



MINE DRAINAGE POLLUTION CONTROL

RESEARCH & DEVELOPMENT PROJECTS

**U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
CINCINNATI, OHIO**

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RESEARCH AND DEVELOPMENT PROJECTS

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1968

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Stream pollution resulting from mining operations is a serious problem in the United States. Annually approximately 500 billion gallons of mine drainage containing 5 to 10 million tons of acid pollute over 10,000 miles of surface streams and more than 15,000 acres of impounded waters. Recognizing the significance of the mine drainage pollution problem, the Federal Water Pollution Control Administration (FWPCA) of the U. S. Department of the Interior has launched a program to prevent and control this source of pollution.

To find solutions to the complex mine drainage problem, FWPCA has initiated a broad research program, including research by its own staff and support of research and development by industry, universities, State Government, and research firms. Research and development grants and contracts were made available under the 1966 amendments to the Federal Water Pollution Control Act.

During fiscal year 1968, the number of mine drainage projects supported by FWPCA increased several fold. For those who have interests in this field, this formal listing of current projects has been compiled. As other projects are initiated, addenda to the loose-leaf folio will be made available. Those wishing to receive these new sheets, as issued, may request them of:

Mine Drainage Pollution Control Activities
Federal Water Pollution Control Administration
U.S. Department of the Interior
4676 Columbia Parkway
Cincinnati, Ohio 45226

Other information and application forms for research and development grants and contracts can be obtained also from the Mine Drainage Pollution Control Activities, or from:

Office of Research and Development
Federal Water Pollution Control Administration
U.S. Department of the Interior
~~633 Indiana Avenue, N.W.~~
Washington, D. C. 20242

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
IN-HOUSE RESEARCH

PROJECT TITLE: Acid Mine Drainage Demonstration Project #1

PROJECT SITE: Coalton, West Virginia

PROJECT DESCRIPTION:

This project was initiated in 1964 near Elkins, West Virginia. Here a large drift mine had been extensively strip mined along the outcrop. As much as 80,000 pounds of acid was discharging daily to Tygart River from the mining complex. The project sought to determine what might be the effects on water quality in the receiving stream if water were diverted away from the deep mine and if land reclamation were applied to the surface mines. During this reclamation, some 450 subsidence holes were filled and 12.5 miles of surface mines were reclaimed. Both wet and dry mine seals were built. The reclamation work was completed in November 1967. In the spring of 1968 the disturbed land was revegetated to prevent erosion and water pollution.

The effectiveness of the reclamation project in reducing water pollution is now being determined through a program of water samples and analysis, and air sampling of the atmosphere within the mines.

PROJECT TITLE: Chemical Treatment of Mine Drainage

PROJECT SITE: Norton, West Virginia

PROJECT DESCRIPTION:

Methods of chemically treating mine drainage will be studied.

Initial studies will be conducted to optimize the neutralization of acid mine drainage with lime and limestone.

The chemical treatment of residues from other mine drainage treatment processes will also be studied. Initial tests will be conducted on the treatment of the brine from a reverse osmosis unit treating acid mine drainage.

Project was initiated in 1968.

PROJECT TITLE: Handling and Disposal of Residues from Mine Drainage
Treatment Systems

PROJECT SITE: Norton, West Virginia

PROJECT DESCRIPTION:

The handling and disposal of sludges and brines produced by mine drainage treatment systems are major problems. This investigation will determine the characteristics of these residual materials and evaluate various methods of handling and disposing of them. Initial studies will include disposal to abandoned strip pits and underground mines of reverse osmosis brine and neutralization process sludges.

Project was initiated in 1968.

PROJECT TITLE: Reverse Osmosis Treatment of Mine Drainage

PROJECT SITE: Norton, West Virginia

PROJECT DESCRIPTION:

This is a cooperative project between the Office of Saline Water and FWPCA to study the treatment of acid mine drainage by reverse osmosis. Areas being studied include: membrane life under acid conditions, maximizing water recovery rates, salt rejection, iron removal and membrane cleaning.

Project was initiated January 1968.

GRANTS AND CONTRACTS

AWARDED

UNDER SECTIONS 5 AND 6

FEDERAL WATER POLLUTION CONTROL ACT

PROJECT TITLE: Sulfide Treatment of Acid Mine Drainage

PROJECT NUMBER: WPRD 271-01

GRANTEE: Bituminous Coal Research, Incorporated

350 Hochberg Road

Monroeville, Pennsylvania 15146

PROJECT SITE: Allegheny County, Monroeville, Pennsylvania

TOTAL PROJECT COST: \$77,690

FEDERAL GRANT: \$54,380 - Awarded June 1968

Research and Development Grant awarded under Section 6, Federal Water Pollution Control Act.

PROJECT DESCRIPTION:

This project involves laboratory process studies on the recovery of sulfide reagents from sludge, production of sulfides from coal refuse material and optimization of various unit operations in the sulfide treatment of acid mine drainage process. Engineering and costs evaluation of the system projected to full industrial scale operation will be made. If these evaluations are favorable, a pilot plant and later a demonstration plant will be considered.

PROJECT TITLE: Treatment of Acid Mine Drainage - Sulfur and Iron Recovery

PROJECT NUMBER: 14-12-529

CONTRACTOR: Black, Sivalls and Bryson, Incorporated

7500 East 12th Street

Kansas City, Missouri 64126

PROJECT SITE: Kansas City, Missouri

TOTAL PROJECT COST: \$250,000

FEDERAL GRANT: \$250,000

CONTRACT PERIOD: April 18, 1969 through April 17, 1970

PROJECT DESCRIPTION:

A process has been described whereby acid mine drainage will be treated to produce a high quality water and iron and sulfur will be recovered from the waste material. During this project the feasibility of this process will be determined and laboratory studies will be conducted on some of the unknown areas.

PROJECT TITLE: Acid Mine Drainage - Pilot Plant Evaluation

PROJECT NUMBER: 14010 DKN

GRANTEE: Carnegie-Mellon Institute

4400 Fifth Avenue

Pittsburgh, Pennsylvania 15213

TOTAL PROJECT COST: \$44,575

FEDERAL GRANT: \$40,117

PROJECT PERIOD: October 1, 1968 through September 30, 1969

PROJECT DESCRIPTION:

The purpose of the research is to advance the understanding of the effect of microbiological factors of formation of acid mine drainage. It is intended to demonstrate the feasibility of a method for quantification of biological-chemical reactions and their rates of production of acid mine water. The study involves a systematic application of selected environmental and physical factors into a laboratory test model to simulate acid mine drainage formation conditions as they occur in the field and to measure their effect.

PROJECT TITLE: Treatment of Acid Mine Drainage - Desulfating

PROJECT NUMBER: 14-12-518

CONTRACTOR: Catalytic Construction Company

1528 Walnut Street

Philadelphia, Pennsylvania 19102

PROJECT SITE: Norton, West Virginia, Pittsburgh, Pennsylvania and

Philadelphia, Pennsylvania

TOTAL PROJECT COST: \$330,000

FEDERAL GRANT: \$330,000

CONTRACT PERIOD: April 7, 1969 through April 6, 1971

PROJECT DESCRIPTION:

The barium sulfate ion exchange process for the treatment of acid mine drainage will be studied. Specifically small laboratory feasibility studies will be conducted at Norton, West Virginia. The marketability of barium sulfate will be determined and a feasibility of the basic desulfating process as applied to the treatment of acid mine drainage will be studied. If applicable, a pilot plant will be constructed and the process further evaluated.

PROJECT TITLE: Microbiological Removal of Iron from Mine Drainage Waters

PROJECT NUMBER: WPRD 36-01-68

GRANTEE: Continental Oil Company

P. O. Drawer 1267

Ponca City, Oklahoma 74601

PROJECT SITE: Ponca City, Oklahoma

TOTAL ESTIMATED PROJECT COST: \$115,996

FEDERAL GRANT: \$75,886 - Awarded August 8, 1967

Research and Development Grant awarded under Section 6, Federal Water Pollution Control Act.

PROJECT DESCRIPTION:

The removal of iron from acid mine drainage waters will be examined using two different microorganisms. First, iron oxidizing bacteria will be used to convert the iron from the ferrous form to a ferric iron precipitate. Then sulfate reducing bacteria will be utilized to precipitate the iron as iron sulfide. Upon completion of the laboratory testing, field studies will be accomplished using lagoons.

PROJECT TITLE: Research, Development and Field Testing of Mine Water
Pollution Abatement Methods

PROJECT NUMBER: 14-12-453

GRANTEE: Halliburton Company

Duncan, Oklahoma 73533

PROJECT SITE: Clarksburg, West Virginia

TOTAL PROJECT COST: \$322,000

FEDERAL CONTRACT: \$322,000 - Awarded July 1968

Research and Development Contract awarded under Section 6, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

To conduct research and development of techniques and materials for rapid building of bulkheads to permit more efficient mine sealing (grouting). Laboratory and field work will be conducted to develop more efficient pneumatic placement of plugs and bulkheads and render them impermeable after placement. Further techniques will be developed for plugging a high flow mine and the feasibility of developing plugs of controlled permeability will be determined. The work to be performed, will expand present knowledge so as to have greater applicability of this sealing method as well as provide more realistic assessment of the technique's limitations in controlling mine drainage.

PROJECT TITLE: Microbial Mediation in Generation of Acid Mine Wastes

PROJECT NUMBER: 14010 DTC

GRANTEE: Harvard University

Cambridge, Massachusetts 02138

PROJECT SITE: Cambridge, Massachusetts

TOTAL PROJECT COST: \$27.018

FEDERAL GRANT: \$25,667

CONTRACT PERIOD: July 1, 1969 through June 30, 1970

Research and Development Grant awarded under Section 5, Federal Water Pollution Control Act.

PROJECT DESCRIPTION:

1. To develop a field method which permits measurements of the synthetic activity of autotrophic iron bacteria in situ.
2. To perform field studies with carbon-14.
3. a. Measure insitu, the activity of autotrophic bacteria directly or indirectly involved in oxidation of pyritic agglomerates.
b. Compare microbial activity of various locations in the mine, i.e., vapor phase and liquid phase reaction sites, and interrelate these findings with results on chemical analysis for pH, Fe (II), Fe (III), acidity, SO_4^{2-} .
4. Comparison of mine waters which differ in the rate of acidity production in an attempt to elucidate the chemical and biological factors responsible for these differences.
5. Evaluation of the results with regard to possible modes of control of microbial activity.

PROJECT TITLE: Oxidation of Iron in Acid Mine Waters

PROJECT NUMBER: PH 36-66-107

GRANTEE: Harvard University

Cambridge, Massachusetts 02138

PROJECT SITE: Cambridge, Massachusetts

TOTAL PROJECT COST: \$40,000

FEDERAL CONTRACT: \$40,000 - Awarded March 1966

PROJECT DESCRIPTION:

The purpose of this project is to study the oxidation of ferrous iron under acid mine drainage conditions. The following specific areas will be studied: to determine rate of air oxidation of ferrous iron in the presence of sulfate within the pH range 2-5, to determine rate of ferric iron hydrolysis within the pH range 2-5, to investigate the colloid-chemistry properties of hydrolyzed iron (III), and to investigate the above under the effect of the following catalysts (Mn^{+2} , Cu^{+2} , Si(OH)_4 , SiO_2 , Fe_2O_3). Project will end December 1968.

Publications: Kinetics of the Oxidation of Ferrous Iron, Phillip Singer and Werner Stumm, Second Symposium on Coal Mine Drainage Research, Mellon Institute, Pittsburgh, Pennsylvania, May 1968.

PROJECT TITLE: Treatment of Acid Mine Drainage - Foam Fractionation

PROJECT NUMBER: 14-12-496

CONTRACTOR: Horizons, Incorporated

2905 East 7th Street

Cleveland, Ohio 44104

PROJECT SITE: Cleveland, Ohio

TOTAL PROJECT COST: \$49,300

FEDERAL GRANT: \$49,300

CONTRACT PERIOD: February 28, 1969 through January 31, 1970

PROJECT DESCRIPTION:

1. To find a single detergent or simple mixture of detergents that would remove iron, manganese, aluminum, and Calcium under mine drainage conditions.
2. To locate detergents that would be specific to each ion individually.
3. To prepare a report indicating the feasibility of removing iron, manganese, aluminum, and calcium from acid mine drainage by foam fraction and estimated cost of such a process to treat flows of 0.1 and 1 mgd.

PROJECT TITLE: Treatment of Acid Mine Drainage - Reverse Osmosis

PROJECT NUMBER: 14-12-525

CONTRACTOR: Gulf General Atomic, Incorporated

P. O. Box 508

San Diego, California 92112

PROJECT SITE: Norton, West Virginia

TOTAL PROJECT COST: \$107,155

FEDERAL GRANT: \$107,155

CONTRACT PERIOD: April 7, 1969 through October 1970

PROJECT DESCRIPTION:

1. Supply engineering services and equipment necessary to provide one 4,000 gpd reverse osmosis plant for operation on mine drainage including sets of high selectivity and intermediate selectivity-high flux modules.

2. Conduct and supervise FWPCA personnel in conducting a series of field test experiments on each of two mine drainage sites to determine the applicability of reverse osmosis to producing water for discharge into streams or for domestic or industrial purposes.

3. Conduct laboratory experiments and investigations to support the overall program.

PROJECT TITLE: Flocculation and Clarification of Mineral Suspensions

PROJECT NUMBER: WP-01497

GRANTEE: University of Minnesota

Minneapolis, Minnesota 55455

PROJECT SITE: Minneapolis, Minnesota

FEDERAL GRANT: \$9,298

CONTRACT PERIOD: January 1, 1969 through December 31, 1969

PROJECT DESCRIPTION:

The proposed investigation will be aimed at developing a mechanism for the combined use of a multivalent cation and a polymeric flocculant, arriving at the most effective choice and use for the control of water pollution problems, and establishing the effect of size distribution on floc formation and clarification.

PROJECT TITLE: A Pilot-Scale Study of Acid Mine Drainage

PROJECT NUMBER: Contract No. 14-12-97

GRANTEE: Ohio State University Research Foundation

1314 Kinnear Road

Columbis, Ohio 43212

PROJECT SITE: Vinton County, Ohio

FEDERAL CONTRACT: \$40,301 - Awarded June 30, 1967

\$39,000 - Additional fund awarded August 1968

Research and Development Grant awarded under Section 6, Federal Water

Pollution Control Act.

PROJECT DESCRIPTION:

The project is designed to establish a systems research approach to the investigation of acid mine drainage. The study will attempt to define the controlling factors and to assess the significance of acidic conditions in abandoned or currently inactive mines, and in areas of future mining. Attempts will be made to assess the characteristics of acid formation, to establish systems to monitor adequately the variables selected, and to attack the problem with suitable abatement measures.

The activities will include two types of research: (1) research concerned with a comprehensive chemical, bacteriological study of the sulfide-to sulfate reaction to establish the rate-controlling mechanism; the sequence of intermediate reactions; and the significance of intermediate substances in the process; and (2) research directed toward designing and establishing a complex and well controlled experimental (model) area where the effects of mining on acid mine waters and on the general recovery of the mining area can be investigated and evaluated on a continuing basis.

PROJECT TITLE: Acid Mine Drainage - An Analysis of the State of the Art

PROJECT NUMBER: WP-01328-01

GRANTEE: Ohio State University Research Foundation

1314 Kinnear Road

Columbus, Ohio 43212

PROJECT SITE: Columbus, Ohio

TOTAL PROJECT COST: \$32,044

FEDERAL CONTRACT: \$32,044 - Awarded February 1968

Research and Development Grant awarded under Section 5, Federal Water Pollution Control Act.

PROJECT DESCRIPTION:

Phase I

This phase, comprising the first six months, has the primary purpose of producing an immediate critical review of available acid mine drainage information, and of the approaches in use toward solving the overall problem. This review will be compiled in an interim report which will identify significant accomplishments, and will provide a sound base for immediate planning of comprehensive and coordinated research needs and areas of greatest potential for the solving of the acid mine drainage problem.

Phase II

This phase, comprising the second six month period, will be essentially a continuation of Phase I in that work can be continued as required in any of the areas reviewed. This final phase of the work will terminate upon submittal to FWPCA of the major State of the Art report in early 1968.

PROJECT TITLE: Study of the Sulfide-to Sulfate Reaction Mechanism

PROJECT NUMBER: WP-00340-07

GRANTEE: Ohio State University Research Foundation

1314 Kinnear Road

Columbus, Ohio 43212

PROJECT SITE: Columbus, Ohio

TOTAL COST: \$24,934 - Awarded June 1968

Research and Development Grant awarded under Section 6, Federal Water Pollution Control Act.

PROJECT DESCRIPTION:

This project is designed to point out the important physical and chemical parameters related to the kinetics of the sulfide-to sulfate reaction. The data observed will be interpreted in light of suggested mechanisms to explain the observed kinetics.

Project Period: June 1, 1968 - May 31, 1969 (1 year)

PROJECT TITLE: Lime/Limestone Neutralization of Acid-Mine Drainage

PROJECT NUMBER: 14010DAX (WPRD-272)

GRANTEE: Peabody Coal Company

301 North Memorial Drive

St. Louis, Missouri 63102

PROJECT SITE: Will Scarlet Mine, Carrier Mills, Illinois

TOTAL PROJECT COST: \$692,000

FEDERAL GRANT: \$472,400 - Awarded August 7, 1968

PROJECT DESCRIPTION:

This project is for the design, construction, and operation of a full-scale demonstration plant for the neutralization of acid mine drainage from the Will Scarlet Mine utilizing lime and limestone.

Time of project: $2\frac{1}{2}$ years

PROJECT TITLE: Construction of Mine Water Treatment Plant at
Hollywood, Pennsylvania

PROJECT NUMBER: WPRD-34

GRANTEE: Commonwealth of Pennsylvania
Department of Mines & Mineral Industries
660 Boas Street
Harrisburg, Pennsylvania 17120

SUBCONTRACTOR: Pennsylvania State University

PROJECT SITE: Hollywood, Pennsylvania

TOTAL PROJECT COST: \$1,000,000

FEDERAL GRANT: \$700,000 - Awarded June 1968

Research and Development Grant awarded under Section 6, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

This project is constructing a 500,000 gallon-per-day acid mine water neutralization treatment plant to be experimentally operated to evaluate performance and costs. Plant design is suited to obtaining cost data for the application of this type of facility by the coal industry and is amenable to experimenting with innovations to reduce costs and/or operational problems. The plant is designed for two basic processes, with variations to permit five separate process options. The University will arrange for the purchase, delivery, and installation of plant equipment and building construction, plus proper display of the facility. Using various neutralizing agents, the operational program will consist of individual two-week process periods and two-day sub-periods for

testing specific combinations of variables. Tests will be conducted to determine plant capacity and to evaluate such process elements as flash mixing, settling, sludge disposal, sludge handling, filtration, influence of pH, the use of catalysts to enhance oxidation of ferrous iron, microbiological oxidation of ferrous iron, corrosion, and sludge scaling.

PROJECT TITLE: Optimization and Development of Improved Chemical
Techniques for the Treatment of Coal Mine Drainage

PROJECT NUMBER: WPRD-63

GRANTEE: Commonwealth of Pennsylvania

Department of Mines & Mineral Industries

660 Boas Street

Harrisburg, Pennsylvania 17120

SUBCONTRACTOR: Bituminous Coal Research

PROJECT SITE: Monroeville, Pennsylvania

TOTAL PROJECT COST: \$150,000

FEDERAL GRANT: \$105,000 - Awarded January 17, 1968

Research and Development Grant awarded under Section 6, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

The project is conducting laboratory studies to develop an improved process for the control and prevention of water pollution by drainage from coal mines. This will include a literature search, bench-scale studies and process design, evaluation and application. The basic process is the use of limestone for neutralization. Various catalysts for increasing the iron oxidation rate will also be evaluated.

PROJECT TITLE: Neutralization and Precoat Filtration of Concentrated
Sludges from Mine Water

PROJECT NUMBER: WPRD-150

GRANTEE: Commonwealth of Pennsylvania
Department of Mines & Mineral Industries
660 Boas Street
Harrisburg, Pennsylvania 17120

SUBCONTRACTOR: Johns-Manville Products Corporation

PROJECT SITE: Sites in Pennsylvania to be selected

TOTAL PROJECT COST: \$100,770

FEDERAL GRANT: \$70,539 - Awarded June 1968

Research and Development Grant awarded under Section 6, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

The project is directed at providing a cost-effectiveness evaluation
of various neutralization processes in the treatment of acid mine drainage.
Sludge disposal problems will be studied with emphasis on precoat filtration.

PROJECT TITLE: Application of Bacteriophages to Eliminate Mine Acids

PROJECT NUMBER: WPRD-164-01-68

GRANTEE: Commonwealth of Pennsylvania

Department of Mines & Mineral Industries

660 Boas Street

Harrisburg, Pennsylvania 17120

SUBCONTRACTOR: MSA Research Corporation

PROJECT SITE: Washington and Green Counties, Pennsylvania

TOTAL PROJECT COST: \$123,723

FEDERAL GRANT: \$86,484 - Awarded June 1968

Research and Development Grant awarded under Section 6, Federal Water Pollution Control Act.

PROJECT DESCRIPTION:

This project will provide data to demonstrate the feasibility of using organisms to inhibit the activity of acid producing bacteria. This will include investigations into the isolation, identification and culture of these inhibitory organisms. Cultures will be developed from natural "sweet" waters of nearby mines and the organisms then tested for their inhibitory action on those bacteria normally present in acid mine effluents. If inhibitory action is proved, 10,000-15,000 gallons of such "sweet" waters will be pumped into two different types of acid-producing mines. The effluents of those mines will then be monitored over a period of several months to establish the effect of the inoculation.

Concurrently, studies will be carried out to determine the rates of movement of bacteria and of potential inhibitory organisms through synthetic coal piles.

PROJECT TITLE: Study of the Use of Inert Gases to Eliminate Acid
Pollution from Abandoned Deep Mines

PROJECT NUMBER: WPRD-227

GRANTEE: Commonwealth of Pennsylvania
Department of Mines & Mineral Industries
660 Boas Street
Harrisburg, Pennsylvania 17120

SUBCONTRACTOR: Cyrus William Rice & Company

PROJECT SITE: Ohiopyle State Park
Fayette County, Pennsylvania

TOTAL PROJECT COST: \$54,143

FEDERAL GRANT: \$37,900 - Awarded May 1968

Research and Development Grant awarded under Section 6, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

Phase I

An abandoned drift mine of approximately 200 acres will be sealed, and air blowing and monitoring equipment installed. The air leak rate from the mine will be determined by correlating variable air input rates to barometric pressure and temperature changes in the mine. Phase I will require about six months to complete. If filling a mine with inert gas is found feasible at the completion of Phase I, a second phase of actually filling the mine will be considered.

PROJECT TITLE: Study of the Use of In situ Precipitation of Sludge
Resulting from Reaction of Mine Water with Low Cost
Additives in an Abandoned Mine to Prevent Mine
Drainage Pollution

PROJECT NUMBER: WPRD-242

GRANTEE: Commonwealth of Pennsylvania
Department of Mines & Mineral Industries
660 Boas Street
Harrisburg, Pennsylvania 17120

SUBCONTRACTOR: Parsons-Jurden Corporation

PROJECT SITE: Cambria County, Pennsylvania

TOTAL PROJECT COST: \$325,034.60

FEDERAL GRANT: \$227,524.20 - Awarded June 1968

Research and Development Grant awarded under Section 6, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

This project is developing and testing an in situ technique for
injecting a mixture or slurry of various neutralizing and filler
materials into an abandoned mine. The initial phase of the study will
involve a four month series of laboratory tests to confirm the technical
feasibility of the method and to evaluate site selection.

Phase II will be the pilot installation and demonstration of the
technique, treating part, or all, of an abandoned mine.

PROJECT TITLE: Use of Latex as a Soil Sealant to Control Acid Mine
Waste Drainage

PROJECT NUMBER: WPRD-252

GRANTEE: Commonwealth of Pennsylvania
Department of Mines & Mineral Industries
660 Boas Street
Harrisburg, Pennsylvania 17120

SUBCONTRACTOR: Uniroyal, Incorporated

PROJECT SITE: Clearfield County, Cooper Township, Pennsylvania

TOTAL PROJECT COST: \$259,770

FEDERAL GRANT: \$181,839 - Awarded June 1968

Research and Development Grant awarded under Section 6, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

The project is attempting to provide a latex rubber seal between
surface water and an underground mine. This will reduce the amount of
water percolating through the soil into the mine and reduce the flow of
mine waters. The project will proceed in three phases:

Phase I

Laboratory Investigation - to study soil characterization
of core samples - determining percolation rates, pH profiles
and analyzing the mineral content, bacterial content, and
particle size of the soil. Soil sealants will be tested to
determine the best formulation.

Phase II

Preparation of Field Application - to study the natural characteristics of the soil and its acid characteristics for coagulation of the latex.

Phase III

Application and Field Evaluation - to demonstrate application of the latex to the soil, coagulation, and evaluation of the properties of the test site and the contiguous control area.

PROJECT TITLE: Evaluation of Pollution Abatement Procedures in the
Moraine State Park, Butler County, Pennsylvania

PROJECT NUMBER: WPRD-260

GRANTEE: Commonwealth of Pennsylvania
Department of Mines & Mineral Industries
660 Boas Street
Harrisburg, Pennsylvania 17120

SUBCONTRACTOR: Gwin Engineers

PROJECT SITE: Butler County, Pennsylvania

TOTAL PROJECT COST: \$21,600

FEDERAL GRANT: \$15,120 - Awarded June 1968

Research and Development Grant awarded under Section 6, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

The project seeks to ascertain the effectiveness of various remedial
procedures which have been applied to a large Western Pennsylvania State
Park so that judgment may be made relative to widespread application of
the procedures to specific pollution abatement projects. Water quality
and quantity measurements will be made at sampling points throughout the
Muddy Creek Watershed.

Time: August 1, 1968 through July 30, 1971, (3 years)

PROJECT TITLE: Abatement of Acid Mine Drainage Pollution by
Reverse Osmosis

PROJECT NUMBER: WPRD-261-01

GRANTEE: Commonwealth of Pennsylvania

Department of Mines & Mineral Industries

660 Boas Street

Harrisburg, Pennsylvania 17120

SUBCONTRACTOR: Haven Industries

PROJECT SITE: Site in Pennsylvania to be selected

TOTAL PROJECT COST: \$39,426

FEDERAL GRANT: \$27,598 - Awarded June 1968

Research and Development Grant awarded under Section 6, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

The project consists of two phases:

Phase I

This phase is to establish general technical parameters for the
design and construction of a 10,000 GPD reverse osmosis pilot
plant.

Phase II

This phase is to design, construct and operate at 10,000 GPD
reverse osmosis pilot plant for 90 days to define optimum
parameters for construction of a 250,000 GPD plant.

PROJECT TITLE: Catawissa Creek Mine Drainage Pollution Abatement Process

PROJECT NUMBER: WPRD-264

GRANTEE: Commonwealth of Pennsylvania

Department of Mines & Mineral Industries

660 Boas Street

Harrisburg, Pennsylvania 17120

SUBCONTRACTOR: Gannett, Fleming, Corddry, and Carpenter, Incorporated

PROJECT SITE: Schuylkill and Luzerne Counties, Pennsylvania

TOTAL PROJECT COST: \$522,200

FEDERAL GRANT: \$365,540 - Awarded June 1968

Research and Development Grant awarded under Section 6, Federal Water Pollution Control Act.

PROJECT DESCRIPTION:

The project is designed to confirm previous estimates of cost and effectiveness of mine drainage pollution abatement procedures and to evaluate the prevention of mine drainage by plugging three existing drainage tunnels within an isolated pocket of coal known as the South Green Mountain Basin. The principle is to inundate the mine to prevent the formation of acid.

PROJECT TITLE: Study of the Use of Inert Gas to Eliminate Acid Pollution
from Abandoned Deep Mines

PROJECT NUMBER: 14010 EFL

GRANTEE: Department of Mines & Mineral Industries

Commonwealth of Pennsylvania

660 Boas Street

Harrisburg, Pennsylvania 17102

SUBCONTRACTOR: Cyrus Wm. Rice & Company

PROJECT SITE: Ohiopyle State Park, Fayette County, Pennsylvania

TOTAL PROJECT COST: \$117,884

FEDERAL GRANT: \$45,884

CONTRACT PERIOD: July 1, 1969 through June 30, 1970

Research and Development Grant awarded under Section 6b, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

It is proposed to continue the study on the use of inert gas, previously funded as WPRD-227. It is planned to study two mines, (15 acres and 50 acres respectively) and to determine the gas requirements needed to maintain a positive pressure in each of these mines during barometric cycles. The maintaining of positive pressures of inert gas will displace all of the oxygen, thus greatly reducing the acid forming potential of these mines. The information thus gained should be applicable to a great many mines.

PROJECT TITLE: Development and Optimization of the Limestone Treatment
of Coal Mine Drainage

PROJECT NUMBER: 14010 EIZ

GRANTEE: Department of Mines & Mineral Industries

Commonwealth of Pennsylvania

660 Boas Street

Harrisburg, Pennsylvania 17102

SUBCONTRACTOR: Bituminous Coal Research

PROJECT SITE: Pittsburgh, Pennsylvania

TOTAL PROJECT COST: \$106,480

FEDERAL GRANT: \$74,436

CONTRACT PERIOD: July 1, 1969 through June 30, 1970

Research and Development Grant awarded under Section 6b, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

Phase I. Laboratory Studies

1. Chemical composition and physical properties of limestones such as particle size, surface area, density, and others as necessary for evaluation will be determined. Neutralization curves, effected by the change in pH resulting from the addition of limestone and a suitable oxidizing agent to simulated and/or actual mine water, will be used to evaluate the limestones as neutralizing agents for mine water. The number of limestones to be examined will be determined as time permits and will be selected on consultation with industry and with the project sponsors.

2. Data obtained from these neutralization curves will be verified by treating one actual mine water with the limestone after evaluation as

discussed under (1) on the preceding page. Both batch scale and one-gallon-per minute continuous flow tests will be utilized with examination, as necessary, of sludge properties with the objective of improving settling of the sludge.

Phase II. Evaluation of Field Research Units (s)

Data from Phase I on preceding page and from previously mentioned studies (WPRD-63-01-68 and CR-75), particularly from the continuous flow experiments, will be used to evaluate field research units for limestone treatment of actual mine waters at the site of discharge. Choice of the mine drainage site(s), conditions for treatment, and effluent standards will be specified as part of the engineering study and recommendation.

PROJECT TITLE: Detection and Location of Concealed Abandoned Underground
Mines and Associated Drainage by Geophysical and Geo-
chemical Techniques

PROJECT NUMBER: 14010 EHN

GRANTEE: Department of Mines & Mineral Industries

Commonwealth of Pennsylvania

660 Boas Street

Harrisburg, Pennsylvania 17102

SUBCONTRACTOR: HRB Singer

PROJECT SITE: State College, Pennsylvania and various mines within
commonwealth.

TOTAL PROJECT COST: \$164,780

FEDERAL GRANT: \$115,346

CONTRACT PERIOD: July 1, 1969 through December 31, 1970

Research and Development Grant awarded under Section 6b, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

It is proposed to attempt to detect the precise location of concealed mine portals, mine workings, vents, fractures, jointing patterns and slump zones. In short, the detection and location of any avenue of water movement into or out of the mine as well as the mine itself. This will provide a more comprehensive approach to the general and effective mine sealing program. Selected geophysical and geochemical approaches will be evaluated in the laboratory and several (4-6) will be selected as being the most promising for field testing and evaluation.

PROJECT TITLE: Feasibility of the Purification of Acid Mine Water by
a Partial Freezing Process

PROJECT NUMBER: WPRD-265

GRANTEE: Commonwealth of Pennsylvania

Department of Mines & Mineral Laboratories

660 Boas Street

Harrisburg, Pennsylvania 17120

SUBCONTRACTOR: Applied Science Laboratories, Incorporated

PROJECT SITE: State College, Pennsylvania

TOTAL PROJECT COST: \$15,000

FEDERAL GRANT: \$10,500 - Awarded June 1968

Research and Development Grant awarded under Section 6, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

The project will assemble from the literature information pertinent to the purification of acid mine water, obtain preliminary experimental test data on the yield and quality of product water obtained by a partial freezing process operating on typical acid mine water, and make preliminary flow diagrams and economic evaluations of possible freezing processes for upgrading the quality of acid mine water.

PROJECT TITLE: The Use of Inert Gases to Eliminate Pollution from
Abandoned Mines

PROJECT NUMBER: 1412-98

GRANTEE: Cyrus William Rice & Company

15 Noble Avenue

Pittsburgh, Pennsylvania 15205

PROJECT SITE: Pittsburgh, Pennsylvania

TOTAL PROJECT COST: \$25,000

FEDERAL CONTRACT: \$25,000 - Awarded May 1968

Research and Development Grant awarded under Section 6, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

The project will determine the effect on the leaching of pyrites
by water and on acid production in the following mine atmospheres: air
(control), pure nitrogen, nitrogen plus CO₂, nitrogen plus NH₃, nitrogen
plus CO₂ plus NH₃, and nitrogen plus chlorine, and determine the effect
of pyrite particle size on the reduction of acid production with various
gas atmospheres.

PROJECT TITLE: Biological Treatment of Acid Mine Water

PROJECT NUMBER: WP-01460-01

GRANTEE: Syracuse University Research Institute

201 Marshall Street

Syracuse, New York 13210

PROJECT SITE: Syracuse, New York

TOTAL COST: \$54,341

FEDERAL GRANT: \$47,238 - Awarded June 11, 1968

Research and Development Grant awarded under Section 5, Federal Water Pollution Control Act.

PROJECT DESCRIPTION:

This project is studying anaerobic bacteria and their use in alleviating acid mine drainage problems. These bacteria generate H_2S while they metabolize the sulfate ion, and thus precipitate ferrous and ferric sulfides. At the same time, the pH of the water is raised. These fine sulfide particles have physical characteristics superior to those of the corresponding metal hydroxides and can be more easily filtered. This technique has the potential of obtaining a relatively pure material which may be used for by-product recovery of sulfur and/or iron, as well as for reducing pollution from acid mine drainage.

PROJECT TITLE: Inorganic Sulfur Oxidation by Iron Oxidizing Bacteria

PROJECT NUMBER: 14010 DAY

GRANTEE: Syracuse University Research Institute

201 Marshall Street

Syracuse, New York 13210

TOTAL PROJECT COST: \$117,575

FEDERAL GRANT: \$98,450 - Awarded July 30, 1968

PROJECT DESCRIPTION:

To assess the role of inorganic sulfur oxidation in maintaining an acid environment required for iron-oxidizing bacteria. These bacteria will be investigated as they oxidize inorganic sulfur and are the common biological catalysts found in acid mine water. Cell free extracts and purified enzymes from sulfur-grown ferrobacilli will be used; physical and chemical parameters will be examined as regards their effect on the enzymes.

Time of project: 3 years

PROJECT TITLE: Demonstration of Control of Acid Drainage from Coal
Mine Refuse Piles and Slurry Areas

PROJECT NUMBER: 14010 DDH (WPRD-95)

GRANTEE: Truax-Traer Coal Company

111 North Wabash Avenue

Chicago, Illinois 60602

PROJECT SITE: Duquoin, Illinois

TOTAL PROJECT COST: \$720,800

FEDERAL GRANT: \$490,560 - Awarded October 7, 1968

PROJECT DESCRIPTION:

It is proposed to demonstrate suitable procedures for reclamation of coal cleaning plant refuse piles and associated slurry lagoons for the elimination of acid drainage. Information desired from this study, covering measurements of acid and acid production sites, and revegetation procedures, will provide a basis for the rational and efficient engineering design of future reclamation projects.

Time of project: 2 years

PROJECT TITLE: Silicate Treatment of Acid Mine Waters

PROJECT NUMBER: 14-12-560

CONTRACTOR: Tyco Laboratories, Incorporated

Waltham, Massachusetts 02154

PROJECT SITE: Waltham, Massachusetts

TOTAL PROJECT COST: \$55.412

FEDERAL GRANT: \$55,412

CONTRACT PERIOD: July 1, 1969 through March 31, 1970

PROJECT DESCRIPTION:

A study will be conducted on the use of sodium silicate to treat acid mine water problems. Three areas will be investigated. (1) Treating the acid-iron mine discharge, (2) treating the reactive pyrite, and (3) treating the porous rock strata within the mine.

PROJECT TITLE: Stream Faunal Recovery after Strip Mine Reclamation

PROJECT NUMBER: 18050 DQH

GRANTEE: Virginia Polytechnic Institute

Department of Forestry & Wildlife

108 Price Road

Blacksburg, Virginia 24061

TOTAL PROJECT COST: \$15,024

PROJECT COST FIRST YEAR: \$7,447

FEDERAL GRANT: \$6,873

PROJECT PERIOD: October 1, 1968 through September 30, 1970

PROJECT DESCRIPTION:

The objectives of this proposed research are to monitor water quality in four tributaries which represent various stages of recovery from strip-mine pollution and to conduct studies on the chronic physiological action of mine effluent on fishes of these waters. The change in water quality following different stages of reclamation work on National Forest lands will be used to measure the rate of stream recovery as well as to document the continuing damage caused by unreclaimed mines. The sublethal action of suspended matter and manganese metal will be described as they affect growth rate and condition index of two representative species, rainbow trout and white sucker, in this watershed.

PROJECT TITLE: Mine Spoil Potentials for Water Quality and Controlled
Erosion

PROJECT NUMBER: 14010 EJE

GRANTEE: West Virginia University

Morgantown, West Virginia 26506

PROJECT SITE: Morgantown, West Virginia

TOTAL PROJECT COST: \$224,028

FEDERAL GRANT: \$156,328

CONTRACT PERIOD: July 1, 1969 through June 30, 1971

Research and Development Grant awarded under Section 6b, Federal Water
Pollution Control Act.

PROJECT DESCRIPTION:

The purpose of this investigation is to enable strip mine operators and soil conservationists to eliminate serious water pollution from mine spoil. Specific objectives are summarized as follows: (1) To determine certain physical and chemical properties of coal overburden strata that influence suitability of mine spoil for soil formation, and unpolluted runoff or seepage water. (2) To determine processes and rate of physical and chemical change of important spoil properties by natural or induced weathering. (3) To determine interactions between growing plants and properties of spoil and water. This will also include interactions between plants and microorganisms and the influence of microbes on mineral mobility. (4) To determine effectiveness of plant cover, microorganisms and related practices in prevention of erosion, sedimentation, and in reducing acidity and chemical pollution of water from characterized spoil. (5) To improve precision of spoil classification.

Amounts and distribution of the various reduced and oxidized forms of sulfur in coal overburden and resulting spoil will be determined. Additionally, the acid neutralizing potential of rocks and spoil will be determined in order to show what admixtures are needed to provide spoil water suitable for a healthy biosphere.



In its assigned function as the Nation's principal natural resource agency, the United States Department of the Interior bears a special obligation to ensure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America - now and in the future.