United States
Environmental Protection
Agency

Industrial Environmental Research
Laboratory
Cincinnati OH 45268

Research and Development

EPA-600/PS7-80-128 Oct. 1980

EPA

Project Summary

Water Infiltration Control to Achieve Mine Water Pollution Control—The Dents Run Watershed Demonstration Project

Jonathan G. Herrmann

One of the most severe mine drainge problems encountered in the Appalachian coal fields is the discharge of highly acidic and iron-bearing drainage from abandoned underground mines. This problem is aggravated by surface water frequently draining into both active and abandoned mines and exposed auger holes. This water then reacts with pyritic material in the roof and floor of underground mines and forms acid mine drainage, a diluted form of sulfuric acid and ferrous sulfate. Since many abandoned underground mines were either sloped so that water would gravity-drain from the mine workings or have since intercepted workings at higher elevations, the contaminated mine water eventually finds its way to a surface discharge point.

In 1971, the Environmental Protection Agency, Office of Research and Development, awarded a grant for a mine drainage demonstration project on the Dents Run Watershed. The grant was awarded to the State of West Virginia, Department of Natural Resources. The state, in turn, contracted with the Cyrus Wm. Rice Division of NUS Corporation in that year to conduct the project feasibility study and subsequent reclamation design and monitoring program. Actual reclamation of the Watershed occurred in 1973 and the project was completed following post-construction water quality monitoring in 1976.

The objective of the Dents Run Watershed Demonstration Project was to demonstrate the effectiveness of surface mined land reclamation measures in establishing surface water infiltration control to prevent or reduce pollution from acid mine drainage. The Dents Run Watershed, located in Monongalia County, West Virginia, was replete with unreclaimed surface mines, drift mines, auger mines, refuse dumps, spoil banks, and borehole discharges; all of which were determined to be significant generators of acid mine drainage.

The project was initiated with a comprehensive field investigation of the Watershed to locate and characterize each mine site and underground mine opening. Based on this information and detailed analyses of regional geologic conditions and past mining history, areas of suspected high infiltration were identified. Site-specific reclamation plans and specifications were then prepared; these plans were designed primarily to increase surface water runoff and reduce infiltration of surface drainage into underground mine workings through unreclaimed surface mines.

Over 40 hectares of surface mines were reclaimed during this project and

nearly 100 percent of the pollutional drainage in the Dents Run Watershed was eliminated through the cooperative efforts of government and industry. Virtually all of the mine drainage from the active workings of the cooperating industry, Consolidation Coal Company, was treated to acceptable water quality standards at the Sears and Loar Treatment Plants before discharge. The project report defines the approach taken in the reclamation effort, describes each mine site and associated reclamation activities, outlines monitoring strategies, and analyzes the overall effectiveness of the project.

This publication is a summary of the complete project report, which can be purchased from the National Technical Information Service (see box on last page).

Introduction

According to 1978 estimates, West Virginia is the second largest coal producing state, following Kentucky, with a total production of 82 million tons of coal. Historically, West Virginia has been one of the leading coal producing states in the nation As a result of this extensive mining activity, acid mine drainage has been a significant problem in the northern portion of the state where the interaction of local geologic and hydrologic conditions generally produces severely polluted drainage from both surface and underground mining operations.

The Dents Run Watershed Demonstration Project was designed to address this problem The project was conducted under the auspices of the Environmental Protection Agency as specified in the provisions of the Water Quality Improvement Act of 1970, PL 91-224. The Act included a subsection entitled "Area Acid and Other Mine Water Pollution Control Demonstrations." This subsection became Section 14 of the Federal Water Pollution Control Act, as amended Section 14 provides for the demonstration of techniques for mine drainage pollution control and directs that the Environmental Protection Agency shall require such feasibility studies as necessary in selecting watersheds for the purpose of demonstration projects. Such feasibility studies are to aid the Environmental Protection Agency in selecting not only the mine drainage pollution control method(s), but also the watershed or drainage area for such application The Act requires that the Environmental Protection Agency give preference to areas which will have the greatest public value and uses.

The Dents Run Watershed is located in Monongalia County, West Virginia, and is part of the Monongahela River Basin. As a minimum, reclamation work in the Watershed was to be performed in accordance with applicable State and Federal regulations In addition to this general requirement, however, special or innovative reclamation and abatement techniques were to be employed in areas of suspected high infiltration in order to reduce drainage into both abandoned and active underground mine workings. It was believed that this approach . could reduce water infiltration by as much as 50 percent.

The terrain of the eastern part of the Watershed can generally be described as rugged and the western portion, as rolling. The elevation of the highest peak in the Watershed is approximately 488 meters, while the valley floor in the vicinity of Laurel Point is 291 meters high with a base of 253 meters at the mouth of Dents Run. Located in the Allegheny Mountains section, the Watershed is part of the Appalachia Plateau's physiographic province. The mountain tops are forested, while the valley sides and bottom are open grassland and farmland Dents Run flows from west to east and enters the Monongahela River at the city of Granville, which is due west of the city of Morgantown

The most prominent and commercially developed coals in the Watershed are the Pittsburgh, Redstone, Sewickley, and Waynesburg seams. These coal seams outcrop along the valley sides beginning at the mouth of Dents Run near Granville The lowest of these is the Pittsburgh seam. The Redstone seam is approximately 107 to 114 meters above the Pittsburgh seam The Pittsburgh seam and all others above it dip to the west. The elevation of the Pittsburgh seam is 107 meters below the valley floor at this point. A typical cross-section of the Watershed is depicted in Figure 1

Surface mining of the Pittsburgh, Redstone, and Sewickley seams was confined largely to the eastern end of the Dents Run Watershed, and was substantially completed prior to 1952. Additional surface mining of these seams took place between 1960 ar 1966. Surface mining of the Wayne burg outcrop has been practiced ne the hilltops throughout the Watershe since 1966. The only drift mining note in the Waynesburg seam occurs c isolated tracts in the extreme weste portions of the Watershed, although th Pittsburgh, Redstone, and th Sewickley seams have been drift mine extensively in the eastern end of th Watershed for many years.

Most of the unreclaimed surfac disturbance occurs in the easte portion of the Watershed Water th entered the subsurface water system a a result of numerous drift mine inte ceptions located in the unreclaime areas eventually drained into th Pittsburgh seam The original premis of the project was that surface reclama tion techniques could be employed t backfill the surface mine pits, cover th exposed seam, and seal the expose drift mine entries or interceptions i order to reduce the surface water entr into the subsurface water system. Th intercepted runoff would then b channeled to the normal surfac drainage courses in the Watershed

Technical Approach

At the onset of this project, th Consolidation Coal Company operate six boreholes which discharged water t the Dents Run Watershed (see Figur 2) Five of the six boreholes discharge water from active or inactive under ground mine workings within th Pittsburgh coal seam. These pump were located within the mines, two c these, the Valotto and the Laurel Point were constant discharge pumps Th Hess, Six-Right, and Loar pumps wer float-controlled. Surface wate intercepted by abandoned unreclaime mining operations in the eastern portio of the Watershed drained to the Hes discharge point and then continued o to Laurel Point The Laurel Poin pumping facilities handled a smal portion of this drainage while the exces continued on to either the Loar or Six Right discharge points. The Snide borehole discharged water from th Sewickley coal seam and the pump wa float-controlled.

As previously stated, the objective o this comprehensive mine drainag abatement program was to demonstrat the effective reduction of pollution fron acid mine drainage through surfac water infiltration control This was to b

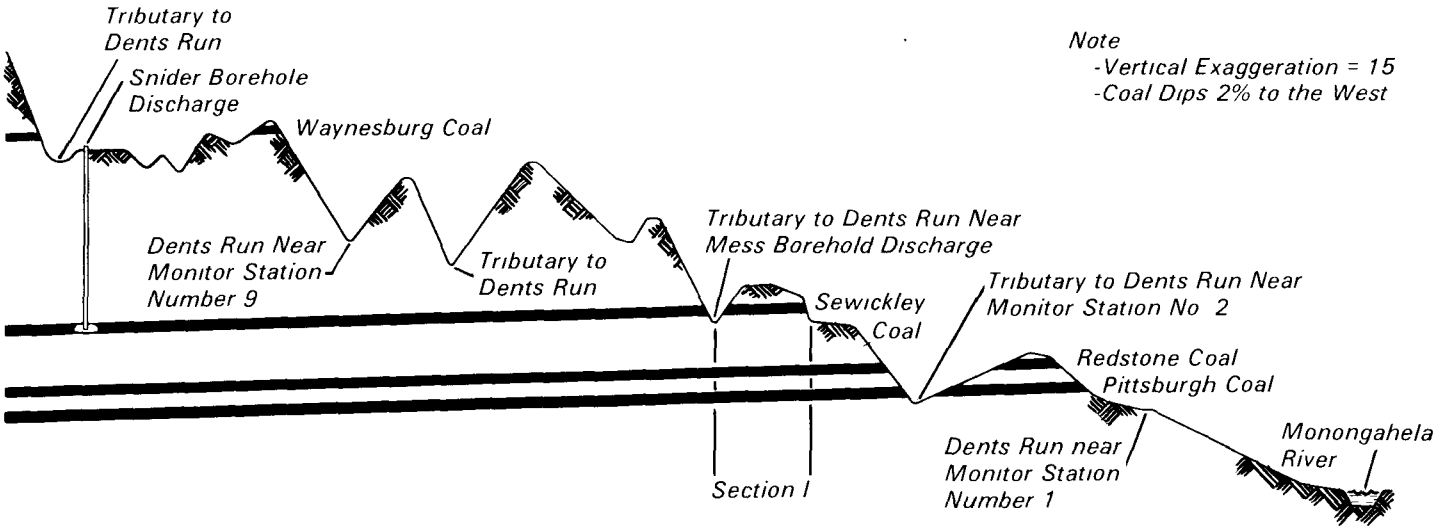

Figure 1. *Typical cross section Dents Run Watershed*

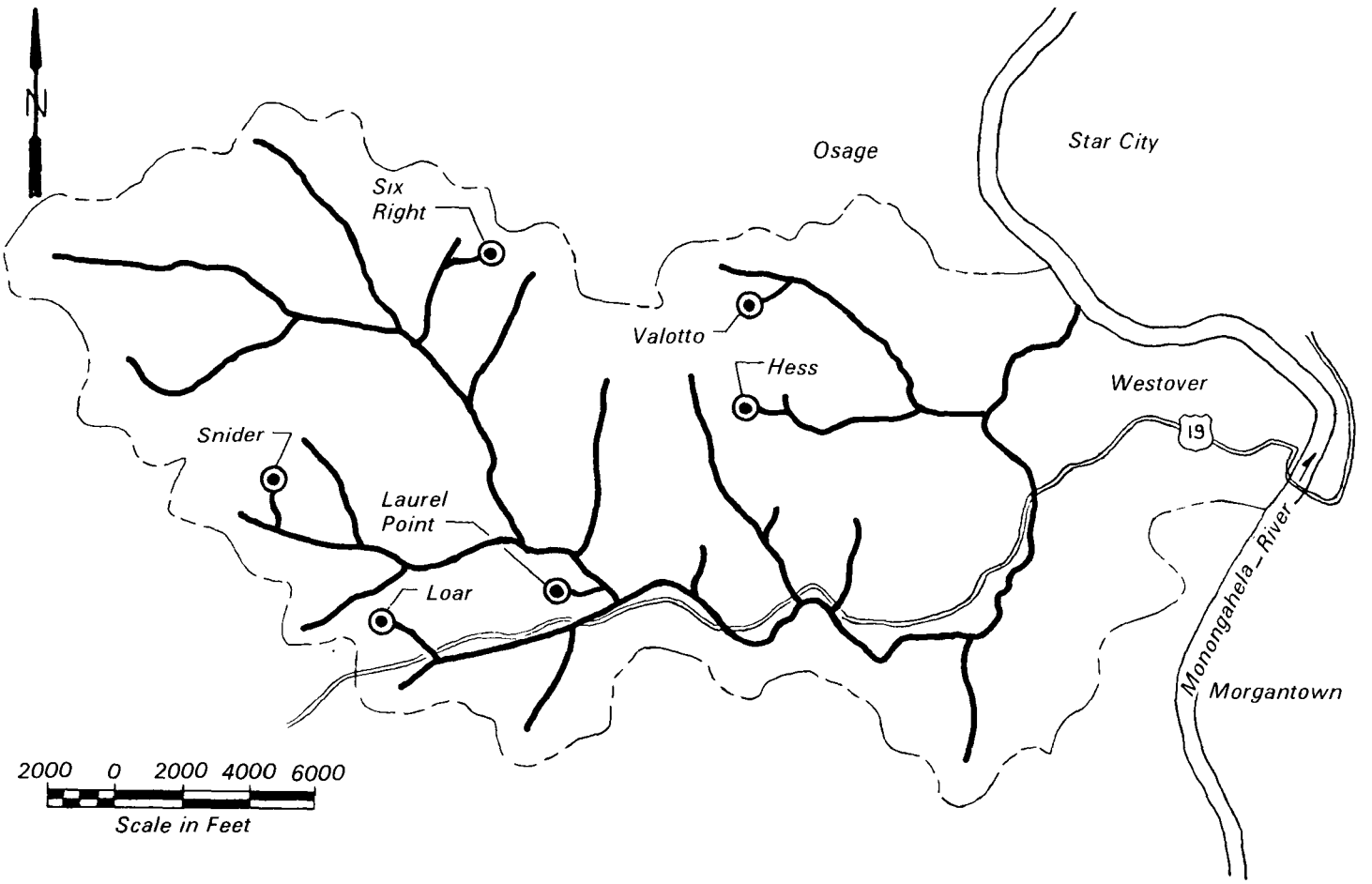

Figure 2. *Borehole locations.*

accomplished by selectively employing specialized reclamation techniques at those abandoned surface mines identified as contributing significantly to infiltration

The first and most important step in such an effort was determining where interconnections existed between underground workings and the surface. This investigative analysis was initiated early in the study and continued throughout the fall and winter of 1971. Each surface mine area, underground mine opening, and refuse bank was located and evaluated as to its pollution potential or its potential to contribute to the underground mine water volume. A priority listing was then developed for the work to be performed Priority I sites referred to those areas which contributed significant amounts of drainage to the underground mine workings, while Priority II sites were those which contributed directly to stream pollution as a result of surface water runoff Priority III sites were those areas which contributed to aesthetic pollution; this includes all of the areas within the Watershed which were not included in the first or second priority listing.

Reclamation work performed as a result of this study was primarily of the contour and pasture-type backfills (Figures 3A and 3B) depending upon the condition of the highwall at each site The pasture-type backfill was used in areas where the highwall was relatively sound and the contour backfill was used where the highwall was highly fractured In each case, the backfills were compacted in order to prevent excessive infiltration into the intercepted deep mine workings and auger holes.

Several of the surface mines contained water impoundments in portions of the unreclaimed pit. When the reclamation work required draining these impoundments, portable treatment facilities were employed to provide adequate treatment of the impounded water prior to discharge to a receiving stream.

Conventional heavy construction equipment was used in the regrading of the surface mines; conventional farm equipment was used in the surface preparation; and seeding, mulch, and fertilizer were applied by hydroseeder Compaction of the backfill in the area of auger mined highwalls was done using a conventional 55-ton roller used in highway construction A minimum of 10 passes were made with the roller. The reclamation specifications called for the placement of impervious material in maximum 61-m^3 lifts in the area from the base of the highwall, a minimum of 6 meters vertically, and at least 3 meters above any auger holes or mine openings. Where impervious material was not available, the contractor used the best material available.

An important part of a demonstration project of this nature is documentation of the effectiveness of the control measures being employed In this project, the quality and quantity of natural stream flows and borehole discharges in the Watershed were monitored. It was felt that this approach would show both the reduction of acid mine drainage as evidenced by Consolidation Coal's reduced pumping rates, and the increase in stream quality due to the increase in natural surface water runoff

To this end, a network of seven stream-monitoring stations was installed to record transient qualitative and quantitative effects. These monitoring stations were designed to continuously record pH, conductivity, and flow Initially, grab samples were collected on a weekly basis at each monitoring station. These samples were analyzed for pH, total iron, sulfate, turbidity, total acidity, alkalinity, and conductivit Samples were also collected at month intervals at both the stream monitorin stations and borehole discharge These samples were analyzed fo alkalinity, total acidity, conductivity, pH turbidity, calcium, magnesium, sulfat total iron, ferrous iron, total solid suspended solids, dissolved solid settleable solids, aluminum, an manganese. Due to the relativ inaccessibility and sporadic operation o the borehole discharge pumps, accurat pumping data was only available for th Snider and Six-Right borehol discharges

In conjunction with the aforemen tioned comprehensive reclamatio effort, Consolidation Coal Compar constructed two mine drainge trea ment plants to treat discharges from th boreholes These facilities are describe below

The Loar Treatment Plant

The Loar discharge and the Laur Point discharge were combined unde ground and an acid mine drainag treatment plant was constructed at th Loar site. This plant consisted of conventional hydrated lime neutraliz tion—aeration system and impoun ment for settling and sludge storag

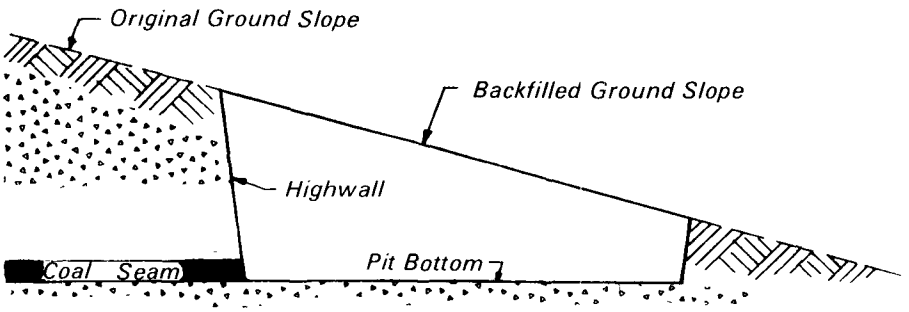

Figure 3A. *Typical contour backfill*

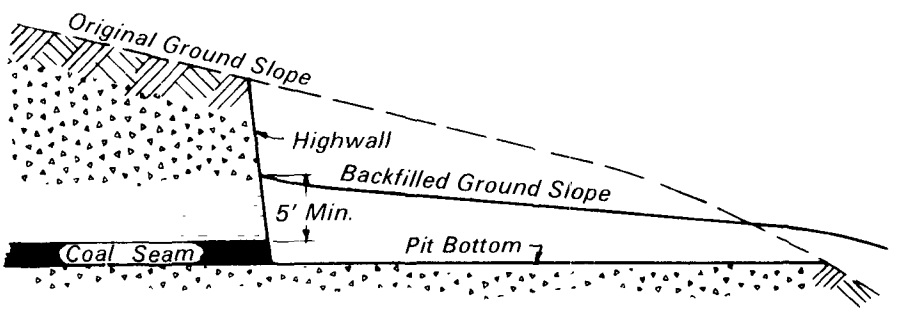

Figure 3B. *Typical pasture backfill*

The plant was designed for a flow of 637 liters/second, contains a dam 24 m high and 259 m long, and impounds an area of approximately 5 3 ha with a capacity of 2 5 x 10^8 liters It was designed for a 25-year life. This plant, activated in October 1973, has operated satisfactorily since startup with no major problems Recent water quality data reported as part of federal water quality monitoring program has shown compliance with all applicable water quality standards Table 1 shows typical water quality data before and after treatment, as analyzed and reported by Consolidation Coal Company

Table 1. *Water Quality at Loar Treatment Plant.*

Before	*Component*	*After*
2 7	*pH*	*8.2*
3170 mg/l	*Acidity*	*0*
860 mg/l	*Iron*	*< 2 mg/l*
0	*Alkalinity*	*> Acidity*

The Sears Treatment Plant

The Hess, Six-Right and Valotto discharges were pumped underground to the Sewickley seam where they were combined with the water discharging from the Snider borehole and treated near the Snider site The Sears facility consisted of a conventional hydrated lime neutralization—aeration system and an impoundment for settling and sludge storage The plant was designed for a flow of 252 liters/second, contains an earthen dam 34 m high and 329 m long, and impounds an area of approximately 15 ha with a capacity of 1 89 x 10^9 liters It was designed with a 25-year life. This plant was activated in September 1974. The discharge from this plant is also reported to be in compliance with all applicable water quality standards Table 2 shows typical water quality data before and after treatment as analyzed and reported by Consolidation Coal Company

Table 2. *Water Quality at Sears Treatment Plant.*

Before	*Component*	*After*
3.3	*pH*	*7.3*
250 mg/l	*Acidity*	*0*
217 mg/l	*Iron*	*< 2 mg/l*
0	*Alkalinity*	*> Acidity*

Conclusions

As a result of this cooperative effort of government and industry (Consolidation Coal Company), nearly all of the mine drainage pollution which was discharging to the Dents Run Watershed at the outset of the project was controlled. As evidenced in Tables 1 and 2, a 99-percent reduction in the level of acidity and iron concentrations contributed to Dents Run was realized This was accomplished through the previously described reclamation activities as well as the design and construction of two mine drainage treatment facilities by Consolidation Coal Company

Surface reclamation techniques employed during the project appeared to have reduced the volume of drainage, although flow monitoring data was not sufficiently detailed to substantiate this suspicion Weirs constructed to accommodate continuous stream flow measurements were extremely costly and a constant source of problems due to siltation and flooding Parshall flumes are much more suitable to this type of application because sediment is less likely to be trapped in the control section of the flume and cause flooding and inaccurate stream flow measurements

Since stream flow measurements through the weirs could not be accurately made, the pumping rates from the Snider and Loar boreholes were used in assessing the effectiveness of the project in reducing surface water infiltration At the onset of the study, the Hess, Loar, Six-Right, and Laurel Point boreholes discharged water from the Pittsburgh coal seam and the Snider borehole discharged water from the Sewickley seam This system was later changed so that Hess, Six-Right, and Valotto, discharges were pumped underground into the Sewickley seam, which was then dewatered through the Snider borehole The Loar and Laurel Point waters were combined and discharged through the Loar borehole The overall Watershed pumping rates would reflect the total volume of water infiltrating the Dents Run Watershed provided that no water was transferred from this area to another drainage basin. Assuming this to be correct, the decrease in the volume of water discharged from the Sewickley seam in 1972 and 1974 was

Borehole	1972	1974
Snider	4.54x10^6 m^3	3.31x10^6 m^3

The years 1972 and 1974 were chosen for study since the rainfall for those two years is approximately the same (see Figure 4) and reclamation of the Watershed occurred between those two years This resulted in a discharge reduction of 4 54x10^6 m^3 - 3 31x10^6 m^3 = 1 23x10^6 m^3

The percent reduction for this period was 1 23x10^6 m^3 - 4 54x10^6 m^3 x 100 = 27 percent

When the pumping rates recorded at Loar borehole were considered, the following discharges were calculated

Borehole	1972	1974
Snider	4 54 x 10^6 m^3	3 31 x 10^6 m^3

Borehole	1972	1974
Snider	4 54 x 10^6 m^3	3 31 x 10^6 m^3
Loar	38 x 10^6 m^3	12 x 10^6 m^3
TOTAL	4 92 x 10^6 m^3	3 43 x 10^6 m^3

This resulted in a discharge of 4 92 x 10^6 m^3 - 3 43 x 10^6 m^3 = 1 49 x 10^6 m^3

The percent reduction for this period was 1 49 x 10^6 m^3 - 4 92 x 10^6 m^3 x 100 = 30 percent

Although this percentage figure is short of the potential 50 percent reduction believed possible at the onset

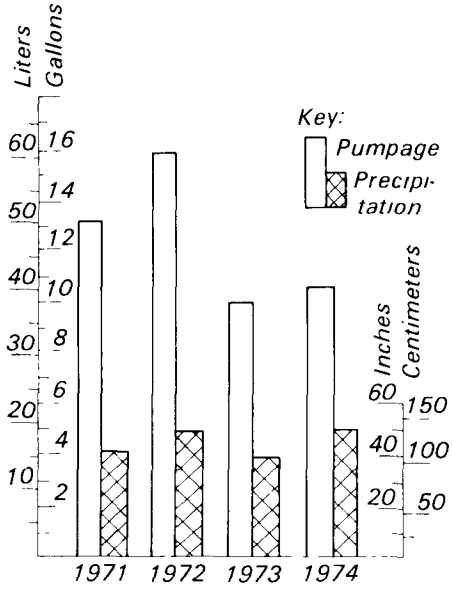

Figure 4. *Borehole pumpage vs precipitation*

of this project, it nevertheless represents a very significant total volume of water - 4,100 m^3/day - from the combined discharges of the Snider and Loar boreholes.

Over 40 hectares of orphaned surface mined land were regraded and revegetated during this project. Unfortunately, inadequate post-reclamation maintenance has resulted in sparse vegetative cover and development of erosion gullies.

Recommendations

Reclamation projects of this nature should incorporate a routine maintenance program to assure the continued success of vegetative cover and minimize degradation of the site by erosion and/or sedimentation Also, access to reclamation sites should be controlled to prevent degradation of the site by dumping of trash and debris, grazing of livestock, and/or disruption of water drainage systems by rutting from vehicular traffic

State and Federal reclamation agencies should develop inventories of the mine sites where selective reclamation techniques (such as those demonstrated in this study) can be employed to reduce infiltration into underground mine workings. By so doing, the responsible government regulatory agency could work with cooperating mine operators to modify reclamation practices in order to obtain maximum benefit on ongoing reclamation efforts

This Project Summary was authored by ***Jonathan G. Herrmann****, who was also the EPA Project Officer (see below)*

The complete report, entitled "Water Infiltration Control to Achieve Mine Water Pollution Control—The Dents Run Watershed Demonstration Project" was authored by J. D. Robins of Robins and Associates for Hittman Associates, Inc., Lexington, KY 40511

The complete report (Order No. PB 80 217748, Cost: $12.00, subject to change) will be available from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

Industrial Environmental Research Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

☆ U.S. GOVERNMENT PRINTING OFFICE 1981 - 757-064/0229

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati OH 45268

Postage and
Fees Paid
Environmental
Protection
Agency
EPA 335

Official Business
Penalty for Private Use $300