Water Research Institute
Annual Technical Report
FY 2001

Introduction

The mission of the West Virginia Water Research Institute (WVWRI) is to address outstanding water issues in West Virginia. The WVWRI is directed by the WV Advisory Committee for Water Research, chaired by WV Division of Environmental Protection Chief of Water Resources with representative of other State and Federal agencies and industry. We receive about $80,000 annually from the U.S. Geological Survey. We use it for administrative support and seed money for new water research technologies. The remainder of ur roughly $5 million annual support comes through competitive research contracts. Water research is interdisciplinary and our research is currently carried out by faculty from the departments of: Geology and Geography, Plant and Soil Science, Resource Economics, Biology, Physics, Chemistry and Forestry. WVWRI is organized into six programs:

1. National Mine Land Reclamation Center which focuses on watershed restoration to correct the effects of mine drainage. 2. Hydrology Research Center which solves problems related to groundwater contamination, use and protection. 3. Combustion Byproducts Recycling Consortium which develops environmentally friendly uses for residues from coal fired power plants. 4. Institute for Industrial Decontamination which develops safer and more efficient decontamination and decommissioning technologies for Defense Department facilities. 5. USEPA/EPSCOR which stimulates broad participation in competitive water research programs within the State's colleges and universities. 6. State Institute Program which provides seed money for developing new water technologies into competitive programs.

Partnerships with West Virginia, and other state's environmental agencies, industry, citizen watershed groups and Federal agencies such as the Office of Surface Mining, USEPA, USGS, the US Army Corps of Engineers and the US Department of Energy have been key in directing our program toward practical results and putting those results into practice.

Research Program

Water Quality Measurement in Polishing Ponds of AMD Treatment Plants for Selection of Commercial Aquaculture Sites and Waste Management Studies

Basic Information

Title:	Water Quality Measurement in Polishing Ponds of AMD Treatment Plants for Selection of Commercial Aquaculture Sites and Waste Management Studies
Project Number:	2001WV2941B
Start Date:	3/1/2001
End Date:	2/28/2002
Funding Source:	104B
Congressional District:	WV 1
Research Category:	Water Quality
Focus Category:	Waste Water, Treatment, Recreation
Descriptors:	post mining land use, waste water,water quality, site selection, waste reduction, parameter of comparison, aquaculture
Principal Investigators:	Ken Semmens, Daniel J. Miller

Publication

Water Quality Measurement in Polishing Ponds of AMD Treatment Plants for Selection of Commercial Aquaculture Sites and Waste Management Studies

(OSP Ref. No.:68-211)
Grant/Contract No.:01HQGR0136

FINAL REPORT

Principal Investigator

Dr. Kenneth Semmens
WVU Extension Specialist - Aquaculture

Partial funding for this research was provided by West Virginia University's Water Resources Research Institute with funding from United States Geological Survey.

This research was made possible by the financial support and cooperation from Eastern Associated's Tygart River Mine.

Water Quality Measurement in Polishing Ponds of AMD Treatment Plants for Selection of Commercial Aquaculture Sites and Waste Management Studies

FINAL REPORT

Objectives

The objective of this study is to collect water quality parameters at two acid mine discharge sites to determine if commercial production of fish is feasible. Stocking and monitoring the growth and survival of fish during the water quality monitoring aided in determining which parameters influenced fish growth or survival. Training of two graduate students occurred during the course of the project.

Introduction

The two sites chosen for the research project were ponds that were previously used for bioassays with encouraging results. Water quality data collected in the initial bioassays was not sufficient to determine if the quality was consistently acceptable. This grant gave us the resources to purchase fish, cages, and electronic monitors (sondes) that were programmed to collect data every hour for the length of the study.

Methods

The **North Branch** acid mine drainage (AMD) site discharges nearly 4,000 gpm of mine water six to seven days per week. Prior to the beginning of this project, there were some mechanical problems that allowed excess liming to occur which resulted in mortality of trout. Management of the plant corrected the problem by adding an additional pH probe after the lime is mixed into the water, and connecting it to the system so the pumps will be shut down when the pH exceeded a predetermined level. When this new system became operational pH levels were stabilized.

As funding became available, sondes and fish cages with demand feeders were ordered and installed. On June 28th 100 Rainbow trout were stocked in two 4'x 4'x 4' closed cages at the North Branch site, placing 50 fish in each cage. One cage received trout feed containing 42% protein and 16% fat. The other cage received a high-energy feed, 44% protein and 24% fat, to determine assimilation rates as a tool for waste management.

Prior to stocking the fish, the water quality monitor (sonde) was suspended between the two floating cages to record temperature, dissolved oxygen, pH, and conductivity on an hourly basis. The cages were connected to a floating dock located near the entrance to the third and final polishing pond receiving treated water from the AMD plant. Each cage had its own demand feeder suspended above it. The cages and feeders were checked weekly and observations were recorded. Larry Campbell, the Tucker Co. extension agent, provided assistance in the data collection at the North Branch site.

The second site chosen in this study was the old acid mine discharge plant for the Tygart River Mine called **Guyses Run**, located in Marion County, WV. Pond water was circulated through a concrete basin previously used as a settling basin. Knotless nylon cages, 8'x 8'x 4',with floating PVC rings were placed in the concrete basins. Three warm water species were chosen for their marketability to the consumer in this area. Channel catfish, largemouth bass, and a hybrid bluegill were stocked in separate cages. Each cage had its own demand feeder suspended above the cage. Weekly visits were made throughout the year. Growth rates were measured every three months and final survival had to be estimated in two cages due to escapement.

Results

The electronic sondes had a software problem that was rectified during the study. With routine maintenance they continue to be useful for unattended data collection in remote locations. Every one to two months a recalibration is needed to keep the measurements accurate. This maintenance was done without any complications.

<u>North Branch</u>

After four weeks, survival was 38% from both cages. No mechanical problems occurred so poor survival was not expected. Data collected from the sonde during that time was compromised due to a malfunctioning temperature probe. Temperature is a factor in the oxygen and pH recordings so all three parameters were compromised. Once the sonde was repaired, data showed the probable reason for poor survivals. The pH was fairly constant but it was considerably higher (8.8) than it was during the initial bioassay (8.0) the previous year. Results from the data collection can be seen in Table 1.

From July 2001 until February 2002 parameters were collected. Temperature data varied between 2 degrees and 20 degrees Celsius, within the tolerance range of trout. During a six week period beginning in August, all data collection was compromised by a software problem. This can be seen on Table 1. The pH levels were consistently in the middle to upper 8's, which is the lethal range for trout. There is an increase in potentially toxic aluminum ion complexes at this pH. The pH levels need to decrease to the lower 8's if the trout are to survive in the polishing pond. Levels of dissolved oxygen remained within acceptable ranges throughout the study.

The cages were stocked a second time in July. Trout were carefully acclimated by mixing the pond water with the transport tank water before stocking. The results showed continued mortalities. The pH has remained relatively consistent during this research study. The modification to the treatment process appears to have had a stabilizing effect on the discharge water, but the pH was too high to support growth and survival of rainbow trout. Since the initial bioassay in 2000, management increased the target pH to 8.8. This was done to reduce manganese discharge levels to comply with NPDES specifications. This change brought the pH higher than the recommended range of 6.0 to 8.5 for trout. This was the only measured parameter that indicated a problem for the trout.

Due to the short period of time that the different feeds were being compared there was insufficient data to determine the feed conversion ratio (FCR) for the trout. Growth occurred in both cages, increasing from 98 grams to 108 grams. The average increase in weight was the same for both the high energy feed as well as the regular trout feed.

Because the North Branch site has potential as a quality aquaculture site, we are asking the WV Dept. of Environmental Protection to seek an exemption from the 1.0 ppm manganese discharge limits for the duration of our research. We have asked WVDEP for a temporary variance at this site (Appendix A). A meeting, to address this request, has been scheduled in Charleston, the first week in March 2002.

The baseline data collection for macroinvertebrate diversity above and below the discharge site was conducted in the spring and the fall of 2001. Results from this rapid bioassay are presented in Appendix B. The results indicate the biodiversity of macroinvertebrates at North Branch is poor both above and below the discharge point of the AMD plant. The main reason for this is the iron precipitation evident in Little Buffalo Creek. Both sites are dominated by riffle areas and considered high gradient streams. The flow was estimated to be between 2000 and 8000 gallons per minute at Little Buffalo Creek. The area has evidence of regular flooding. No semivoltine species, those that require more than one year to emerge, were identified in the samples taken.

<u>Guyses Run</u>

Catfish and largemouth bass were stocked into cages on June 20th, 2001. Hybrid bluegill were stocked two months later due to their smaller size, and the likelihood that they would have been able to swim through the mesh of the cage. The average weight of the fish at the time of stocking, were 24 grams for the catfish, and 12 grams for the bass. Due to the small size of the bluegill the stocking was delayed until August (Table 3). Temperatures ranged from 4 to 29 degrees Celsius. During the summer it reached the upper 20's, which improved the growth of the warm water fish in the cages. Dissolved oxygen concentrations remained acceptable throughout the seasons.

On September 18th, 2001 the fish were sampled for growth. The average weight of catfish increased from 24 grams in June to 182 grams in 13 weeks. The average weight of bass increased from 12 grams to 103 grams over the same interval. The hybrid bluegill were measured for the first time averaging 23 grams.

TABLE 3 **<u>Growth and Survival at Guyses Run</u>**

Date	**Channel Catfish**	**Largemouth Bass**	**Hybrid Bluegill**
June 2001	24 grams	12 grams	NA
Sept. 2001	182 grams	103 grams	23 grams
Dec. 2001	227 grams	NA (escaped)	21 grams
Feb. 2002	249 grams	NA (escaped)	25 grams
Final % Survival	90% (estimated)	90% (estimated)	42%

The fish were sampled again on December 20th . The average weight of catfish increased to 227 grams. All of the bass escaped from the cage due to holes in the cage. The final measurements occurred on February 20th, 2002. During this sampling it was discovered that the catfish cage had a large hole extending below the waterline, allowing the fish to swim out easily. A raccoon or muskrat is the suspected culprit. Estimated mortality in the above table was based on twice the number of noted mortality. When temperatures rise in the spring, the basin will be pumped dry in order to remove the bass and catfish from the basin.

The minor loss of weight in the bluegill is due to the lack of feeding during the colder temperatures. This is common during the winter season. The poor survival is probably due to the stocking of such young fish, that had not yet learned how to use a demand feeder, so late in the warm season. They ate when fed by hand, but did not learn how to activate the feeder before the cold temperatures arrived. This may have left them in poor condition going into the winter months. The bluegill cage did not appear to gain the attention of the nocturnal predator that ate its way into the catfish and bass cages.

The metrics applied to the macroinvertebrate sampling at Guyses Run showed 35 percent of the animals collected (Ephemeroptera, Plecoptera, and Trichoptera) to be associated with higher quality water (see Appendix 2: tables 1-8). Leaf litter from the deciduous trees, located along the stream, provides an annual food source for the invertebrates. The stream was also dominated by riffles with a flow volume estimated to be less than 100 gpm. Land use is predominately rural agriculture and single-family homes.

Conclusion

The hourly collection of water quality data at the two mine sites has allowed us to determine the parameter limitations for the aquaculture potential at each site. The consistently high pH (8.8) of the water at the North Branch site explains why trout did not survive the trials. Reasons for the high pH deal with regulatory issues and they are being addressed. Until the manganese discharge limits are changed, and a lower operating pH is possible, we have decided to temporarily suspend trout research at the North Branch site.

The Rapid Bioassay Protocols conducted in the spring and fall at each site showed very little difference between seasons, and minor differences above and below the discharge point at each site, indicating the impact of the discharge is not seen in a change of biodiversity. The pond discharge from Guyses Run occurs only from runoff entering the pond after heavy rains or snow melts. So there is little reason to find an impact below the discharge point. The major difference between the two sites, besides flow rates of the stream, is that nearly half of the flow in Little Buffalo Creek below the discharge point, results from the treated mine water entering the stream. Flow rates were about 100 times greater at North Branch (Little Buffalo Creek) than at Guyses Run. The biodiversity was much greater at Guyses Run due to the negative impact of iron precipitation in Little Buffalo Creek. The mining activities in the Little Buffalo Creek watershed appear to have impacted the diversity in the stream.

The success of the cage stocking of three warm water species at the Guyses Run site is evident in the survival and growth of the fish. Minor problems with nocturnal predators are a result of keeping the fish in cages. If commercial production occurs at this site, the predator problem could be controlled with minor changes in management. The next step at this site is to design a plan for outdoor recreation activities that include the water resources. Efforts in this direction are being planned with the Department of Landscape Architecture at West Virginia University.

Old AMD plan for Tygart River Mine:
Stocked with 3 warm water species
Infrastructure: elec./road/fenced/3 ponds/ 2x100,000 gal. basins


West Virginia University
Extension Service
Helping you put knowledge to work
Eastern
ASSOCIATED
COOPERATIVE AQUACULTURE
RESEARCH SITE
West Virginia University and Eastern Associated are combining to conduct aquaculture research at Guyses Run AMD facilitiy in hopes of improving the community by developing an outdoor recreational fishing facility.
Funding has been provided by:
WVU - Water Resources Research Institute
WVU - Extension Service
WVU - Aquaculture Food and Marketing Development Project
Eastern Associated - Tygart River Mine
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APPENDIX A

Daniel Miller
WVU Ag. Sci. Bldg. Rm 2026
Morgantown, WV 26506

September 26, 2001

Mr. Ken Politan
WV Department of Environmental Protection

Dear Mr. Politan,

One of the research aspects of my job is to identify potential aquaculture sites in the state for commercial development. Least year one of the the sites that provided us with encouraging results was the North Branch AMD plant in Grant Co. (NPDES # WV0005606) We stocked the final polishing pond with rainbow trout in a small cage to determine if they would survive. Although there were some mortalities the cause of the problems were related to the operations at the liming plant and were corrected by installing an additional pH probe after the liming area and connecting it to the pumps so that an automatic shut down occurs if the pH exceeds a predetermined level.

The modifications were installed by Consol to maintain better control of the liming and pH levels. Earlier this year Consol allowed us to continue with this research by restocking trout and placing a water quality probe that measures pH, temperature, dissolved oxygen, and conductivity on an hourly basis to give us a better understanding of the daily fluctuations of these important parameters in the polishing pond. To our surprise the experiment showed us that the pH levels were raised to a level (8.7-8.9) that was beyond the tolerance level of the trout. For this reason we have temporarily suspended trout experiments at this site.

In discussing this problem with the management of the plant we learned that the plant was occasionally violating the manganese discharge limits of 1.0 ppm. In order to remain in compliance with the permit the pH levels were raised to above 8.5.

We believe the North Branch site has good potential to become a quality fee fishing site that would bring tourists to the area for a quality fishing experience. The pond design allows excellent access with wide banks and the continual water flow keeps the temperatures cool throughout the year. We would like to continue to conduct research with rainbow trout at this site in order to demonstrate the feasibility of utilizing this site as a quality outdoor recreational activity for tourists, which would help to improve the economical development of the community.

I am asking you if it is possible to change the manganese discharge limits for the permit at the North Branch AMD site from 1.0 ppm to the national standard of 2.0 ppm average and 4.0 ppm maximum. I believe this modification to the permit would allow the management of the plant to reduce the pH of the outgoing water enough to allow trout to thrive in the pond. Our research is needed to quantify the risks at each site and if the data is positive, allow a small business to operate an aquaculture venture for the benefit of all involved.

Could you look into this possibility and let me know if there is anything else I can do to allow for a modification of the manganese discharge limits at the North Branch AMD site?

Sincerely,

Daniel Miller
WVU Sr. Project Coordinator-Aquaculture
Phone: 293-4832 ext.4465

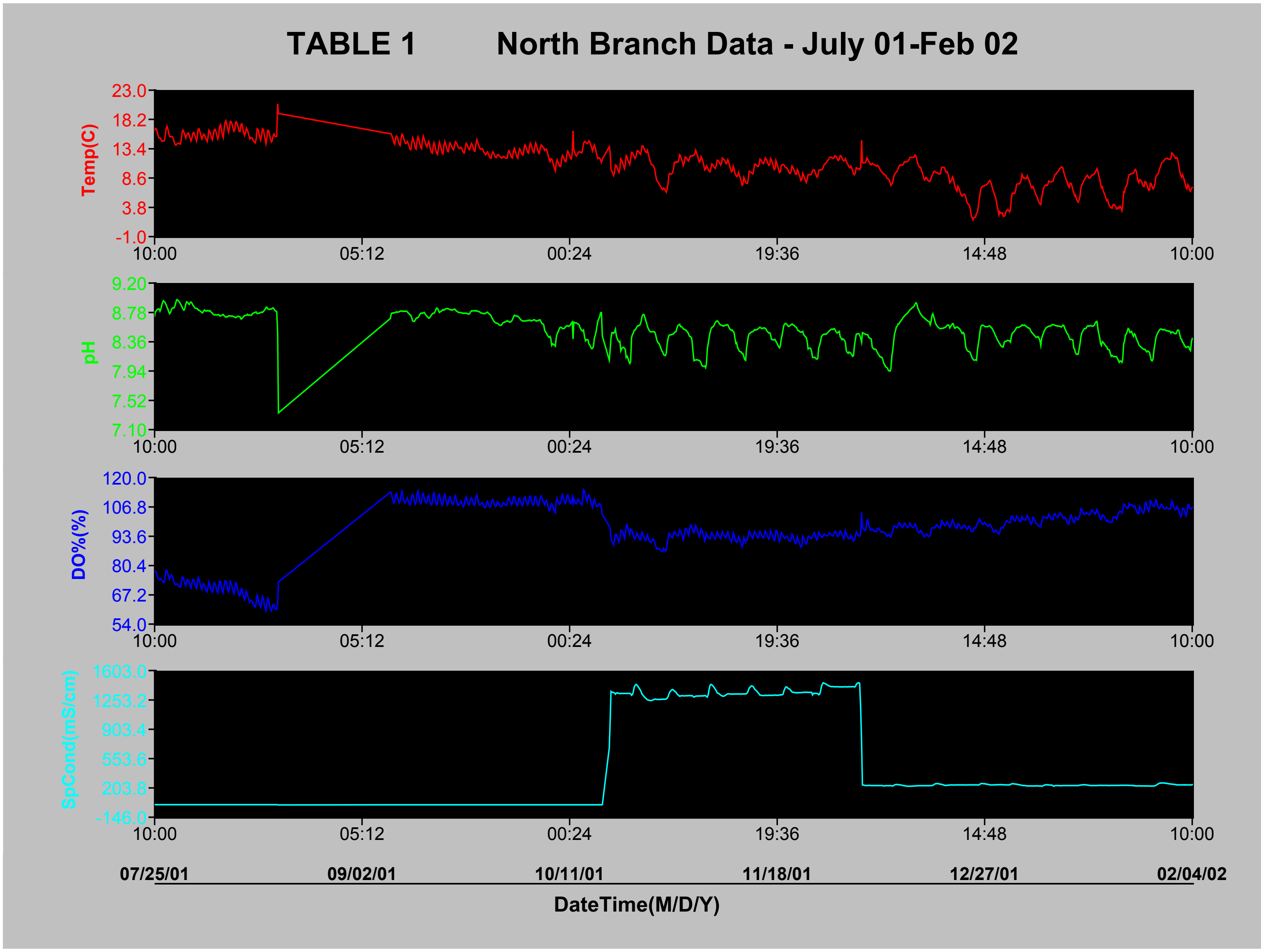
TABLE 1 North Branch Data - July 01-Feb 02
Temp(C)
23.0
18.2
13.4
8.6
3.8
-1.0
pH
9.20
8.78
8.36
7.94
7.52
7.10
DO%(%)
120.0
106.8
93.6
80.4
67.2
54.0
SpCond(mS/cm)
1603.0
1253.2
903.4
553.6
203.8
-146.0
10:00
05:12
00:24
19:36
14:48
10:00
07/25/01
09/02/01
10/11/01
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02/04/02
DateTime(M/D/Y)

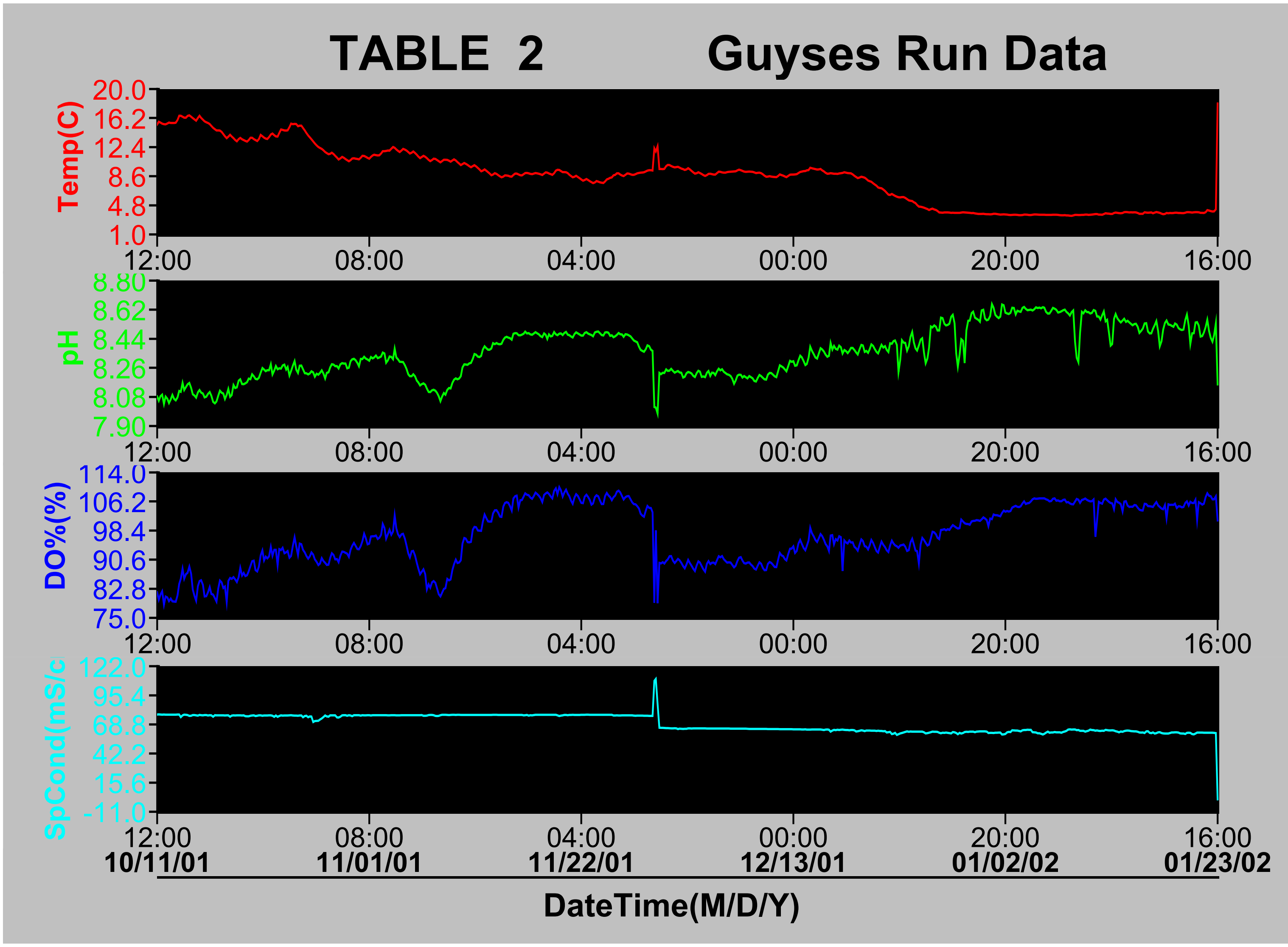
TABLE 2 Guyses Run Data
Temp(C)
20.0
16.2
12.4
8.6
4.8
1.0
pH
8.80
8.62
8.44
8.26
8.08
7.90
DO%(%)
114.0
106.2
98.4
90.6
82.8
75.0
SpCond(mS/c
122.0
95.4
68.8
42.2
15.6
-11.0
12:00
08:00
04:00
00:00
20:00
16:00
10/11/01
11/01/01
11/22/01
12/13/01
01/02/02
01/23/02
DateTime(M/D/Y)

APPENDIX B

SPRING AND FALL AQUATIC BIOASSESSMENT OF GUYSES RUN AND LITTLE BUFFALO CREEK

Objective:

The objective of this assessment is to determine the relative diversity of aquatic macroinvertebrates through spring and fall collections (rapid bioassay protocols) both above and below the confluence of the old AMD pond discharge site at Guyses Run in Marion Co. and above and below the AMD pond discharge at the Little Buffalo Creek in Grant Co., West Virginia.

Introduction:

This rapid bioassay protocol was conducted in the spring and the fall of 2001 to begin to determine the overall biological health of Guyses Run and Little Buffalo Creek. A single bioassay of an area has limited value without previous baseline data. This study is being done to collect the baseline data for comparison with future collections. Guyses Run does not receive regular flows from the pond. Little Buffalo Creek receives a nearly constant flow of at least 2000 gpm from the polishing pond.

Methods:

The procedures used for the rapid bioassay were adapted from the Mid Atlantic Coastal Streams Workshop recommendations designed for use in variable habitat streams. A standard D shaped dip net was used to collect samples from five places that represented the habitats found along Guyses Run and Little Buffalo Creek, WV. At each site an area of approximately 0.3 meters by 0.5 meters was disturbed and washed into the net. Sampling sites were successively upstream from the previous site and within a 100 foot stretch of stream. Five kicks above the pond discharge area were combined in a jar with 70% ethyl alcohol for preservation. The microhabitats seen in the stretch of stream sampled were represented in the specific location chosen for the five kick sites. There was evidence of flooding and the riparian zone consisted of mature trees providing shade along most of one side of the stream. The same procedure was done just below the discharge point. Lab identification was completed using a compound microscope and additional lighting.

The estimated latitude and longitude were determined using the West Virginia Atlas and Gazetteer. Taxonomic identification was done to the family level using the Third Edition of *An Introduction to the Aquatic Insects of North America* by R.W. Merritt and K.W. Cummins. The macroinvertebrate collection was properly labeled and sent to the WVU Entomology Department for storage in the basement of the Agricultural Sciences Building. For each collection there are two tables showing the results from the bioassay. One table lists the families identified and the number of macroinvertebrates from each family including the functional feeding group. The other table is a metric analysis that calculates relative number of individuals from tolerant (Diptera) and intolerant families (EPT), their percentages, and any semivoltine representatives.

Results:

Guyses Run, Marion Co. WV (latitude: 39° 27' 00", longitude: 80° 07' 00")

Samples taken above and below the confluence of the pond discharge with the stream. During both sampling periods, based on visual observations, the stream was running well below high flows. The flow was estimated to be about 20-60 gallons per minute during each sample with a temperature of 17°C in the May sample as well as the October sample. Due to the dominance of riffle areas Guyses Run is considered a high gradient stream. The altitude is approximately 1000 feet above sea level.

The stream width averages one meter and is dominated by rocky and woody debris. Grasses are found on either side and looking upstream, on the left side, there are mature deciduous trees (maples, walnuts, oaks) providing shade during part of the day. The leaf litter provided by these trees becomes a main food source for the system each year. No iron or aluminum precipitates were evident in the stream. The percentage of EPT's compared to the total number of animals above the pond discharge averaged only 30%, while below the discharge it averaged 39%, which indicates reasonable quality.

Little Buffalo Creek, Grant Co. WV (latitude: 39° 15' 30", longitude: 79° 21' 00")

Samples were taken above and below the confluence of the pond discharge with the stream. Based on visual observations the flow during sampling was low, however the volume was estimated to be about 8,000 gallons per minute below the discharge area. Approximately half of the flow originates from the pond discharge. Iron deposits in the stream were also evident above the discharge area. The riparian zone consists of vegetation on both sides of the creek with exposed clay on steep embankments along parts where a county road winds near the creek. Maple, pine and cherry trees up to 18 inches in diameter provide food and shade for the invertebrates in the water. Occasional woody debris can be seen, yet the majority of the habitat is riffles interrupted by pools of water. Stream width varies from 3-7 meters.

Altitude is 2600 feet above sea level. May temperature reading was 13.1°C upstream from the discharge and 12.9°C downstream. The October sampling recorded water temperatures of 6.4°C both above and below the confluence. There was no water flow from the pond during the sampling on the 18th of October. A heavy coating of iron on all rocks below the confluence and minor iron deposits above the confluence was visible. Flow was estimated to be 2500 gpm. Fresh leaf litter was falling into the stream. The EPT metric indicator for above and below the pond discharge point may be misleading due to the lack of quantity found during the collection. The %EPT metric was 93% for the sample above the pond and 75% for the sample below the pond. No semivoltine species were found in the stream.

GUYSES RUN BIOASSAY

TABLE 1

Above Pond Discharge

Latitude 39^{0} 27' 00" Altitude: 1000' asl May 18, 2001

Longititude 80^{0} 07' 00' Temp: 17.1 ^{o}C

Flow: +/-40gpm

MACROINVERTEBRATE IDENTIFICATION

Order	Family	Trophic Level	Number
Ephemeroptera	Siphlonuridae	Gatherer/Collector	1
	Ephemerellidae	Gatherer/Collector	1
	Heptageniadae	Gatherer/Collector	43
Plecoptera	Leuctridae	Shredder	2
	Nemouridae	Shredder	7
	Perlidae	Predator	12
	Perlodidae	Predator	17
Trichoptera	Hydroptilidae	Collector	2
Coleoptera	Carabidae	Predator	10
	Dytiscidae	Predator	5
	Psephinidae	Gatherer	12
	Elmidae	Gatherer/Collector	62
Diptera	Chironomidae	Gatherer/Collector	2
	Culicidae	Gatherer/Collector	2
	Tipulidae	Shredder	8
Odonata	Calopterygidae	Gatherer	1
Hemiptera	Corixidae	Predator	3
Isopoda	Asellidae	Omnivore	11
Amphipoda	Gammaridae	Gatherer	2
Decapoda	Cambaridae	Shredder	2
		Total	**205**

TABLE 2 **METRICS**

Total # Families	20
# EPT	85
# Ephemeroptera taxa	3
# Plecoptera taxa	4
# Trichoptera taxa	1
# Diptera taxa	3
% EPT	41%
% Ephemeroptera	22%
% Chironomidae	1%
% Hydropsychidae/Trichoptera	0%
% Trichoptera	1%
% Semivoltine	0%

GUYSES RUN BIOASSAY

TABLE 3

Below Pond Discharge

Latitude 39^0 27' 00" Altitude: 1000' asl May 18, 2001

Longititude 80^0 07' 00' Temp: 17.2 ^{o}C

Flow: +/-40gpm

MACROINVERTEBRATE IDENTIFICATION

Order	Family	Trophic Level	Number
Ephemeroptera	Ephemiridae	Gatherer/Collector	3
	Siphlonuridae	Gatherer/Collector	1
	Heptagenidae	Gatherer/Collector	42
Plecoptera	Perlidae	Predator	5
	Perlodidae	Predator	3
	Nemouridae	Shredder	1
	Leuctridae	Shredder	1
	Chloroperlidae	Predator	11
Coleoptera	Carabidae	Predator	1
	Psephenidae	Gatherer	1
Hemiptera	Corixidae	Predator	2
Coleoptera	Psephenidae	Gatherer	1
	Elmidae	Gatherer/Collector	23
Diptera	Tipulidae	Shredder	2
	Chironomidae	Gatherer/Collector	2
	Culicidae	Gatherer/Collector	2
Odonata	Aeshnidae	Predator	2
	Petaluridae	Predator	1
Amphipoda	Gammaridae	Gatherer	2
		Total	**106**

TABLE 4 **METRICS**

Total # Families	19
# EPT	67
# Ephemeroptera taxa	3
# Plecoptera taxa	5
# Trichoptera taxa	0
# Diptera taxa	3
% EPT	63%
% Ephemeroptera	43%
% Chironomidae	2%
% Hydropsychidae/Trichoptera	0%
% Trichoptera	0%
% Semivoltine	0%

GUYSES RUN BIOASSAY

TABLE 5

Above Pond Discharge

Latitude 39^0 27' 00" | Altitude: 1000' asl | Oct. 5, 2001

Longititude 80^0 07' 00' | Temp: 14.5 ^{o}C

Flow: +/-40gpm

MACROINVERTEBRATE IDENTIFICATION

Order	Family	Trophic Level	Number
Ephemeroptera	Heptageniadae	Scraper	1
	Caenidae	Gatherer/Collector	1
	Baetidae	Gatherer/Collector	9
Trichoptera	Hydropsychidae	Filterer/Collector	15
Isopoda	Aesllidae	Gatherer/Collector	3
Diptera	Tipulidae	Shredder	11
	Stratiamyidae	Gatherer/Collector	2
	Chironomidae	Gatherer/Collector	9
Hemiptera	Corixidae	Predator	12
Amphipoda	Gammaridae	Gatherer/Collector	70
Coleoptera	Elmidae	Gatherer/Collector	5
	Psephinidae	Gatherer/Collector	1
Collembola	Isotomidae	Gatherer/Collector	1
Odonata	Corduligastridae	Predator	1
	Calopterigidae	Predator	21
		Total	**162**

TABLE 6 **METRICS**

Total # Families	15
# EPT	26
# Ephemeroptera taxa	3
# Plecoptera taxa	0
# Trichoptera taxa	1
# Diptera taxa	3
% EPT	16%
% Ephemeroptera	7%
% Chironomidae	6%
% Hydropsychidae/Trichoptera	100%
% Trichoptera	9%
% Semivoltine	0%

GUYSES RUN BIOASSAY

TABLE 7

Below Pond Discharge

Latitude 39^{0} 27' 00" Altitude: 1000' asl Oct 5, 2001

Longititude 80^{0} 07' 00' Temp: 15.9 ^{o}C

Flow: +/-40gpm

MACROINVERTEBRATE IDENTIFICATION

Order	Family	Trophic Level	Number
Ephemeroptera	Heptageniadae	Scraper	20
	Caenidae	Gatherer/Collector	3
	Baetidae	Gatherer/Collector	12
Trichoptera	Hydropsychidae	Filterer/Collector	40
Coleoptera	Elmidae	Gatherer/Collector	24
	Psephinidae	Gatherer	1
	Carabidae	Predator	1
Hemiptera	Corixidae	Predator	1
Diptera	Simulidae	Filterer/Collector	12
	Tipulidae	Shredder	9
	Chronomidae	Gatherer/Collector	42
Isopoda	Asellidae	Gatherer/Collector	70
Odonata	Gomphidae	Predator	1
	Calopterigidae	Predator	14
Amphipoda	Gammaridae	Gatherer/Collector	9

Total 259

TABLE 8 METRICS

Total # Families	15
# EPT	75
# Ephemeroptera taxa	3
# Plecoptera taxa	0
# Trichoptera taxa	1
# Diptera taxa	3
% EPT	29%
% Ephemeroptera	14%
% Chironomidae	16%
% Hydropsychidae/Trichoptera	100%
% Trichoptera	15%
% Semivoltine	0%

LITTLE BUFFALO CREEK BIOASSAY

TABLE 9

Above Pond Drainage

Latitude 39^0 15' 30" Altitude: 3000' asl May 18, 2001

Longititude 79^0 21' 00' Temp: 13.1 ^{o}C

Flow: 3000gpm

MACROINVERTEBRATE IDENTIFICATION

Order	Family	Trophic Level	Number
Ephemeroptera	Ephemerillidae	Gatherer / Collector	1
Plecoptera	Perlodidae	Predator	4
	Chloroperlidae	Predator	2
	Peltoperlidae	Shredder	3
Trichoptera	Polycentropodidae	Filterer / Collector	1
	Hydropsychidae	Filterer / Collector	1

Total 12

TABLE 10 **METRICS**

Total # Families	6
# EPT	12
# Ephemeroptera taxa	1
# Plecoptera taxa	3
# Trichoptera taxa	2
# Diptera taxa	0
% EPT	100%
% Ephemeroptera	8%
% Chironomidae	0%
% Hydropsychidae/Trichoptera	50%
% Trichoptera	17%
% Semivoltine	0%

LITTLE BUFFALO CREEK BIOASSAY

TABLE 11

Below Pond Drainage

Latitude 39^{0} 15' 30" Altitude: 3000' asl May 18, 2001

Longititude 79^{0} 21' 00' Temp: 12.9 ^{o}C

Flow: 8000gpm

MACROINVERTEBRATE IDENTIFICATION

Order	Family	Trophic Level	Number
Plecoptera	Perlodidae	Predator	1
Trichoptera	Hydropsychidae	Filterer / Collector	1
	Phryganeidae	Filterer / Collector	2
Hemiptera	Gerridae	Predator	1

Total 5

METRICS

TABLE 12

Total # Families	4
# EPT	4
# Ephemeroptera taxa	0
# Plecoptera taxa	1
# Trichoptera taxa	2
# Diptera taxa	0
% EPT	80%
% Ephemeroptera	0%
% Chironomidae	0%
% Hydropsychidae/Trichoptera	33%
% Trichoptera	60%
% Semivoltine	0%

LITTLE BUFFALO CREEK BIOASSAY

TABLE 13

Above Pond Drainage

Latitude 39^0 15' 30" Altitude: 3000' asl Oct. 18, 2001

Longititude 79^0 21' 00' Temp: 6.4 ^oC

Flow: 2500gpm

MACROINVERTEBRATE IDENTIFICATION

Order	Family	Trophic Level	Number
Plecoptera	Capniiadae	Predator	1
Trichoptera	Hydropsychidae	Filterer / Collector	1
Diptera	Chronomidae	Gatherer / Collector	1

Total 3

TABLE 14 METRICS

Total # Families	3
# EPT	2
# Ephemeroptera taxa	0
# Plecoptera taxa	1
# Trichoptera taxa	1
# Diptera taxa	1
% EPT	67%
% Ephemeroptera	0%
% Chironomidae	33%
% Hydropsychidae/Trichoptera	100%
% Trichoptera	33%
% Semivoltine	0%

LITTLE BUFFALO CREEK BIOASSAY

TABLE 15

Below Pond Drainage

Latitude 39^0 15' 30" Altitude: 3000' asl Oct. 18, 2001

Longititude 79^0 21' 00' Temp: 6.4 ^{o}C

Flow: 2500gpm

MACROINVERTEBRATE IDENTIFICATION

Order	Family	Trophic Level	Number
Plecoptera	Capniiadae	Predator	2
Trichoptera	Polycentropodidae	Filterer / Collector	1

Total 3

TABLE 16 METRICS

Total # Families	2
# EPT	2
# Ephemeroptera taxa	0
# Plecoptera taxa	1
# Trichoptera taxa	1
# Diptera taxa	0
% EPT	100%
% Ephemeroptera	0%
% Chironomidae	0%
% Hydropsychidae/Trichoptera	0%
% Trichoptera	0%
% Semivoltine	0%

Aquaculture Waste Control and Optimizing Nutrient Utilitization Trough Diet Composition and Feeding Strategies

Basic Information

Title:	Aquaculture Waste Control and Optimizing Nutrient Utilitization Trough Diet Composition and Feeding Strategies
Project Number:	2001WV2981B
Start Date:	4/1/2001
End Date:	3/31/2003
Funding Source:	
Congressional District:	WV 2
Research Category:	
Focus Category:	Agriculture, Nutrients, Water Quality
Descriptors:	feeding strategies, zeolites, phosphorus bioavailability, nutrient utilitization, waste control,aquaculture
Principal Investigators:	Jonathan C. Eya

Publication

" ANNUAL REPORT OF ACCOMPLISHEMENTS AND RESULTS"

PROJECT SPECIFICATIONS:

Subcontract No. 68-211-WVSC
Project Sponsor: U.S. Geological Service
Project Title: Aquaculture Waste Control and Optimizing Nutrient Utilization through Diet Composition and Feeding Strategies" for the FY 2001.
Period of Performance: March 1, 2001 to February 28, 2002

SUMMARY

The present report provides an update of the annual accomplishments for the project titled " Aquaculture Waste Control and Optimizing Nutrient Utilization through Diet Composition and Feeding Strategies" for the FY 2001.

STATEMENT OF PROBLEMS:

The ultimate source of wastes in an aquaculture system is feed; and phosphorus and nitrogen are the major elements of concern in discharge from aquaculture operations. The source and amount of the nutrients in the feed, daily feeding rate and the amount of feed wasted in the ponds or raceways influence the amount of unretained nitrogen and phosphorus in the salmonid culture systems. Therefore, minimizing the allowances of the nutrients in the feed, increasing bioavailability of these nutrients to the fish, and more efficient feeding of the fish, offer opportunities to reduce the unretained nutrients in the culture systems. Consequently, reducing phosphorus and nitrogen load in aquaculture effluent can be most effectively implemented by increasing the retention of the nutrients by fish. Most emerging trout farmers in West Virginia feed 1.5 to 2 kg of feed for each kg of fish harvested. This suggests that a great amount of the nutrients are wasted in commercial culture operations. Reasons for poor efficiency in nutrient retention in commercial culture operations are not clear. Feeding practices vary considerable among farmers, some feed on restricted basis, and some try to feed to satiation, while some inadvertently over-feed because of lack of knowledge of what the fish will consume. Reducing aquaculture waste loads and optimizing nutrient utilization through diet composition and feeding strategies will allow for increased production, increased profits for producers (small- and large-scale), and possibly offer more affordable foods for the consumers.

Therefore, there is the need to reduce aquaculture wastes and improve nutrient utilization through diet formulation and appropriate feeding strategy or practice.

This research will provide information on the bioavailability of different chemical forms of phosphorus to determine the optimum phosphorus allowance in commercial feeds and make accurate estimates of phosphorus budgets in aquaculture systems. Also, this research will evaluate the potential effects of various forms of zeolites (crystalline, hydrated aluminosilicate of alkali and alkaline earth cation) on nutrient utilization as well as their ability to remove ammonia and nitrite toxicity in aquaculture systems. Furthermore, one phase of this proposed study will compare nitrogen and phosphorus loads in aquaculture systems under various feeding regimens to determine how much improvement in feeding practices can reduce the waste loads in the systems.

RESEARCH OBJECTIVES:

1. Determine effects of feeding practices on waste load in trout culture systems.
2. Evaluate the effects of different chemical forms of phosphorus on net absorption of phosphorus and orthophosphate concentrations in tank water effluents.
3. Determine the effects of dietary supplementation of various zeolites on ammonia and nitrite concentrations in trout rearing system.
4. Determine the effects of dietary supplementation of various zeolites on growth, feed efficiency and health of rainbow trout.
5. Determine the economic impact of changes in feed formulation and feeding practices.

PROGRAM STATUS:

The first year's study would have been the determination of the effects of feeding practices on waste load in trout culture systems (Objective 1) and the evaluation of the effects of different chemical forms of phosphorus on net absorption of phosphorus and orthophosphate concentrations in tank water effluents.

The experimental diets for study 1 (objective 1) were formulated and two thousand year-1 rainbow trout averaging 20 g were obtained from High Appalachia Trout Inc. Forty fish were stocked into each of the 36 twenty-nine gallons glass aquaria. The water temperature was to be maintained at 15 ^{o}C. The experiment was terminated after the water temperature control system failed and 100% mortality recorded. The water temperature rose to 27 ^{o}C (trout is coldwater fish and optimum temperature for growth of trout ranges 12-15 ^{o}C and not higher than 18 ^{o}C) and the dissolved oxygen level dropped too low to support the fish.

PRINCIPAL FINDINGS AND SIGNIFICANCE OF FINDINGS:

The work is not sufficiently mature to show principal findings and their significance this time.

PUBLICATIONS:

The project has not progressed to the point of publishing research findings. Only preliminary data is available but insufficient to support to support any scientific evidence.

AWARDS AND ACHIEVEMENTS:

No award or achievement recorded at this time because of the delay in the commencement of study 1.

INFORMATION TRANSFER SYSTEM:

The project has not progressed to the point of making research findings available to the public.

STUDENT SUPPORT:

One student was involved in the preparation of the experimental diets and taking care of the fish within the first week of the arrival of the fish to Aquaculture wet laboratory.

PLANS FOR YEAR 2:

The first year's studies were not conducted because of the problems mentioned above. Objectives 1 and 2 will be carried over and out in the second year. I am requesting an extension for objectives 3, 4 and 5 to be completed in the third year.

Because of the aforementioned problems, only some expenses including the purchase of fish, materials and supplies, and payment of student worker have been drawn from the account.

PROGRESS AND SETBACKS:

The first year's study would have been the determination of the effects of feeding practices on waste load in trout culture systems (Objective 1) and the evaluation of the effects of different chemical forms of phosphorus on net absorption of phosphorus and orthophosphate concentrations in the tank water effluents.

The experimental diets for study 1 (objective 1) were formulated and two thousand year-1 rainbow trout averaging 20 g were obtained from High Appalachia Trout Inc. Forty fish were stocked into each of the 36 twenty-nine gallons glass aquaria. The water temperature was to be maintained at 15 ^{o}C. The experiment was terminated after the water temperature control system failed and 100% mortality recorded. The water temperature rose to 27 ^{o}C (trout is coldwater fish and optimum temperature for growth of trout ranges 12-15 ^{o}C and not higher than 18 ^{o}C), and the dissolved oxygen level dropped too low to support the fish.

To correct the design flaw, an engineering firm was contracted to design a system that can maintain the temperature of water in the ranges of 10-2 0 ^{o}C. Also, air-cooling system was to be designed that can maintain the room temperature to that of the water temperature to minimize net gain or loss of heat. Based on the engineer's recommendation, both air and water chillers have been purchased and a local contractor is currently installing the designed system to correct the problem.

After the completion of the installation of the temperature control system that will be in mid of April 2001, a trial run will be conducted before objective 1 is started to ensure that the system works to the specification.

Development of a Design Manual for Abandoned Mine Land Reclamation

Basic Information

Title:	Development of a Design Manual for Abandoned Mine Land Reclamation
Project Number:	
Start Date:	8/1/2001
End Date:	9/1/2002
Funding Source:	Other
Congressional District:	WV 1st
Research Category:	Water Quality
Focus Category:	Treatment, Surface Water, Groundwater
Descriptors:	acid mine drainage, design, regulations, remediation, cost
Principal Investigators:	Paul F Ziemkiewicz, Jennifer Simmons, Jeff Skousen, Tamara Vandivort

Publication

Draft Detailed Outline For:
Engineering and Design
GUIDELINES FOR DESIGN OF ABANDONED MINE LAND REMEDIATION

Table of Contents

a. Surface Workings
   (1) Shallow and Deep Pits
   (2) Structures and Chemicals
   (3) Tailings and Waste Rock

b. Underground workings
   (1) Stability of workings
   (2) Air quality
   (3) Water

2.5 Coal Mines

a. Surface
   (1) Area mines
   (2) Contour mines
   (3) Mountain top mines
   (4) Auger

b. Underground Mines
   (1)Room and Pillar
      a. Development
      b. Retreat
   (2) Long wall

c. Surface Facilities
   (1) Coal Cleaning
   (2) Loading
   (3) Refuse
   (4) Slurry
   (5) Spoil
   (6) AMD

Chapter 3 HEALTH AND SAFETY

a. Regulatory Requirements
   (1) Federal Regulations
   (2) State and Local Regulations
   (3) Tribal Lands

b. Documentation
   (1) Health and Safety Plans
   (2) Chain of Custody

c. AML Site Health and Safety Implementation

Chapter 4 REGULATORY AGENCY OVERSIGHT OF AML

a. Land Ownership
b. Federal Agency Oversight
c. State Agency Oversight
d. Tribal Oversight

Chapter 5 SITE INVESTIGATIONS

5.1 Background

a. Surface History
b. Mine History
c. Mine Maps
d. Photographs

5.2 Initial Evaluation

a. Water Chemistry
  (1) PH, Fe, Al. Mn
  (2) Suite of 12
  (3) Flow Measurements

b. HTRW Concerns

c. Geology
  (1) Lithology
  (2) Minerology

d. Hydrology
  (1) Surface Run Off
    a. Seasonal / Episodic
    b. Ground Water Interactions
    c. Estimating Flow
  (2) Ground Water
    a. Seasonal / Episodic
    b. Surface Water Interactions
    c. Mine Inundation
    d. Estimating Recharge / Sources
    e. Ground Water Levels

(3) Impoundments

e. Water Quality Targets
- (1) Receiving stream standards
- (2) 303 (d) listing
- (3) TMDL

f. Establishing sampling network
- (1) Parameters
- (2) Methods
- (3) Locations
- (4) Duration

Chapter 6 REMEDIATION

(Paul to add this section)

Chapter 7 REMEDIAL DESIGN AND REMEDIAL ACTION

7.1. Introduction

a. Quick review of
1. Mine Settings
2. Hazards of AMLs
3. Assessment Strategies
    - a. Acid-Base Accounting
    - b. Water Sampling
4. Acid Mine Drainage Formation and Control

b. Predominant Concepts
1. Overburden Chemistry
2. Hydrology and Flushing
3. Effluent Limit Requirements

7.2 Control Methods

a. Effects of Land Reclamation
1. Covering with Soil
2. Topical Lime Applications and Ripping
3. Revegetation
4. Remining

b. Overview of Special Handling and Placement

1. Experience with Practices
2. Shortcomings and Potential Application on AMLs

c. Alkaline Amendments
1. Addition and Mixing of Lime with Spoils
2. Addition and Mixing of Lime with Refuse
3. Use of other Alkaline Materials

d. Alkaline Recharge Trenches
1. Early Uses with Natural Rainfall
2. Later Uses with Excess Water Pumping

e. Biological Treatment
1. Bactericides
2. Others

f. Dry Barriers and Capping
1. Soil Covers
2. Plastic or PVC Covers
3. Layering of other Materials on the Surface

g. Water Covers and Underground Seals/Barriers
1. Inundation
2. Barriers and Seals to Cause Inundation
3. Other Water Management Techniques

h. In-Situ Treatment in Underground Mines
1. Placing Limestone in Portals and Headings (Burnett et al.)
2. Grout Curtains or Walls in Underground Mines (placing of barriers)
3. Filling of Underground Mines (fly ash/cement mixtures)
4. Injection of Alkaline Materials Underground

7.3 Chemical (Active) Treatment

a. Oxidation and Aeration

b. Limestone Based Systems
1. Hydrated Lime Plants
2. Calcium Oxide and the Aquafix System
3. Limestone Drums
4. Limestone Sand Applied to Streams
5. Diversion Wells

c. Caustic Soda

d. Sodium Carbonate Briquettes
e. Ammonia
f. Coagulants, Flocculants and Oxidants
g. Flocs and Sludge

7.4 Passive System Treatment

a. Aeration

b. Wetlands
1. Aerobic Wetlands and Ponds
2. Anaerobic Wetlands

c. Limestone Based Systems
1. Anoxic Limestone Drains
2. Vertical Flow Wetlands (SAPS)
3. Open Limestone Channels
4. Limestone Leach Beds
5. Limestone Ponds

d. Use of Slag in Ponds

e. Combination Systems

Chapter 8 QUANTIFICATION OF COSTS AND BENEFITS

8.1 Introduction

a. Watershed Economics, Cost/Benefit Analysis

8.2 Cost Estimation

a. Review of Applicable Methods of Cost Engineering for Estimating Capital and Operation and Maintenance

b. Opportunity Cost

8.3 Benefits

a. Resource Valuation

(1) Overview of Methods and Current Issues
  a. Use and Nonuse Values
  b. Nonmarket Benefit Estimation
(2) Ability to place monetary values on watershed/ecosystem characteristics
(3) A review of cost benefit analysis methods applicable to watersheds (attention paid to water uses described in previous chapters)

8.4 Methods

a. Detailed Discussion of Applicable Methods
b. Cost Engineering Approach
c. Direct and Indirect Approach
d. Benefit Transfer
e. Risk Analysis

APPENDIX

a. Definition of Terms
b. Introduction to Acid Drainage
c. Federal Water Quality Criteria
d. Summary of Design Guidances (provide summary tables based on information in text for design of various elements, e.g. limestone drains, evaporative covers, etc.)
e. Case Study Summaries (?)
f. Other Appendices Identified When Text is Developed

Information Transfer Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	1	0	0	8	0
Masters	1	0	0	10	0
Ph.D.	0	0	0	0	0
Post-Doc.	0	0	0	0	0
Total	2	0	0	18	0

Notable Awards and Achievements

Publications from Prior Projects

None