Final Project Report

NE30158

Design, Implementation, and Evaluation of an Anoxic Limestone Drain and Passive Aerobic Wetland Treatment System for the Pine Forest Discharge, Schuylkill River Basin, Schuylkill County, PA

Prepared for: Commonwealth of Pennsylvania
Department of Environmental Protection

Prepared By: Schuylkill Headwaters Association, Inc.

In Association with: RETTEW Associates, Inc.

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NARRATIVE DESCRIPTION OF PROJECT

INTRODUCTION

Abandoned mine drainage (AMD) from the Pine Forest Mine pump shaft contributes aluminum, iron, manganese, and acidity to Mill Creek, a tributary to the Schuylkill River in Schuylkill County. Consequently, Mill Creek is designated "impaired because of metals" on the 303(d) list. This project implemented a passive treatment system consisting of a flushable, anoxic limestone drain (ALD) followed by an aerobic wetland basin to neutralize acidity and reduce metals loadings from the discharge. Underdrain networks and outflow pipes within the ALD enable flushing of accumulated metals from the limestone bed to the wetland where final oxidation, precipitation, and settling of metallic-rich particles occurs. Because of the large flow rate and corresponding large size of the treatment system, "cubitainer" testing was conducted to evaluate the rate of limestone dissolution and any effects of the metal precipitate on limestone dissolution rates. This project has reduced AMD loadings from the Pine Forest discharge to Mill Creek and the Schuylkill River, and it will demonstrate the effectiveness of using an ALD for treatment of a large volume, near-neutral-pH, iron-contaminated discharge.

PROJECT DESCRIPTION

This project involved the design and installation of a passive treatment system consisting of an ALD, aerobic settling pond and wetland cells to reduce the acidity and metals loadings from the Pine Forest mine discharge to receiving streams. The conceptual design of the treatment system utilized information that was collected by the Pennsylvania Department of Environmental Protection (PaDEP) and the U.S. Geological Survey (USGS) for evaluating the project feasibility and for development of total maximum daily loads (TMDLs) on Mill Creek. This treatment system will raise the pH and alkalinity of the water and promote the precipitation of dissolved iron and other metals.

Flow and chemistry data collected since 1997 by the PaDEP (M. Hill, 2002, written commun.) and the USGS (C.A. Cravotta III, 2002, written commun.) indicated that the flow rate at the Pine Forest Discharge ranges from 1,180 to 1,580 gal/min and averages about 1,360 gal/min. The discharge water has consistently been acidic (pH 5.5 to 5.9; net alkalinity -1 to -38 mg/L $CaCO_3$), anoxic to suboxic (0.2 to 2.2 mg/L O_2), and contaminated with dissolved metals (Fe = 16.3 to 23.7 mg/L; Mn = 5.3 to 8.2 mg/L; Al = <0.5 to 1.6 mg/L). Water having this chemical character, but less than one-tenth the flow rate, has successfully been treated with 15-hour detention times in ALDs (Cravotta and Watzlaf, 2002). Recently constructed ALDs, such as that at the Buck Mountain discharge in the Swatara Creek basin, have been effectively producing net alkaline effluent with an average 3-hour detention time and have incorporated perforated piping within the limestone bed to enable flushing and hence reduce the potential for clogging. Cubitainer tests for the Pine Forest Discharge indicate comparable alkalinity production rates and maximum alkalinities for uncoated limestone and limestone that was placed at the site to become coated with precipitates. Nevertheless, field studies are needed to evaluate the actual performance and benefits of such large-scale passive treatment systems.

- **What was the project supposed to accomplish?**

The conceptual design for this system was to construct three parallel ALD beds of crushed limestone (approximately 5,720 tons), each 125 ft. long x 20 ft. wide x 5 ft. deep. A perforated pipe network, equipped with valves, was proposed along the length of the ALD to facilitate periodic flushing of accumulated solids. At the average flow rate, the proposed design will provide for an initial detention time of approximately 4.6 hours and will have an estimated life span of 15 to 20 years. On the basis of cubitainer tests that evaluated coated and uncoated limestone, effluent from the ALD is expected to be alkaline over this life span. The conceptual plan proposed the Effluent from the ALD be sequentially routed through an aerobic pond (100 ft. long x 270 ft. wide x 3 ft. deep) and three shallow wetland cells (100 ft. long x 390 ft. wide x 1 ft. deep, 100 ft. long x 380 ft. wide x 1 ft. deep, and 100 ft. long x 110 ft. wide x 1 ft. deep) having a total surface area of approximately 2.6 acres or 10,200 m^2. Given the average iron loading rate of 2,120 g/day for the Pine Forest discharge, the total surface area is 1.5 times greater than the minimum aerobic wetland size of 7,175 m^2 per criteria of Hedin and others (1994) to achieve an average iron removal rate of 20 $g/m^2/day$. The oxidation pond outfall was proposed to allow the water level to be raised to compensate for depth reductions that result from iron sludge accumulation. Iron loading calculations indicate approximately 0.8 foot of iron sludge per acre may accumulate over the site in a 10-yr period. The pre-design site survey seemed to indicate sufficient elevation differential to accommodate several feet of freeboard adjustment to the level(s) of the oxidation pond and wetland cells.

Monitoring will continue to be conducted by SHA in conjunction with the Philadelphia Water Department (PWD).

The treatment system was designed to completely neutralize the AMD and remove all the iron at average loading rates for the design life of the project (15-20 years). Metals loading to Mill Creek will be reduced accordingly. Monitoring for the project will document the load reductions as they may pertain to TMDLs developed for the watershed.

- **What did you actually do & how does it differ from your plan?**

A design flow rate of 1,632 gpm, 120% of the average flow rate from the conceptual plan, was used in the final design of the system and the system was also designed to safely pass additional contributing overland flow from the 100-year flow through the system. The influent collection system required a design that would minimize aeration of the discharge prior to entering the ALDs and throughout the ALDs while maintaining the pool level in the pump shaft. This was a critical design element to decrease the chance of the ALDs becoming clogged with metal precipitate due to increasing the dissolved oxygen levels and preventing the mine pool from discharging at another location. The influent collection system chosen was an 18" SLCPP which has a 90° elbow on the upstream end which is turned down into the pump shaft. The influent lines and the ALD discharge structures were designed so the route to the ALDs was the easiest flow path for the discharge. This configuration allows the water to enter the treatment system without being aerated and still allows the pool level to be maintained and overflow should the flow from the discharge exceed what the system can handle. During construction it was noticed that coal particles were being suspended in the pump shaft by the constant upflow of water. This was seen as a possible negative impact for the treatment system since these particles in the discharge could have caused clogging in the ALDs. A modified 1,500 gallon septic tank was added to the influent line as an inline sediment structure. The tank was completely buried to reduce aeration within the tank and a stainless steel baffle was bolted to the wall on the influent side of the tanks. The baffle was added to slow the velocity of the water through the tank and allow for sedimentation of the particles seen in the pump shaft.

The discharge water is distributed into the ALDs with vertical perforated risers controlled by valves. There is a primary riser and a secondary riser in each of the two ALDs. The most troublesome problem with both ALDs and OLDs has been clogging due to early metal precipitation and ineffective flushing to dislodge and evacuate the precipitate. The secondary riser was installed in case the area around the primary riser becomes clogged with metal precipitate. Should this happen, the valve to the primary riser can be closed and the secondary riser valve opened. Although the secondary riser is located approximately one-third of the way through the ALD it was felt that the decreased detention time in the drain was better than no treatment at all. The installation of the second riser will extend the life of the system should the primary riser become clogged and allow time for repairs while treatment is still possible in a partially disabled system.

The conceptual design called for three parallel ALDs but due to site constraints and construction costs it was decided that two ALDs would be installed. Each of the installed ALDs measures approximately 170 ft. long x 30 ft. wide x 5 ft. deep and they are filled with a total of approximately 1,800 tons of crushed limestone. A perforated pipe flushing network was installed in the bottom of the ALDs in the upstream two-thirds, which included two separate flushing zones in each ALD controlled by valves. The intent of the flushing system was to flush out accumulated solids within the drain where solids were most likely to accumulate near and directly downstream of the influent riser structures. The flushing zones were manifolded together within the ALD central berm and outleted to the settling pond. Additionally, due to springs in the ALD area, perforated drain piping was laid beneath the liners of both ALDs to drain the springs to the settling pond and prevent the springs from washing sediment into the drain. The ALD outlet structures (2 per ALD) are modified inlet boxes with grating on the upstream side to hold the limestone in the drain, a stainless steel baffle plate placed in the center of the box to regulate flow from the ALD, and a weir at the top of the downstream side. An 8" PVC pipe penetrates the baffle to enable draining of the ALD for maintenance and the water level within the ALD is maintained by the weir on the downstream side of the modified inlet box and an Agri-Drain on the drain line. During normal operation the ALD discharge flows through the weir in the downstream side of the modified inlet boxes and over a riprap lined spillway into the settling pond.

The settling pond measures approximately 200 ft. long x 120 ft. wide x 3 ft. deep (0.51 acres) and can be drained via a valved drain pipe which discharges to the existing stream. The settling pond discharges to a series of three wetland cells via a 90 ft. wide broad crested spillway. All of the wetland cells are approximately one foot deep, can be drained by valved drain pipes, and have a topsoil/mushroom compost substrate placed in the bottom to accelerate wetland plant growth. The wetland cells measure approximately as follows: Cell #1 – 260 ft. long x 120 ft. wide; Cell #2 – 300 ft. long x 100 ft. wide; and Cell #3 – 180 ft. long x 50 ft. wide. The total surface area of the wetland cells is approximately 1.55 acres. Each wetland cell overflows to the next over a riprap lined broad crested spillway, these spillways control the water level and provide aeration between the cells. The discharge for the treatment system is a broad crested spillway which discharges to the existing stream.

- **What were your successes & reasons for your success?**

One of the major successes of the project was the ability to complete the project on Reading Anthracite Company (RAC) property using RAC as a construction partner in the project. This project has set the cornerstone for more projects on RAC property.

- **What problems were encountered & how did you deal with them?**

One of the major problems encountered during construction was the identification of material in the mine discharge that could potentially clog the limestone beds or piping. To eliminate this problem SHA installed a settling chamber in the influent line prior to the anoxic drains to eliminate this issue.

- **How did your work contribute to the solution of the original problem?**

Our project should remediate the contamination from the Pine Knot Discharge from ing the Mill Creek.

- **What else needs to be done?**

A much smaller intermittent discharge was identified during construction. This discharge will need to be evaluated for a future treatment system.

- **What are your plans for disseminating results of your work?**

An interpretative sign is on order and will be installed and a media event is being scheduled.

- **How well did your spending align with your budget request?**

Our awarded grant amount was well under the amount of our original grant application. Therefore, SHA was forced to seek additional funding sources. Overall, our project was very close to our original grant request.

Project Report Summary

PROJECT REPORT SUMMARY

The primary goal of the project was to eliminate AMD (acid and metal) loadings from the Pine Forest Shaft Discharge to Mill Creek and the Schuylkill River. The passive treatment system reduces non-point source pollution, improves water quality, and improves wildlife and fisheries habitats. The secondary goal was to evaluate the effectiveness of an anoxic limestone drain for treatment of a low-pH, moderately oxygenated and iron-contaminated, moderate-to-high-flow discharge. The knowledge gained from this evaluation is being used for improving remedial designs for treatment of AMD.

Accomplishment Worksheets

1000-FM-OA0053 3/2005

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Growing Greener
Goals and Accomplishments Worksheets

Project Name Pine Forest Discharge AMD Treatment Project

Project Number NE30158 County Schuylkill

State Watershed Plan Name and Code Schuylkill River - 3A
(e.g., Clark-Paxton Creeks – 7C)

Date Prepared 10 / 31 / 07 (month/day/year)

This Report is *(choose one)*:

- ☐ Project Goals
- ☒ Project Accomplishments *(to be submitted with final report)*

Project Type *(check all that apply)*

- ☐ Organization of a Watershed Group *(fill out Sheet A*)*

Watershed Assessments and Development of Restoration and/or Protection Plan *(check all that apply and fill out sheet B*)*

- ☐ AML/AMD
- ☐ Non-Point Source
- ☐ Assessment
- ☐ Development of Restoration Plan
- ☐ Development of Protection Plan

Implementation of Watershed Restoration and/or Protection Project *(check all that apply and fill out Sheets C, D, E, F, and G*)*

- ☒ AML/AMD
- ☐ Oil and Gas
- ☐ Non-Point Source
- ☐ Restoration
- ☐ Protection

- ☐ Demonstration *(fill out Sheet H*)*
- ☐ Education/Outreach *(fill out Sheet I*)*

*Please fill out all the appropriate information on the sheets corresponding to your project type. Leave blank any sheets or information on the sheets that do not apply to your specific project. If you have any questions call the Grants Center at 717-705-5400.

Organization of a Watershed Group

Name of Group ______________________________

Watershed Area ______________________ Acres

Membership ______________________ Number

Meetings Held ______________________ Number Held

______________________ Attendance

Mission Defined ☐ Yes ☐ No

Incorporation ☐ Yes ______________________ Date

☐ Applied ______________________ Date

☐ No

Non-Profit Status ☐ Yes ______________________ Date

☐ Applied ______________________ Date

☐ No

Officers Elected ☐ Yes ☐ No

Strategic Plan Developed ☐ Yes ☐ No ______________________ Date

Newsletter ______________________ Number Printed

Brochures ______________________ Number Printed

Webpage ______________________ Web Address

Other Outreach ☐ Describe in Narrative

Describe Activities to date for your organization:

Watershed Assessments and Development of Watershed Restoration and/or Protection Plans

Area Assessed ______ acres

Stream Reach ______ feet

☐ Data Gathered ______ briefly describe

☐ Monitoring Measurements ______ type

☐ Maps Developed ______ number/type

☐ Surveys Completed ______ type

☐ Fish Identified ______ species

☐ Macroinvertebrates Identified ______ species

☐ Riparian Buffers Restored ______ feet planned

☐ Riparian Buffers Protected ______ feet planned

Stations Monitored: Chemistry ______ #/frequency

Biology ______ #/frequency

Problems Identified: ☐ AMD ☐ Trash ☐ Point Source Pollutants ☐ Erosion & Sedimentation ☐ Stormwater ☐ Temperature

303D Listed ☐ Yes ☐ No

Chapter 93 designation ______

☐ Nutrient Assessed ______ list below

☐ Frequency of Monitoring ______ describe

☐ Stream Corridors Restored ______ feet planned

☐ Stream Corridors Protected ______ feet planned

☐ Education/Outreach ______ describe

☐ TMDL Completed ______ describe

☐ Public Input ______ describe

Describe your project activities to date:

Sheet B

Receiving Stream Mill Creek, East Norwegian Township & St. Clair Borough, Schuylkill County, PA ________ name/location

Receiving Stream Benefits

Upstream Quality	Before	After	Downstream Quality	Before	After
Iron	NA	mg/L	Iron	28	Sytem just started mg/L
pH	NA	S.U.	pH	5.5	Sytem just started S.U.
Acid	NA	mg/L as $CaCO_3$	Acid		Sytem just started mg/L as $CaCO_3$
Alk	NA	mg/L as $CaCO_3$	Alk	-38	Sytem just started mg/L as $CaCO_3$
Al	NA	mg/L	Al	1.6	Sytem just started mg/L
Mn	NA	mg/L	Mn	8	Sytem just started Mg/L

AMD Treatment

- ☒ Anoxic Limestone Drain 5,720 tons Limestone(LS)
- ☐ Successive Alkalinity Producing System (SAP) ____ tons (LS) ____ tons organic matter
- ☒ Wetlands 2 aerobic acres ____ anaerobic acres
- ☐ Diversion Wells ____ # ____ total LS capacity
- ☐ Settling Ponds ____ # ____ capacity (gpm)
- ☐ Limestone Channel ____ ft. OLC ____ ft. MOLC
- ☐ Limestone Dosing/Dumping ____ tons LS
- ☐ Reverse Alkalinity Producing Systems ____ #
- ☐ Bactericide Remediation ____ lbs/acre
- ☐ Beneficial Use of Dredged Material ____ tons
- ☐ Manganese Oxidizing Bacteria Systems ____ #

Total Treated Flow Rate

1,600 gpm average ____ gpm high

Predicted lifespan of system 20 years

Sludge Capacity 30 years

Contaminants removed/Contained by system (average)

Iron 538 ppd Al 30.7 ppd

Mn 153 ppd Acid tbd ppd

Excess Alkalinity added tbd ppd

pH change 5.5 influent 6.7 effluent

AML

- ☐ Openings Closed ____ #
- ☐ High Walls Removed ____ Feet
- ☐ Land Remined ____ Acres
- ☐ Wildlife Habitat Improved ____ Acres
- ☐ Trees Planted ____ #
- ☐ Sealing Mine Portals ____ # ____ wet or dry seal
- ☐ Revegetation ____ acres
- ☐ Grout Injection ____ tons
- ☐ Mine Capping ____ acres

Oil and Gas

Wells Plugged ____ #

Total Flow Before ____ gpm

Total Flow After ____ gpm

Contaminants Removed/Prevented

Iron ____ (ppd) pounds per day

Acidity ____ (ppd)

Alkalinity ____ (ppd)

Wildlife Habitat Created ____ acres

Describe Activities to Date: Design, permitting, & construction completed, system is in operation. Planning official press conference for spring.

Sheet C

Sheet D

Name of Project: ____________________

Non-Point Agricultural

Farmstead/Barnyard

Manure Storages:

	Number	Cubic Feet	AEUs
Dairy	______	______	______
Beef	______	______	______
Swine	______	______	______
Poultry	______	______	______
Latitude	______	Longitude	______

Barnyard runoff controls:

Built with manure storage ______ number

Built without manure storage ______ number

Curbing ______ feet

Roof Gutters ______ feet

Buffer Strips ______ feet

Other (Describe)

Upland

Soil Conservation Plans Developed

On conventional cropland ______ acres

On hayland ______ acres

On pasture ______ acres

Grazing land ______ acres protected

No till ______ acres protected

Cover crops planted ______ acres planted

Nutrient management plans ______ acres

Waterways ______ feet

Diversions/Terraces ______ feet

Pesticide management ______ acres

Wildlife land improved ______ acres

Woodland improved ______ acres

Stream Fencing ______ feet

Stabilized Crossings ______ #

Latitude ______ Longitude ______

Streams/Wetlands

Measures on Separate pages

Describe your implementation activities to date:

Name of Project: ______________________

Non-Point Other

Stormwater				Other BMP			Streams/Wetlands
Latitude ________	Longitude ________						Measures on separate pages
Extended dry detention basin	____ number	____ drainage area		Sediment Ponds	____	number	
Wet detention pond	____ number	____ drainage area		Septic Pumping	____	number	
Conversion of dry retention to wet	____ number	____ drainage area		Home Septic			
Pond-wetland system	____ number	____ drainage area		Denitrification installed	____	number	
Stormwater wetland	____ number	____ drainage area		Septic systems connected			
Sand Filter	____ number	____ drainage area		to WWTP POTW	____	number	
Infiltration Swale	____ number	____ drainage area		Nutrient Management	____	acres	
Porous Pavement	____ number	____ drainage area		Dirt/Gravel Road Maintenance	____	feet	
Roof Water Management	____ number	____ drainage area		Road Bank Stabilized	____	ft^2	

Operation & Maintenance (describe below)

Other (describe below)

Describe your implementation activities to date: (Advise if your improvements are new construction, replacements, or changes to existing systems)

Streams

Name of Project: ______________________ **303D Listed** ☐ Yes ☐ No

Chapter 93 Designation
☐ WWF ☐ CWF ☐ TSF
☐ HQ ☐ EV

Riparian buffers installed __________ length (ft) __________
avg width (ft) __________ __________ type (trees, shrubs, grasses)
(Report both sides of stream if appropriate)
Latitude __________ Longitude __________
Prior land use where established __________ type
Filter Strips installed __________ length (ft) __________ avg width (ft)
Land use where established __________ type
Stream bank protection with fencing __________ length (ft) __________ avg. width (FT)
Stream bank protection without fencing __________ length (ft) __________ avg. width (FT)
Barerooted plantings ☐ __________ type/species (trees, shrubs, grasses)
Container grown plants ☐ __________ type/species (trees, shrubs, grasses)
Protected root stock ☐ __________ type/species (trees, shrubs, grasses)
Weed control ☐ __________ type/species (trees, shrubs, grasses)
Invasive species removed ☐ __________ type/species (trees, shrubs, grasses)
Dams removed __________ number __________ length (ft) __________ height (ft)
Fluvial Geomorphology (FGM) __________ (ft)
Stream channel restoration __________ length (ft)
Fish structures __________ number __________ type
Rootwads ☐ __________ length
J-hook vanes ☐ __________ __________ number
Trash removed __________ tons __________ number of sites
Protection Measures Implemented (describe below)
Please describe activities to date: (include sources of technical assistance)

Wetlands

Existing Site Conditions

Are wetlands present on the site? ☐ Yes ☐ No

If present, what are the types and acreages:

Type:	Size:
☐ PEM (palustrine emergent)	______
☐ PSS (palustrine scrub/shrub)	______
☐ PFO (palustrine forested)	______
☐ POW (palustrine open water)	______
Total Size:	______

Are prior Converted Wetlands Areas Present? ☐ Yes ☐ No

Are any water course(s) affected by the project? ☐ Yes ☐ No

If affected, what are the Ch. 93 Classification(s):

☐ WWF (Warm Water Fishery) ☐ CWF (Cold Water Fishery) ☐ TSF (Trout Stocks) ☐ HQ (High Quality) ☐ EV (Exceptional Value)

What is the contributing drainage area to the wetland project (in acres)?

______ acres

What is the predominant land use in the contributing drainage area?

______

Wetland Protection/Restoration/Creation Projects

Hydrogeomorphic Classification of Wetland
(stream areas are considered riverine):

Existing Wetland Acreage Impacted (0.0):

Type	Size
☐ PEM	______
☐ PSS	______
☐ PFO	______
☐ POW	______

Acreage Restored or created (0.0):

Type	Size
☐ PEM	______
☐ PSS	______
☐ PFO	______
☐ POW	______

Latitude ______ Longitude ______ Latitude ______ Longitude ______

Enhancement/Functional Gain Projects

Hydrogeomorphic Classification of Wetland
(stream areas are considered riverine):

Enhancement Activity Type	**Size of area affected (0.0)**
☐ Streambank Fencing	______
☐ Wetland Fencing	______
☐ Exotic/Invasive Sp. Cont	______
☐ Hydrologic Manipulation	______
☐ Other	______

Other Desc.: ______

Latitude ______ Longitude ______

Please describe activities to date:

Demonstration Project

Name of project: ______________________________

Type of project ______________________________

Mining Related ☐ Yes ☐ No

Non-point Related ☐ Yes ☐ No

Demonstrations Held ____________ Number

____________ Attendance

Publicity ____________ Number

Newspapers ____________ Number

Radio Spots ____________ Number

TV Spots ____________ Number

Internet ____________ Number

Magazine Articles ____________ Number

Other ____________ Number

Describe activities and technologies developed to date for your demonstration project:

Education Project/Outreach

Schools reached	____________	number
Children reached	____________	number
Adults reached	____________	number
Brochures distributed	____________	number
Newspaper articles	____________	number
Radio/TV spots	____________	number
Magazines	____________	number
Web site hits	____________	number
Training sessions held	____________	number
	____________	attendance
Workshops held	____________	number
	____________	attendance

Describe your efforts to date:

Photographs

Operation, Maintenance, and Replacement Plans

OPERATION, MAINTENANCE, AND REPLACEMENT PLANS

The treatment system was designed to minimize maintenance. Nevertheless, specific features were incorporated to facilitate adjustments needed to accommodate changes in flow rates and/or the accumulation of precipitated iron-rich sludge. Monitoring for the project is providing data needed to evaluate iron loading rates and the function of the treatment system for possible modifications for long-term performance. The anoxic limestone drain (ALD) includes a perforated pipe flushing system installed along its length that facilitates the removal of accumulated sludge, if required. The flushing system diverts the sludge to the oxidation pond. The oxidation pond outfall is designed to allow the water level to be raised to compensate for depth reductions that result from iron sludge accumulation. Iron loading calculations indicate approximately 0.8 foot of iron per acre may accumulate over the site in a 10-year period. The pre-design site survey indicated sufficient elevation differential to accommodate several feet of freeboard adjustment to the level(s) of the oxidation pond and wetland cells.

Maintenance will be performed by Schuylkill Headwaters Association, Inc. (SHA) and Schuylkill Conservation District (SCD) and will include such tasks as periodic flushing of the ALD; cleanout of the septic tank, as needed, to prevent clogging of the ALD; monitoring water levels in the treatment system; monthly monitoring of the entire system to determine if there is plugging of the ALD with sediment; and, general observation for erosion as well as removal of debris and sediment. The Philadelphia Water Department (PWA) will continue its water quality monitoring program on the Mill Creek, downstream of the Pine Forest treatment system in order to determine the effectiveness of the system. In addition, SHA is in the process of selecting a graduate student to study and evaluate the effectiveness of the treatment system in reducing metals loading from the mine discharge.

SHA has received a planning grant from the William Penn Foundation to determine a funding mechanism for operation, maintenance and replacement issues that occur in the future. If problems arise with the operation of the Pine Forest Discharge AMD Treatment System, SHA will apply for funding to make the necessary repairs and changes.