ABANDONED MINE LAND RECLAMATION - UNIQUE PROJECTS IN WEST VIRGINIA[1]

by

Neil A. Robinson[2]

Abstract. The Abandoned Mine Lands Program (AML) in West Virginia has completed reclamation on 215 projects at a total construction cost of $90 million. Typical projects encountered daily by the AML staff including mine portal sealing, coal refuse pile regrading and extinguishment (if burning), landslide correction, subsidence abatement, and mine drainage control. Some of these projects require a different reclamation approach than is commonly used on typical AML projects. This paper provides information concerning the abatement and correction of several AML projects that required different approaches. One site consisted of a burning coal refuse pile covered with asbestos which had to be handled and disposed of in a specific manner. The use of a coarse sand aggregate was utilized to extinguish a deep mine seam fire on a project in Kistler, West Virginia. Two projects required special water handling and treatment facilities. Transforming a hazardous burning coal refuse pile into an extention of a state park campground facility was the reclamation objective of one AML site. Another project involved correcting a subsidence problem with steel rod reinforcement.

Additional key words: Abandoned Mine Land Reclamation, mine portal, coal refuse pile, mine fire, subsidence and acid mine drainage.

Introduction

The purpose of this paper is to provide information on West Virginia AML projects which required unique or unconventional reclamation Techniques. Visual observation of the original problem area does not always provide the information necessary to determine what reclamation is required to eliminate the associated hazards. Detailed geotechnical investigations occasionally reveal a completely different situation that what is actually occurring. Once the actual situation is understood, the reclamation design must often be approached from a different angle. New reclamation techniques also have to be considered when developing a plan of action.

Materials and Methods

Iroquois Burning Coal Refuse Pile

A burning coal refuse pile, covering approximately eight acres in southern West Virginia, was the site of an experimental extinguishment project conducted by the West Virginia Air Pollution Control Commission between 1966 and 1968. Various mixtures of petroleum asphalt, water, sand, flyash and asbestos cement were applied to the surface of the burning pile in an attempt to eliminate the flow of oxygen to the fire. Temperature reductions throughout the pile were noted after the sealer was applied, but continuous settling of the pile cracked the sealer opening the pile to oxygen.

In the summer of 1988, West Virginia AML personnel investigated the burning pile to evaluate extinguishment and reclamation alternatives. The burning area was delineated during a subsurface investigation and samples of the asbestos material

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[2]N.A. Robinson is a Project Manager for the WVDOE, AML&R, Charleston, WV 25311.

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were taken to determine if special handling would be necessary. The material was found to contain 5% chrysotile (a form of asbestos) which indicated that the material would require special handling and disposal.

Despite numerous conversations with the Environmental Protection Agency (EPA), it could not be determined which EPA program regulates the removal of asbestos from a coal refuse pile. Since EPA did not impose any additional regulations, only OSHA requirements needed to be followed for the removal and disposal of the asbestos materials.

Kistler Mine Fire

During a field investigation of what was thought to be a burning coal refuse pile, located in the town of Kistler, W.Va. it was noticed that smoke was venting along the coal outcrop beyond the small burning pile. The refuse pile fire had ignited the abandoned coal mine at the outcrop and subsequently seven acres of deep mine workings were burning. As the fire burned from the outcrop back into the mine, the overburden rock subsided leaving large fractures in the ground surface. Heat, sparks or flames moving up through these fractures ignited several forest fires threatening the safety of the Kistler residents.

Four reclamation alternatives were examined for mine fire control and extinguishment. The first option considered utilized a combination of a flush barrier and total excavation of the mine fire. The flush barrier would limit the advancement of the fire during the total excavation process. This option would guarantee total extinguishment of the fire but would leave a 450 foot highwall above the town and would be cost prohibitive.

The second option discussed was referred to as bench seal and stream diversion. This method consisted of sealing the coal outcrop and diverting a nearby stream into the mine workings to extinguish the fire. There were many inherent problems associated with this method. To extinguish the fire, water would have to be impounded in the mine in order to come in contact with the roof where most of the fire is typically located. Impounding of water would create the hazard of an uncontrolled blowout which could flood the residents of Kistler.

An attempt to eliminate oxygen from fueling the fire was the basis for the third option-bench seal and flush barrier. A flush barrier would be constructed as in option one in conjunction with sealing off the coal outcrop from oxygen inflow. This option was rejected due to the fact that it was not possible to locate and seal off all sources of air flow into the mine. The fire would continue to burn until all coal reserves are depleted.

The method selected for reclamation of the mine fire was total blind flushing. Blind flushing is a method of filling the void with an inert material through injection boreholes. The locations of the injection holes were determined by overlying the deep mine map onto a 100 scale topographic map of the project area. Material used to fill the mine void consisted of a coarse sand and water slurry. The objective was to fill the entire mine void with the slurry material, thus extinguishing the fire.

Higgenbotham Subsidence

The Higgenbotham residence in northern West Virginia was experiencing severe structural distress. Concrete block basement walls contained several vertical and horizontal cracks from hairline up to 1/2 inch in width. The family room floor had sunk at one end and the interior doors would not close.

An abandoned deep mine causing the structural damage was located approximately 385 feet below the house. An exploratory borehole was drilled next to the Higgenbotham residence to the mine level. Results of this drilling provided evidence of subsidence due to the highly fractured geologic material that the borehole encountered.

Due to the depth of the mine workings, stabilization by injection grouting would not have been cost effective. There would have been little control over grout flow. Additionally, the effectiveness of the stabilization process could not be monitored as it could be at shallow depths with a borehole camera. It also would have been expensive to have to repeatedly drill a 385 foot borehole when the mine void was not encountered.

The method used to stabilize the Higgenbotham home was referred to as fractured rock reinforcing. With this method an attempt is made to tie the fractured rock strata together so that it will respond as a single unit during a subsidence event. This design does not attempt to eliminate settlement but it does eliminate abrupt differential settlement that results in structural damage due to mine subsidence.

Six rows of 4 inch diameter holes were drilled on either side of the house at spacings of 12 feet between rows and 3 feet between holes. The holes were angle drilled beneath the house ranging from 4.5 degrees to 51 degrees from vertical forming an interlocking pattern (see Figure 1). The bottom elevations of all holes were the same. Hole depth varied from 50 to 90 feet depending on the ground surface elevation from which it was drilled. Number 10 deformed reinforcement

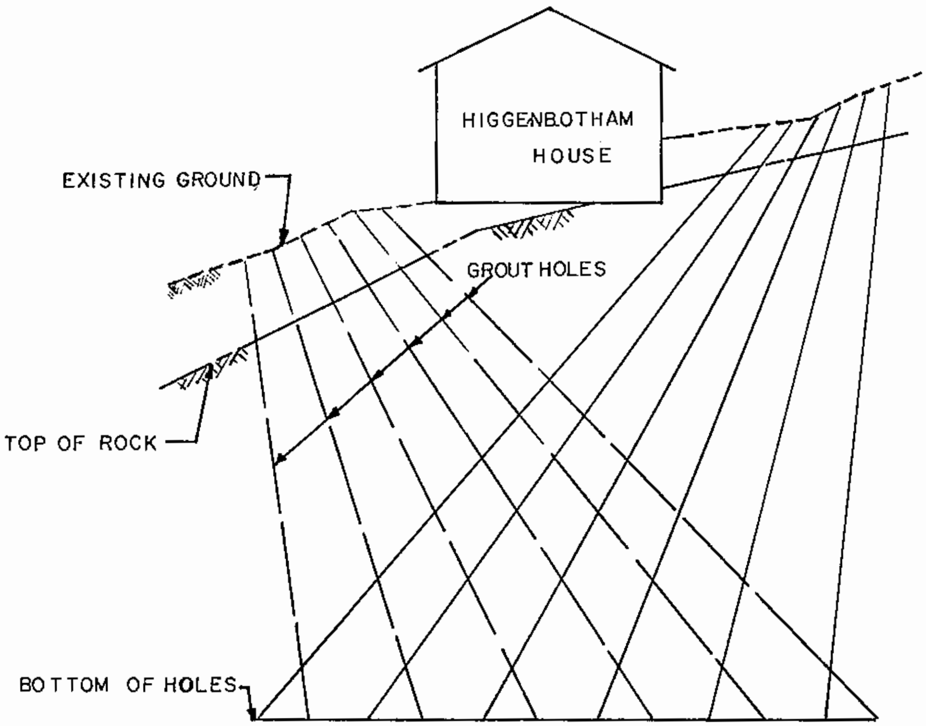

Figure 1. Higgenbotham grout borehole locations.

bars (rebars) with centralizer were placed in the hole. A grout mixture was then pumped to fill the holes around the rebar. Extensometers were installed prior to the start of construction to monitor ground movements, before, during and after the work conducted at this site.

Meriden Drainage

Mine drainage (583 GPM) from what was assumed to be a collapsed mine entry was causing saturated and unstable conditions on a mountainside above a county road along the Tygart River. Preliminary research of existing mine maps indicated that the mine drainage was associated with the Middle Kittanning coal seam.

An exploratory drilling program was initiated to determine the amount of water impounded in the mine and the magnitude of hydraulic head buildup. After several attempts to intercept the mine void failed, questions began to arise as to the origin of the drainage. The decision was then made to advance another borehole an additional 45 feet below the Middle Kittanning to the Lower Kittanning coal seam. The rock strata between the seams was found to be highly fractured. A collapsed void was encountered at the Lower Kittanning elevation. When the mine void was intercepted by the drill bit, the water level in the borehole rose 93.5 feet indicating the presence of an extreme hydraulic head buildup. The Lower Kittanning coal seam dipped below the Tygart River, which was recharging the subsided mine. The river recharge in combination with mine water caused the water level to rise up through the fractured rock into the Middle Kittanning coal seam and seeping out onto the mountainside.

Initial reclamation plans were to wet seal the draining mine entry and regrade the sliding material. Results from the drilling program indicated that the initial plan would have to be significantly revised. Reclamation of this site consisted of installing a deep trench drain down to the base of the Middle Kittanning coal seam to collect all water being forced up from below. Large diameter relief wells were to be drilled to the Lower Kittanning mine to relieve the hydraulic head.

Typical quality of water from the Kittanning coal seams is some of the most acidic of all coal seams in this region. Water quality samples taken along the county road revealed a pH of 6.3, sulfates at 760 mg/l, iron at 23 mg/l and alkalinity at 35 mg/l. Further investigation into the reasons for relatively good water quality than that which is normally found indicated that the water is flowing through fractured and subsided alkaline shales between the Lower and Middle

Kittanning coal seams. Due to this discovery, the large diameter wells were eliminated so that the water would come in contact with the alkaline material, thus improving water quality.

Webster Refuse

The Webster Refuse site consisted of approximately 1800 feet of highwall, five acres of coal refuse, and three collapsed deep mine openings discharging roughly 53 gpm of acid mine drainage into Webster Run. The quality of the drainage was pH 3.8, iron 1.8 mg/1, aluminum 6.2 mg/1, manganese 2.0 mg/1 sulfate 800 mg/1 and alkalinity 0 mg/1.

Any increase in the water quality of Webster Run would have a significant effect on the receiving stream. The improvement of the Webster Refuse water quality would greatly improve the productivity of the receiving stream.

Along with using typical reclamation techniques the reclamation design of this project emphasized an experimental attempt to improve water quality. The entire highwall, including all of the exposed coal seam and pits, were backfilled with existing spoil material to eliminate any direct contact of surface drainage with the coal seam and acid producing spoil. All acid producing coal refuse was covered with one foot of topsoil obtained from a borrow area. A sediment control pond was constructed as the soil borrow was removed.

Wet mine seals were installed in the draining mine entries. During construction the drainage was treated in-line with soda ash. Upon completion of regrading and establishment of permanent vegetation, the sediment pond was converted into an alkaline leach bed. The principle spillway of the sediment pond was perforated all around so that the drainage into the pond would immediately flow out rather than having to reach the top of the spillway pipe. Limestone aggregate (AASHTO No. 2) was used to fill the leach bed. The pipeline from the wet seals to the leach bed was connected to a 12" PVC pipe header and then into three 6" perforated PVC pipes lying on top of the limestone. The three 6" pipes functioned to disperse the acid mine drainage across the top of the limestone. As the drainage filtered down through the limestone it picked up the alkalinity needed to increase water quality. Once the drainage reached the bottom of the leach bed; it flowed through the perforated principal spillway and then into Webster Run.

Chief Logan State Park

This abandoned mine land project was located within the boundaries of Chief Logan State Park in southern West Virginia. The site consisted of several coal refuse disposal areas encompassing approximately 30 acres. A portion of this refuse was burning and contained dangerous underground voids. Smoke from the burning areas often fill the narrow valleys of the park. Acid mine drainage from the old underground workings and sediment from the refuse piles had greatly deteriorated the quality of the receiving stream. Collapsed mine entries with pooled water created a potential for hydraulic head buildup and subsequent blowout. In short, the entire area represented a hazardous and environmentally degraded condition within the confines of a highly used and popular recreation facility.

The project area could have been successfully reclaimed to improve the environment and eliminate the hazards with a minimal planning and construction effort. The unique potential of the site and its location, however, led abandoned mine land personnel to initiate a joint project with the West Virginia Department of Commerce, Parks Division. Funding for the project was secured through the National Abandoned Mine Lands Fund, state appropriations, and Soil and Water Conservation Funds. The construction activities on the site not only resulted in complete reclamation but was further developed to include the establishment of a 25-site campground and associated recreational facilities.

Results and Discussion

Iroquois Burning Coal Refuse Pile

Reclamation proceeded initially with the removal of the asbestos - containing material. The asbestos material was removed by hand, thus the workers were required to wear disposal coveralls, respirators, rubber boots and gloves. Air sampling instruments were placed on the workers to monitor their exposure to asbestos fibers during the removal process. If the asbestos levels in these samples would have exceeded 0.2 fibers/cc, it would have been necessary to set up a decontamination facility where each worker could be processed before leaving the site. Asbestos levels measured on the workers never exceeded 0.04 fibers/cc, thus the decontamination facility was not needed.

Since the asbestos material could be seen on the surface of the refuse pile as a thin, broken, bituminous layer, the most efficient method of removing the material was by raking and shoveling. The material was continually kept moist to reduce the amount of asbestos released into the air. A dump trailer lined with a 6 mil plastic bed liner was kept on-site to haul the asbestos material to a landfill approved to receive such materials.

Once all asbestos material was removed from the site, the Contractor began to excavate and extinguish the burning coal refuse. Extinguishment was achieved by excavating the burning material, spreading it out and applying water. Quenched material was allowed to dry and then incorporated back into the fill. A subsurface investigation, conducted during project design delineated the limits of burning. When the Contractor reached these limits, burning temperatures were found existing beyond these limits. To ensure that all burning was completely extinguished, excavation continued beyond the initial limits.

Excavation quantities were initially estimated at 73,886 cubic yards. Due to the extent of the burning the entire pile had to be excavated which increased the quantity to 278,000 cubic yards. The significant underestimate in the quantity of burning material occurred during the subsurface investigation. The boreholes that were advanced into the pile to determine the extent of burning encountered large heat fused masses of reddog, known as "clinkers". These clinkers were misinterpreted as original ground, thus the boring was terminated. During construction it was found that there was a large amount of burning material below the clinkers. It has also been found that coal refuse fires can increase or decrease in size and intensity in the time interval between exploratory drilling and construction. This makes it extremely difficult to try to estimate the volume of burning for competitive bidding purposes. Reclamation of the Iroquois Burning Coal Refuse Pile was completed within a ten month time period at a total cost of $1,179,734.09.

Kistler Mine Fire

Construction proceeded on the Kistler Mine Fire for approximately one year. At project completion a total of 145 boreholes had been drilled at a total linear footage of 23,292. The boreholes were broken down into injection holes and assurance holes. A total of 38,385 tons of coarse sand aggregate was injected into the mine through the injection holes. Assurance holes were installed to determine the relative success of the injection material filling the mine with coarse sand slurry or to monitor mine level temperatures. Temperature readings taken upon completion of the project revealed that there were three small areas that were still burning. These hot spots caused little concern because they were each surrounded by inert injection slurry which would eliminate the fire from spreading. Subsequent monitoring of assurance holes since completion of reclamation has indicated a slow decline in temperature. Total cost of reclamation for the Kistler Mine Fire project was $1,585,124.41.

Higgenbotham Subsidence

Rock reinforcing was completed in August 1989 after approximately 90 days of construction at a total cost of $99,500.00. Construction was slowed due to rainy weather and encountering water in some boreholes at the 40 foot depth. Water in the boreholes was remedied by grouting the boreholes from the bottom and displacing the water.

According to reports, no additional structural distress to the Higgenbotham residence have been observed. Therefore, it is assumed that the reinforcement technique was successful.

Meriden Drainage

After 240 days of work, reclamation was completed in July 1989 at a construction cost of $701,673.46. At the present time all drainage is being collected in the trench drains and conveyed to the river in riprap channels. No seepage can be detected in the final regrade and the slope has been stabilized.

Webster Refuse

An initial concern with the leach bed technology was that within a relatively short period of time the limestone would coat with iron precipitate rendering it ineffective for water treatment. However, the iron levels in this drainage were only 1.8 mg/1. Thus the chances of complete limestone coating would require a considerable time period. As the drainage flowed across the aggregate and the limestone decomposed a minimal amount of iron coating hopefully would be broken up and fresh reactive surfaces of limestone would be exposed.

The contract specifications for this project stated that if after one year from the date of completion of reclamation water quality tests indicated that the leach bed was no longer functioning to significantly increase water quality it would be removed, the site regraded and drainage carried to the receiving stream by riprap channels. Water quality data was obtained before, during and at one month intervals after the completion of reclamation. A portion of this data is contained in Table 1. Alkalinity and pH values have increased, while iron has decreased.

The major quesiton that remains is how long will the leach bed continue to produce good water quality? This project was selected as the northern West Virginia 1989 Abandoned Mine Land Reclamation Award winner.

Chief Logan State Park

Reclamation of this site included the excavation and extinguishment of the burning coal refuse material. A detailed regrading plan was specifically designed to support the camping facility. A minimum of 12 inches of soil material was used to cover the entire refuse area with 3 feet of soil under the camping areas

Table 1. Water quality data from the Webster Refuse Project after the water was treated by the limestone leach bed.

Sampling Date	pH	Fe	Al	Mn	SO4	Alkalinity
		Mg/1				
04-26-88	3.9	8.8	11.0	2.3	1000	0
06-15-88	3.6	31.5	16.5	4.2	1400	0
07-21-88[a]	7.0	0.2	0.4	2.4	600	45
12-01-88	7.3	0.0	0.1	0.0	1000	59
04-27-89	6.7	0.1	0.1	0.1	1000	131
09-05-89	6.6	0.0	0.3	0.0	1260	138

[a] Date on which acid mine drainage was routed through the limestone leach bed.

and facility buildings. The camping sites were constructed with paved spurs and level grass pads with water, sanitary, and electrical hookups. Earthen mounds were constructed between campsites to provide the maximum amount of privacy.

Stream channel reconstruction was accomplished to provide environmental improvements throughout the site. The stream channel before reclamation flowed through and eroded the acidic refuse material, contributing large amounts of sediment and acid loads to the stream. Improvements to the channel included lining the regraded channel with an impervious clay material and using filter fabric and rock riprap to stabilize the stream. The impervious channel lining functioned to keep the stream from coming in contact with the acidic coal refuse material.

A borrow area was excavated for both soil and rock which was used as soil cover and channel lining, respectively. Upon completion of borrowing activities, the borrow pit was backfilled and regraded into the configuration of an amphitheater. The amphitheater has been used as a meeting place for interpretive programs.

The drainage from mine entries, located in a side hollow, was causing saturated conditions which posed a threat to people using the park. Many of the entries were also open and accessible to the general public. Sealing these entries was accomplished by using aggregate bulkhead seals with PVC pipe, allowing the entries to drain, thus eliminating hydraulic head buildup. Drainage was diverted around the saturated areas so that these areas could dry and be regraded.

Many of the existing structures left from past mining activities were rehabilitated to provide new uses. At the campground entrance an old railroad trestle was restored and is serving as a roadway bridge crossing the stream. Overlooking the new campground was a coal load out chute which facilitated the movement of mined coal from the mountainside deep mine entries to the valley floor. This chute was upgraded to serve as an overlook platform located off one of the nature trails. A series of haulroads leading from the valley floor up to the mine entries and along the mountainside serve as hiking/nature trails.

The project also included the construction of various facility buildings for the basic functioning of the campground. These buildings included a campground check-in building, wastewater treatment facility, booster pump station and bathhouse.

The project illustrates that future land-use planning is a complimentary addition to reclamation. The emphasis that was placed on future land-use for the Chief Logan State Park project represents the highest goal in the abandoned mine land program: the transformation of useless, hazardous land into useful or productive areas.