The Recovery of the North Branch: 1940 to 2000 and Beyond

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Overview

The Potomac River's North Branch forms the boundary between Maryland and West Virginia. Downstream, the Potomac separates Maryland from Virginia and prior to entering and helping form the Chesapeake Bay, flows through the nation's capital. It is this segment flowing through Washington D.C. that has given rise to it's nick-name, "Our Nation's River".

The area of interest is the first 30 miles of the North Branch, from the headspring at the Fairfax Stone downstream to the Jennings Randolph Dam. This watershed covers 212 square miles, and includes 70 sub-watersheds. There are over 350 miles of streams in the watershed (3). Its major tributaries are Stoney River, Buffalo and Abrams Creeks in West Virginia and Laurel, Lostland and Three Forks Runs in Maryland. The total drop along the mainstem of the Potomac is 1200 feet, from 2700 feet near its headwaters to 1500 feet where it enters the lake. Within its watershed are the towns of Bayard, Gormania, and Elk Garden, West Virginia, and in Maryland, Gorman and Kitzmiller are the largest towns. The majority of the 212 square miles of drainage area of the North Branch is forested.

Recreational opportunities abound within the watershed. A large portion of the watershed is public property allowing access for hunting, fishing, hiking, camping and other outdoor activities. Numerous state parks, camp grounds, ski slopes, lakes and other recreational facilities can be found in or within a very short drive of the North Branch watershed.

Mining in the North Branch basin began in the early 1800's. Mining has occurred in almost all of the 70 sub-watersheds in the basin. Visible within the basin are many miles of un-reclaimed, abandoned highwalls and numerous gob piles. Most pre-1900 underground mines were small, with larger underground mines beginning after the turn of the century and increasing in numbers and size until after World War II, while surface mining generally began after 1920 and increased significantly after World War II. These early deep mines were usually developed in a manner that utilized gravity drainage to avoid water accumulation in the mine.

The Problem

The ingenuity shown by our forefathers in engineering mines to utilize gravity to remove the water from their work area is the main reason that the problem of acid mine drainage (AMD) exists in the North Branch today. How do we stop water from flowing downhill?

Today's problem is almost entirely due to these abandoned, gravity flow mines that continue to discharge AMD. If the mine mouth can be sealed, it usually does not hold and blows out, sending a gush of acid into the stream. The active mining industry, by remining many of these old mines, can play an important role in solving the problem that was created by the pioneers of the industry.

Acid mine drainage is formed when the water and pyritic material associated with the coal seams is exposed to air through the mining process as shown in the chemical equation below;

$$2\,FeS_2 + 7\,O_2 + 2\,H_2O \rightarrow 2\,FeSO_4 + 2\,H_2SO_4$$
$$\text{(Pyrite)} + \text{(Oxygen)} + \text{(Water)} \rightarrow \text{(Ferrous Sulfate)} + \text{(Sulfuric Acid)}$$

Dependent upon pH, temperature and element concentrations, additional reactions may take place forming additional acid.

AMD is characterized by low pH and high acidity as well as high concentrations of sulfate and dissolved metals such as iron, aluminum and manganese. The damage done to road culverts and concrete embankments by the acid results in millions of dollars in repair and replacement costs in the U.S. annually. Industry not only has to deal with the corrosive nature of AMD but also with the clogging effects of the metals as they precipitate.

Streams impacted by AMD will often be stained orange due to the iron and sulfur compounds precipitating onto the rocks in the stream. AMD is detrimental to all aquatic life, except for a few invertebrates, some algae, and many forms of bacteria. In high stream concentrations, AMD kills the fish and invertebrates in the stream. In lower stream concentrations, AMD stresses the biologic community by reducing the numbers of individuals through increased mortality rates, lowered reproductive success and increased juvenile mortality. Acid tolerant species will take over niches that once held members of the natural community. In addition, habitat is destroyed due to the precipitates filling the spaces between the rocks and gravel of the streambed.

The 1940's

By 1940, the North Branch, as well as the entire Potomac River was in poor environmental condition. An estimated 173,000 pounds (86.5 tons) of acid from both active and abandoned coal mines, discharged into the North Branch on a daily basis (1). In addition to AMD, a tremendous raw sewage load was being dumped into the river each day. Almost no natural biological communities existed upstream of Kitzmiller, Maryland (1). From the town of Kempton downstream to Beryl, a distance of over 33 miles, the pH of the North Branch didn't rise above 4.5 during the year (4).

The first recovery efforts of the North Branch began in the early 1940's with the establishment of the Interstate Commission on the Potomac River Basin as a fact-finding and coordinating (between federal, state and local governments) agency. Their role and mission has expanded over the years to include water quality monitoring, evaluation and studies, dissemination of information and technical support. During this decade, President Truman signed into law the first bill designed to reduce water pollution on a national scale, but it lacked workable enforcement actions.

The 1950's

By 1956, water pollution was becoming a national concern when President Eisenhower signed into law the 1956 Federal Water Pollution Control Act, which allowed for the first grants for pollution abatement. During the early 1950's, the mines at Kitzmiller, Shallmar, Vindex and Kempton, Maryland ceased operations, but their legacy of AMD to future generations was just beginning.

By the end of the decade, these mines, were collectively discharging an average of 17,000 pounds (8.5 tons) of acid per day into the North Branch. Today they continue as some of the worst contributors of pollution in the basin.

The 1960's

Federal water quality standards were established for America's rivers and streams by 1965. During the 1960's, surface mining activity increased in the basin resulting in increased AMD problems. Pollutants, other than AMD, were decreasing in the basin due to requirements for treatment of sewage and industrial effluents. The 1961 Federal Water Pollution Control Act increased enforcement of the 1956 law. After President Johnson's 1965 "State of the Union" address, the Water Quality Act of 1965 was passed, establishing the Federal Water Pollution Control Agency (FWPCA) and the requirements for water quality standards. A 1969 FWPCA study (2) found that the pH of the North Branch at Steyer, Md. was between 2.3 and 3.3 and at Kitzmiller was between 2.4 and 4.9. This same study identified 79,000 pounds per day of acid (67% of the total) entering the North Branch from West Virginia and 39,000 pounds per day (33 % of the total) from Maryland. According to this study the majority of the acid from West Virginia was coming from active surface mines while abandoned underground mines were producing the acid from the Maryland side of the river.

The 1970's

In 1970, the first Earth Day is observed. This event indicates the trend toward greater environmental awareness and concern that was taking place in America. In 1972, the Federal Water Pollution Control Act was again amended, charging the Federal Government with setting national standards and maintaining oversight of the individual state programs of pollution control and regulation. The Act also established the Environmental Protection Agency and created the National Pollution Discharge Elimination System (NPDES) which required a "permit-to-discharge."

With increasing coal prices in the early 1970's, mining of coal increased nationally, including Maryland. In 1977, the Surface Mining Control and Reclamation Act

(SMCRA) was passed into law, in response to the nation's concern about the impact of mining on the environment. This law required that all mining operations nationwide met or exceeded a set of standards for reclamation and required all water to pass through a treatment pond prior to discharging from the mine site. This law, in conjunction with the efforts of both Maryland and West Virginia helped eliminate a portion of the acid discharging into the North Branch. The pH of the North Branch was raised about two pH units during this time period.

The 1980's

Bloomington Dam is dedicated in 1981. The design and construction of the dam was completed using acid resistant materials due to the anticipated high acid content of the water to be impounded. The dam's design included the capability to discharge a mixture of waters from different levels in the lake allowing the operator to discharge a relatively high quality water almost year around. This allowed the tailrace waters to begin some biological recovery. The section of the River above the dam still experienced seasonal variations in water quality from pre-law discharges that precluded the establishment of biological communities. During low flows experienced by the River in the fall months, a larger percentage of the water in the River is AMD and thus often a lower pH than during the months of higher flows (2). Improved mining practices and a better understanding of the 1977 Surface Mining Control and Reclamation Act continued to play a major role in the recovery of the North Branch.

In 1988, Maryland, West Virginia, and the Office of Surface Mining entered into a cooperative agreement to investigate abandoned mine drainage sources in the North Branch watershed (2). The objectives of the study were to locate AMD sources, to identify the impacts of AMD on individual stream reaches, and to recommend potential abatement or treatment alternatives. This study determined that abandoned mine drainage is produced in 20 of the 70 sub-watersheds comprising the North Branch above Jennings Randolph Lake. This study showed a drop in acid loading of over 150,000 per day, from 173,000 pounds per day in the 1940's to an average of about 23,000 pounds per day in 1988.

The 1990's

By early 1990, Maryland was actively seeking solutions to the pre-law AMD problems in the North Branch. Using water quality and flow data from the 1988 cooperative study, a model was developed to determine the most strategic location for treatment facilities to restore the pH of the River to sufficiently support fish. In 1992, the Maryland Department of the Environment, Bureau of Mines' (BOM) first two lime dosers were installed in the North Branch watershed on Lostland Run and on the abandoned deep mine drainage that discharges directly into the North Branch near Kitzmiller, MD. By the end of 1993, two more dosers were installed at two other locations identified by the model -- Laurel Run near the town of Kempton, Maryland and the mainstem of the North Branch near the town of Gorman, Maryland. In 1997, a fifth doser was added to the system at the Vindex AML site. The Vindex doser treats an acid source before it flows into Three Forks Run, effectively eliminating a chemical barrier that existed in the North Branch, and prevented fish from migrating out of the Lake and up the River. In 1998, a sixth doser was added at the Kempton Air Shaft. The Air Shaft doser has become the “Work Horse” of the system by treating the majority of the AMD in Laurel Run. It also guarantees a degree of safety for the system by having two dosers (the Laurel Run Doser and The Kempton Air Shaft Doser) on this major AMD source in the North Branch, both of which are capable of treating the AMD in Laurel Run independently from one another.

In anticipation of the doser project, a comprehensive baseline biological and chemical evaluation of the entire length of the North Branch above the Lake was conducted prior to doser installation in 1991 and 1992. To evaluate the effectiveness of the doser project, post-treatment biological and chemical data have been collected on a monthly basis from 1994 to 1999. These data show that the Doser Project has been successful 1) in increasing the average pH of the entire length of the North Branch and 2) in allowing for the initiation of biological recovery of the system. The dosers not only increased the average pH of the North Branch but more importantly, they have eliminated the episodes of low pH. Low pH is usually associated with low flows in AMD impacted systems, these low pH waters can kill the macroinvertebrates and fishes in the system. By eliminating the episodes of low pH in the North Branch, the biologic community has been allowed to reestablish. In 1994, as a result of the success of the doser project, the North Branch above Jennings Randolph Dam was stocked with trout for the first time ever. The annual stocking of trout has continued and is a boon to the local economy.

In addition to the dosers, the BOM has installed two passive systems in the North Branch watershed at Elklick Run. The first project, an Anoxic Limestone Drain was constructed in 1994, and has successfully eliminated 70 tons of acid and 3,200 pounds of iron per year while adding 3,000 pounds of excess alkalinity to the system. In 1998, the second system, a Successive Alkalinity Producing System (SAPS) was constructed near the headwaters of Elklick Run. This project is eliminating 3.2 tons of acid and 1,600 pounds of iron annually. These two projects have raised the pH of Elklick Run from 4.3 to 5.4.

An AML project near the headwaters of the North Branch of the Potomac River was completed in 1998. This project reclaimed 28 acres of coal waste in the town of Kempton, Maryland. Gob was removed from the stream channel and 5 acres of wetland were restored on the project area. Prior to reclamation, sediment and acid flowed into the North Branch from this site and into a “Wetland of State Concern”. Reclamation of this site has resulted in the elimination of significant environmental impacts to the stream and the wetland.

2000 and Beyond

Elklick Run

Modifications to the second Elklick System are planned for 2000 and are expected to result in the annual removal of an additional 1.5 tons of acid and to annually contribute an additional 1.5 tons of alkalinity to Elklick Run and ultimately the North Branch. A third project will be under construction in the Elklick Run watershed in the spring of 2000. This SAPS system is expected to remove 180 tons of acid, 46,000 lbs. of iron and add an additional 2.6 tons of alkalinity per year to Elklick Run. The completion of these 2 projects should raise the pH of Elklick Run to over 6.0 and allow for the reestablishment of a healthy biological community in the stream.

Abandoned Mine Lands Projects

Three AML projects are currently at the design phase. The reclamation of the Shallmar Refuse Pile will result in the elimination of a hazardous situation and the reduction of sediment and acid runoff from the refuse pile. In addition, a doser will be installed to treat the AMD from an abandoned deep mine. The second project, the Kitzmiller Refuse project, will reclaim 12 acres of refuse, and redirect the AMD from an abandoned deep mine through the existing Kitzmiller Lime Doser. This will allow for more efficient and effective treatment of the AMD. The third project, located on the 74 acre Vindex AML site that was reclaimed in 1997, will utilize a series of passive system technologies to treat the AMD at the previously reclaimed AML site. These passive systems will reduce the dependency on the doser at this site.

Kempton Mine Complex

The BOM is undertaking a full scale, cooperative investigation of the Kempton Mine Complex (KMC) with a variety of agencies. It is the goal of all involved to develop a remedial measure that will reduce the AMD at Laurel Run by 1) decreasing the quantity of recharge to the pool (14) and/or 2) improving the quality of the discharge from the mine pool. In order to correctly characterize the hydrogeologic interactions occurring in the area, it is important to collaborate with many agencies that have the capabilities of providing a variety of services. The end result of this study will be brought together in a Geographical Information System (GIS) for analysis and project planning purposes.

The BOM in cooperation with Maryland Department of Natural Resources, Power Plant Research Program (PPRP) provide monies to Frostburg State University, Department of Geography (FSU) that fund a fully operational GIS Laboratory. Western Pocahontas Properties digitized the underground workings from historic mining maps. The completed coverages were then refined by Dr. Ben Hayes of Susquehanna University and supplied to the BOM for their project. Although this has been a collaborative effort among many parties, FSU will centralize the development of this representative GIS package. The GIS in its completed form will provide a comprehensive informational database of the analysis completed and of all imagery and maps developed.

A crucial component in learning about the hydrogeologic conditions in the underground mine complex is the collection of field data. Weirs were installed by BOM at all KMC pool discharge locations. Data is collected at the weirs on a regular basis and plotted against daily precipitation values to help in determining recharge to the mine pool. Flows have been taken at all streams that bisect the complex to determine if direct infiltration to the mine pool is occurring through the stream beds. Stream flows at sites that have been identified as possible water loss locations continue to be monitored. By determining infiltration losses found in these streams, it may be possible to select remediation measures to decrease the discharge quantity by a substantial amount. One suggested technique is stream-bed lining.

To aid in accurately assessing both the AMD discharges from and water recharge into the KMC pool, a variety of cutting edge remote sensing technologies have been conducted. Sub-contracted by FSU, 3DI, LLC (15), an aerial photography company, provided the first digital images of the KMC area in a format known as hyperspectral imagery. Hyperspectral imagery utilizes an airborne imaging spectrometer to represent the characteristic reflectance of objects on the earth's surface unique to specific compositions. This imagery aids in the identification of AMD seeps previously unknown but related to the Kempton pools.

Contracts with BOM and PPRP have secured the Federal Department of Energy (DOE) to provide digital images that represent thermal changes on the surface. These images will also be useful in identifying hidden seeps occurring within a water body, but unable to be detected spectrally due to dilution. To aid in identifying losses, DOE is carrying out conductivity studies that will help to locate fracture zones or subsidence that would allow the passage of water into the KMC pools. This will aid in determining water losses from the surface and into the abandoned mine complex.

To further assess the geology of the area, the agencies involved have depended upon other state organizations and private industries to fill in some of the blanks not obtainable through regular field observations. West Virginia Division of Environmental Protection has been exceptionally helpful in providing Maryland with data found in their archives. Much information concerning problems that have already arose due to the mining in the area was obtained through their records. Private industries in the area have been extremely cooperative in providing past hydrologic and geologic data that is being incorporated into the GIS. Both Buffalo Coal Company and Mettiki Coal Corporation are supplying information ranging from historic mine facts to geologic core logs. West Virginia Geological and Economic Survey has allowed access to a variety of coal maps depicting the coal layer mined in the KMC. The New Historic Society of Thomas, West Virginia, has allowed FSU staff to review old mine documents and maps abandoned by the mine company upon closure of the mines. All of these records are being sorted and organized into the GIS for use in analysis.

Summary

The recovery of the North Branch of the Potomac River that has taken place over the last half century must be attributed to many events and many dedicated individuals. The fact that no one event, individual, or piece of legislation can be singled out for all of the credit for this recovery sheds light on the complexity of the problem. It also lends credence to the idea that the "final solution" will be found through a cooperative effort between state, local, federal, academia and private individuals. Although the biology and chemistry of the North Branch has improved significantly during the last half century, much more improvement can be realized. The continued efforts of all of the individuals and organizations will be necessary to allow the North Branch to achieve its full potential.

Legislative, Agency and Other Important History

1940 Interstate Commission on the Potomac River Basin (ICPRB) is created.

1943 ICPRB publishes its first report on the condition of the basin.

1947 Maryland's Water Pollution Control commission is created.

1948 The first Federal Water Pollution Control Act is enacted.

1950 Soil Conservation Districts are established to cover the basin.

1952 Savage River Reservoir goes into operation.

1955 Congress directs the Army Corp of Engineers to study the North Branch.

1956 Legislation is passed that strengthens the 1948 Federal Water Pollution and Control Act.

1957 The U.S. Public Health Service declares the Potomac River unsafe for swimming.

1960 Upper Potomac River Commission treatment plant in Westernport, MD begins operation.

1962 Congress authorizes the Bloomington Dam.

1965 The Water Quality Act of 1965 passes, establishing a Federal Water Pollution Control Agency and requiring water quality standards.

1970 The U.S. Environmental Protection Agency is established.

1971 The Federal Water Pollution Control Act Amendments are passed, establishing a national goal of "swimmable-fishable" waters.

1977 The Federal Surface Mining Control and Reclamation Act is passed.

1981 The Bloomington Dam is dedicated.

1987 The Clean Water Act is revised.

1992 WV, MD and U.S. OSM joint North Branch AMD Study is completed (Published 1994).

1994 MD's first 4 Lime Dosers begin fulltime operation.

1995 MD stocks trout in the North Branch for the first time.

1997 Vindex Lime Doser installed.

1998 Kempton Air Shaft Doser installed.

1998 The Potomac River is designated an American Heritage River.

Literature

#1 Interstate Commission on the Potomac River Basin, "**Healing a River, The Potomac: 1940-1990"**, 1990

#2 Federal Water Pollution Control Administration, "**Mine Drainage in the North Branch Potomac River Basin**" Technical Report No. 13,

#3 West Virginia Department of Environmental Protection, Maryland Bureau of Mines, Office of Surface Mining Reclamation and Enforcement, "**North Branch Potomac River Abandoned Mine Drainage Study",** 1994.

#4 **Mine Acid Summary, State of Maryland,** June 1,1940

#5 Corp of Engineers, Baltimore District, **"North Branch Potomac River Basin Mine Drainage Study, Phase I, Task I Report"**, 1976

#6 U.S. Department of the Interior, Chesapeake Technical Support Laboratory, **"Mine Drainage in the North Branch Potomac River Basin"**, Technical Report No. 13, 1969

#7 Maryland Bureau of Mines, **"Biological and Chemical Evaluation of the North Branch of the Potomac River Restoration"**, 1992

#8 Federal Water Pollution Control Agency, **"Mine Drainage Pollution of the North Branch of Potomac River 1966 – 1968"**, 1968

#9 Interstate Commission on the Potomac River Basin, **"Potomac Water Quality Status and Trends (1973 – 1984)"**, 1987

#10 Interstate Commission on the Potomac River Basin, **"State of the Potomac River Basin",** 1985

#11 Interstate Commission on the Potomac River Basin, **"Potomac River Basin Water Quality 1986 – 1987"**, 1990

#12 Interstate Commission on the Potomac River Basin, **"Critical Areas in the Potomac River Basin, A Mid-1977 Review of Water Pollution Control"**, 1977

#13 U. S. Geological Service, 1979

#14 Hayes, Benjamin, Meiser, Edgar, and Lyons, Constance. **"Characterizing the Hydrology of Acid Mine Discharges from the Kempton Mine Complex, West Virginia and Maryland"**, North Branch of the Potomac River Symposium, 1999.

#15 3Di, LLC. 29111 Newman Road, Easton, Maryland 21601. 1-800-546-4437.

TPY= Tons/Yr TPD Tons/day H = ACID load	1938 MD's Mine Acid Summary	Historical Data from 1976 COE (1966 - 68)	1969 USGS Clark	1979 USGS	1984 USGS	1988-89 MMEC	1992 U of MD A.L.	1994 BOM	1999 BOM
NB @ Town of Kempton	pH = 2.9 Fe = 7 TPD H =16 TPD H=5,968 TPY	pH = 4.5 – 5.2							pH = 6.7
Laurel Run @ Dobbin Road	pH = 6.5 Alkalinity load = 137 TPY	pH = 2.8 – 3.3	pH = 3.0 H = 6.5 TPD H = 2,373 TPY	pH = 3 - 3.7	pH = 2.9	pH = 3.5 H = 3.2 TPD H = 1,174 TPY		pH = 5.5 – 6.7	pH = 5.7
NB @ Wilson				pH = 3.9 – 4.8		pH = 7.0	pH = 3.5 – 6.5	pH = 6.6 – 7.5	pH = 6.8
NB @ Bayard	pH = 3.6 Fe = 2.5 TPD H = 8 TPD H = 3,011 TPY						pH = 4.2 – 6.7	pH = 6.5 – 7.5	pH = 6.8
Buffalo Creek		pH = 3 – 3.2	pH = 2 - 3			pH = 6 – 6.0			
NB @ Steyer		pH = 2.9 – 3.3	pH = 2.3 – 3.3	pH = 3.9 – 5.4				pH = 6.7 – 7.7	pH = 7.0
NB @ Shallmar	pH = 4.2 Fe = 1 TPD H = 5 TPD H = 1,705 TPY						pH = 6.5 – 7.2	pH = 6.7 – 7.7	pH = 7.2
Abrams Creek		pH = 3.7 - 4	pH = 3 - 4			pH = 4.7 – 5.1 Fe = 103 TPY H = 5.5 TPD H = 1,918 TPY			
NB @ Kitzmiller		pH = 3.5 – 3.6	pH = 2.4 – 4.7	pH = 4.6 – 5.6			pH = 6.5 – 7.0	pH = 6.7 – 7.5	pH = 7.3
Three Forks Run	pH = 3.2 Fe = 1.5 TPD H = 4.5 TPD H = 1,708 TPY	pH = 2.9 – 3.3	pH = 2.1 – 3.2 H = 1.5 TPD H = 602 TPY		pH = 3.2	pH = 3.1 – 4.0 H = 2.2 TPD H = 813 TPY		pH = 2.9 – 3.8	pH =5.4
Elklick Run		pH = 4.7 - 7	pH = 4 – 7.5			pH = 6.2 – 6.9 Fe = 25 TPY H = .75 TPD H = 274 TPY			
NB @ Barnum		pH = 3.3 – 4	pH = 2.7 – 4.9	pH = 4.7 – 4.9					pH = 6.9
NB @ Beryl	pH = 3.8 – 4.5	pH = 2.7 – 3.6						pH = 5.6 – 6.9	pH = 6.8

North Branch Potomac River
Site Locations