MANAGEMENT AND CONTROL OF ABANDONED MINE POOL DISCHARGES – PENNSYLVANIA CASE STUDIES WORKSHOP

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ABSTRACT

Abandoned underground mine pools and associated AMD discharges in Pennsylvania frequently present substantial challenges in terms of both mitigation of environmental damage and alleviating health and safety impacts to residents and public infrastructure. Mine blowouts are also a constant concern in many areas. Over the years, the Pennsylvania Department of Environmental Protection's, Bureau of Abandoned Mine Reclamation has employed a variety of methods to address these problems. This workshop will present a series of Pennsylvania case studies that highlight various approaches. Topics to be discussed include; vertical and horizontal (directional) drilling technology for controlling mine pool hydraulic head and/or relocating discharges, conveyance structures to combine and/or redirect discharges, hydrogeologic investigations of mine pool response, and public/private partnership arrangements for treatment and reuse of mine pool waters. Participants will be encouraged to interact in a discussion of the case studies and to share their experiences in addressing similar problems.

PRESENTATION OUTLINE/ FORMAT

1. ***Discharge Relocation*** ***(5 minutes)***
   - Issues
     i. Availability of accurate mine mapping
     ii. Mine pool water quality – stratification
     iii. Overburden geology
     iv. Condition of mine workings
     v. Hydrologic conditions within the mine
     vi. Surface and mineral ownership
     vii. Future treatment plans

2. ***Mine Pool Dewatering*** ***(5 minutes)***
   - Issues
     i. Treatment requirements
        1. Availability of land for treatment
        2. Chemical choices
        3. Sludge handling
        4. Monitoring
        5. Costs
     ii. Safety
     iii. Protection of receiving stream water quality
     iv. Mine pool water quality – stratification

v. Determining dewatering rates / recharge rates
vi. Controlling discharge rates
    1. Preventing uncontrolled releases
    2. Increasing or decreasing rates as needed
        a. To effectively dewater
        b. To protect receiving stream water quality
        c. To maximize efficiency of treatment operations
vii. Determining mine pool volumes
viii. Monitoring during drawdown
    1. Mine pool elevation
    2. Mine pool/discharge quality

3. Drilling (Horizontal and Vertical) ***(5 minutes)***

- Issues
    i. Surface & mineral ownership
    ii. Control of any potential mine pool discharges
    iii. Protection of shallow or perched potable aquifers
    iv. Access
    v. Availability of experienced drilling companies/personnel
    vi. Costs

4. Mine Pool Stabilization / Mine Blow-Out Prevention ***(5 minutes)***

- Issues
    i. Ability to monitor mine pool elevation
    ii. Maintaining mine pool elevation
    iii. Contingency plans
        1. Borehole monitors
        2. Overflow boreholes
        3. Overflow discharge pipes

5. Beneficial use of mine pool water ***(5 minutes)***

- Uses
    i. Low flow make up water in streams
    ii. Fish culture stations
    iii. Cooling water for power plants

6. Mine Pool Transfer ***(5 minutes)***

- Issues
    i. Water in must equal water out – consider blow-out potential
    ii. Compatibility of mine pool chemistries – Time required to mix/stabilize
    iii. Combined pool quality – better or worse?
    iv. Mineral rights issues – access to unmined reserves
    v. Protection of potable water aquifers
    vi. Stability of existing barriers – Changes in hydraulic pressure
    vii. Conditions in receiving mine
    viii. Plan for the worst and hope for the best – Contingency Plans

7. Case Studies Discussion ***(60 minutes)***

Case Study Examples

Melcroft & Kalp
Discharge Relocation via Horizontal Drilling, Mine Pool Dewatering, Temporary Active Treatment, Mine Blow-Out Prevention, Future Passive Treatment

Tanoma
Discharge Relocation via Vertical Drilling, Passive Treatment, Mine Pool Elevation Stabilization

McDonald
Discharge Relocation via Alternate Mine Opening, Mine Pool Dewatering, Mine Blow-Out Prevention/Mitigation, Mine Pool Elevation Stabilization

Caledonia
Mine Pool Dewatering, Unforeseen Conditions, Mine Pool Elevation Stabilization

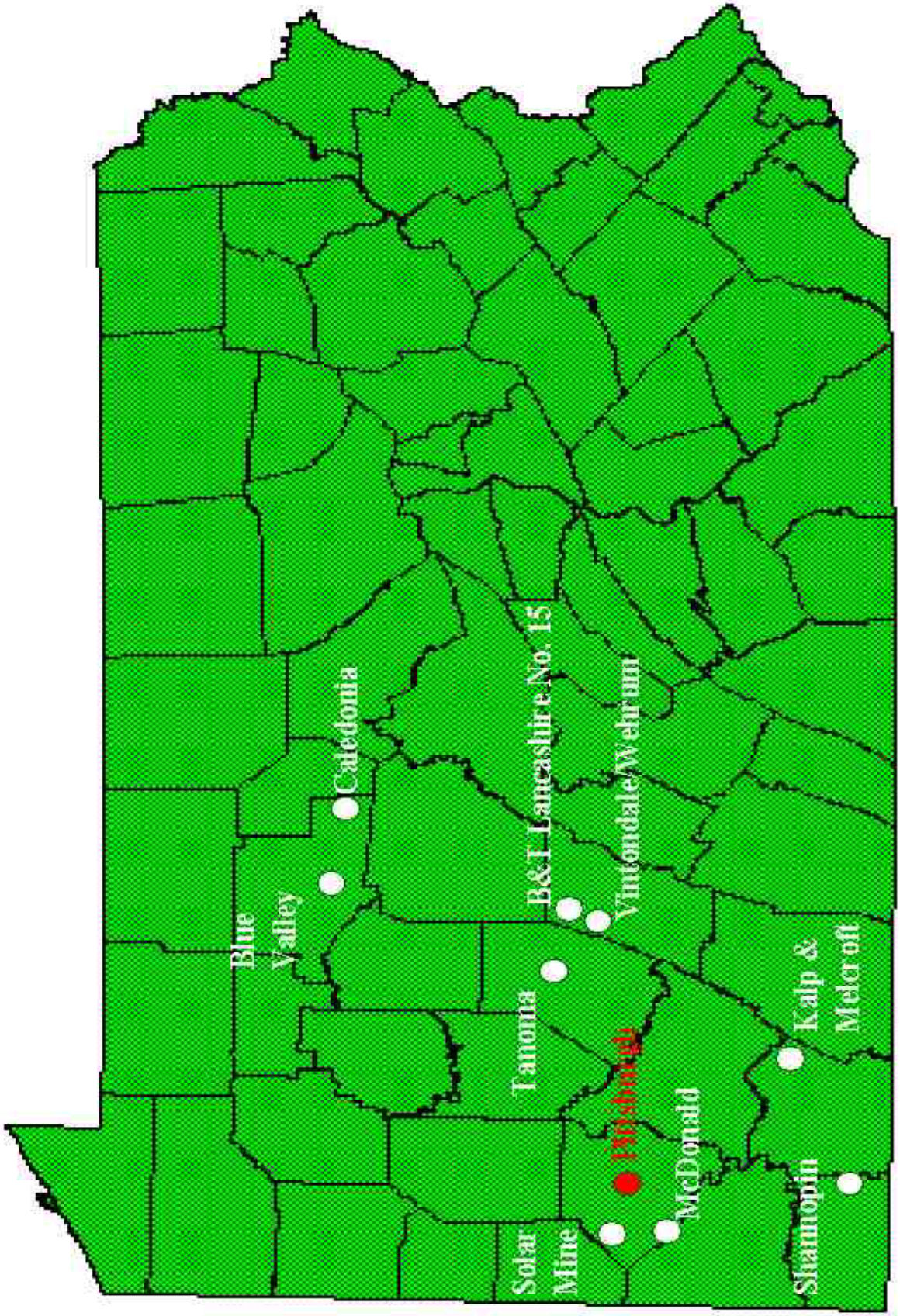
Barnes & Tucker Lancashire No. 15
Discharge Relocation via Vertical Drilling, Mine Pool Elevation Stabilization, Active Treatment, SRBC Low-Flow Storage and Release

Vintondale / Wehrum
Discharge Relocation via Vertical Drilling, Mine Pool Elevation Stabilization, Future Active Treatment

Shannopin
Discharge Relocation via Vertical Drilling, Mine Pool Dewatering, Active Treatment, Industrial Re-Use of Treated Mine Pool Water

Blue Valley
Mine Pool Active Treatment, Fish Culture Station

Solar Mine (Cooperative project with the Pennsylvania Turnpike Commission)
Discharge Relocation, Mine Pool Dewatering and Treatment, Mine Pool Stabilization



Location Map - Pennsylvania Mine Pool Case Studies

The Kalp and Melcroft AMD Abatement Projects

Project Background/Description: The Pennsylvania Dept. of Environmental Protection, Bureau of Abandoned Mine Reclamation (PA-DEP BAMR), the USDA Natural Resources Conservation Service (NRCS), and the Mountain Watershed Association, Inc. (MWA), a local grassroots group, completed phase I of an innovative mine drainage abatement project. The project involved two abandoned underground mine sites that exhibit significant water quality and public health and safety problems.

Remediation efforts at both sites relied on in-seam directional drilling to facilitate control of the mine pools and collection of the mine discharges. Directional drilling is used extensively in underground mining applications; however, this was the first time that this approach was used on a Pennsylvania AML site to convey and control abandoned mine pool discharges. In-seam directional drilling relocated the current discharges to areas proximal to the proposed (phase 2) treatment systems. Approximately 30 feet of mine pool hydraulic head was gradually and permanently removed at both project sites. Directional drilling provided both a mechanism to address and reduce the blowout potential along with providing a lower cost and minimal disturbance alternative to the construction of overland mine drainage pipelines that would be required in order to route the existing discharges to the treatment areas. Overland pipelines from the current discharge locations would not lower the head in the mines and would result in substantially increased disturbance to properties, homes and public roads located between the discharge areas and the treatment system locations. An overland pipeline would also have required partial dewatering of the mine pools during construction in order to gain access and to stabilize the current discharge locations.

After completion of drilling activities BAMR released two contracts to dewater and chemically treat the Kalp and Melcroft mine pools. Twin objectives were to expeditiously address the aforementioned health and safety concerns and to aid in the design and construction of the pending phase 2 treatment projects. At the Kalp site a total of 80,655,000 gallons of mine pool water has been removed and chemically treated. At the Melcroft site a total of 48,630,000 gallons of mine pool water was removed and chemically treated. The directional boreholes functioned flawlessly in dewatering and controlling the mine pool discharges. At the Kalp site crop line seeps and discharges, including the original discharge point for the mine (Kalp discharge), have been eliminated. The potential for a mine pool blowout has been significantly reduced and homeowners who had been experiencing problems with mine drainage in their yards and basements no longer are subject to these problems. The mine is currently discharging from the directional boreholes at its baseflow condition. Significant reduction of flow has been noted in existing discharges from the mine complex at the Melcroft site (Melcroft #3 Mine). Homeowners have reported substantially improved conditions. Monitoring of impacts of these sites and of adjacent homes with mine drainage problems is continuing.

Project Cost: $1.1 million

Before and after photos showing a typical cropline discharge area at the Kalp site

The Tanoma Passive Mine Drainage Treatment Project

Project Background/Description: Mine Drainage from the defunct Clearfield Bituminous Coal Corporation's underground mines has impaired the upper Crooked Creek watershed in Indiana County, Pennsylvania. The mines form an interconnected and partially inundated complex, covering 4,500 acres. The primary mine drainage outlet, known locally as the 'Tanoma Borehole' has discharged continuously since mining completion in the 1950s, averaging 2,500 gpm (3.6 mgd), and degrading Crooked Creek for several miles. In 1995, at the request of the Crooked Creek Watershed Association, the Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation, PA-DEP-BAMR, decided to address the Tanoma borehole discharge. BAMR established a monitoring program and initialized water sampling, stream bioassessments, and a hydrogeologic study to evaluate the potential for relocating the discharge to a suitable site for passive treatment. Critical to this evaluation was the protection of an aquifer located above the mine and used for domestic consumption. The relationship of mine discharge volume to in-stream iron concentration was evaluated to determine an effective design sizing criteria. A two-phase construction approach was undertaken, with new cased and grouted boreholes installed in the first phase. After evaluating the new boreholes, phase two treatment system construction and sealing of the original boreholes occurred. An overflow borehole was left open for monitoring and for mine pool discharge in the event that system capacity was exceeded. Since full-scale treatment of the mine discharge began in June of 2001, the passive treatment system has removed an average of ~70% of the total iron while experiencing flows up to ~3,000 gallons per minute (gpm).

Mine Pool Size: Approximately 2 billion gallons

Project Quantities and Costs: installation of new discharge boreholes - $19,783.50 (3 wells – 90 ft. deep each); property acquisition cost - $38,000 (~10 acres); sealing abandoned Tanoma boreholes - $7,535 (2 boreholes sealed); and construction of the passive treatment system - $351,367.31 (7.5 acre passive treatment system – aerobic wetlands and settling ponds).

Date Completed: New Wells installed 1998; Passive treatment system completed in 2000.

Aerial view of the completed Tanoma Mine Drainage Treatment System

McDonald Mine Pool Blowout

Project Background/Description: At approximately 2:00 pm Jan 25, 2005, a mine pool blowout occurred in the town of McDonald, Washington County Pennsylvania. An estimated continuous release of approximately 8,000 to 10,000 gallons per minute of mine water resulted. The blowout location was along the down dip cropline of the Pittsburgh Coal Seam. The area contains a 1930's era abandoned underground mine that was owned and operated by the now defunct Pittsburgh Coal Company. The mine was called the Nickel Plate Mine. Approximately 1,100 acres of interconnected mine workings were upgradient of the blowout area. Public health and safety aspects of the mine pool blowout were substantial given its location. Substantial disruption within the local community had taken place. Initially, streets had to be closed, natural gas service lines within the immediate vicinity had to be closely monitored and inspected to insure that they had not been damaged and several nearby residences were evacuated. First responders included an array of local, state and federal government agencies as well as utility companies, local fire departments and other emergency personnel. Initially, very little information was known or available for the abandoned mine complex in order to evaluate the long-term impact of the blowout.

OSM and DEP initially took the lead working cooperatively to evaluate and manage the problem. OSM developed a short-term plan/project to address the immediate emergency. DEP's Bureau of Abandoned Mine Reclamation (BAMR) assisted in this initial effort and committed to implement a plan/project to manage the long term impacts of the abandoned mine and the discharge. Because the emergency pumping activities also required the closure of certain borough streets, the project was disruptive to town activities. As a result, the DEP entered into an emergency procurement contract with Environmentally Innovative Solutions to continue pumping and to develop a solution to the problem. The project work entailed drilling monitoring wells, conducting a hydrogelogic study and developing a plan for, and to install, a gravity drain. Open lines of communication between the agencies and to all stakeholders were established and carefully maintained. Throughout the project and especially early on, every effort was made to insure that local officials, residents and the general public was aware and up to date as to the ongoing efforts to manage and resolve the problem. The long-term benefits of keeping all parties informed proved to be worth the effort. Local residents, landowners and local government officials were extremely helpful and cooperative in providing assistance, information and access to conduct the necessary data collection and for the eventual construction of the project.

The evaluation of the mine pool complex reveled several areas adjacent to the Borough, one on the east side and one on the west side of the town, that had good potential for the development of a gravity drain system to control the mine pool. The area just east of the borough was selected as the preferred location. This area was clearly the most desirable location for a number of reasons. The property was undeveloped and offered the least impact to local community. Construction costs at this location are more favorable than any other options due to its undeveloped condition. Sufficient area was available for future treatment of the mine pool discharge (All other optional areas did not have available space for consideration of future treatment of the discharge).

Project Summary

- ***Mine pool pumping: $21,840.00***
- ***Development & Design: $82,914.00***
- ***Construction: $297,749.00***
- ***Total Cost: $402,503.00***
- ***Contract Start Date: Feb. 28,2005***
- ***Project completed: June 15, 2005***

Completed Gravity Drain

The Caledonia Mine Pool Dewatering Event

Project Background/Description: The Caledonia abandoned mine reclamation project is located in Jay Township, Elk County, Pennsylvania. The project involved the restoration of 18 acres of abandoned surface mine with dangerous highwalls (95,000 cy of grading); alkaline addition (11,680 tons); the demolition of an old fan house; reclamation of a small coal refuse pile; and the installation of two wet mine seals. The project was undertaken as part of the Bennett Branch stream restoration efforts that are ongoing in the area. The mine seals were required to adequately collect and convey two abandoned deep mine discharges through the backfill for potential future treatment. One discharge emanated from a mine opening located at a down dip section of the abandoned Shawmut No. 22 mine, and was determined to be nearly free draining. The second discharge flowed from an opening that was near the top of the structure of another section of the Shawmut No. 33 mine. Since this opening was near the most up dip limits of that section of the mine, it was assumed that no mine pool head existed behind the opening and the discharge was flowing as an overflow from a completely inundated down dip section of the mine.

During construction of the mine seal at the discharge site located at the up dip section of the mine, an uncontrolled release of several million gallons of mine water occurred. The contractor had excavated down to the base of the coal and still not encountered the source of the mine discharge. Continued excavation found a rock tunnel that had been driven into the mine approximately 10 feet lower in elevation than the base of the coal. This rock drain had been constructed to dewater a large portion of the mine workings to keep the main haulage way open. Once daylighted, the drainage tunnel dewatered a large section of the mine in roughly six hours. The receiving stream is severely impacted by a number of other mine discharges and supports little or no aquatic life consequently, there were no additional aquatic impacts. At the time of the event, most rivers and streams in the area were flowing at bank full. By the time the mine water reached a good quality stream, dilution minimized the impacts.

Mine Pool Size: Approximately 20 million gallons

Project Bid Price: $543,367.05

Date Completed: Spring 2007

Discharge and weir prior to construction *(lower left);* ***drainage tunnel following mine pool release*** *(lower right);* ***and completed mine seal and weir following construction*** *(upper right)*

The Lancashire No. 15 Mine Drainage Treatment Project

Project Background/Description: The purpose of the project is to control, treat and discharge water from the abandoned Lancashire No.15 underground mine. Barnes & Tucker (B&T) operated the Lancashire No.15 Mine until 1968. While operating, a pump station, known as the Dumans Lake facility, kept the mine dewatered. B&T ceased pumping the Lancashire #15 mine in 1968. In 1969 the mine pool rose and broke out causing a major pollutional event in the West Branch of the Susquehanna River. B&T was ordered by the PA-DEP to resume pumping and to construct a treatment facility. As a result, B&T constructed and operated the Duman Treatment Facility until 1999, when B&T alerted the DEP that they were filing for bankruptcy and did not have funds to establish an escrow account to pay for the perpetual treatment of Lancashire No. 15 mine pool. The DEP petitioned the bankruptcy court and was successful in acquiring some of B&T's assets. The DEP established a non-profit environmental trust fund through the Clean Stream Foundation (CSF) with the assets, exclusively for the continued treatment of the Lancashire No. 15 Treatment Facility.

The CSF, with direction from the DEP has been operating the facilities and managing the assets received since 9/11/01. However, the treatment process is antiquated and inefficient and in need of replacement. Annual treatment cost is approximately $600,000 a year A new treatment plant will be located so that the treated water is discharged to the Susquehanna River Basin to augment water volume in this drainage basin. The Susquehanna River Basin Commission has established a trust fund for the long term operational and maintenance needs. It is anticipated that upwards of 10 MGD (near 7,000 gpm) will be treated and discharged to the Susquehanna River Basin during the low flow season each year. During the remainder of the year pumping rates will routinely average 4,000 to 6,000 gpm to maintain the mine pool at a constant level.

Mine Pool Size: 7,100 acres with 1.42 Billion gallons

Estimated Project Cost: $10.5 Million

Anticipated Construction: 2008

Artist rendering of the proposed Lancashire No. 15 Treatment Plant

The Vintondale / Wehrum Mine Pool Relocation and Treatment Project

Project Background/Description: Mine Drainage from the abandoned Vinton No. 6 underground mine located in Blacklick Township, Cambria County began to enter basements along Main Street in the Village of Vintondale in the early 1980s due to artesian pressure. Many options to alleviate the situation were evaluated, but due to the geologic structure and the elevation of the basements, the only viable way to lower the mine pool to an elevation that would assure no infiltration of mine water into the homes was to drill several mine pool relief boreholes in the stream bed of Blacklick Creek. This would result in the relocation of the Vinton No. 6 outfall over 1,000 feet downstream from its then current discharge location. So in 1994, three stainless-steel cased boreholes were drilled into the mine pool to relieve pressure and lower the mine pool approximately 10 feet. This project corrected the mine drainage problems impacting the residents living along Main Street in the Village of Vintondale.

Since that time, the DEP has been working with the Blacklick Creek Watershed Association to develop a plan to collect and treat both the Vinton No. 6 discharges and the Wehrum Shaft discharge to help restore water quality in the Blacklick Creek Watershed. The current plan is to collect and route the Vinton No. 6 discharges over a coal barrier and transfer them into the structurally down dip Wehrum Mine. Once transferred, the combined discharges would be collected at the Wehrum Shaft outfall and conveyed to location where a large-scale chemical treatment facility is planned.

Date Completed and Project Costs: Phase 1 - Vinton No. 6 Outfall relocation – 1994 at a cost of $58,415; Phase 2 – Transfer of the relocated Vinton No. 6 discharges to the down dip Wehrum Mine (planned for 2008 – estimated cost: ~$250,000); Phase 3 – Construction and operation of a large-scale chemical treatment facility to treat the discharge from the Wehrum Mine (2010 or beyond- estimated capital cost: ~ $10 million)

Mine Pool Size: Hundreds of millions of gallons

AMD in basement *(lower left);* ***relocated mine pool outfall discharge wells*** *(lower right);* ***and Blacklick Creek below the Wehrum Shaft discharge during low flow stream conditions*** *(upper right)*

Shannopin Mine Pool Treatment Facility

Project Background/Description: This project provided for treatment of acid mine drainage (AMD) from the abandoned Shannopin deep mine complex in Dunkard Township, Greene County. The project involved the installation of pumping facilities at an existing mineshaft, known as the Steele Shaft. Treatment is provided by a chemical treatment plant that includes facilities for neutralization, aeration and settling of precipitated metals. Failure to pump and treat this flow would have resulted in a break-out of untreated AMD into Dunkard Creek from the abandoned portals. DEP and OSM staff closely monitored mine pool elevations since abandonment of the Shannopin Mine in 1992. The pool was expected to discharge into Dunkard Creek at the mine openings during late 2004 or early 2005. Adverse impacts were expected to extend beyond Dunkard Creek downstream into the Monongahela River. There are four municipal water intakes within 15 miles downstream on the Monongahela River, which supply potable water to over 42,000 customers. Two industrial intakes are also located within these distances. Active underground mines on the overlying Sewickley Coal seam were also being adversely impacted (flooded) by the rising Shannopin mine pool. These mines were operated by Dana Mining Company.

The Commonwealth of Pennsylvania and Dana Mining Company developed a partnership to address the problem. AML funds and other state funds and low interest loans were provided to cover the capital construction costs of the facility. Dana Mining currently provides all operation and maintenance of the facility. Long-term operation will be provided either by a company called GenPower, who may take the treated effluent to use at a power plant that may be constructed just over the state line in West Virginia, or the Commonwealth of Pennsylvania will assume operations.

- ***Capital Cost $7,111,445.00***
- ***Annual O&M $2,000,000.00***
- ***Raw Water Quality:***
  - Pumping rate – 4500 gpm
  - Hot Acidity – 450 mg/l
  - Total Iron - >300 mg/l
  - Sulfates – 5000 mg/l

Shannopin Treatment Plant

The Blue Valley AMD Treatment and Fish Culture Station Project

Project Background/Description: The project involves the construction, installation and startup of three components of the Blue Valley AMD and Fish Culture Station that will essentially function as one facility under one roof. The mine drainage treatment system will consist of a pump lift station, flocculant mix and oxidation tanks, an inclined plate clarifier, polishing carbon filter, sludge tank, and a filter belt press. The mine drainage treatment system will remove the iron and manganese from all of the mine discharge and dewater the pollutants through the filter bed press into a solid cake-like sludge that will be acceptable for landfill disposal or reuse as a chemical raw material for dyes, pigments, or perhaps the pressed metal industry. A portion of the water will be diverted into the Fish Culture Station as needed. The remaining treated water will be discharged to the stream. The metal sludge from the treated mine drainage can be boxed, placed in a hopper, or loaded directly to a truck from the conveyor belt from the filter belt press. Design treatment flow is for 500 gpm.

Within the Fish Culture Station, a hatchery and nursery subsystem will utilize 50 gpm of recirculated water to hatch up to 500,000 trout eggs per stocking. A second system will utilize up to 1600 gpm of recirculated water to grow the fry to the appropriate weight (about 5 grams). The fingerling trout are then transferred to the grow-out areas where up to 1300 gpm of recirculated water will be used. Once the fingerlings reach a weight of approximately 30 grams, they will be transferred to the final grow out area, which will utilize another 5000 gpm of recirculated water from an intake of 200 - 300 gpm. The trout will be raised until they are approximately 225 grams in weight and suitable for stocking.

The final component of the project will consist of a treatment system for the fish waste/manure wastewater stream. This unit will consist of equalization tanks, chemical coagulation and flocculant mixing tanks, an inclined plane clarifier, sludge dewaterer, and a polishing lagoon. This process has been demonstrated at the Emmaus, PA Integrated Foods Fish Culture Station as being able to produce an acceptable effluent and a fish waste product suitable for land application as a fertilizer.

Mine Pool Size: Approximately 2.2 billion gallons

Project Cost: $1.3 million

Date Completed: 2004

View of exterior of Blue Valley Treatment Plant and tank with 3,000 fingerling brown trout

Solar Mine Pool Project
(Cooperative Project with the Pennsylvania Turnpike Commission)

Project Background/Description: In 2004, during construction of a portion of the Pennsylvania Turnpike's Southern Beltway project in Findlay Township, Allegheny County, abandoned underground mine workings and associated acidic mine pool discharges from the Solar Mine complex were encountered. Areas that contained abandoned underground mine workings were over-excavated to eliminate any potential for future mine subsidence along the roadway. The Pennsylvania Turnpike Commission's (PTC) construction plan originally called for simply routing any encountered mine discharges through the construction area via open joint pipe drains located at the base of the excavation.

During construction, PTC consulted with the PA DEP Bureau of Abandoned Mine Reclamation (BAMR) in an effort to determine if any options were available to improve the quality of these encountered discharges. It was agreed that a modification to PTC drain structures would be employed to provide in-situ neutralization of the mine discharges. Immediately underlying the Pittsburgh Coal seam is a 12 foot thick Limestone unit (Pittsburgh Limestone). This material was shot and left in place and the open joint pipe drains were placed on top of the shot limestone. The outlet of the drain structures was directed to existing sedimentation pond facilities that will remain in place for oxidation and precipitation of metals.

July 2004 Drain Construction

Drain Outlet to Existing Ponds

Project Start: April 2004

Project Completion: May 2005

Project Cost (additional) ~ $150,000.00

AML FUNDS EXPENDED: $0.00