OSM 40 (3218) 101.1
PARDEESVILLE
HAZLE TOWNSHIP
LUZERNE COUNTY, PENNSYLVANIA

Nomination for the Reclamation
of Abandoned Mine Lands By:

Pennsylvania Department of Environmental Protection
Bureau of Abandoned Mine Reclamation
Wilkes-Barre District Office

Nomination Submitted March 5, 2000

Nomination Committee

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Start Date:	July 13, 1998
Completion Date:	December 22, 1998
Cost:	$232,957.73
Contractor:	D. A. Kessler Construction Company Inc.

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NARRATIVE DESCRIPTION OF WORK

HISTORY

The Anthracite Region of Pennsylvania was environmentally devastated by coal mining in the late nineteenth century and during most of the twentieth century. Unregulated mining produced a legacy of abandoned mines that pose severe health and safety risks and produce pollution. Steady progress has been made over the past twenty years to eliminate many of the hazards, but most of the pollution problems that were not easily corrected have been left unresolved. Recently, environmental pollution of watersheds has been addressed in conjunction with traditional hazard reclamation using evolving technologies.

PROJECT BACKGROUND

The Pardeesville site in Luzerne County, Pennsylvania, was part of a large abandoned mine complex that was extensively deep mined beginning in the late nineteenth century and strip mined at the coal seam outcrops in the 1940's. The site consisted of three strip pits with highwalls or unconsolidated spoil walls that were seasonally flooded to a depth of twenty (20) to fifty (50) feet. Upon being alerted by the property owner of heavy visitation at the site, and of his concerns due to a drowning in a nearby strip pit, the decision was made to proceed immediately on a preliminary design for the site.

The preliminary design began in November, 1993 with site reconnaissance, investigation of mining records, aerial photography and mapping, hydrographic survey of the flooded pits, water quality analysis, wetland delineations, and a stream assessment.

The investigation revealed the existence of the following site-specific conditions that needed special attention: (Refer to photograph # 1, page 7, for an overview of the site.)

a) Deep Mines – Examination of the water quality results, the physical expression of the site, and a study of the historical mine maps showed a direct connection between the floors of the strip pit and the deep mine workings. The following conditions were observed: 1) The entire area had been deep mined leaving pillars to support the roof of the underground workings. 2) Several crop falls were observed in the bottom of Abandoned Mine Land Feature (AMLF) #5. 3) The water quality at the stream entering AMLF #2 was significantly better than at any other location. 5) The water level fluctuation in the three pits was nearly identical. This information led to the conclusion that the pit floors were directly connected to the deep mines and the source of water pollution was the intermingling of surface water with the deep mine pool.

b) Water-filled Pits – The site was inspected for the existence and quality of water and plant resources. The study revealed that the water-filled pits had no vegetative component because of poor water quality (the pH values were below 4.9 with heavy metal concentration commonly associated with mine water) and the rapid fluctuation of water surface levels within the pits.

c) Wetlands – Three (3) small pockets of wetlands, each consisting of less than .05 acres in area, were located adjacent to the strip pits and were delineated. These wetlands had hydric soils, wetland vegetation, and were hydrated by freshwater springs. Their locations were marked in the field for inspection by regulatory authorities and for the excavation of the muck for mitigation.

d) Freshwater Springs – Observation revealed springs discharging along the highwalls and at the wetland pockets. These would need to be addressed to prevent erosion and to take advantage of the supply of freshwater.

e) Pumping Facility – Located just to the east of the reclamation site is a deep mine well that was a vital source of water to the operation of a mineral processing facility to the west. The ability of the mining operation to continue to process culm economically was potentially contingent on the success of the Pardeesville project.

f) Stream – An unnamed stream with a pH of 6.0 entered the site at the eastern corner of AMLF #2 and then plunged into the strip pits mixing with the mine pool water. The flow discharged from the westernmost corner of AMLF #5 at a pH of 4.9 when the mine pool complex became completely flooded. (See Photograph #1.) A conveyance structure would have to be designed to transport base flows and storm flows for the entire watershed and prevent contact with the mine workings.

DESIGN/IMPLEMENTATION

The goals of the design were to eliminate the hazards at the site, to improve the water quality, to create wildlife habitat, and to modify the pumping system.

Developing a grading plan for the site was challenging. The final plan, using only on-site material, met the requirements for the wetland layout, created positive drainage for surface water runoff, and allowed for the stream channel and flood plain geometry. The grading plan would be instrumental in preventing freshwater from continuing to infiltrate into the mine workings. The strip pits would be sealed and positive drainage achieved across them to prevent infiltration. The wetland and stream channel flood plain were graded across a peninsula of unmined ground that lay between the coal seam outcrops. (Compare Photograph #1 and Photograph #3.)

A pre-application site meeting was held with Pennsylvania's Department of Environmental Protection, Bureau of Waterways Management to determine regulatory implications of performing reclamation at this site. It was agreed to use a wetland waiver process and mitigate for the existing wetland pockets by creating a 1.5 acre wetland. Property owner cooperation was vital at this point and the owner did agree to the mitigation as well as all other habitat modifications that were proposed during the design process. The wetland was planned for a location where it could take advantage of the freshwater springs as a source of hydrology. The grading at this location was designed to create shallow areas and deepwater areas

that would promote biodiversity. (See Photograph #6.) The muck material from the pockets of wetlands was removed, stockpiled, and eventually spread throughout the wetland and then the area was seeded with a wetland seed mixture.

An existing mine water pumping facility was problematic because the Pardeesville site lies directly between the location where a deep mine well was drilled and the mineral processing operation, which relied on pumped water when the strip pits were not discharging. A four (4) inch diameter polyvinyl chloride (PVC) pipe dissected the Pardeesville site to bypass the strip pits and connect the well to the off-site channel. The pipeline would have to be removed and replaced by a channel in order to complete the reclamation. The owner of the facilities came to support the reclamation effort especially when he learned that pumping costs could be reduced as it was likely that the pump would rarely need to be operated in the future due to collection of freshwater and the elimination of infiltration. The PVC pipe would be carefully removed and stockpiled for re-use by the owner, except for the sections needed to connect to the constructed stream channel for emergency pumping. To date, no pumping has been necessary.

A Natural Channel Design was determined to be the preferred alternative at this site. A stream channel assessment was needed to prepare a "blueprint". This blueprint included the dimension, pattern, and profile of the stable stream that nature had intended for this watershed. A stable stream has the ability, over time, to transport sediment and flows produced by the stream's watershed in such a manner that the stream's dimension, pattern and profile are maintained without aggrading or degrading. The assessment process included data collection, calculations for the five (5) primary criteria, and then classification by stream type. The data collected determined the "bankfull" discharge of the watershed. Bankfull is defined as the momentary maximum flow which, on the average, has a recurrence interval of 1.3 to 1.5 years. This stage or elevation is the single most important parameter used in classification, because bankfull is a function of the dimension, pattern and profile. Once bankfull was determined, the following five (5) criteria were calculated : 1) Entrenchment Ratio, 2) Width/Depth Ratio, 3) Sinuosity, 4) Channel Materials, and 5) Slope. Using these results, the stream type was chosen using the "Rosgen Classification of Natural Channels" Table. This table indicates the stream type ("A" through "G") and shows a range of values a stream can vary between and still remain stable. The criteria are interdependent. A change in sinuosity will affect the slope, which could change the bankfull dimensions, thereby changing the width/depth and entrenchment ratios. The channel will be stable only within the ranges of the classification criteria. Site-specific design decisions were necessary along the entire length of the channel to prevent it from deviating out of range.

The Channel was classified as a "C" channel, meaning that it needed to be slightly entrenched, with a moderate to high width/depth ratio, and high sinuosity. The post-reclamation bankfull discharge was calculated to be approximately 100 cfs. The entire watershed was not reclaimed as part of this project because of the lack of property owner cooperation. The owner of the western end of the Problem Area is considering utilizing the large water filled pit, identified as AMLF # 4 on photograph 3, as the water supply for a future mining operation. Computations showed that the bankfull discharge would increase to 150 cfs when the entire Problem Area is reclaimed.

A natural channel design was conceived that would create a "C" type channel to accommodate the existing 100 cfs discharge and the 150 cfs discharge expected after the entire Problem Area is reclaimed . The solution was a V-shaped channel that could easily change itself morphologically to accommodate additional flow, yet remain stable. This design methodology may be applied to other sites where a potential increase in future flow is anticipated. The V-shape allowed for a width/depth ratio of more than twelve (12) and an entrenchment ratio of greater than 2.2 for both bankfull

discharges. The flood plain was designed at the valley slope of one percent (1%), with the channel meandering through it at a sinuosity of approximately 1.25.

The channel was designed at a slope of eight tenths of one percent (0.008 ft/ft). The slope changed along the profile from 0.01 ft/ft to 0.006 ft/ft, to provide for a riffle/pool sequence in the channel. There were nineteen (19) bends incorporated to provide the sinuosity needed to dissipate the stream's energy. At the outside bank of each bend, channel stability and habitat enhancement structures were installed. The structures consisted of root wad revetments, comprised of trees from the site, used to deflect flow velocities; or rock veins installed to roll the flows and direct velocity toward the center of the channel (See Photograph #5.) The entire channel was placed inside a 100+ foot wide, grass-lined floodplain at a set meander geometry. The geometry was calculated between 135 feet and 280 feet long for meander length, and between 37.5 feet and 60 feet wide for meander width. (See Photograph #4.) The profile and geometry values above were derived as a function of bankfull. The floodplain was designed to contain flows in excess of 800 cfs, which is the flow expected during a one hundred year storm event.

Habitat enhancements that were also part of this project included placing large stumps reserved during grading operations into the deeper areas in the wetland and saving trees to build brush piles. The brush piles that were placed beginning at the water's edge and extending upland have been particularly effective in attracting wildlife. (See Photograph #4.) Additionally, the root masses and logs for constructing the root wad revetments were placed in a fashion such that they would protect the stream banks and promote the formation of deep scour pools in the stream bed for wildlife. Seed mixes were specified that were beneficial to wildlife, and wood duck and bluebird boxes were constructed and installed by Bureau personnel using recycled core boring sample boxes. Bureau personnel also traveled to a federal government plant propagation area and harvested willows. The willows were cut into live stakes and planted at the Pardeesville site along the stream's riparian zone to promote the establishment of a forested buffer.

The project was constructed by diverting the existing inlet channel into AMLF #5 while AMLF #2 was being backfilled. The water in the pits was displaced into the deep mines during backfilling. The channel was constructed as the pits were being backfilled. The floodplain and wetland were graded using large earthmoving equipment. Then, the geometry and slope of the channel were laid out by grade stakes within the floodplain. Next, using a small bulldozer and excavator, the channel was formed to the grades and limits, as shown on the drawings. The entire floodplain was then seeded and mulched. Lastly, habitat enhancements were added, the flow was introduced into the new channel, final grading of the pits was completed, and then the remaining areas were vegetated.

Construction was completed on December 22, 1998, by D.A. Kessler Construction Company, Inc., with the final inspection on December 30, 1998. The final cost of the project was $232,957.73 to grade and vegetate twenty-nine (29) acres, utilizing 255,204 cubic yards of on-site material. The project was paid for with funds from Pennsylvania's 1997 AML, Title IV Grant. There was an estimated cost savings of $66,000 realized by constructing the "natural channel", as opposed to building the traditional straight rock-lined channel typically designed to transport storm flows for a 10 year, 24 hour storm event. The rock-lined channel would have been shorter, but the placement of riprap is costly.

RESULTS:

The following is a list of major accomplishments at the Pardeesville site:

1) The elimination of three (3) hazardous water bodies.
2) The elimination of one thousand (1,000) linear feet of dangerous highwall.
3) The restoration of twenty-nine (29) acres of land resource.
4) The creation of twenty-two hundred (2,200) linear feet of a natural stream.
5) The creation of a one and one-half (1 ½) acre freshwater wetland.
6) The diversion of freshwater from the polluted deep mines.
7) The improvement of water quality from pH 4.9 to pH 6.1.
8) The creation of brush piles and wetland stumps for wildlife.
9) The installation of nesting boxes.
10) The planting of willow trees using live stakes.
11) The cost savings from using a natural channel design vs. rock lined channel.
12) The storm water capacity of a 100+ year event by the natural channel's floodplain.
13) The creation of biodiversity.
14) The alleviation of the need to pump by the downstream mining operation.

After construction, the site was closely monitored by visual inspection and sampling. The timing of the project's completion was worrisome because the channel was seeded in late fall, with no chance of vegetative cover being established before the spring thaw. The channel would have to withstand the high flows of bankfull or greater flows without the benefit of a vegetative component helping to stabilize the channel. Large volumes of water did pass through the stream that spring, and many times thereafter, with the channel functioning effectively. The geometry has remained intact, with little bank erosion or change in the profile of the surface water elevations. However, the V-shape dimension of the channel and the channel bed did morphologically adapt to bankfull flow, as had been anticipated. The pool sections became wider and deeper due to scour at the root wads and rock veins. The riffle sections are now narrow and shallow. Sediment, mostly created by the scour in the pool areas, was carried downstream and deposited on the inside banks, at the bends, creating point bars. Throughout the length of channel, channel bed material "miraculously" appeared. Gravel to cobble-sized material now lines the riffle sections, while finer material, sand to silt-sized, lines the pool sections.

A dramatic and definitive success at the reclamation site is the improvement of the water resource in terms of water quality and biological function. The wetland became filled with water immediately and continues to discharge freshwater at the rate the springs are recharging it. The water in the wetland is alkaline with a pH of 6.1 and barely measurable levels of metal. The vegetative growth at the site was exceptional. A diverse community of cattails, common rush, spiked rush, and water plantain colonized and flourished along the shallow flats circling the wetlands. The deep water section remained as open water. Muskrats, ducks, swallows, and sand pipers took up residence and began to utilize the diverse habitat that was created. The immediate success of this wetland is attributed to the ideal conditions that were provided for by the placement of the stockpiled muck and the supply of freshwater.

The stream has flowed every day since the project was completed. The water quality, which has been measured at multiple locations, is alkaline with a consistent pH of 6.1 and only trace amounts of metals. In June of 1999, less than six months after the flow of water was returned to the newly constructed channel, minnows, crayfish, and snakes were noticed to had taken up residence in the stream. A subsequent preliminary biological survey, taken on June 29, 1999, revealed that the stream is teeming with life. Biological samples were taken from three riffle sections within the stream using a D-frame net and by picking specimens from rocks. The specimens were then taken to the lab to be identified and counted. The non-insect taxa that were collected included minnows, salamanders, crayfish, and tadpoles. Twenty-five (25) taxa of macroinvertebrates were collected. They included three (3) types of mayflies, five (5) types of stoneflies, three (3) types of caddisflies, five (5) types of midges, six (5) types of beetles, one (1) fishfly, one (1) dragonfly larva, and worms. The biological study was qualitative to determine the diversity of species that might be living in the stream. A quantitative study would have to be done for statistical purposes, however, statistics will not change the fact that, only six months after restoration, this stream is full of living things – as it must have been fifty years ago, before the watershed was destroyed by mining.

CONCLUSION

The results at the Pardeesville site have been encouraging. The potential exists to marry the field of engineering and the study of fluvial geomorphology, such that bank protection, flood protection, habitat creation, and providing channel capacity for future development can be packaged as goals for a single project. Additional sites are being identified where similar designs can be implemented and the techniques can be perfected. Designers and regulators must be encouraged not only to reuse and approve conservative designs, but to use new tools and to expand the scope of their goals to include restoring a biological function to the watershed and its stream.

The benefits of this project will be lasting. 1) The constructed channel will enable the entire watershed to be easily reclaimed, since the expected hydrology has already been taken into account. 2) The property owner was so well pleased with the final product that he might forego his plans to develop the site residentially and retain the area as a wildlife sanctuary where he can continue to observe bear, deer, and turkey. 3) The Pardeesville site is currently being used to promote the understanding of reclamation techniques and to teach their proper implementation. The site has been toured repeatedly by those wishing to see the “on the ground” results. Technical staff and interns have been trained in the collection of morphological and biological data at the site. Technical training was recently conducted at the site for watershed professionals from the Susquehanna Basin of Pennsylvania. In the end, other projects that are conceived from lessons learned at the Pardeesville site might well be the most lasting benefit of all.

The Pardeesville project applied innovative reclamation techniques that created wildlife habitat and corrected pollution problems, while eliminating the hazards caused by past mining. This exemplary effort is deserving of recognition and consideration for a National Abandoned Mine Land Reclamation Award.