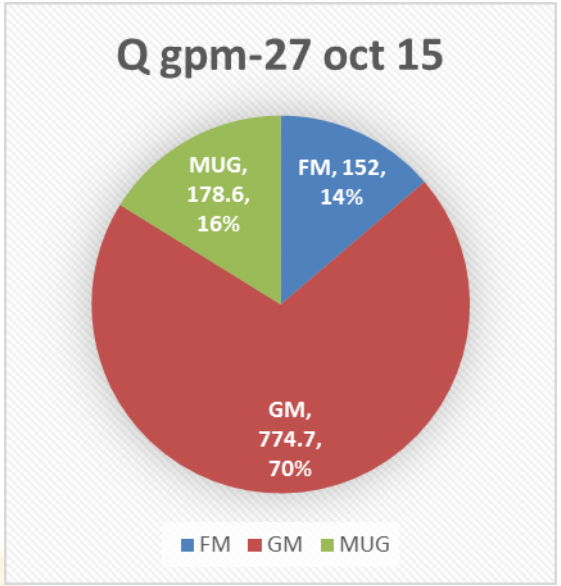
Dosers
M1, F1 went on line around
3 nov 15
F1 offline 1 dec 15

G1 scheduled to go online
3 dec 15

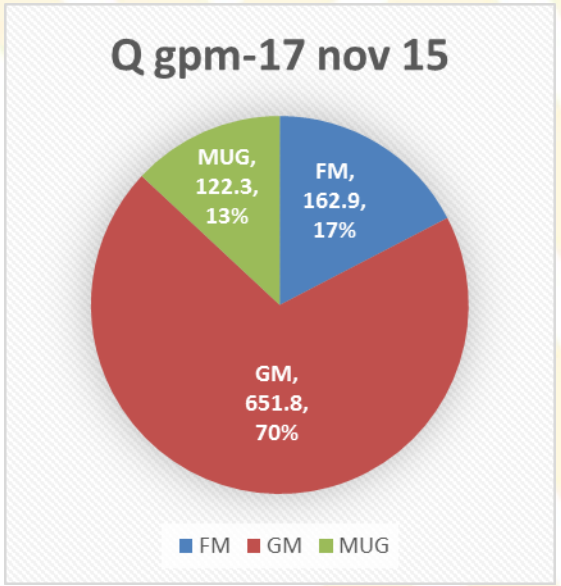


Flow distribution in Fickey, Glade and Martin Cks

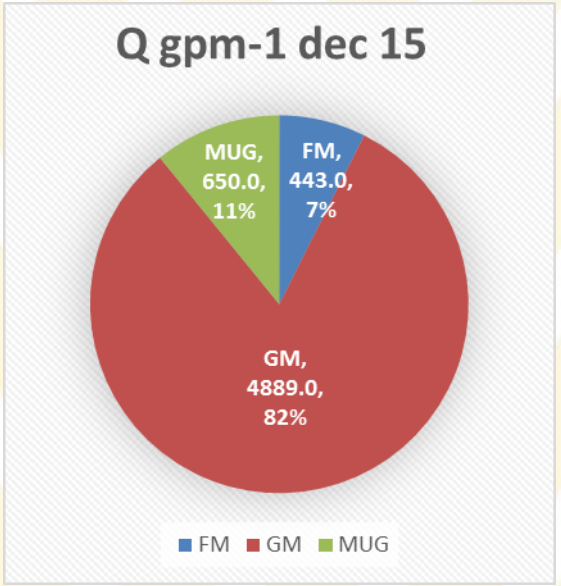
Low flow



Low flow



High flow



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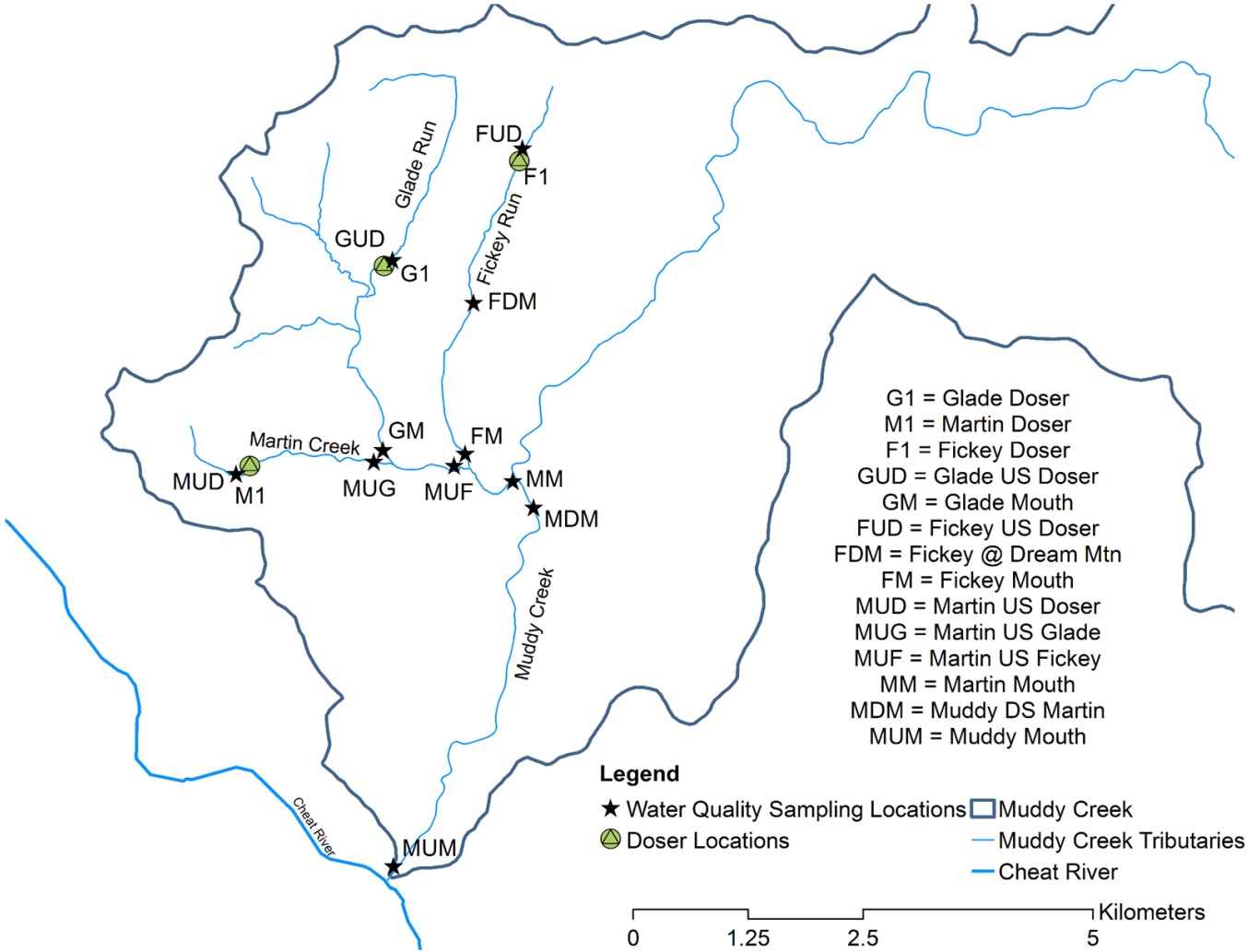
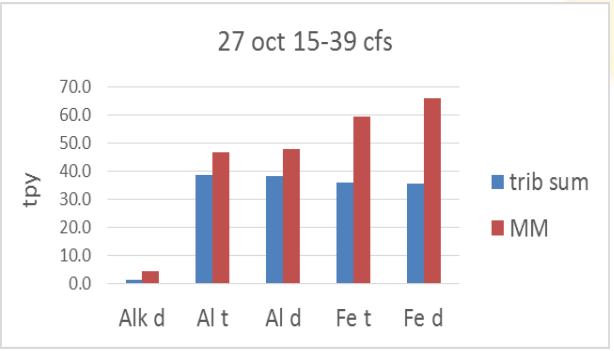
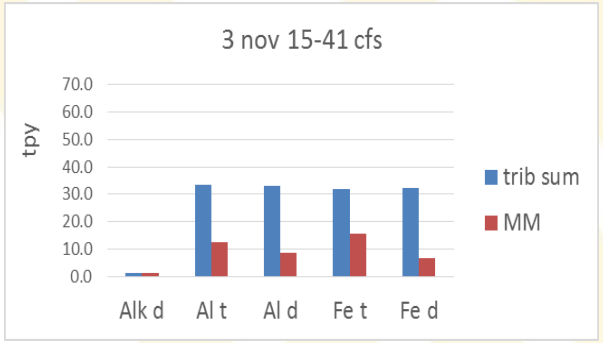


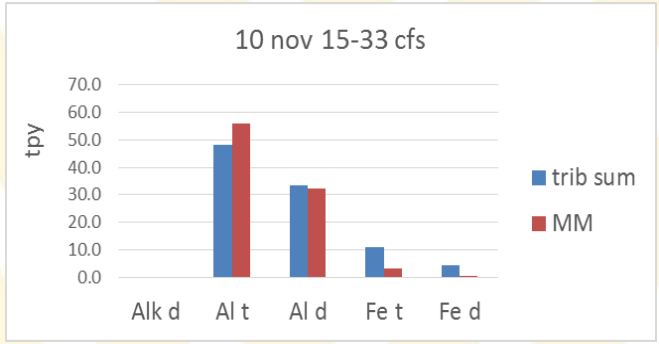
Pre-dosing



F1, M1 startup



F1, M1 online



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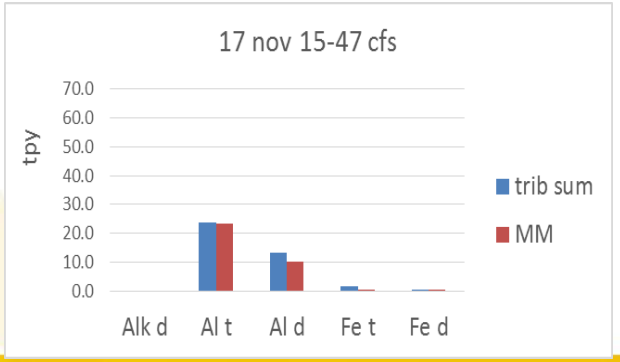

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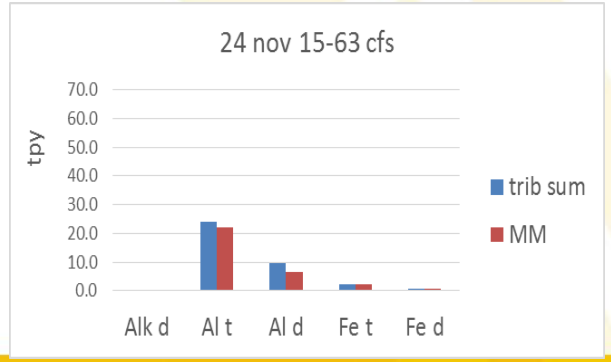
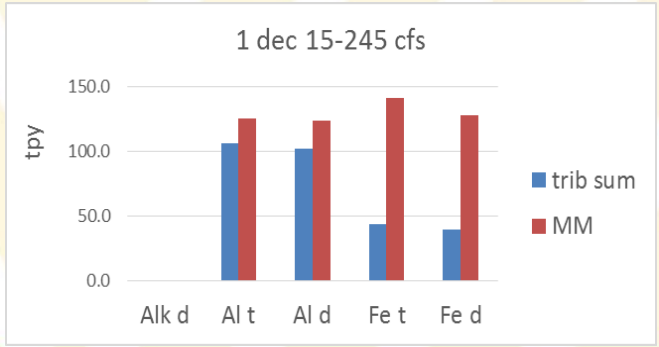


F1 off, M1 on

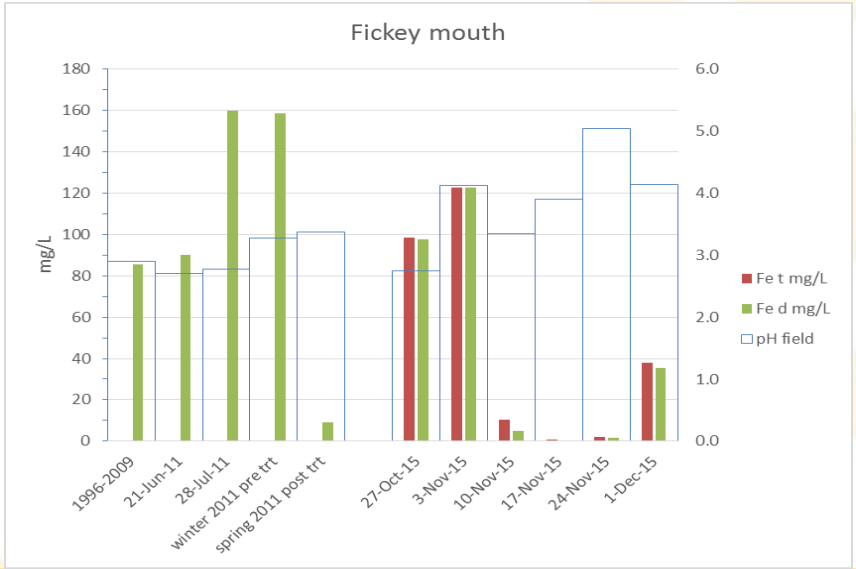


Q from USGS Rockville Gauge

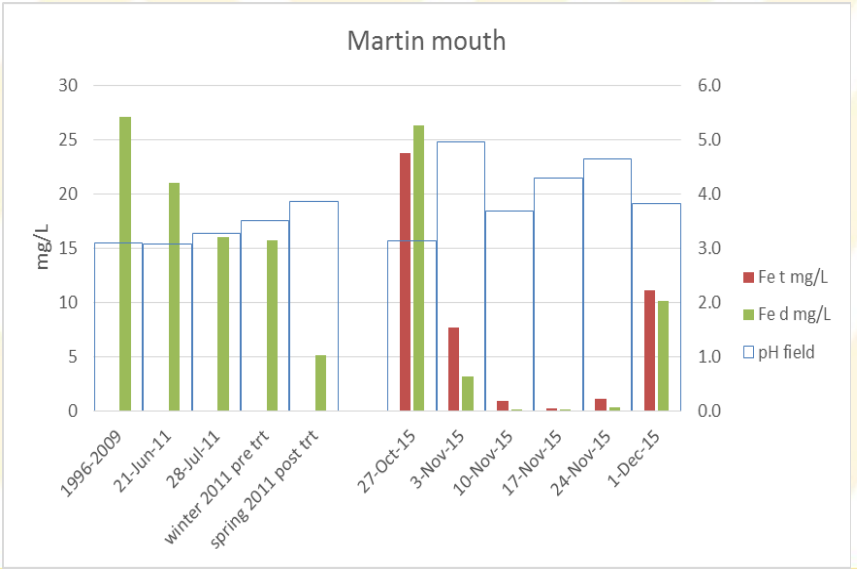
Historic vs. wv342 results

Martin and Fickey dosers online 4 Nov 15-Fickey Doser offline 1 Dec 15

Fickey Mouth



Martin Mouth



STATUS

- The Glade Run doser is not yet on line
- Iron and aluminum loads in Muddy Ck have been substantially reduced
- Concentrations in Martin Ck are within restoration targets during low to mid flow stream conditions
- High flow events cause excessive turbidity in Muddy Ck and exceedance of the restoration target for iron
- Need to optimize dosing rates at Fickey and Glade Run

FOR MORE INFORMATION PLEASE CONTACT:

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