THE WHITESIDE RUN RESTORATION PROJECT: WETLANDS AND STREAM MITIGATION AND RESTORATION OF A PREVIOUSLY POLLUTED STREAM[1]

by

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Abstract: An 841,000 m^3 (1,100,000 yd^3) coal refuse pile from the operation of a now abandoned Lower Kitanning (B) coal deep mine had been the source of over 95% of the mine drainage pollution in Whiteside Run, a tributary of Moshannon Creek in Gulich and Woodward Townships, Clearfield County, Pennsylvania. Representative water quality upstream of the refuse pile was: pH = 6.9; alkalinity = 31 and acidity = 0 mg/L as $CaCO_3$ equivalent; [Fe] = 0.85 mg/L; [Mn] = 0.31 mg/L; and [Al] = 0.25 mg/L. Representative water quality downstream of the refuse pile before the project was: pH = 3.0; alkalinity = 0 and acidity = 358 mg/L as $CaCO_3$ equivalent; [Fe] = 7.08 mg/L; [Mn] = 0.81 mg/L; and [Al]= 46.86 mg/L. Present downstream water quality is: pH = 5.9; alkalinity = 14.3 and acidity = 8.1 mg/L as $CaCO_3$ equivalent; [Fe] = 1.57 mg/L; [Mn] = 0.92 mg/L; and [Al] = 0.97 mg/L. There has been a significant improvement in the diversity of aquatic life since the project was undertaken.

Power Operating Co., Inc., a local coal mining company, applied for authorization to conduct coal mining activities which would affect a wetland with an area of 1.7 ha (4.1 ac) and 790 m (2600 ft) of an unnamed tributary of Moshannon Creek. Although part of this wetland was anthropogenic, having developed because earlier mining activities by others had affected the channel of the unnamed tributary of Moshannon Creek, the major portion of the area was a natural wetland. Power Operating developed 2.6 ha (6.5 ac) of constructed wetlands to replace the wetland disturbed by mining. The refuse pile was removed and placed in the backfilled area of Power's adjacent surface mine permit, and the mitigation wetland was constructed on the area formerly occupied by the refuse pile. As a result, 6.4 km (4 mi) of formerly polluted stream are now capable of supporting fish.

Additional key words: wetlands, mitigation, refuse pile, mine drainage

Introduction

Pennsylvania (USA) has 86843 km (53962 mi) of streams, of which 79365 km (49315 mi), or 91.4%, are believed to be supporting the federal Clean Water Act's goal of the waters of the United States being kept at or restored to fishable and swimmable quality. The remaining 7479 km (4647 mi) cannot fully support swimming and fishing because of water pollution. The largest source of water pollution in Pennsylvania is from mineral resource extraction, which accounts for 4178 km (2596 mi) of degraded water, most of which, 3869 km (2404 mi) is due to drainage from mines which were abandoned before modern mining laws and regulations were adopted (PA DEP, 1996; Arway 1996).

When the Pennsylvania Department of Environmental Resources (Now Department of Environmental Protection, DEP) was formed in 1971, one of its priorities was the abatement of pollution from mine drainage. Accordingly, "Operation Scarlift" reports were prepared to document and prioritize sources of pollution from mine drainage in Pennsylvania. Reports were developed which considered pollution of streams in the Muddy Run watershed (tributary of Clearfield Creek), including Little Muddy Run (Skelly and Loy 1971), and in the Moshannon Creek watershed,

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including Whiteside Run (Skelly and Loy 1973), in north-central Pennsylvania. The water from Clearfield and Moshannon Creeks ultimately flows to the Chesapeake Bay via the West Branch Susquehanna River. While the Department has always been keenly aware of the impact of mine drainage pollution, funds for implementation of reclamation and abatement work have proven scarce.

In 1981, the Department (Hellier, 1981) investigated the pollution of Whiteside Run and of Little Muddy Run from the Brookwood Shaft, a large abandoned Lower Kittanning (B) coal deep mine. The investigation found that over 90% of the pollution to Whiteside Run was emanating from a large refuse (boney) pile which had been placed in and along the headwaters of Whiteside Run during the mining of the Brookwood Shaft. Although Moshannon Creek is among the most severely polluted watersheds in the USA, there was hope for the restoration of 6.4 km (4 mi) of Whiteside Run from the boney pile to the confluence of that stream with Moshannon Creek. The refuse was analyzed and found to be of insufficient value for reprocessing. The plan which evolved was to move the 8.41×10^5 m^3 (1.10×10^6 yd^3) of refuse to an active mine to be used as backfill material, conforming to best available environmental safeguards. The area formerly occupied by the boney pile would be replaced in part by constructed wetlands.

Development of Mitigation Plan

The opportunity for implementation of this plan manifested itself in 1994, when Power Operating Company, Inc., submitted to the Hawk Run District Mining Office an application for a new mining authorization (bonded increment) on the adjacent active 455 ha (1125 ac) "Rosemary" (Surface Mine Permit 17673057) coal mining operation in Gulich Township, Clearfield County, PA.

Power Operating Co., Inc. proposed the authorization of new coal mining activities which would affect a wooded scrub shrub and emergent wetland, having an area of 1.7 ha (4. lac), and 790 m (2600 ft) of an unnamed tributary of Moshannon Creek. Although part of the wetland was anthropogenic, having developed because the prior unregulated earlier mining activities by others had affected the channel of the unnamed tributary of Moshannon Creek, the major portion of the area was a natural wetland with exceptionally high value as wildlife habitat. The original surface mine permit included protective barriers around the perennial stream and diverse wetland system, as required by Pennsylvania mining regulations. The agencies responsible for reviewing the application for the new mining authorization, including the Fish and Boat Commission and the Hawk Run District Office, determined that Power's proposed mining authorization should not be issued because of concerns for the wetland.

Power Operating then proposed that in order to mitigate the wetlands to be removed by mining, Power would remove the refuse pile at Whiteside Run, dispose of the refuse in an environmentally sound manner on the Rosemary Operation, and develop no less than 2.6 ha (6.5 ac) of wetlands to replace the wetlands to be disturbed by mining, thereby improving approximately 7.3 ha (18 acres) of former refuse pile and adjacent area by replacing it with the wetland and with upland wildlife habitat (Figure 1).

Sampling conducted by Power Operating indicated that the abandoned Brookwood Shaft refuse pile was contributing over 95% of the pollution to Whiteside Run. Water sampling locations are shown as Figure 2.

Power developed a plan to excavate, transport and use the coal refuse as part of the backfilling of an existing pit on the Rosemary site, placed at the level of the Upper and Middle Kittanning coal seams, well above the Lower Kittanning pit floor, and covered with alkaline overburden to inhibit acid production and provide neutralization. Any dissolved materials in groundwater contributed by rainfall would ultimately drain to the Lower Kittanning horizon, and thence into the Brookwood Shaft underground mine, the original source of the coal refuse pile. There would be negligible lateral groundwater flow or pollution from outside this backfill area. Hence, the proposed wetland mitigation would not result in transferring pollution from one area to another. With the refuse pile removed, the wetlands mitigation could be implemented.

This proposal was in harmony with Pennsylvania's Comprehensive Mine Reclamation Strategy in general and the Upper West Branch Susquehanna Assessment by the Headwaters Resource Conservation and Development Council, Inc. and the Clearfield and Cambria County Conservation Districts in particular. Power Operating Co. submitted the new mining authorization proposal to the PA Department of Environmental Protection in 1994. The revised proposal was approved and implementation was begun in spring, 1995.

Several abandoned refuse piles were associated with the Brookwood Shaft deep mine. The main refuse pile was extremely large, containing approximately 6.12 x 10^5 m^3 (8.00 x 10^5 yd^3) of material. Adjacent to the main pile, there were several "outlier" piles, whose total volume was estimated at 2.29 x 10^5 m^3 (3.00 x 10^5 yd^3). Thus approximately 8.41 x 10^5 m^3 (1.10 x 10^6 yd^3) of acid mine drainage forming coal refuse was removed from Whiteside Run. The project was accomplished in two phases. In Phase 1, the "outlier" piles were excavated and removed and constructed wetlands developed. In Phase 2, the main refuse pile was excavated and removed and replaced by constructed wetlands. The total areal extent of the refuse pile was approximately 2.83 ha (7 ac), and the total improved area amounted to 7.3 ha (18 acres).

The seven primary activities of construction associated with this project are summarized as follows:

1. Excavate the Brookwood Shaft refuse pile materials. Most of the refuse materials were excavated using an O&K RH-120 hydraulic excavator (13 m^3 or 17 yd^3) and loaded into CAT 777 rock trucks for transport to the disposal facility. The upgradient refuse piles were removed first to eliminate the potential for storm water runoff to transport refuse from the upgradient areas into the completed areas. The excavation work associated with the complete removal of all of the upgradient piles was completed during the first year of construction and these areas were reclaimed (Phase 1). The main refuse pile was removed during the next year, although the major portion of the material was removed during an intense excavation period lasting approximately 1 month (Phase 2). Excavation of the refuse materials continued until the refuse was completely removed and native soils were encountered. Several areas required very careful excavation to preserve certain features that were deemed as environmentally sensitive.

2. Transport the excavated refuse materials to the refuse preparation area. During excavation, refuse material that appeared to have sufficient fuel value was set aside so that it could be evaluated and, if deemed suitable, processed for sale. Unfortunately, the material left after 50-100 years was not generally suitable; and less than 1% of the material encountered was set aside for supplemental processing.

3. Prepare (process) the refuse materials prior to disposal (pit burial). The refuse material had spontaneously combusted on several occasions in the past. This minimized the potential for recovery of coal that could be further processed at Power's preparation plant or at a co-generation (co-gen) facility. Thus, while there was some potential for additional combustion, there was generally very little coal left in the pile and site processing became a very minor issue.

4. Transport and dispose the prepared refuse materials in the Power 07 pit on the "Rosemary" operation. The transportation of the refuse was a critical aspect in the overall cost of this project. Fortunately, Power Operating Co. had an adjacent mine pit in which mining had just been completed and backfilling was continuing. There are no other suitable sites within economic proximity where the large amount of coal refuse could have been placed. The disposal of the refuse in this adjacent pit limited the round trip transportation distance to maximum of 1.6 km (1 mi). This short distance haul had several challenges, because it required trucking the coal refuse across a major state highway (State Route 153), thereby requiring a plan to ensure traffic safety.

5. Construct replacement wetlands to mitigate loss of wetlands at Power 14 pit on the "Rosemary" operation. Due to the size and extent of the project area coupled with the environmental sensitivity of the adjacent area, it was decided that the best approach to wetland construction would be the joint development of each wetland area by consensus between Power, the DEP, and PA Fish and Boat Commission (PFBC). It became clear to all parties involved that this partnership approach to the development and siting of each wetland area resulted in a final site configuration that is clearly superior to that which would have resulted if each area had been preplanned without the knowledge of the underlying topography which was discovered only after the refuse was removed.

6. Vegetate replacement wetland areas to PA Game Commission (PGC) and PFBC standards. Site vegetation was accomplished by using the wetland soils from the Rosemary wetlands as a seed-bed and then this was supplemented by the follow-up revegetation. The use of natural wetland soil and indigenous vegetative species in the mitigation was an effort to make it similar to the wetland affected by mining.

Implementation

The initial plan design for the pile removal included site review for identification of areas which were not to be disturbed. These areas were identified as a naturally occurring cranberry bog and some additional wetlands adjacent to the refuse area. Staged refuse removal was implemented in the two phases discussed above. The upstream phase (Phase 1) consisted of approximately 2.0 ha (5.0 ac) of refuse which had been placed adjacent to the stream with an average depth of 3.7 m (12.0 ft). The downstream phase (Phase 2), which included the largest volume of refuse, consisted of a large refuse pile placed completely across the stream valley causing significant degradation to the water quality in the Whiteside Run basin. The combined volume of the refuse piles was estimated to be approximately 8.41 x 10^5 m^3 (1.10 x 10^6 yd^3).

The refuse removal operation and wetland construction began on Phase I in the spring of 1995. A haul road was constructed to enable heavy equipment to access the site. Removal on this upstream phase was conducted using a D-9 bulldozer, track hoes, and tri-axle dump trucks. Phase 2 was conducted beginning in the late fall of 1996 into spring of 1997 in which the remaining portion of the refuse pile was removed. Because of the large volume, larger equipment was utilized. This included the hydraulic shovel, three 68 tonne (75 ton) rock trucks, a D-11 bulldozer, and other support equipment. This enabled relatively quick removal of the refuse material and was accomplished in less than one month. The refuse material was transported to the active mining operation and placed in the backfill following approved permit conditions.

A distinct clay was identified during refuse removal which apparently had been the soil for the original stream and wetland system. Using this clay as an indicator of the base of the refuse pile, the final refuse removal and site clean-up were conducted.

Following the natural contours of the clay horizon, wetland pockets were constructed using existing hydrologic conditions to ensure continual inundation. DEP, PFBC, and company personnel were extensively involved during construction activities to ensure project success. Direct interaction between agency personnel and Power's equipment operators allowed wetlands construction to proceed smoothly, considering the extensive on-site decision making involved.

As areas were contoured, soils and plants from the wetland affected by mining at the Power 14 pit were placed in the newly constructed wetlands to provide proper conditions for wetland development. This placement of material was a special condition of the permit, which required the operator to move the material from the wetlands area affected by mining at the Power 14 pit directly to the newly created wetlands without stockpiling the material. Additional measures were taken to enhance the existing wetlands adjacent to Whiteside Run and the wetlands associated with the cranberry bog. Rock material (rip rap) was incorporated in areas of possible heavy erosion to further stabilize and protect the created systems.

Numerous upland areas were enhanced for wildlife by forming windrows from large concrete structures remaining from the Brookwood Mine complex, large rocks, and woody material. These materials were subsequently covered with soil materials to provide denning areas for mammals. All exposed areas were seeded using a wildlife habitat enhancement seed mix approved by the PGC. Wetland vegetation was mostly naturally introduced, with a small portion of the project being planted by hand from adjacent wetlands areas. Figures 3 and 4 show the refuse pile areas before and after the project.

Within two years the new wetlands pockets had filled in with a variety of wetlands species. They had thriving communities of insects and amphibians and the water quality was improved enough to support fish in the pools adjacent to the stream.

Results and Discussion

The Brookwood Shaft coal refuse reclamation project met the majority of the goals established for the initial project proposal. Although the project is about 95 percent complete, it is anticipated that the final upland and wetland vegetation will not be fully established until the 1998 growing season. Other variables during the 1997 growing season, including a drought and nearby herbicide application by others, also caused problems with re-establishment of the in-stream biological communities.

The wetland restoration has resulted in establishment of more than 2.6 ha (6.5 ac) of mostly open-water and emergent wetland. Some portions adjacent to pre-existing wetlands have enhanced adjacent scrub-shrub, and forested wetland complexes. Phase I of the project area has been completed for two growing seasons and exhibits a diverse community structure of wetland species including soft rush *(Juncus effusus)*, sedges *(Carex* spp.), wool grass *(Scirpus cypernus)*, broadleaf cattail *(Typha latifolia)*, skunk cabbage *(Symplocarpus foetus)*, sensitive fem *(Ohoclea sensibilus)*, and other associated species. The Phase 2 portion should establish comparably during the 1998 growing season due to the available seed base.

Water quality improvement in Whiteside Run was perhaps the most dramatic result, with water quality parameters improving immediately upon removal of the refuse pile and its contact with the flowing water of Whiteside Run. As can be seen from Figures 5 through 9, in-stream water quality exhibited levels that would protect the aquatic life uses of the system with pH ranging from 6.5 to 6.9, alkalinity greater that 30 mg/L, and low concentrations of aluminum, manganese, and iron. Prior to removal of the refuse, the downstream samples had shown degraded conditions with pH from 2.8 to 3.2 (Figure 5), acidity usually greater than 300 mg/L (Figure 6), and elevated metals concentrations (Figures 7, 8, and 9). Aluminum had been measured at concentrations greater than 85 mg/L (Figure 9), whereas the recommended aquatic life use protection level is < 0.7 mg/L (Commonwealth of Pennsylvania, 1998). Recent (1997) results for the downstream samples have shown downstream pH levels at greater than 6.0, with alkalinity greater than acidity and metal concentrations near or below the levels for aquatic life use protection.

Extremely low flow conditions occurred during the 1997 sampling year; thus sampling had to be abandoned from June through September. It is anticipated that once flows completely reestablish and stabilize, more consistent water quality will be measured.

The benthic macroinvertebrate sampling was conducted at numerous sites upstream and downstream of the project area. Both quantitative (Surber 1 ft^2) and qualitative (kick-net) samples were conducted at each site. The benthics sampled followed the results of the water quality sampling with the upstream sites revealing a diverse aquatic community (Figure 10) with numerous individuals represented by orders Ephemeroptera (Mayfly), Plecoptera (Stonefly), and Trichoptera (Casddisfly), indicating the relatively unpolluted nature of the system. Samples were collected during the 1994, 1995, and 1996 sampling seasons prior to final refuse pile removal. Benthic sampling conducted downstream of the refuse area documented the polluted nature of the aquatic system, with 2 to 4 taxa being collected. The total taxa collected at upstream areas in comparison ranged from 14 to 16 taxa. Once again, because of the extremely low flow conditions during the 1997 year, no post project benthic sampling could be conducted prior to this report. Further sampling will be conducted in the spring of 1998.

Although no fish sampling was conducted for the initial portion of this study, stations upstream and downstream will be sampled following complete stabilization of the site and associated water quality. It can be noted that within the stream and open water areas, fish have been seen with these appearing to be mostly minnow species. An experimental stocking was conducted by transferring pre-spawn bluegill *(Lepomis macrochirus)* into one of the open water areas. Follow-up surveys will be conducted.

Conclusions and Recommendations

1. This project demonstrated the benefits of cooperative efforts among a coal mining company (Power Operating Co., a large, central PA surface mining company) and several PA regulatory agencies including the Department of Environmental Protection, the Fish and Boat Commission and the Game Commission.
2. This project demonstrated the restoration to fishable quality of a previously polluted stream by means of removing its dominant source of pollution, an acid forming coal refuse pile.
3. Mitigation projects allowing mining of wetland areas can be designed and implemented in ways that accomplish a substantial net gain to the environment. Even though 1.7 ha (4.1 ac) of forested wetland were destroyed, 2.6 ha (6.5 ac) of replacement wetlands were created and an aesthetic eyesore was removed. A severe pollution source was removed, resulting in the recovery of 6.5 km (4.0 mi) of Whiteside Run.
4. Replacement wetland projects are particularly effective where original wetland soils are saved and then promptly placed at the site of the replacement wetland. Use of the original soils allows natural reseeding with indigenous wetland species. Also, proper siting of the replacement wetland in areas conducive to wetland development was a key factor in the success of this project.
5. An existing public safety hazard and aesthetic intrusion has been converted to wetlands and fish and wildlife habitat. This was accomplished while protecting adjacent wetlands, including a natural cranberry bog.
6. Abatement of pollution to Whiteside Run from mine drainage enhances the feasibility of other projects to improve local water quality, such as the funding of a sewer project for the adjacent communities of Ginter, Morann, and Whiteside. The flow from Whiteside Run itself will contribute to the improvement of the water quality of Moshannon Creek, a part of the Chesapeake Bay drainage system.

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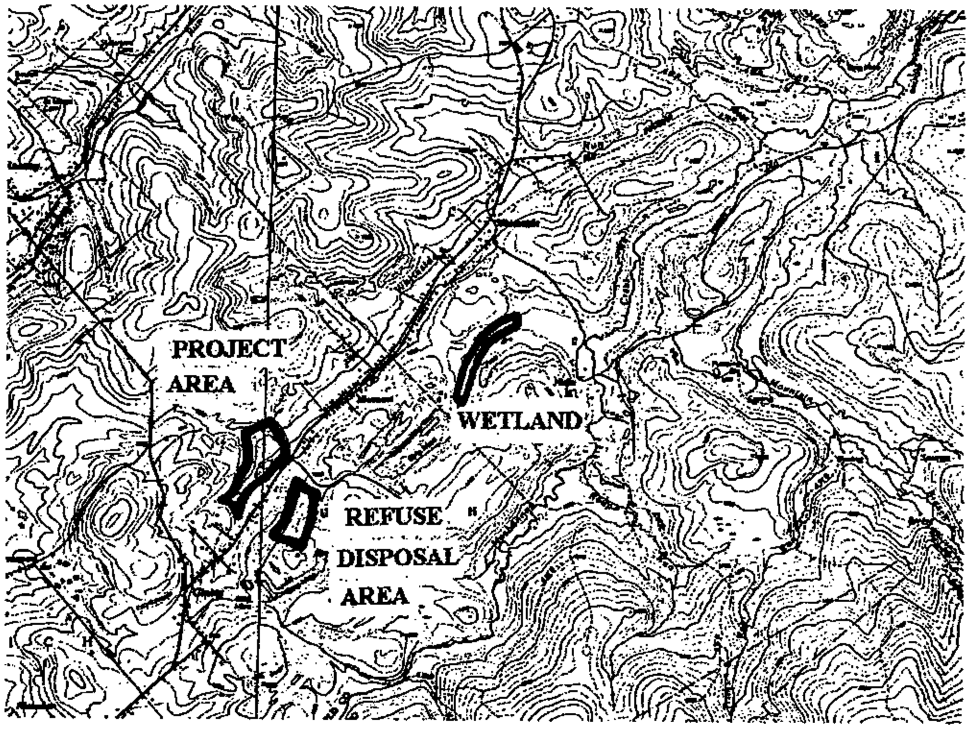

Figure 1: Watershed areas affected by the mitigation and restoration process

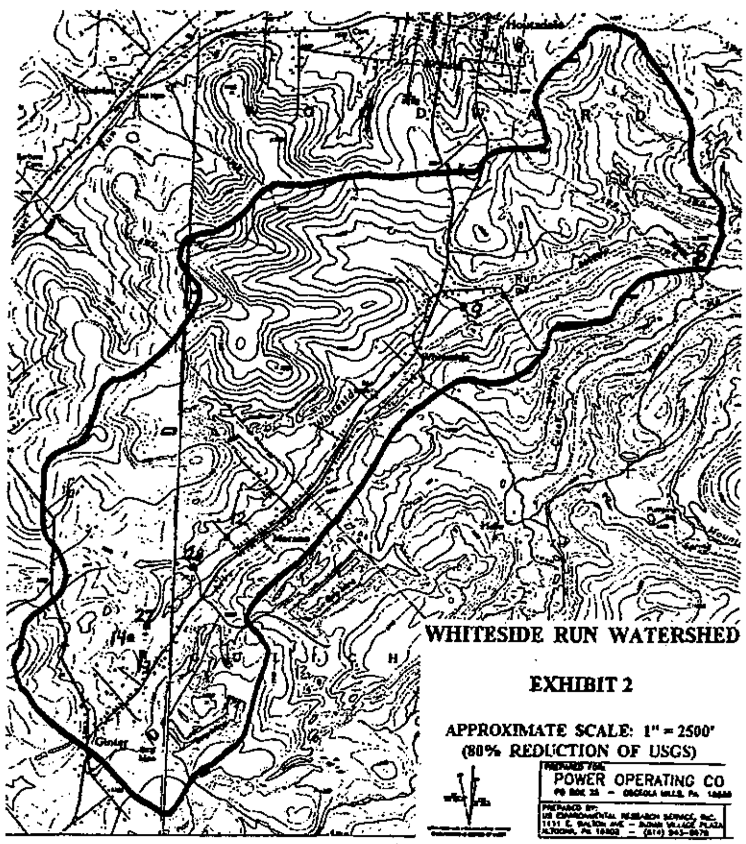

Figure 2: Whiteside Run water sample locations

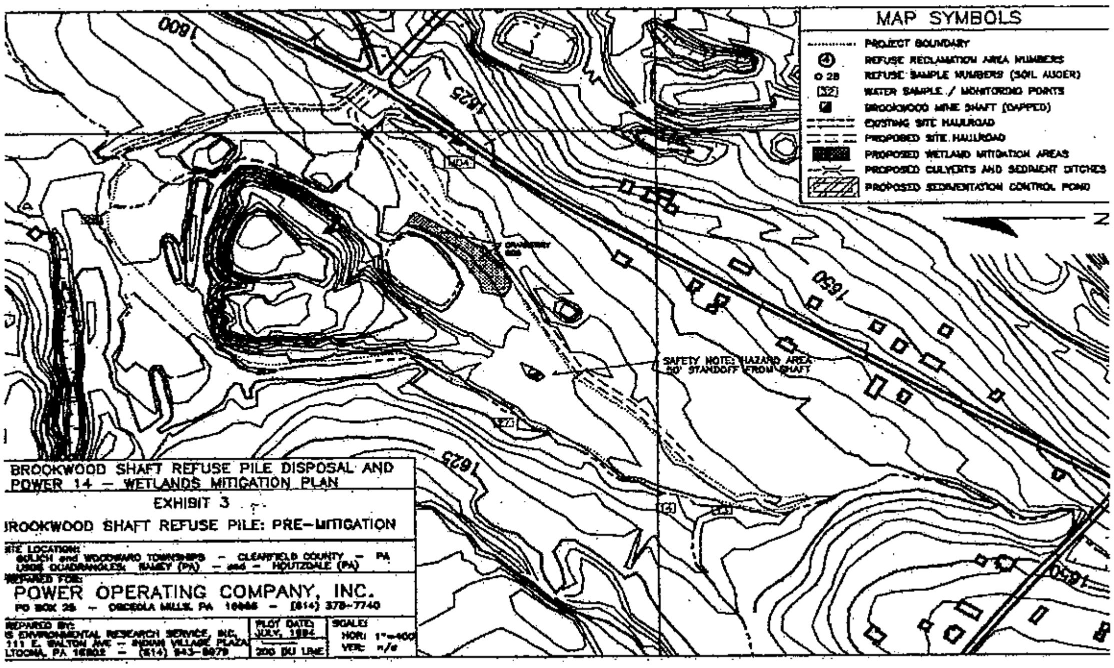

Figure 3: Refuse pile before project

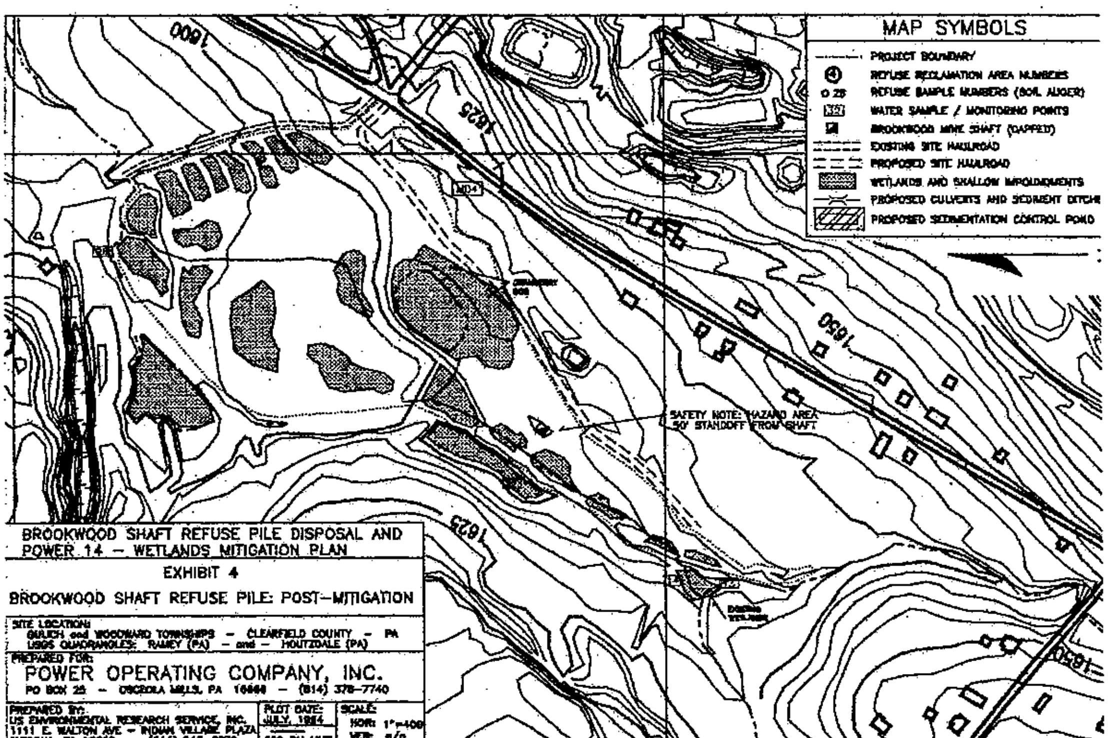

Figure 4: Refuse pile after project

Laboratory pH
Expressed in Standard Units

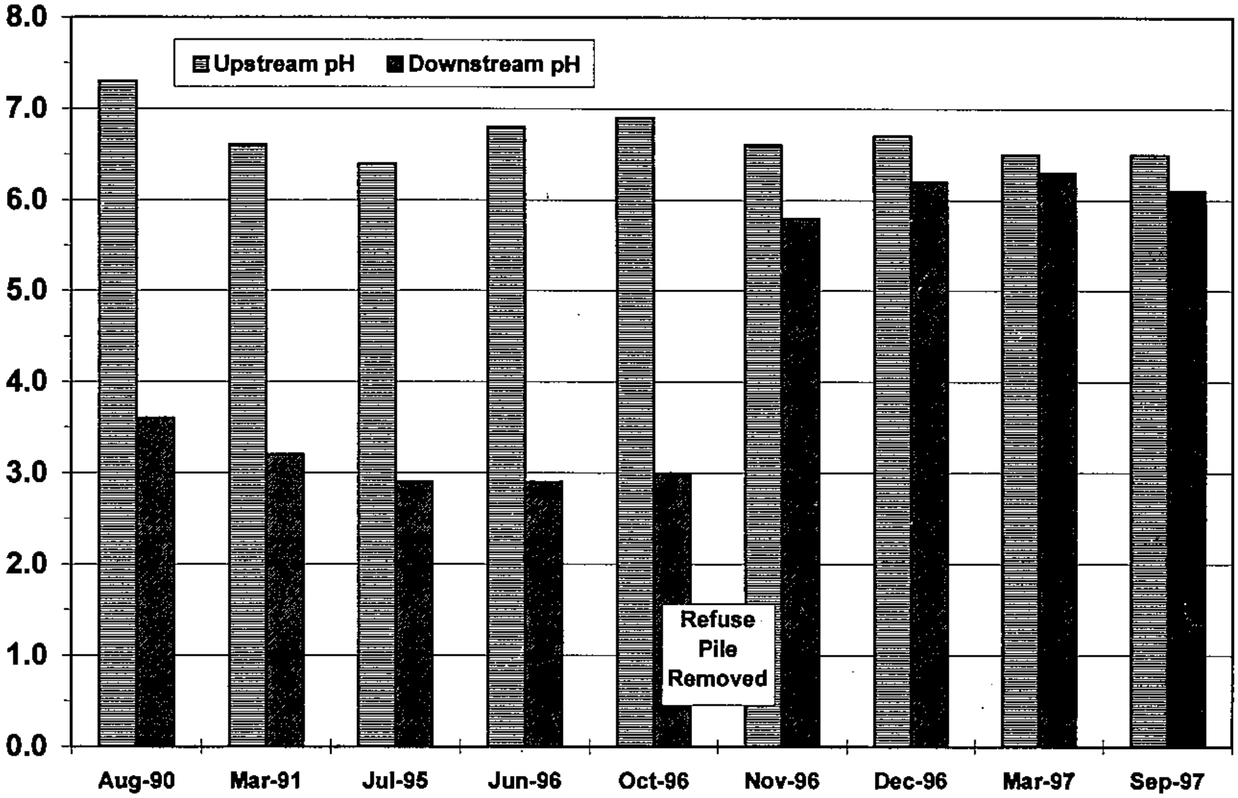

Figure 5

Net Alkalinity
Expressed in Standard Units

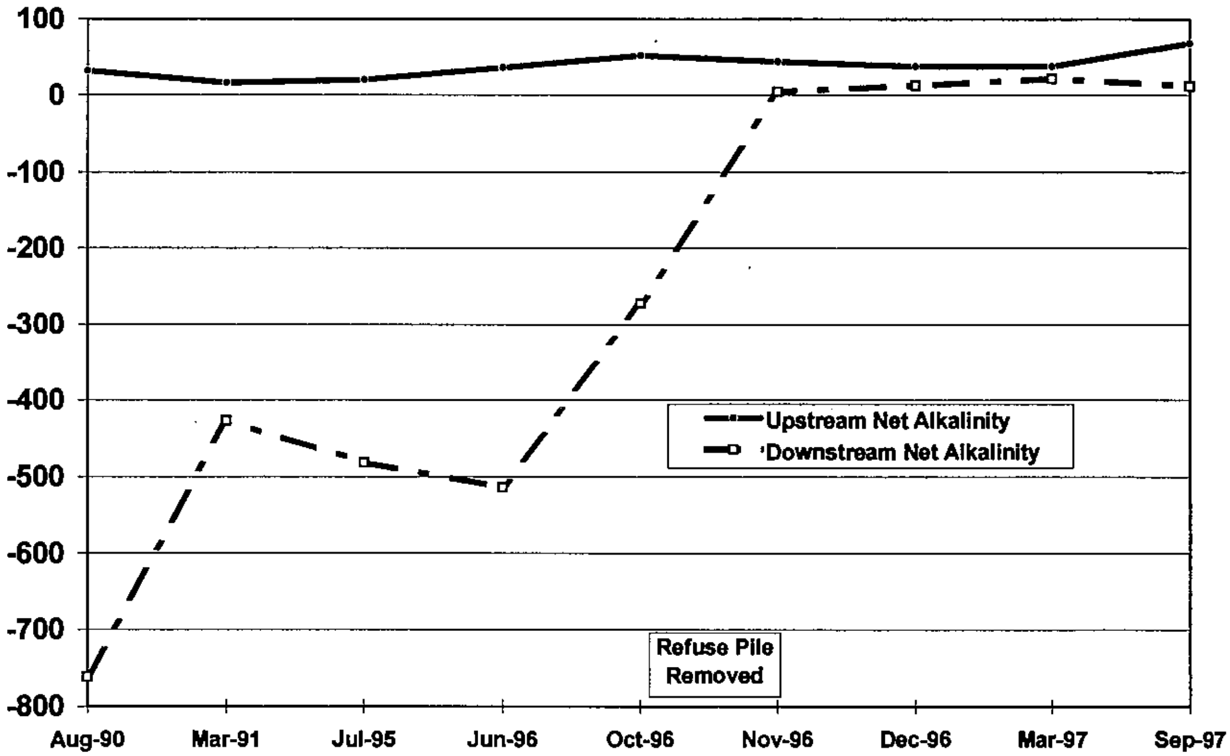

Figure 6

Iron Concentration
Expressed in milligrams per liter (mg/L)

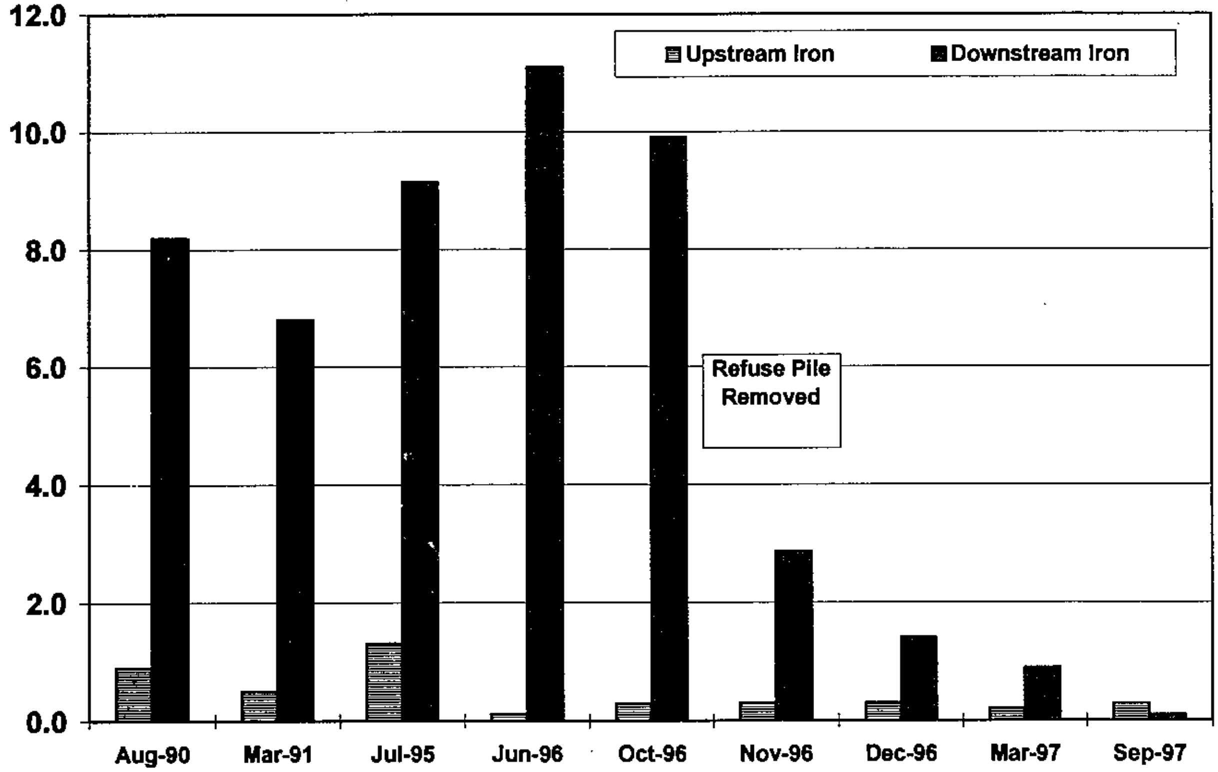

Figure 7

Manganese Concentration
Expressed in milligrams per liter (mg/L)

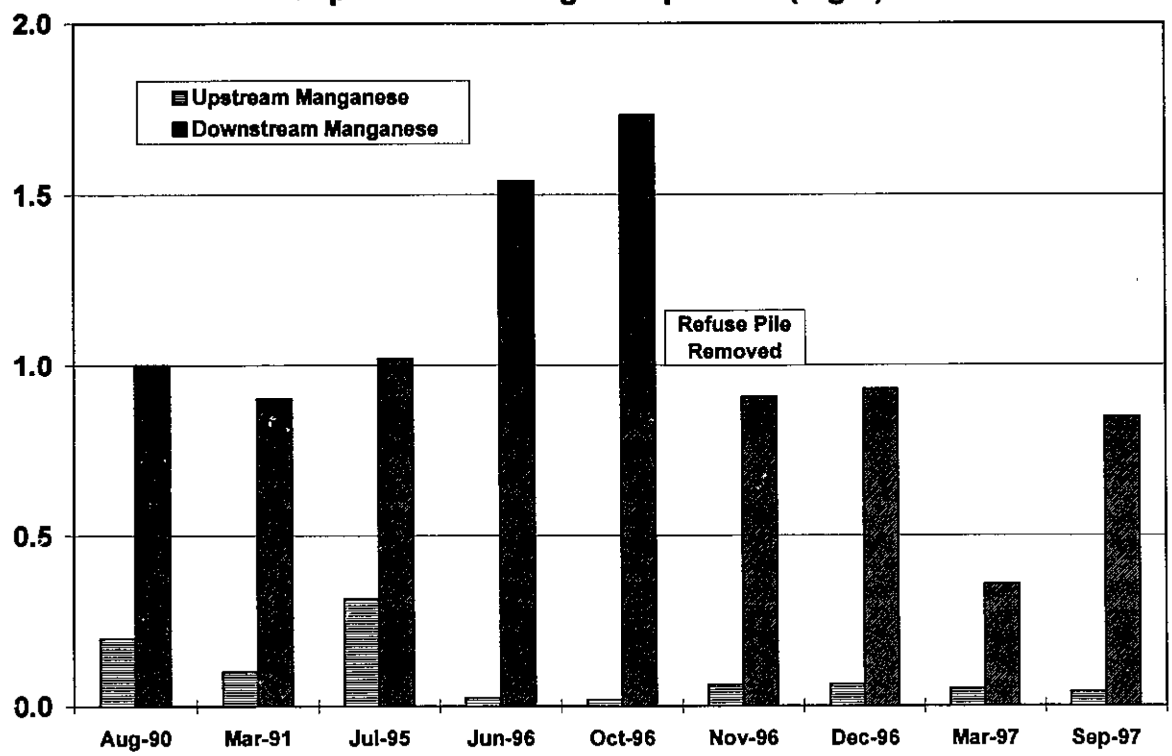

Figure 8

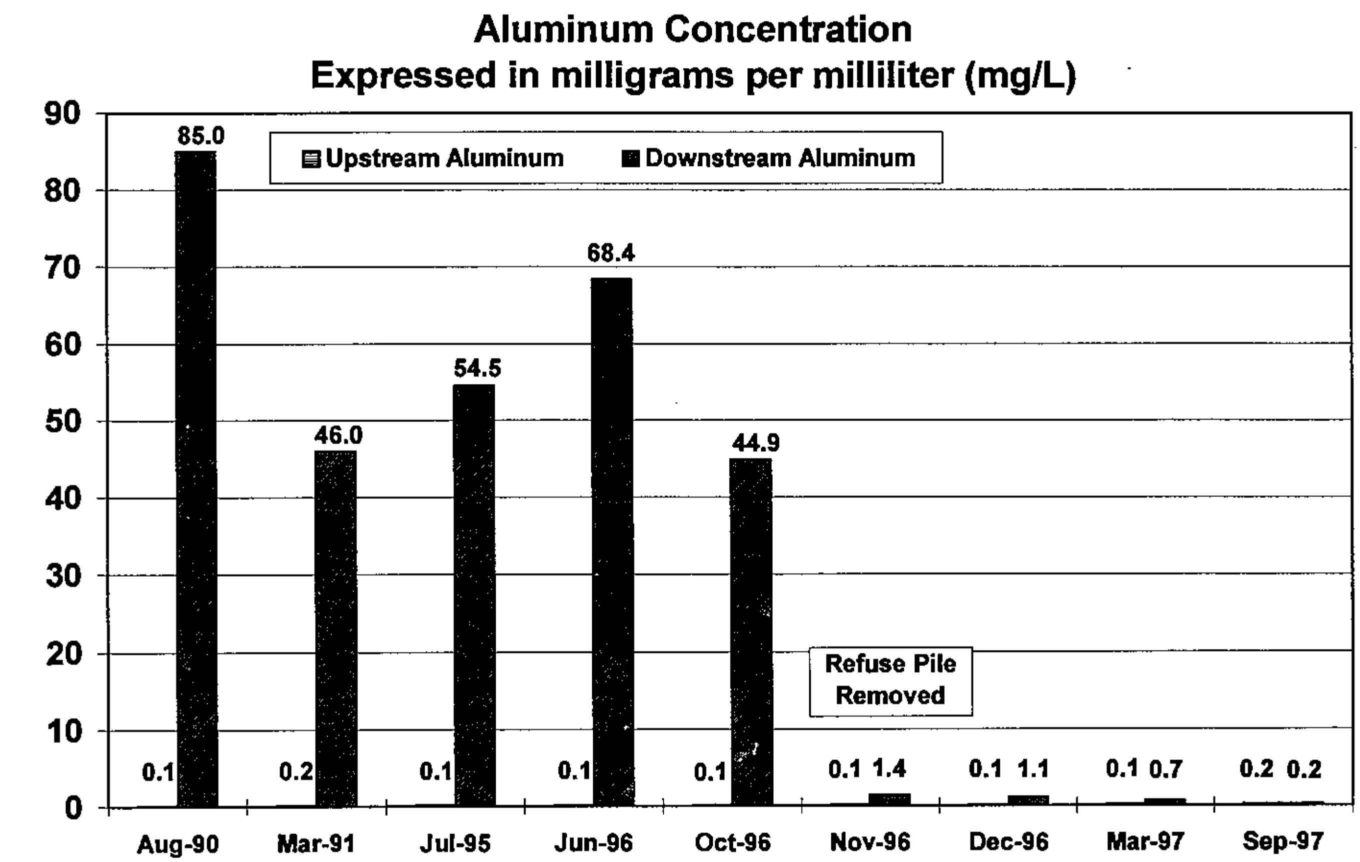

Figure 9

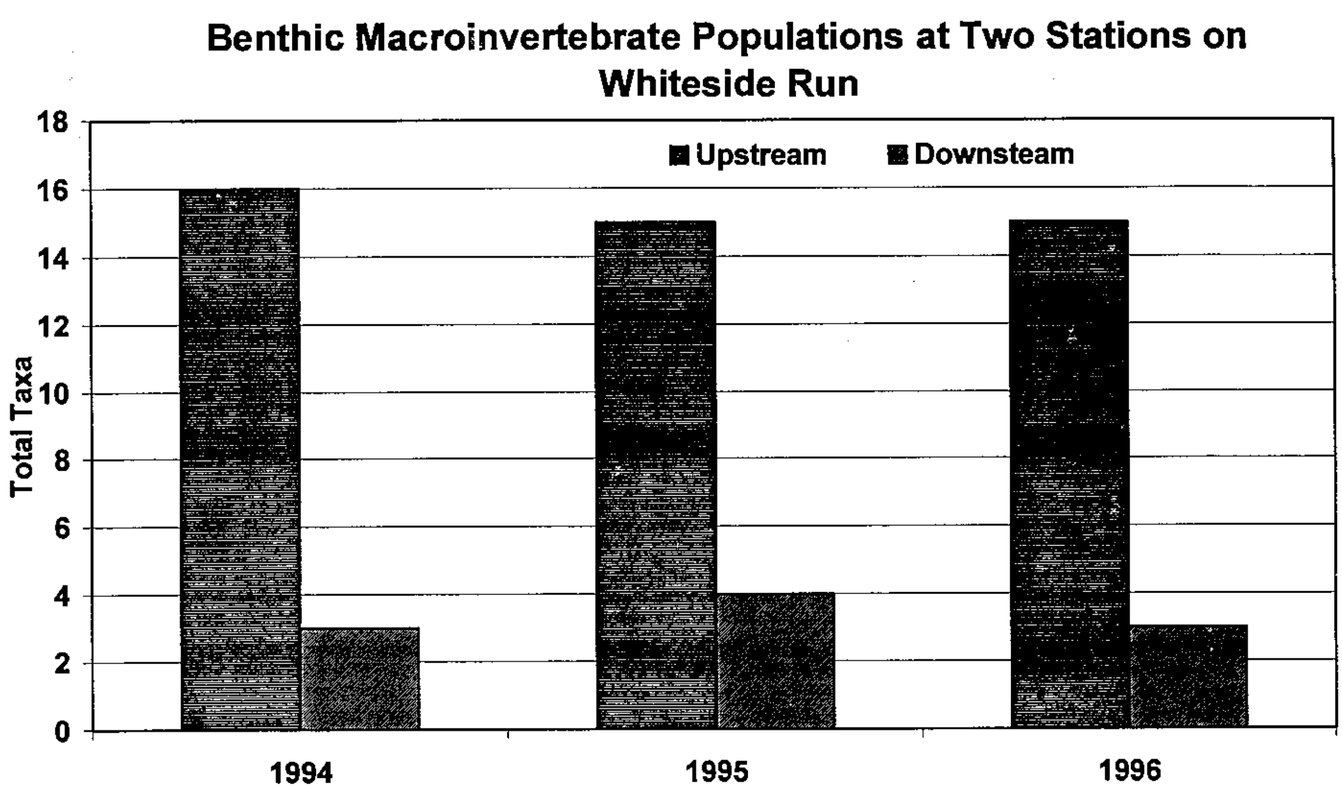

Figure 10