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In 2009, SRBC initiated the Susquehanna River Basin Anthracite Region Strategy, which is based on a similar scope of work completed for the West Branch Susquehanna Subbasin in 2008.

In the Anthracite Region, SRBC is coordinating its efforts with the Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR). Sharing data between EPCAMR's Anthracite Region Mine Pooling Mapping Initiative and SRBC's remediation strategy is valuable in moving both initiatives forward. Both agencies will continue to work together to implement the restoration strategy and continue the mine pool mapping effort in additional Anthracite Coal Fields.



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*Sterling Slope Pump Discharge in the Shamokin Creek Watershed.*

# Anthracite Region Mine Drainage Remediation Strategy

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## SUMMARY

The largest source of Anthracite Coal within the United States is found in the four distinct Anthracite Coal Fields of northeastern Pennsylvania. The four fields – Northern, Eastern-Middle, Western-Middle, and Southern – lie mostly in the Susquehanna River Basin; the remaining portions are in the Delaware River Basin. The Susquehanna watershed portion covers about 517 square miles (Figure 1).

The sheer size of these four Anthracite Coal Fields made this portion of Pennsylvania one of the most important resource extraction regions in the United States and helped spur the nation's Industrial Revolution. Anthracite Coal became the premier fuel source of nineteenth and early twentieth century America and heated most homes and businesses.

The Anthracite Region of Pennsylvania, however, bears the legacy of past unregulated mining. With almost 534 miles of waterways impaired by abandoned mine drainage (AMD), it is the second most AMD-impaired region of the Susquehanna River Basin. Only the Bituminous Coal Region in the West Branch Susquehanna River Subbasin contains more AMD-impaired stream miles.

These mining impacts degrade the environment and limit the use of the waters of the Susquehanna River Basin as a resource. These losses are not just limited to biology, habitat, and recreation, but affect human health, quality of life and the region's socioeconomic status as well.

The long-term goal of fully restoring the Anthracite Coal Region of the Susquehanna basin is an extremely

challenging and ambitious one, especially in light of current funding limitations. However, opportunities exist in the Anthracite Coal Region that could encourage and assist in the restoration of its lands and waters.

For example, the numerous underground mine pools of the Anthracite Region hold vast quantities of water that could be utilized by industry or for augmenting streamflows during times of drought. In addition, the large flow discharges indicative of the Anthracite Region also hold hydroelectric development potential that can offset energy needs and, at the same time, assist in the treatment of the utilized AMD discharge.

To help address the environmental impacts while promoting the resource development potential of the Anthracite Coal Region, the Susquehanna River Basin Commission (SRBC) determined there would be significant benefits to developing a remediation strategy for this AMD-impaired region. SRBC initiated a review and analysis of water quality impacts and prepared the remediation strategy to be used as a guide to help resource agencies and organizations achieve comprehensive, region-wide environmental results over the long term.

From the outset of this project, SRBC stated its intention not to duplicate the efforts of other agencies and organizations where problem-identification and problem-prioritization initiatives were already underway or completed. Instead, the purpose of this strategy is to help identify overlapping goals and opportunities, and to offer alternatives for remediation efforts through conceptual treatment plant suggestions.

## METHODS

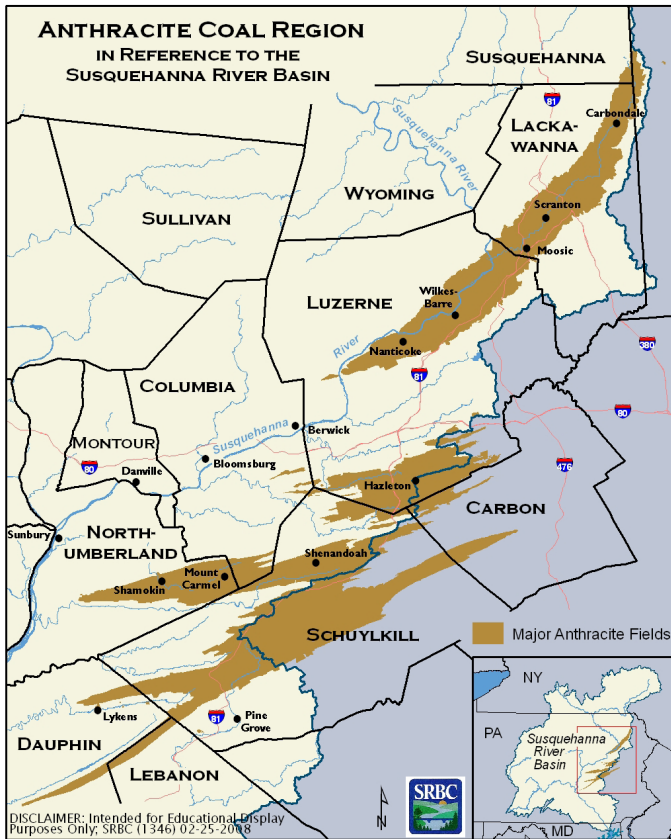


Figure 1. Anthracite Coal Region

### Data Collection

This strategy is based entirely on existing data and information — no new water quality information was collected. The Pennsylvania Department of Environmental Protection (PADEP) served as the primary source of information. Additional sources included the U.S. Geological Survey (USGS), SRBC monitoring data, Skelly & Loy, Inc., Dietz-Gourley Consulting, LLC, and Bloomsburg and Wilkes Universities. In its calculations, SRBC focused water quality data collected post-2000. Data from years prior to 2000, however, were not excluded and were utilized when more recent data were not available.

### Data Review & Database Creation

In total, there are 745 unique stations in the database, containing 17,661 individual samples. The database emphasizes information on discharges and instream stations, but also includes information on boreholes, strip pits, and

impoundments. Only instream and discharge stations were utilized for the analyses. Of the 745 unique stations, 346 are AMD discharge points while 399 are instream points. In the final strategy, of the 346 discharge points, only 320 were used for analysis because several points were sampled on the same total discharge flow.

### Data Comparisons

Using GIS, SRBC calculated the amount of abandoned mine land (AML) areas within each of the four Anthracite Coal Fields and the ten major Anthracite Coal Field watersheds. Calculations of AMD

stream mileage were also made for the Coal Field watersheds.

Staff further compared the difference in discharge flows and metal loads/yields between both the coal fields and individual watersheds.

### Current Stream Conditions

Using the most recent data at mainstem sampling locations, SRBC selected 128 of the 399 instream data points to analyze current stream conditions.

Those 128 points were then used for a GIS mapping exercise that illustrates sections of the watershed mainstem that do not meet water quality standards for pH and iron and/or aluminum concentrations.

### AMD Loadings to the River

Fourteen tributaries that contain listed AMD impairment along with five AMD discharges from the Anthracite Coal Region flow into the Susquehanna River.

Those 14 tributaries and five discharges were analyzed for their direct AMD (iron, manganese, aluminum, acidity) loading contribution to the Susquehanna River. All five of the discharges that directly flow into the Susquehanna River are located in the Northern Field.

### Comparison of Anthracite Coal Field Discharges

Flow, iron, manganese, aluminum, and acidity loading were calculated for all of the 320 discharges found in the Anthracite Region of the Susquehanna River Basin. The 320 discharges were then ranked from highest to lowest for each parameter. The top 10 ranked discharges for each parameter were selected and are noted in Tables 3 - 7.

Twenty discharges were represented in at least one of the Top-10 parameter rankings. Since these 20 discharges comprise a vast majority of the flow and AMD loading that impacts the Susquehanna River Basin, they constitute the initial treatment system recommendations plan of this strategy, called the Top-20 Plan.

### Potential Consumptive Water Use Mitigation Sites

Due to massive mine pool water storage capacity, the Anthracite Coal Region holds tremendous potential as a center for consumptive water use mitigation projects that will also improve basin water quality. Using the Anthracite Region Water Quality Database, SRBC highlighted several potential consumptive water use mitigation/water quality improvement projects to create a short list of examples for initial investigation. The estimated amount of water creation/storage for each of these prospective projects was calculated to illustrate the consumptive use mitigation potential held within the Anthracite Region of the Susquehanna River Basin.

## RESULTS AND DISCUSSION

### COMPARISON OF THE ANTHRACITE COAL FIELDS

#### Impaired Stream Miles

Susquehanna River Basin streams that drain the four Anthracite Coal Fields contain 533.75 stream miles that are listed by PADEP as AMD impaired. Those impaired stream miles are fairly comparable between the four fields.

#### Abandoned Mine Lands

More than 12 percent of the total Anthracite Coal Field area within the Susquehanna River Basin (63.81 square miles) is listed on PADEP's AML Inventory System (AMLIS). Total AML acreage between the fields is quite different. The Northern and Western-Middle Fields contain 83.1 percent, 48.8 and 34.3 percent, respectively, of the total AMLs. The Eastern-Middle and Southern Fields contain significantly less of the AML area with 16.9 percent of the total (9.6 and 7.3 percent, respectively). Nearly 52 percent of the Anthracite Region AML area within the Susquehanna River Basin is un-prioritized as of the end of 2010.

#### Discharge Numbers

According to the compiled historical water quality data, 320 AMD discharges are found within the Anthracite Coal Region of the Susquehanna River Basin. A majority of those discharges are found in two fields, the Western-Middle (40.0 percent) and the Southern (37.8 percent).

#### Discharge Flow

The amount of AMD discharge flow per field is not related to the amount of discharges per field. The Northern Field, which only contains 16.2 percent of the Anthracite Field discharges, contributes 38.0 percent of the Anthracite Field discharge flow. This is due to the fact that the Northern Field contains several very high flow discharges. In comparison, the Southern Field, which contains the second most discharges (39.9 percent), contributes the least amount of discharge flow at 10.9 percent.

#### AMD Pollution Loading

The AMD discharge loadings differ due to several geological and mining differences between the Eastern-Middle Coal Field and the remaining fields. The Northern and Western-Middle Fields create a majority of the iron (88.5%), manganese (75.3%), and acidity loading (60.7%), while the Eastern-Middle creates a majority of the aluminum loading (67.1%) and a significant percentage of the acidity loading (28.9%). The Southern Field is the least pervasive of the four fields in terms of AMD loading.

**“The amount of AMD discharge flow per field is not related to the amount of discharges per field.”**

### COMPARISON OF THE ANTHRACITE COAL FIELD WATERSHEDS

#### Impaired Stream Miles

The four Anthracite Coal Fields are drained by ten large watersheds: Lackawanna River, Nescopeck Creek, Catawissa Creek, Shamokin Creek, Mahanoy Creek, Mahantango Creek, Wiconisco Creek, Stony Creek, and Swatara Creek (Table 1). Several small watersheds also drain the area of the Northern Field that is not drained by the Lackawanna River and will be considered a separate tenth watershed area (Susquehanna River–Northern Field).

Impaired stream miles are fairly comparable between seven of the ten watersheds and range from 10.5 to 15.1 percent of the total AMD impaired mileage. Three watersheds, Wiconisco Creek, Mahantango Creek, and Stony Creek, contain significantly less impaired mileage, 5.0, 3.2, and 2.6 percent, respectively.

#### Abandoned Mine Lands

A large percentage (82.8 percent) of the AMLs are found in only four of the ten watersheds: Lackawanna River (27.4 percent), Susquehanna River–Northern Field (21.5 percent), Mahanoy Creek (20.9 percent), and Shamokin Creek (13.0 percent) (Table 1).

#### Discharge Numbers

Of the 320 compiled historical discharges, a large percentage (65.9 percent) of them are found in only three of the ten watersheds: Swatara Creek (25.9 percent), Shamokin Creek (20.9 percent), and Mahanoy Creek (19.1 percent) (Table 2).

Once again, the amount of discharges found in each watershed does not always correlate with the amount of discharge flow and loading created in each watershed. For example, Solomon Creek, located in the Susquehanna River–Northern Field, contains only two discharges (0.6 percent), yet is impacted by 9.3 percent (61.72 cubic feet per second (cfs)) of the total Anthracite discharge flow within the Susquehanna River Basin. *(continued on page 5)*



*Quaker Run — tributary to Shamokin Creek.*

**Table 1. AMD-impaired Stream Mileage and AML Land Coverage Data for Each of the Anthracite Coal Field Watersheds**

Watershed	Total Watershed	Watershed Contained Within Coal Field	AMD Impairment	Total AMLs	PI AMLs	PII AMLs	PIII AMLs	Undetermined Priority	AML/Watershed Area
	mi <sup>2</sup>	mi <sup>2</sup>	Stream Miles	mi <sup>2</sup>	mi <sup>2</sup>	mi <sup>2</sup>	mi <sup>2</sup>	mi <sup>2</sup>	%
Lackawanna River	347.66	126.64	73.93	17.46	0.12	6.01	3.66	7.67	5.02
Susquehanna River – Northern Field	nd	99.84	80.78	13.68	0.24	4.20	1.78	7.46	nd
Nescopeck Creek	173.94	51.57	64.43	3.90	0.05	1.04	1.39	1.42	2.24
Catawissa Creek	152.69	25.77	56.13	2.37	0.20	0.50	0.13	1.54	1.55
Shamokin Creek	136.85	49.66	60.95	8.29	0.14	1.88	1.23	5.04	6.06
Mahanoy Creek	157.10	57.09	80.18	13.28	0.37	3.44	1.91	7.56	8.45
Mahantango Creek	164.63	19.57	16.87	0.80	0.00	0.28	0.14	0.38	0.49
Wiconisco Creek	116.37	14.78	26.60	1.21	0.00	0.40	0.01	0.80	1.04
Stony Creek	35.64	11.09	13.58	0.001	0.00	0.00	0.00	0.001	0.00
Swatara Creek	571.14	43.21	60.00	2.69	0.00	1.26	0.44	0.99	0.47
Total		499.22	533.45	63.68	1.12	19.01	10.69	32.86	

**Table 2. Discharge Numbers, Flow, Loading Statistics, and Yields for Each of the Anthracite Coal Watersheds Containing Discharges**

	Discharges	Flow	Fe Loading	Mn Loading	Al Loading	Alk Loading	Acidity Loading
	#	cfs	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Catawissa Creek	8	31.55	223.27	300.00	964.70	242.61	18,697.17
Nescopeck Creek	12	95.94	2,781.84	2,200.66	5,051.74	5,340.01	35,967.51
Lackawanna River	30	147.12	18,285.08	2,574.93	251.55	51,206.89	8,334.24
Solomon Creek	2	61.72	12,499.37	1,291.02	78.04	103,339.39	22,171.76
Newport Creek	11	23.47	3,880.17	587.26	147.71	7,754.09	4,644.75
Nanticoke Creek	3	4.76	3,319.93	118.63	0.77	3,793.92	5,520.44
Susquehanna River — Northern Field	5	14.90	3,359.26	430.83	144.67	2,273.83	12,824.35
Swatara Creek	83	38.80	2,607.23	341.43	206.00	5,056.58	6,842.53
Mahantango Creek	23	16.75	1,616.22	232.48	176.56	1,414.75	8,690.85
Stony Creek	3	5.68	1.16	8.48	0.00	87.28	326.45
Wiconisco Creek	12	11.09	1,277.33	116.10	201.03	3,167.01	3,847.48
Shamokin Creek	67	79.63	10,670.58	1,396.27	657.17	13,695.79	26,176.75
Mahanoy Creek	61	132.18	13,325.32	3,330.12	1,084.76	58,179.64	35,400.02
Total	320	663.59	73,846.76	12,928.21	8,964.70	255,551.79	189,444.30
	Discharge Yield	Flow Yield	Fe Loading Yield	Mn Loading Yield	Al Loading Yield	Alk Loading Yield	Acidity Loading Yield
	#/mi <sup>2</sup>	cfs/mi <sup>2</sup>	lbs/day/mi <sup>2</sup>	lbs/day/mi <sup>2</sup>	lbs/day/mi <sup>2</sup>	lbs/day/mi <sup>2</sup>	lbs/day/mi <sup>2</sup>
Catawissa Creek	0.05	0.21	1.46	1.96	6.32	1.59	122.45
Nescopeck Creek	0.07	0.55	15.99	12.65	29.04	30.70	206.78
Lackawanna River	0.09	0.42	52.59	7.41	0.72	147.29	23.97
Solomon Creek	0.11	3.39	686.78	70.94	4.29	5,677.99	1,218.23
Newport Creek	0.79	1.68	277.35	41.98	10.56	554.26	332.00
Nanticoke Creek	0.40	0.63	440.31	15.73	0.10	503.52	732.15
Susquehanna River — Northern Field	0.02	0.06	12.90	1.65	0.56	8.73	49.26
Swatara Creek	0.15	0.07	4.56	0.60	0.36	8.85	11.98
Mahantango Creek	0.14	0.10	9.82	1.41	1.07	8.59	52.79
Stony Creek	0.08	0.16	0.03	0.24	0.00	2.45	9.16
Wiconisco Creek	0.10	0.10	10.98	1.00	1.73	27.22	33.06
Shamokin Creek	0.49	0.58	77.97	10.20	4.80	100.08	191.28
Mahanoy Creek	0.39	0.84	84.82	21.20	6.90	370.34	225.33
Total	0.15	0.31	34.24	5.99	4.16	118.52	87.85

**Discharge Flow**

The analysis of the compiled historical water quality calculated an average total flow of 663.6 cfs from the 320 discharges documented in the Anthracite Fields of the Susquehanna River Basin.

A slight majority (56.6 percent) of that flow is contained within only three watersheds: Lackawanna River (22.2 percent), Mahanoy Creek (19.9 percent), and Nescopeck Creek (14.5 percent) (Table 2). Of those, only Mahanoy Creek contains a significant number of actual discharges at 19.1 percent. Both the Lackawanna River and Nescopeck Creek can be characterized as watersheds that are impacted by several very large flow discharges, namely the Old Forge Borehole (~76.0 cfs), Duryea Breach (~27.7 cfs), and Jermyn Shaft (~18.1 cfs) in the Lackawanna River Watershed and the Jeddo Tunnel (~64.9 cfs) and Gowen Tunnel (~19.9 cfs) in the Nescopeck Creek Watershed.

When discharge flow yields (ft<sup>3</sup>/s/mi<sup>2</sup>) are analyzed, the Susquehanna River–Northern Field contains the highest. Solomon Creek is a small watershed that contains only two discharges; however, those two discharges, the Solomon Creek Boreholes and the Buttonwood Airshaft, are the third and fourth highest average flow AMD discharges in the

entire Susquehanna River Basin portion of the Anthracite Coal Fields (Table 3). Consequently, the discharge flow rate in Solomon Creek is the highest of any watershed at 3.39 ft<sup>3</sup>/s/mi<sup>2</sup>. The other two small watersheds of the Susquehanna River–Northern Field, Newport Creek and Nanticoke Creek, contain yields of 1.68 ft<sup>3</sup>/s/mi<sup>2</sup> and 0.63 ft<sup>3</sup>/s/mi<sup>2</sup>, respectively. Only one other watershed, Mahanoy Creek at 0.84 ft<sup>3</sup>/s/mi<sup>2</sup>, is higher than the yield found in Nanticoke Creek.

**AMD Pollution Loading**

The 320 discharges of the Susquehanna River Basin Anthracite Fields create 36.9 tons/day of iron loading, 6.5 tons/day of manganese loading, 4.5 tons/day of aluminum loading, and 94.7 tons/day of acidity loading (Table 2).

Almost three-quarters (74.1 percent) of the iron loading originates in four watersheds: Lackawanna River (24.8 percent), Mahanoy Creek (18.0 percent), Solomon Creek (16.9 percent), and Shamokin Creek (14.4 percent).

A large majority (83.5 percent) of the manganese loading originates in five watersheds: Mahanoy Creek (25.8 percent), Lackawanna River (19.9 percent), Nescopeck Creek (17.0 percent), Shamokin Creek (10.8 percent), and Solomon Creek (10.0 percent).

A slight majority (56.4 percent) of the aluminum loading originates in one watershed, Nescopeck Creek, due to the high aluminum loading of the Jeddo and Gowen Tunnels. Mahanoy Creek (12.1 percent) and Catawissa Creek (10.8 percent) contribute a significant amount of aluminum loading as well.

A majority (63.2 percent) of the acidity loading originates in four watersheds: Nescopeck Creek (19.0 percent), Mahanoy Creek (18.7 percent), Shamokin Creek (13.8 percent), and Solomon Creek (11.7 percent).

Tributaries of the Susquehanna River that contain high amounts of AMD pollution loading do not always have a large impact to the Susquehanna River proper due to natural processes and dilution improving tributary water quality before the confluence.

By concentrating restoration efforts on only two watersheds, Lackawanna River and Nescopeck Creek, 42.1 percent of the iron loading, 43.8 percent of the manganese loading, 52.2 percent of the aluminum loading, and 58.3 percent of the acidity loading currently entering the Susquehanna River proper from the Anthracite Region would be eliminated.

**Table 3. Top-10 Flow Discharges in the Susquehanna River Basin Anthracite Region**

Ranking	Discharge - CFS	% Discharge Total	Site Number	Watershed	Mine Discharge
1	75.95	11.45	NFD016	Lackawanna River	Old Forge Borehole
2	64.89	9.78	EFD009	Nescopeck Creek	Jeddo Tunnel
3	31.21	4.70	NFD022	Solomon Creek	Solomon Creek Boreholes
4	30.51	4.60	NFD012	Solomon Creek	Nottingham-Buttonwood Airshaft
5	27.66	4.17	NFD020	Lackawanna River	Duryea Breach
6	20.19	3.04	WFD027	Mahanoy Creek	Packer #5 Breach and Borehole
7	19.94	3.00	EFD005	Nescopeck Creek	Gowen Tunnel
8	19.93	3.00	EFD001	Catawissa Creek	Audenreid Tunnel
9	18.06	2.72	NFD006	Lackawanna River	Jermyn Slope
10	14.47	2.18	WFD089	Mahanoy Creek	Gilberton Pump Discharge
<b>Top 10 Total</b>	<b>322.81</b>				
<b>All</b>	<b>663.59</b>				
<b>% Discharge Total</b>	<b>48.65</b>				

**Table 4. Top-10 Iron Loading Discharges in the Susquehanna River Basin Anthracite Region**

Ranking	Fe Loading - lbs/day	% Loading Total	Site Number	Watershed	Mine Discharge
1	12,393.02	16.78	NFD016	Lackawanna River	Old Forge Borehole
2	6,700.92	9.07	NFD022	Solomon Creek	Solomon Creek Boreholes
3	5,798.45	7.85	NFD012	Solomon Creek	Nottingham-Buttonwood Airshaft
4	5,464.45	7.40	NFD020	Lackawanna River	Duryea Breach
5	3,435.41	4.65	WFD089	Mahanoy Creek	Gilberton Pump Discharge
6	3,319.93	4.50	NFD033	Nanticoke Creek	Truesdale/Dundee Outfall
7	2,746.11	3.72	WFD027	Mahanoy Creek	Packer #5 Breach and Borehole
8	2,544.26	3.45	EFD009	Nescopeck Creek	Jeddo Tunnel
9	2,434.14	3.30	NFD014	Newport Creek	Susquehanna #7 Shaft
10	1,778.10	2.41	NFD017	Susquehanna River	Plainsville Outlet
Top 10 Total	46,614.79				
All	73,846.76				
% Loading Total	63.12				

**Table 5. Top-10 Manganese Loading Discharges in the Susquehanna River Basin Anthracite Region**

Rankings	Mn Loading - lbs/day	% Loading Total	Site Number	Watershed	Mine Discharge
1	1,726.76	13.36	NFD016	Lackawanna River	Old Forge Borehole
2	1,461.01	11.30	EFD009	Nescopeck Creek	Jeddo Tunnel
3	785.01	6.07	WFD027	Mahanoy Creek	Packer #5 Breach and Borehole
4	739.48	5.72	NFD020	Lackawanna River	Duryea Breach
5	674.81	5.22	NFD012	Solomon Creek	Nottingham-Buttonwood Airshaft
6	660.77	5.11	WFD089	Mahanoy Creek	Gilberton Pump Discharge
7	616.21	4.77	NFD022	Solomon Creek	Solomon Creek Boreholes
8	582.27	4.50	EFD005	Nescopeck Creek	Gowen Tunnel
9	388.23	3.00	WFD116	Mahanoy Creek	Continental Plant Bypass
10	320.77	2.48	WFD114	Mahanoy Creek	Centralia Tunnel
Top 10 Total	7,955.32				
All	12,928.21				
% Loading Total	61.53				

**Table 6. Top-10 Aluminum Loading Discharges in the Susquehanna River Basin Anthracite Region**

Rankings	Al Loading - lbs/day	% Loading Total	Site Number	Watershed	Mine Discharge
1	3,847.62	42.92	EFD009	Nescopeck Creek	Jeddo Tunnel
2	937.87	10.46	EFD005	Nescopeck Creek	Gowen Tunnel
3	856.61	9.56	EFD001	Catawissa Creek	Audenreid Tunnel
4	337.01	3.76	WFD114	Mahanoy Creek	Centralia Tunnel
5	253.13	2.82	EFD004	Nescopeck Creek	Derringer Tunnel
6	182.23	2.03	SFD089	Wiconisco Creek	Porter Tunnel
7	167.77	1.87	NFD016	Lackawanna River	Old Forge Borehole
8	153.68	1.71	WFD127	Mahanoy Creek	West Penn Breaker Discharge
9	138.41	1.54	WFD019	Mahanoy Creek	Doutyville Tunnel
10	132.53	1.48	NFD025	Susquehanna River	Mocanaqua Tunnel
Top 10 Total	7,006.84				
All	8,964.70				
% Loading Total	78.16				

**Table 7. Top-10 Acidity Loading Discharges in the Susquehanna River Basin Anthracite Region**

Rankings	Acidity Loading - lbs/day	% Loading Total	Site Number	Watershed	Mine Discharge
1	25,410.56	13.41	EFD009	Nescopeck Creek	Jeddo Tunnel
2	16,570.82	8.75	EFD001	Catawissa Creek	Audenreid Tunnel
3	14,024.59	7.40	NFD012	Solomon Creek	Nottingham-Buttonwood Airshaft
4	8,147.17	4.30	NFD022	Solomon Creek	Solomon Creek Boreholes
5	7,130.31	3.76	EFD005	Nescopeck Creek	Gowen Tunnel
6	6,902.56	3.64	NFD025	Susquehanna River	Mocanaqua Tunnel
7	5,480.49	2.89	NFD033	Nanticoke Creek	Truesdale/Dundee Outfall
8	4,804.65	2.54	WFD027	Mahanoy Creek	Packer #5 Breach and Borehole
9	4,804.59	2.54	WFD114	Mahanoy Creek	Centralia Tunnel
10	4,726.07	2.49	NFD016	Lackawanna River	Old Forge Borehole
<b>Top 10 Total</b>	<b>98,001.81</b>				
<b>All</b>	<b>189,444.30</b>				
<b>% Loading Total</b>	<b>51.73</b>				

## THE TOP-20 PLAN

Using the Top-10 Tables 3-7 and scoring each discharge listed (ten points for ranking first and one point for ranking tenth), a prioritization system was constructed according to combined impact. Twenty discharges throughout the Susquehanna River Basin Anthracite Region should be a focal point to begin basin-scale watershed restoration.

These 20 discharges, representing only 6 percent of the 320 total discharges, contribute 57.6 percent of the total discharge flow, 70.0 percent of the total iron loading, 72.0 percent of the total manganese loading, 80.8 percent of the total aluminum loading, and 63.0 percent of the total acidity loading entering the Susquehanna River Basin from the Anthracite Region (Table 8).

As mentioned, this Top-20 Plan is for basin-scale restoration. Even though the Top-20 Plan addresses a vast majority of the AMD pollution loading in the Northern and Eastern-Middle Fields, the plan offers less watershed-scale restoration in the Western-Middle and Southern Fields.

When analyzing the watershed-scale improvements that would occur if the Top-20 Plan is implemented, Nescopeck Creek, Lackawanna River, Solomon Creek, and Nanticoke Creek would be virtually restored. Catawissa Creek and the Susquehanna River proper would be nearly restored. Wiconisco Creek and Mahanoy Creek would be significantly improved. Newport Creek would be partially improved. No improvement would occur in Swatara Creek, Shamokin Creek, and Stony Creek. Due to the

Rausch Creek Treatment Plant, no additional treatment is needed within the Mahantango Creek Watershed.

Of the three watersheds where no improvement would occur, only Shamokin Creek has a significant impact to the Susquehanna River Basin. Swatara Creek is impaired mainly in the headwaters and is completely restored by its confluence with the Susquehanna River. Stony Creek is impaired by mildly acidic discharges that contain virtually no metal concentrations. In addition, Rausch Creek, which is one of the AMD impacts to Stony Creek, is treated via limestone diversion wells constructed and maintained by the Doc Fritchey Chapter of Trout Unlimited. Consequently, only Shamokin Creek should gain secondary focus post Top-20 Plan implementation.



*Abandoned mine land near residences in the Western-Middle Coal Field.*

**Table 8. Top-20 Prioritized Discharges within the Anthracite Region of the Susquehanna River Basin and their Separated Pollution Contribution Percentages**

Discharge	Field	Watershed	Flow %	Fe Load %	Mn Load %	Al Load %	Acid Load %	Loading Average %
Jeddo Tunnel	Eastern-Middle	Nescopeck Creek	9.78	3.45	11.30	42.92	13.41	17.8
Old Forge Borehole	Northern	Lackawanna River	11.45	16.78	13.36	1.87	2.49	8.6
Nottingham-Buttonwood Airshaft	Northern	Solomon Creek	4.60	7.85	5.22	0.53	7.40	5.3
Solomon Creek Boreholes	Northern	Solomon Creek	4.70	9.07	4.77	0.34	4.30	4.6
Gowen Tunnel	Eastern-Middle	Nescopeck Creek	3.00	0.19	4.50	10.46	3.76	4.7
Duryea Breach	Northern	Lackawanna River	4.17	7.40	5.72	0.42	0.88	3.6
Audenreid Tunnel	Eastern-Middle	Catawissa Creek	3.00	0.26	2.05	9.56	8.75	5.2
Packer #5 Breach and Boreholes	Western-Middle	Mahanoy Creek	3.04	3.72	6.07	0.08	2.54	3.1
Gilberton Pump	Western-Middle	Mahanoy Creek	2.18	4.65	5.11	0.63	1.72	3.0
Centralia Tunnel	Western-Middle	Mahanoy Creek	1.27	0.49	2.48	3.76	2.54	2.3
Dundee Outfall	Northern	Nanticoke Creek	0.72	4.50	0.92	0.00	2.89	2.1
Derringer Tunnel	Eastern-Middle	Nescopeck Creek	0.78	0.04	1.09	2.82	1.16	1.3
Mocanaqua Tunnel	Northern	Susquehanna River	0.62	2.02	1.85	1.48	3.64	2.2
Porter Tunnel	Southern	Wiconisco Creek	0.17	0.82	0.34	2.03	1.40	1.1
West Penn Breaker Plant Discharge	Western-Middle	Mahanoy Creek	0.27	0.96	0.75	1.71	0.40	1.0
Jermyn Slope	Northern	Lackawanna River	2.72	0.25	0.31	0.12	0.27	0.2
Doutyville Tunnel	Western-Middle	Mahanoy Creek	1.49	0.47	0.88	1.54	1.07	1.0
Continental Plant Bypass	Western-Middle	Mahanoy Creek	1.48	1.36	3.00	0.18	1.80	1.6
Susquehanna #7 Shaft	Northern	Newport Creek	1.43	3.30	1.70	0.23	0.49	1.4
Plainsville Outlet	Northern	Susquehanna River	0.69	2.41	0.62	0.14	2.08	1.3
		Total %	57.6	70.0	72.0	80.8	63.0	

## Summary

### Susquehanna River Basin Anthracite Region Recommendations

**Implement** the Top-20 Discharge Treatment Plan for water quality reclamation within the Anthracite Region of the Susquehanna River Basin.

**Assess** the 33 square miles of Abandoned Mine Lands that are not currently prioritized under the Surface Mining Control and Reclamation Act.

**Complete** a restoration study for the Shamokin Creek Watershed after implementing the Top-20 Plan.

**Initiate** a water quality monitoring program for the Stony Creek Watershed given the lack of available data.

**Complete** a flow monitoring study of the Old Forge Borehole to assess storage and consumptive water use mitigation potential.

**Complete** a study of the consumptive water use mitigation and hydroelectric potential of the Jeddo Tunnel.

**Explore** active treatment alternatives for the Audenreid Tunnel and surrounding discharges.

**Complete** a study focusing on the consumptive water use mitigation potential of the West End Mine Pool (Mocanaqua Tunnel).

**Initiate** a water quality/quantity monitoring program for the Upper Lackawanna River discharges to support a study on consumptive water use mitigation potential.

**Enhance** the implementation of the Eastern Pennsylvania Coalition for Abandoned Mine Reclamation's borehole monitoring plan with the use of more advanced monitoring technology needed to characterize pool/discharge volumes.

**Complete** a study of the 260 flooded surface mines within the region for prioritizing potential consumptive water use mitigation.

**Explore** the use of mine pools along the Susquehanna and Delaware drainage divide.