The Conowingo Tunnel and the Anthracite Mine Flood-Control Project
A Historical Perspective on a "Solution" to the Anthracite Mine Drainage Problem

Michael C. Korb, P.E.
Environmental Program Manager
Pennsylvania Department of Environmental Protection
Bureau of Abandoned Mine Reclamation (BAMR)
Wilkes Barre District Office
mkorb@state.pa.us
www.depweb.state.pa.us

Abstract

Fifty-seven years ago, Pennsylvania's Anthracite Mine Drainage Commission recommended that the Conowingo Tunnel, an expensive, long-range solution to the Anthracite Mine Drainage problem, be "tabled" and that a cheaper, short-range "job-stimulus" project be implemented instead.

Today Pennsylvania's anthracite region has more than 40 major mine water discharges, which have a combined average flow of more than 285,000 gallons per minute (GPM). Two of these average more than 30,000 GPM, 10 more of the discharges are greater than 6,000 GPM, while another 15 average more than 1,000 GPM. Had the Conowingo Tunnel Project been completed, most of this Pennsylvania Anthracite mine water problem would have been Maryland's mine water problem.

Between 1944 and 1954, engineers of the US Bureau of Mines carried out a comprehensive study resulting in more than 25 publications on all aspects of the mine water problem. The engineering study resulted in a recommendation of a fantastic and impressive plan to allow the gravity drainage of most of the Pennsylvania anthracite mines into the estuary of the Susquehanna River, below Conowingo, Maryland, by driving a 137-mile main tunnel with several laterals into the four separate anthracite fields. The $280 million (1954 dollars) scheme was not executed, but rather a $17 million program of pump installations, ditch installation, stream bed improvement and targeted strip-pit backfilling was initiated.

This review of a remarkable engineering study, discussion of some of its effects we might be observing today, and a look at the interim project that was implemented seems to suggest some potential solutions to alleviate today's problems.

Thanks…

to colleagues who were invaluable in reading, commenting, and encouraging:
Larry Dobash and Ron Ryczak from Wilkes Barre BAMR; Eric Cavazza and Rich Beam from Ebensburg BAMR; Rod Fletcher and Brian Bradley from Harrisburg BAMR; Chuck Cravotta from USGS Pennsylvania Water Science Center, New Cumberland PA; Mick Kuhns, Dave Philbin, and Edie Zabroski from US OSMRE Wilkes Barre.

The Conowingo Tunnel and the Anthracite Mine Flood-Control Project
A Historical Perspective on a "Solution" to the Anthracite Mine Drainage Problem

Popular myth in the anthracite region is that the Knox Mine Disaster in 1959 caused the end of deep mining in the Wyoming Valley. Although Knox may have hastened it, the mine-water problem and its economics had caused the abandonment of a number of mines before that date. Reduced demand for anthracite after World War II forced curtailment of production that was accomplished by closing and abandonment of many mines, particularly those with high production and pumping costs. Pumps had been removed from mines and their underground workings filled with water, causing the eventual shutdown of other mines.

By the early 1950s, many of the mines in the Lackawanna Basin and northern side of the Wyoming Basin had been inactive and filled with water; over 1/3 of the underground mines in the Southern Field and 2/3 in the Middle Western Field had been abandoned. When a mine was closed, there was no reduction in mine water pumped; rather the burden was placed on adjoining active mines. The effects of the pumping load on the economics of mining anthracite coal can be illustrated by the ratios of water pumped to tons of anthracite hoisted:

YEAR	RATIO WATER PUMPED: PA ANTHRACITE COAL MINED
1920	**8 TONS WATER: 1 TON COAL**
1940	**14 TONS WATER: 1 TON COAL**
1951	**27 TONS WATER: 1 TON COAL**
1957	**56 TONS WATER: 1 TON COAL**

Source: *Mine Water Problems of the Pennsylvania Anthracite Region*[1]

Mine water control in anthracite mines was one of the industry's most advanced sciences, utilizing drainage tunnels, advanced pumping technology, underground pump stations. The anthracite industry, the Commonwealth, and the US Bureau of Mines all were looking for options to "save" the industry by lowering pumping costs. [1]

Most of the anthracite fields are found in the five Pennsylvania counties of Schuylkill, Carbon, Northumberland, Lackawanna and Luzerne, extending 50 miles east and west and 100 miles north and south covering approximately 484 square miles. Anthracite has been mined in eastern Pennsylvania for more than 200 years, with production of some 8 billion tons. Most mining (~90%) was done by deep mining methods, creating vast underground voids. Precipitation percolates from the surface into these voids. During active underground mining, water was removed by pumping. Pumping increased production costs and forced the closing of many deep mines as the demand for anthracite declined after 1930. As more underground mines closed, pumping costs of the remaining mines increased and today there is no underground mining below drainage.

[1] Dierks, H. A., *Mine Water Problems of the Pennsylvania Anthracite Region, USBMTP 4629F*, AIME Transactions, 1957

Today nearly all 484 square miles of the anthracite fields are underlain by large abandoned mine pools, with overflows and discharges from drainage tunnels, boreholes, strip pits, and various openings.[2]

The Conowingo Tunnel

The US Bureau of Mines (USBM) was established 100 years ago, mainly to address the alarming number of fatalities and injuries in coal mines that took place during the first decade of the 1900s. The Bureau had other roles including *to make diligent investigation of ... the possible improvement of conditions under which mining operations are carried on…*[3] These other roles were soon broadened to include *conducting inquiries and scientific and technologic investigations concerning mining…to increase safety, efficiency, economic development and conserving resources… to inquire into economic conditions affecting these industries*.[4]

The USBM's extensive list of accomplishments include significant contibutions toward reducing mine fatalities (In 1910, the first year of the USBM, there were 2,642 fatalities in coal mines- 4 per million tons mined- and in 1995, its last year, there were 47 – 0.04 per million tons.); discovering a method to remove sulfur from smelter fumes so as not to harm national forests (1911); doing research (1920s) on exhaust gases making it possible to properly ventilate the Holland Tunnel between New York and New Jersey; and developing technologies for the safe handling of radioactive materials (1940s), which ultimately led to the creation of the first atomic-powered submarine. In addition, during the 1960s and 1970s, the USBM developed safer methods of treating mine drainage, measures to stabilize the earth around mining sites, to control and extinguish fires at abandoned mines, and restore and reclaim mined lands.[5] McDade Park in Scranton and Taylor was a 1970s USBM demonstration project for reclaiming strip mines for recreational use.

During World War II, USBM research focused on minerals critical to national defense, such as base metals, iron ore and anthracite coal, where market conditions and underground mining economies affected availability and sustainability.

Water problems in deep mines were identified as impediments to sustainable production and economic mining conditions, and as a major cost, especially in base metals and anthracite. In 1943 the Bureau began construction of the Leadville Colorado Mine Drainage Tunnel (LMDT). Construction of that tunnel was initiated to provide drainage of seepage from some of the underground mine workings in the northern part of the Leadville mining district so that development of mineral reserves could continue. The

---

[2] Growitz, D.J., Reed, L.A., and Beard, M.M., *Reconnaissance of Mine Drainage in the Coal Fields of Eastern Pennsylvania, USGS WRIR 83-4274,* U.S. Department of the Interior Geological Survey, 1983
[3] US Public Law 179, 36 STAT 369, May 16, 1910
[4] US Public Law 179 amended, 27 STAT 881, Feb. 25, 1913
[5] Kirk, William S. *The History of the U.S. Bureau of Mines,* U.S. Department of the Interior, Bureau of Mines, 1995

project was completed in 1952 at a total tunnel length of 11,299 ft. The Conowingo Tunnel Project proposal was partially fueled by the success of this project.[6]

(In February 2008 ongoing collapses of the LMDT generated a lot of attention in the press when the county commissioners issued a disaster declaration and press release about the "immediate risk of a catastrophic blow out." Soon, television news trucks and politicians were circling. The Bureau of Reclamation, which runs a water treatment plant at the tunnel's mouth, had known about collapses in the tunnel for years, but said they posed no threat. The U.S. Environmental Protection Agency and county officials, though, believed a backed-up pool of mine water could burst through the tunnel mouth and cause flooding and contamination or seep through the hillsides into the Arkansas River. EPA drilled a relief well into the tunnel, installed a pump and constructed nearly a mile of pipeline to transport water from the tunnel to the water treatment plant built in 1991 and managed by the Bureau of Reclamation. EPA has been pumping water to the treatment plant for the past three years.)[7]

Between 1944 and 1954, engineers of the USBM Anthracite Flood-Prevention Section carried out a study to suggest potential solutions to the mine water problem in anthracite. In the course of this study the USBM published 25 bulletins, information circulars, reports of investigations, and technical papers on all aspects of the mine water problem, such as pumping records of all mines, underground mine water pools, condition of barrier pillars, evaluation of surface and stream bed seepages, corrosion properties of mine water, and mapping of the buried valley of the Susquehanna River.

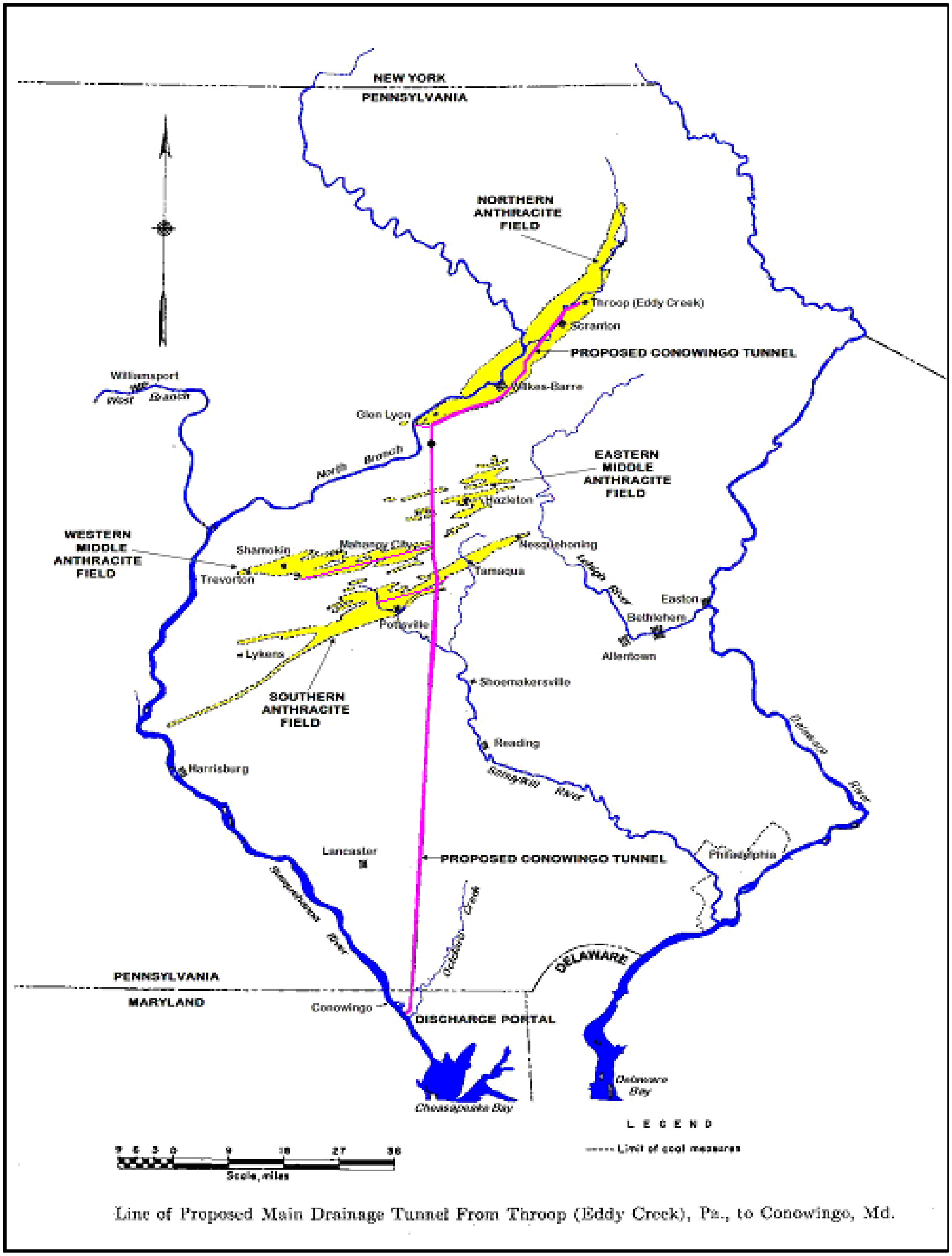
The engineering study made comprehensive recommendations for possible solutions of the anthracite mine water problem. Most spectacular and ambitious was a plan for an extensive drainage tunnel system that would provide for gravity drainage of all anthracite mine water into the Octoraro Creek, the last significant tributary of the Susquehanna, which discharges into the estuary of the Susquehanna River below the Conowingo Dam. The plan called for driving a main tunnel 137 miles long, with several lateral or branch tunnels leading to three of the four separate anthracite fields.[8]

---

[6] *A Summary of Existing Reports which have Examined the Leadville Mine Drainage Tunnel (LMDT) Technical Memorandum 8220-05-11* U.S. Department of the Interior Bureau of Reclamation April 2005

[7] Colorado Springs Gazette, *A potential problem averted in Leadville, officials say*, February 13, 2009

[8] Ash, S.H., Dierks, H.A., and Miller, P.S., Mine Flood Prevention and Control Anthracite Region of Pennsylvania, USBM Bulletin 562, U.S. Department of the Interior, Bureau of Mines, 1957.



Line of Proposed Main Drainage Tunnel From Throop (Eddy Creek), Pa., to Conowingo, Md.

Route of Conowingo Tunnel

Source - Mine Flood Prevention and Control Anthracite Region of Pennsylvania, USBM Bulletin 562[8]

The preliminary design of the Tunnel was based on the anthracite region's Jeddo Tunnel system, which will be described more fully later in a subsequent section of this paper; California's Colorado River aqueduct and San Joaquin River projects; New York's Delaware aqueduct; and mine pumping systems in place in the early 1950s.

The Conowingo Tunnel would have consisted of a single circular concrete-lined tube, varying in size from 9' diameter (Φ) at the inlet in the Eddy Creek Mine to 16' Φ at the discharge portal in Maryland. It would have been driven at a gradient of 1 foot per mile, and would have had a capacity of 381,000 GPM. At Eddy Creek the invert would have been 152' above sea level and at the discharge the invert would have been 15'. Several lateral and connector tunnels, fifteen new shafts, utilization and rehabilitation of another 15 existing mine shafts and two emergency pumping plants with 300,000 GPM capacity each would have allowed for construction, inspections, emergencies, and possible maintenance. The project's price tag was "estimated" at $280,292,163 in 1954 – some $3.8 billion in today's dollars (the build-out of the project, including lateral tunnel extensions, and a Wyoming Valley North tunnel would have increased the cost to some $400 million), with an estimated five to ten-year construction period.

The comprehensive tunnel project was broken into construction projects that were somewhat independent of each other but that could be combined with the others for various options. Additional work would have been needed to service all of the anthracite fields.

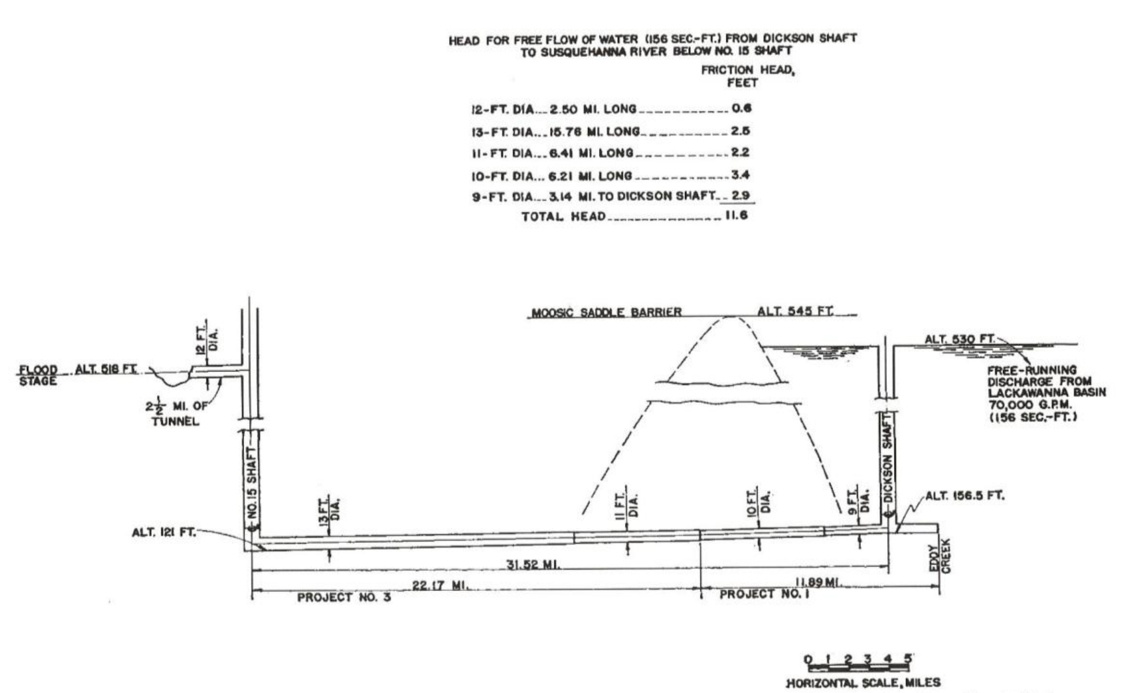
- Project No.1 (Lackawanna Basin – Lackawanna County), consisting of
  - 5.7 miles of 9' Φ tunnel and 6.2 miles of 10' Φ tunnel from Eddy Creek in Throop to between the Old Forge and Laflin Shafts
  - Reconditioning the Dickson, Dodge and Old Forge Shafts
  - Installing a temporary pumping plant in the Old Forge Shaft and constructing a discharge tunnel from the Old Forge Shaft to the Lackawanna River.

All water from the Lackawanna mines could be drained by gravity to this tunnel (145'-157' elevation in this section). The pumping plant at Old Forge could have been used to dewater all of the active mines in the Lackawanna Basin, or could have been used to prevent the flooding of the Wyoming Basin when the entire Lackawanna Basin was abandoned.

- Project No. 3 (Wyoming Basin – Luzerne County – the next project geographically south), which consisted of
  - Main Tunnel – 6.4 miles of 11' Φ tunnel, 15.8 miles of 13'Φ and 1 mile of 14' Φ from near Laflin to 1 mile past the No. 15 Shaft at Glen Lyon
  - North Wyoming Lateral – 1 mile of 9' Φ to connect to a future project to drain the northern side of the basin No. 7 to Swoyersville (an additional 13.9 miles, with two shafts and a maintenance slope)
  - Recondition the Alden and Baltimore No.2 Shafts
  - Recondition and deepen the No. 15 water discharge, Sugar Notch, Laflin
  - Excavate shaft at No. 15 (Glen Lyon) Install a permanent pumping station and a 2.4 mile 12' Φ tunnel to the Susquehanna River (at 518' elevation).

Mines in the Wyoming Basin are deeper than the level of the tunnel (elevation 121' -145' through this portion), and pumping would have to continue from active mines, but at a lowered head (and cost). The main tunnel could also be used to drain the Lackawanna Basin to the Susquehanna River. The pumping station, consisting of three 200 CFS pumps, would allow for drainage while the remainder of the Tunnel was completed, or to pump for inspection of the completed Tunnel.

Apparently, there was an opinion that only Project 1 and the main tunnel of Project 3 would be funded and completed. There was a strong argument made in all of the published papers that the most critical and most economic value was to prevent the flooding of the Wyoming Basin when the mines of the Lackawanna Basin were shut down. Completing Project 1 and the main tunnel of 3 would allow the Lackawanna Basin Mines to be abandoned and the water would not overflow to be pumped to the river at Mocanaqua.



Graphic Analysis of Conditions Permitting Free Flow of Water From Lackawanna Basin Into Susquehanna River Below No. 15 Shaft.

Source - Mine Flood Prevention and Control Anthracite Region of Pennsylvania, USBM Bulletin 562[8]

- Project No. 4 (Luzerne and Schuylkill Counties – the next project South):
  - 19.5 miles of 14' Φ tunnel between Glen Lyon and Mahanoy City
  - Three construction/maintenance shafts located at low points in the topography approximately 7 miles apart (one of them located near my home in Hobbie).

Project 4 was to connect Project 3 and Project 2. This portion of the tunnel did not drain any mines. It was located so it also did not cross under any major stream.

- Project No. 2 (Schuylkill and Northumberland Counties) consisting of
  - Main tunnel consisting of 2.6 miles of 14' Φ; 5.04 miles of 15' Φ; and 3.8 miles of 16' Φ between Mahanoy City and Brockton, between 102' and 113' elevation.

- Lansford Lateral - 2 miles of 9’ Φ tunnel to Tuscarora to connect with future lateral to drain Panther Valley (an additional 13.5 miles and three maintenance slopes)
- Lykens Lateral - 9 miles of 10’ Φ and 1.6 miles of 9’ Φ tunnel from Brockton to Pine Knot, to later be extended to Williamstown-Lykens (16.8 miles)
- Trevorton Lateral – 10 miles of 11’ Φ; 5 miles of 10’ Φ and 5 miles of 9’ Φ between Mahanoy City and near Helfenstein, ultimately to extend to Trevorton (10.2 miles and two maintenance slopes)
- Five construction/maintenance shafts: at Mahanoy City on the main tunnel; Broad Mt and Mine Hill shafts on the Lykens Lateral; and Boston Run and Girardville shafts on the Trevorton Lateral
- Construction/Maintenance slopes at Locustdale and Helfenstein on the Trevorton Lateral
- One shaft and a permanent emergency pumping station at Brockton with six 200 CFS pumps. The pumps would have discharged to the Schuylkill.

The shaft and pumping station at Brockton would have allowed Project 2 to be independent of any of the others. Pumps could have dewatered the Western Middle and part of the Southern Fields, or, with extension of the three laterals, the Southern Field.

- Project No. 5 (Schuylkill, Berks, Lancaster Counties PA, Cecil County MD) consisting of
  - 71 miles of 16’ Φ concrete-lined tunnel.
  - Ten construction/maintenance shafts
  - Portal on Octoraro Creek
  - Concrete canal to convey mine water into center of Susquehanna.[8]

Approximate Location of Proposed Portal of Tunnel, Conowingo MD - Google Map

[8] Ash, S.H., Dierks, H.A., and Miller, P.S., *Mine Flood Prevention and Control Anthracite Region of Pennsylvania, USBM Bulletin 562,* U.S. Department of the Interior, Bureau of Mines, 1957.

Mine Drainage in the Anthracite District

A reconnaissance of mine drainage in the Pennsylvania anthracite coalfields by the United States Geological Survey (USGS) in 1983 identified 251 sites (more than one discharge per every two square miles of coal measures) that had a total discharge of 918 cubic feet per second (CFS) (412,000 GPM).

MAJOR ANTHRACITE MINE WATER DISCHARGES (all data approximate)						
Description	**Discharge (CFS)**	**Discharge (GPM)**	**pH**	**Sulfate (mg/L)**	**Iron (mg/L)**	**Manganese (mg/L)**
NORTHERN FIELD						
Jermyn Slope	26	11,500	5.8	205	1	1
Peckville Shaft	14	6,000	5.6	160	1	1
Old Forge Borehole	83	37,000	6.0	600	33	4
Duryea Breech	20	9,000	6.1	505	37	5
Solomon Creek Boreholes	30	13,000	5.7	1220	190	11
Airshaft Number 22	16	7,200	5.8	760	74	7
EASTERN MIDDLE FIELD						
Beaver Meadows Tunnel	13	6,000	3.7	160	1	3
Jeddo Tunnel	83	37,000	3.8	515	4	8
Audenreid Tunnel	12	6,000	3.4	290	2	4
WESTERN MIDDLE FIELD						
Gilberton Pump	15	7,000	6.1	820	53	13
Packer Number 5	35	16,000	6.1	1000	32	10
Scott Ridge Mine	11	5,000	5.4	680	41	5
SOUTHERN FIELD						
Greenwood Mine	17	8,000	6.7	1400	21	9
Pine Knot Mine	16	7,000	5.9	335	9	4

Source USGS Water-Resources Investigations Report 95-4243[9]

The Tunnel would have intercepted and diverted more than 80% of this water to the portal at Conowingo.[10]

EST. MINE DRAINAGE TO CONOWINGO

	(CFS)	(GPM)
NORTHERN FIELD	618	277,000
WESTERN MIDDLE FIELD	149	67,000
SOUTHERN FIELD	121	54,000
CONOWINGO TOTAL	**888**	**398,000**
EST. MINE DRAINAGE REMAINING IN NEPA		
EASTERN MIDDLE	**107**	**58,000**

[9] Wood, Charles R., *Water Quality of Large Discharges from Mines in the Anthracite Region of Eastern Pennsylvania, USGS WRIR 95-4243*, U.S. Department of the Interior Geological Survey, 1996

[10] Growitz, Douglas J et. al., *Reconnaissance of Mine Drainage in the Coal Fields of Eastern Pennsylvania, USGS WRIR 83-4274*, U.S. Department of the Interior Geological Survey 1985

No provisions were made for the treatment of water at the discharge "because it has been stated many times that the treatment of acid mine water at the mine is impracticable and too costly"[8], but that treatment (neutralization) of the water at Conowingo "in the future" should be considered to utilize the water for industrial or agricultural purposes in lieu of "utilizing desalinized seawater".

Jeddo Tunnel

The project would not have taken any water from the Eastern Middle Anthracite Field, because it was assumed that the reserves in the Hazleton area were nearing exhaustion. The largest single anthracite discharge at that time and today, the Jeddo Tunnel, would not have discharged into the Conowingo, although the Tunnel would have been almost directly under the Jeddo discharge.

There are 13 functional mine drainage tunnels in the Eastern Middle Field that were specifically driven between 1890 and 1934 to dewater the mine workings. This drainage system, part of the genesis for the Conowingo proposal, was most successful in the Eastern Middle Field because the comparable elevation of the drainage tunnel discharges to the receiving streams, as would the Conowingo. The Jeddo Tunnel is by far the most extensive of these tunnels. Much has been written about the Jeddo Tunnel, in terms of an extraordinary engineering feat and the eventual success of dewatering the coal basins (before the Conowingo proposal) and more recently, its deleterious environmental impact.

The Jeddo Tunnel mine discharge near Hazleton is the largest abandoned underground mine discharge in Pennsylvania. The Jeddo Tunnel has a total drainage area of 32.24 square miles, and its underground drainage system collects and discharges more than half of the precipitation received in the drainage area.[11]

The Jeddo Tunnel's measured average annual discharge flow during a three-year 1995-1998 period was 80 CFS (35,600 GPM) and the range of recorded flow measurements was between 20 CFS (9,000 GPM) in October 1995 and 480 CFS (216,000 GPM) in November 1996.[12] Much of the rainfall over the Jeddo Basin reports to this tunnel, with a 2.56" rainfall on January 19, 1996 raising the flow of the Jeddo Tunnel from 34 CFS (12,700 GPM) to 409 CFS (152,900 GPM).

The average (design) flow of the Conowingo Tunnel was 630 CFS (280,000 GPM), with a maximum capacity of 850 CFS (381,000 GPM).

---

[11] Hornberger, R.J, et. al., *Coal Ash Beneficial Use in Mine Land Reclamation and Mine Drainage Remediation in Pennsylvania, Chapter 2, GEOLOGY OF THE PENNSYLVANIA COAL REGIONS, PA DEP, 2004*

[12] Ballaron, P. B., *Water balance for the Jeddo Tunnel basin, Luzerne County, Pennsylvania*, SRBC, 1999

JEDDO MINE DRAINAGE TUNNEL, Sugarloaf Township, Luzerne County PA

Showing Jeddo Tunnel discharging ~220,000 GPM, similar to the Conowingo Tunnel average flow.

-M. C. Korb, 2005

Assuming a composition based on a flow weighted average, the water discharged at the Conowingo would have had an estimated analysis of 5.3 pH, 650 ppm Sulfates, 25 ppm Iron, 6 ppm Manganese, and 200 ppm Acidity.

SCOTT RIDGE DISCHARGE, Kulpmont, Northumberland Co.

(Scarlift Site 19) has chemistry similar to the anticipated Conowingo Tunnel discharge parameters

-M. C. Korb, 2006

Decision of the Commission

In 1954 the Commonwealth of Pennsylvania established an Anthracite Mine Drainage Commission (Edward G. Fox, Bituminous Coal Operators, Francis O. Case, Glen Alden Corporation, and Edgar C. Weichel, Hudson Coal for the industry; August J. Lippi, District 1, Martin Brennan, District 7 and Joseph Kershetsky, District 9, for the UMWA) under the chairmanship of W. J. Clements, the Secretary of Mines, to evaluate proposals for dealing with the anthracite mine water problem and, more specifically, *to review the drainage tunnel scheme*.

The Commission submitted a report to John S. Fine, Governor of Pennsylvania with a recommendation that the long-range tunnel plan be shelved, because of its magnitude in scope and expenditures, in favor of a short-range action plan of limited scope and cost. The plan recommended was a revision of a postwar employment proposal, formulated in 1943, providing for pumping plants in mines, and for ditches, stream bed improvement, and backfilling of stripping pits to reduce surface water seepage into the mines.[1] The Commission listed their objections to the tunnel plan:

1. *borrowing $400 million @3% interest would cost $12 million/year vs. pumping costs of $8.5 million;*
2. *the danger of lowering the water table in the limestone area south of the mine lands;*
3. *special land condemnation legislation in PA and MD would be required for the rights-of-way and shaft locations and rock disposal;*
4. *high standby costs for power at pump stations;*
5. *communities in the anthracite region might lose their stream sources of drinking water during low flow periods;*
6. *possible damage to aquatic habitat and wildlife such as oyster beds in the Chesapeake Bay;*
7. *The inability of the anthracite companies to financially participate in the plan*.[13]

From today's perspective the plan was fantastic, and perhaps preposterous. In its 2010 State of the Susquehanna Report[14], the Susquehanna River Basin Commission states:

> *The effects of abandoned mine drainage on the Chesapeake Bay may not be immediately apparent, but AMD has an effect on upstream reaches in the Susquehanna basin, which then can impact the Bay ecosystem. In an AMD-impacted stream, aquatic life, such as macroinvertebrates, plants and fish, is reduced or eliminated, which inhibits the proper functioning of a stream ecosystem. The introduction of sediment from abandoned mine land areas also contributes to downstream loads that reach the Bay, while cleaning up streams impacted by AMD benefits the Bay ecosystem.*

Obviously the Tunnel would have made the effects of abandoned mine drainage immediately apparent to the Bay and the introduction of the AMD in a large slug in the estuary without the dilution and settling in the River likely would have caused a

---

[13] Gettysburg Times, *State commission Rejects Big Mine Drainage Tunnel*, Dec. 20, 1954

[14] *State of the SUSQUEHANNA 2010 Report,* Susquehanna River Basin Commission, 2010

substantially different impact on the Bay ecosystem. However, it would have also cleaned up some 400 miles of rivers and streams that are impaired by AMD.

Consumptive water use plans for the River would have been greatly impacted with the removal of some 400 CFS (258.5 million gallons per day - MGD) from the River. As a reference, PPL's Susquehanna Generating Station in Luzerne County withdraws 41 MGD, and the low flow recorded at Marietta PA is ~1250 MGD.

> "During periods of low flow, most stream habitats are reduced in extent and water quality, and biota can be affected. During summer months, natural low flow conditions can be exacerbated by the effects of increased water demand for agricultural, household, recreational, and energy uses. The Susquehanna River Basin (Basin) is experiencing increased demands, particularly in the energy sector, which are expected to continue to increase, potentially straining the resources of the mainstem Susquehanna River as well as its smaller tributaries. Additionally, as climate changes over time, the occurrence intervals and intensity of droughts may change in response."

Legislative Action

On the basis of the report by the Anthracite Mine Drainage Commission to the Governor of Pennsylvania, the Conowingo Tunnel Comprehensive Project was shelved, because of its magnitude and scope of expenditures, in favor of a short-range action plan of more limited scope and cost. The General Assembly of Pennsylvania and the 84th Congress of the U. S. enacted legislation that established a State-Federal Mine Drainage Program, for which a total appropriation of $17,000,000 was to be made available. The Federal government established a Branch of Mine Drainage in the USBM Branch of Anthracite, and the Pennsylvania legislation authorized the Department of Mines and Mineral Industries mine drainage program to formulate and execute projects under the acts and in accordance with administrative procedures between the agencies.

Flood Control Program

Actual work done under the State-Federal flood control program included installation or construction of three major types of facilities designed to assist the operating companies in their individual and cooperative efforts to reduce pumping costs and prevent the flooding of active mines:

1) Electrically driven deep-well pumps, of the vertical turbine type, to be placed in shafts or boreholes of idle and abandoned mines for the purpose of controlling the level of the mine water pools and preventing overflow into adjacent active mines.

2) Stream bed improvement to eliminate or at least materially reduce stream bed seepage by lining the old channels with concrete slabs or bituminous coatings, or by relocating channels onto noncaving or impervious ground or conducting the flow over broken and subsided surface in flumes or pipes made of wood, steel, or concrete.

3) Surface improvement to reduce surface seepage in certain limited critical areas by grading or ditching for unimpeded run-off and by backfilling and grading crop falls and abandoned stripping pits that are connected to underground workings. [15]

There were 29 projects approved under the acts, of which 7 were canceled because mining, drainage or economic conditions changed. Of the remaining 22 projects, eight provided deep-well pumping plants to control mine water pools and 14 provided surface improvements to eliminate or control surface seepage into mines. Total expenditures under the program were $7,017,555(~$96 million 2010$), 50% Commonwealth and 50% Federal funds.

Deep-well Pump Projects

Twenty-nine deep-well pump units (pump, motor, column line, and controls) plus five spare motors and seven spare bowls, were supplied for these projects. Twenty five of these were purchased with funds from the Federal-State Mine Water Control Program and four owned by the Commonwealth were supplied to the project. The twenty five pumps were purchased at a cost of $4 million and the cost of installation, including some head frames, fencing, pumping platforms, discharge basins, and discharge lines, brought the total cost to $5,243,000 (~$72 million 2010$). The only pumps still in their original site are the two in Project 7 Tamaqua.

[15] Dierks, H.A., et. al., *Mine Water Control Program, Anthracite Region of Pennsylvania, July 1955-December 1961 USBM IC 8115*, U.S. Department of the Interior, Bureau of Mines, 1962

DEEP-WELL PUMP PROJECTS							
	PROJECT	LOCATION	PUMPS		CAPACITY	HEAD (FEET)	MOTOR HP EA.
			#	GPM	(GPM)		
1	DELAWARE-PINE RIDGE 1	NORTHERN	2	5000	10,000	460	800
4	EWEN (HOYT SHAFT)	NORTHERN	4	6000	24,000	470	1000
5	GREENWOOD	SOUTHERN	2	3000	6,000	1000	1000
7	TAMAQUA	SOUTHERN	2	6000	12,000	487	1000
13	BUTTONWOOD	NORTHERN	4	4000	16,000	580	800
22	ASKAM	NORTHERN	4	4000	16,000	900	1250
26	SOUTH WILKES-BARRE	NORTHERN	3	4000	12,000	850	1000
27	DELAWARE-PINE RIDGE 2	NORTHERN	4	6000	24,000	270	600
			25		120,000		

(On October 2, 1961 the Federal-State Mine Water Control Program (MWCP) resulted in one of the Events That Shaped Our Environment[16], when more than 300,000 fish were killed in the North Branch of the Susquehanna River when Glen Alden Coal Company began de-watering No. 5 South Wilkes-Barre colliery, an underground mine near Wilkes-Barre. Using the pumps supplied by the MWCP, Glen Alden pumped 19 MGD of acidic mine water into Solomon's Run which flowed into the river affecting water quality for more than 50 miles downstream. It caused the largest fish kill on the Susquehanna River and ultimately resulted in the largest fine levied by the Pennsylvania Fish and Boat Commission at that time - $45,000. The 1961 incident started a four year court and legislative battle to not only bring the Glen Alden mine water discharge under control, but to bring bituminous and anthracite mining operations under the provisions of the state Clean Streams Law.)

State-operated pump at Gilberton, Schuylkill County, one of the remaining MWCP pumps in operation.
This pump is currently operated to protect several hundred homes in Gilberton Borough whose basements and foundations are below the overflow level of the minepool - M. C. Korb, 2010

[16] http://www.portal.state.pa.us/portal/server.pt/community/events_that_shaped_our_environment/13894

Surface-drainage improvements

The mountains that surround the anthracite fields are steep and water runoff from the slopes pass across the coal measures to reach the valley drainage. Removal of the coal causes cracks in the rock cover that result in surface subsidences, allowing infiltration of surface water into the mines. In some instances, drainage channels had been altered by strip pits and cropfalls that provided additional inflows of surface water. Subsidence in streambeds has also altered the natural drainage to the extent that some or all the water from the stream flows to the mine.

Fourteen surface-drainage improvement projects were installed at a total cost of $1.8 million (~$25 million 2010$). Projects included paving 2.3 miles of streambed; installing 4.4 miles of half-round concrete flume, 0.6 miles of concrete pipe, and 1.8 miles of steel flume; construction of 8.9 miles of earth ditches; and backfilling 5.5 million cubic yards of strip pits.

Eight of the projects were in the Northern Field - four streambed improvements and four strip pit backfillings to reestablish drainage courses; two projects in the Western Middle and four in the Southern Field consisted of constructing side-hill ditches above the coal outcrops and strip pits to collect runoff, divert the water around strip pits, and installing flumes to convey the water to the valley streams.

1958 **2010**

Project 9, Leuders Creek, Nanticoke, Luzerne County
USGS[17]

These fourteen projects diverted an estimated 2.9 billion gallons of water annually, roughly equivalent to a mine drainage discharge of 5,500 GPM. (The Rausch Creek Treatment Facility, operated by the Commonwealth in Valley View PA treats an about 6,000 GPM of mine drainage. Built in 1973 at a cost of $3.6 million, ~$20 million 2010$, the plant annual operation and maintenance cost is $750,000.)

---

[17] Chaplin, J.J., Cravotta, C.A., III, Weitzel, J.B., and Klemow, K.M., *Effects of historical coal mining and drainage from abandoned mines on streamflow and water quality in Newport and Nanticoke Creeks, Luzerne County, Pennsylvania, 1999-2000: U.S. Geological Survey Scientific Investigations Report 2007-5061*, 2007

Maintenance of the projects was the responsibility of the operating companies, who are all out of business. None of the project improvements have been maintained, so a good portion of the diversion has been lost.

A look at several of the projects

The Lehigh Coal and Navigation Company (LC&N) began mining and transporting coal from the Panther Valley in the Southern Anthracite field in the 1790s. By the last quarter of the nineteenth century, it was among the half dozen major firms that constituted a cartel that set prices and production quotas and divided the market for clean-burning anthracite coal. The company operated underground mines in Nesquehoning, Lansford, Coaldale and Tamaqua that were somewhat interconnected and extended as much as 1,500 feet below the surface. In 1920 LC&N production was 4.8 million tons and employment was 7,000 men. In 1940 production had dropped to 2.5 million tons, and by 1960, all sales from the property were from lessees, mainly Fauzio Brothers Stripping and Hauling, and Coaldale Mining Company, the last underground operation in the Panther Valley. Coaldale Mining produced 865,000 tons in 1958 and employed 1,300 men.

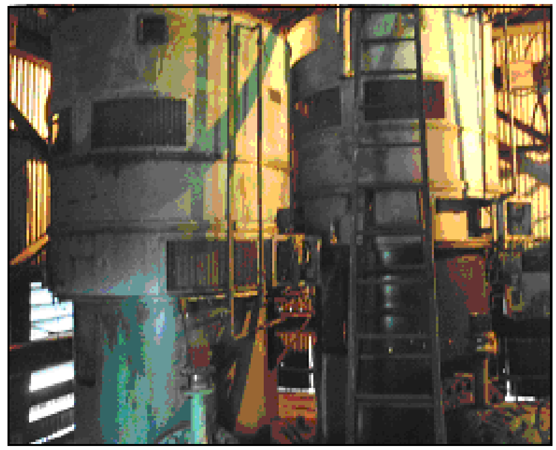
Five of the Federal-State Mine Water Control Program projects – two pumping plants and three surface improvements were installed on LC&N property to keep water out of the Coaldale Mining operations.

Pumping plants were installed in the inactive Greenwood and Tamaqua mines. Two 3000 GPM @ 1,000’ TDH with 1000 HP in the Greenwood #10, and two 6,000 GPM @ 487’ TDH 1,000 HP at Tamaqua #14. Both were supplied with head frames, hoist, pump platforms, controls, and fencing, at a total cost of $990,000 in 1960 ($12 million 2010$). Operation and maintenance were the responsibility of LC&N.

The pump projects were completed in July 1960, about four months after Coaldale Mining was closed. No further underground mining below drainage was attempted in the Panther Valley.

LC&N went out of business in 1965, when the Fauzio brothers bought the property. The pumping installations were then modified and used to allow deep stripping of the Greenwood and Tamaqua mine areas by the Fauzios, operating as Greenwood Mining and Stripping, and by Bethlehem Steel which purchased Greenwood’s operations in 1974. Deep stripping began by contractors for LC&N in the late 1940s and was continued by Greenwood Stripping, Bethlehem Mines, and the second Lehigh Coal and Navigation until the early 1990s.

Greenwood #10 Head Frame Today



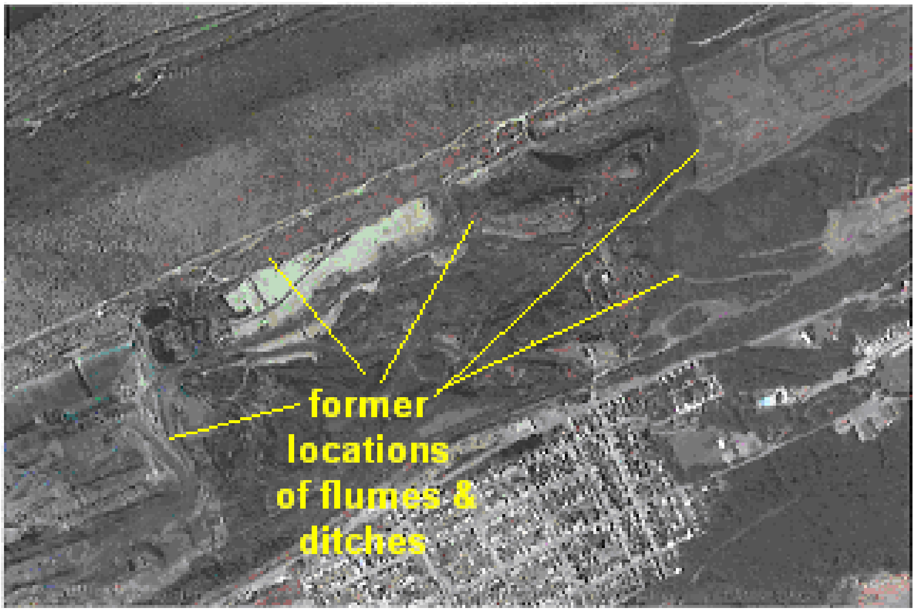
Tamaqua #14 Pumps Today
-M. C. Korb

Today, both the #10 and #14 head frames and fences are still in place, and pumps are still installed at Tamaqua #14, where they may be used by the present property owners to once again maintain the mine pool. The pumps at #10 Greenwood have been sold for scrap.

The Greenwood Job 111 pit was worked to an elevation of 300', about 500' below the current water level, and some 800' below the surface level. In 1992, a successor company, also called Lehigh Coal & Navigation (LCN2), ceased pumping and the mine pool rose and discharged at a location along Route 309 south of Tamaqua. LCN2 resumed pumping and the discharge did not flow again until 2001 when pumping was permanently ceased. Reclamation of the Greenwood Pit has not been completed although mining in the pit ceased more than twenty years ago. Several million cubic yards of backfill have not been placed in the pit, and LCN2 had not completed the reclamation when they went into bankruptcy in 2008 and were forced to sell in 2010.

111 Pit with Pumps Shut Down - 2010
Oblique - M. C. Korb **Aerial Photo – Google Map**

Three surface improvement projects to collect surface water above open strip mine pits and convey it by flume to the Panther Creek were constructed in 1957-1960, consisting of 14,600' of earth ditch, 14,600' of steel and concrete flume, 1,100' of concrete pipe, and other surface improvements costing $400,000 ($5 million 2010$). LC&N was to maintain the projects.



Coaldale Surface-Improvement Project 17
-Google Map 2010

The surface improvements and ditch work were never really maintained, with new strip pits, roads and drainage changes probably starting the day they were installed. In 1973 few of the flumes were existent and the ditches had trees growing in them. In the Coaldale Project 17 area, the concrete flume was nowhere to be seen, roadways were running where several of the flumes had been placed, strip pits crossed the route of the flumes, and a fine-coal plant was on one of the gathering ditches. Today, some steel flume exists, but no water flows in them.

Despite mine reclamation and AML backfilling of thousands of feet of exposed bottom rock – "highwall", Panther Valley today has over 18 miles of "highwall" and crop fall that runoff from the mountain enters when it rains. A rough estimation, based on the 1955 project data, of the effects of ditching and diverting water to the streams calculates more than 3,000 GPM (approximately 1/3 of the Panther Valley mine drainage) not reaching the mine pool. The 1973 Scarlift Little Schuylkill Project estimated 3,200 GPM from the western ½ of the Valley.[18]

[18] A.W. Martin Associates, *Little Schuylkill River Basin Mine Drainage Study Project WCE SL-167*, 1973

"Highwall" Exposures in Panther Valley
- PA DEP BAMR

Cropfall Exposures in Panther Valley
- Bing© Map

Watershed assessments and TMDL (total maximum daily load) studies conducted in the 2000s included remediation priorities and alternatives that reinforce the efficacy of the projects –

Various restoration activities could be considered to mitigate AMD contamination… The following restoration strategies generally could be applicable in watersheds affected by abandoned mines.

• Reclamation of abandoned surface mines, including removal of abandoned "highwalls" and spoil banks and filling abandoned surface-mine pits would eliminate surface- water accumulations that become contaminated with mine drainage because of contact with exposed acid-producing strata and reduce the amount of surface runoff directed into the

mine-pool systems. The regrading of disturbed areas, if returned to original contour before mining, would provide a more natural flow pattern for runoff and prevent surface water from percolating through abandoned refuse and entering underground mine pools.

• *Restoration of surface channels and flow of streams that now disappear into spoil banks and enter deep-mine pools could lessen the volume of water discharged by AMD sources.*[19]

Backfilling pits and crop falls, and managing drainage are a longer term solution, but it would appear that constructing and maintaining ditches and diversion channels would be a shorter term option for the property owners who want to keep the "highwalls" open, while lessening mine drainage from their properties.

The Scarlift Mine Drainage Study Reports of the 1970s gave estimates of the abatement that could be accomplished in the various watersheds.

Summary and Conclusions

What a different environment we would have if the Anthracite Mine Drainage Commission had recommended that the Conowingo Tunnel be built! Most of the anthracite region's major mine water discharges would have been moved from our streams and rivers to Maryland - More than 200,000 GPM of mine drainage discharges, and over 400 miles of Pennsylvania streams would not be impaired by AMD. If the remarkable engineering study had been implemented, the anthracite region, the Schuylkill River, the Lehigh River, the Delaware River, the Susquehanna River and the Chesapeake Bay all would be changed.

Legend in the anthracite region, supported by published accounts, of "traveling from Nanticoke to Carbondale without coming to the surface"[20] would have become fact, and your trip could have been on the "express" instead of the "local".

In spite of all the grand projects that were being done in the 1950s – the Interstate Highway System, the St. Lawrence Seaway, building nuclear power plants, and the space race - the Commission recommended the Anthracite Mine Flood-Control Project in lieu of the Conowingo Tunnel. That project only spent one-half its $14 million funding; proved to be "too little too late" in saving the anthracite underground mines; caused environmental damage and a stiffer enforcement of the Clean Water Act; and indirectly created one of today's largest enforcement problems for the PA DEP Pottsville District Mining Office.

Operation and maintenance of the projects was dependent upon the large companies that were in financial stress and soon went out of business, and few, if any of the projects were maintained. The benefits of the ditch installations, diversions and stream bed improvement only lasted for a short time. Today water is not being diverted from the bottom rock exposures and crop falls in the Panther Valley; streams in Nanticoke,

---

[19] Cravotta, Charles A., III and Kirby, Carl S., *Effects of Abandoned Coal-Mine Drainage on Streamflow and Water Quality in the Shamokin Creek Basin, Northumberland and Columbia Counties, Pennsylvania, 1999-2001 USGS Water-Resources Investigations Report 03-4311,*U S Department of Interior Geological Survey 2004
[20] Smith, S. R., *The Black Trail of Anthracite,* Kingston PA, 1907

Pittston, and Plymouth are disappearing into the mines, and mine drainage gushes from the tunnels, boreholes, strip pits, and other openings whenever it rains hard.

Mine drainage treatment is expensive and the magnitude of the mine drainage problem in Pennsylvania is great. Estimates to correct the entire AMD problem exceed $5 billion in capital costs alone. With current technology, there would be a tremendous ongoing operation and maintenance cost as well which would reduce the amount that could be spent on capital construction of new treatment systems. At current estimates, Pennsylvania could potentially focus up to $400 million toward AMD problems over the next 15 years which means that many, and in fact a vast majority, of mine drainage problems will not be addressed through the AML Program during this time period unless less costly technologies are implemented.[21]

Landowners are not required to abate, prevent, remediate, or ameliorate abandoned mine drainage from their properties. They are not required to divert drainage from abandoned mine features, nor in some cases, from active mine openings. They have no responsibility for the environmental damage caused by mine drainage from abandoned discharges, and many of them do not want the open strip pits filled because they may be remined in the future.

Landowners should be encouraged to divert water from mine openings they do not want to have reclaimed. Regulations to prevent highways, active mine operations, municipalities, and developments from directing water into underground mine openings should be promulgated.

I would also recommend that consideration should be given to making the prevention measures of diverting water from mine pools; filling strip pits where diversion isn't feasible; and alleviating infiltration the highest priority of the use of AML Program AMD reclamation moneys.

The Catawissa Creek Restoration Association (CCRA) has constructed mine drainage treatment systems on three of the five tunnels that contribute mine drainage the Catawissa, and they have been damaged by high water flow events. In a recent communication from Ed Wytovich, President of the CCRA, about damage at Oneida #1 from a storm in March, Ed says, "Almost all of the problems that we have had on any of our systems on the Catawissa can be traced back to storm events when we had extremely high flows through the discharges. If a way can be found to slow down or even stop streams [and storm water drainage systems] from entering the underground mine system it would not only help to then have continuous treatment of AMD but also reduce considerably repair costs due to frequent high water events. The only way we are going to be able to have reliable, long term treatment of AMD on these systems, in my estimation, is to stop the incursion of surface streams [and storm water drainage systems] into the mine drainage system especially during storm events."

---

[21] PA DEP BAMR, *Mine Drainage Treatability and Project Selection Draft Guidelines*, 2008

There will never be enough money available to construct, operate and maintain mine drainage treatment facilities for all of the discharges in Pennsylvania. Facilities that are constructed must bypass during rain events, and encounter damage from high flows frequently. Every tool we have should be used to prevent surface water from entering the mine pools of Northeast Pennsylvania.