ESTABLISHMENT OF A VEGETATIVE COVER TO CONTROL ACIDIC DRAINAGE FROM COAL COMBUSTION WASTE[1]

C.D. Barton[2], D. Marx, D.C. Adriano, and H. Bartley

Abstract. The 488-D Ash Basin is an unlined containment basin that received ash and coal reject material from the operation of a powerhouse at the USDOE's Savannah River Site. The pyritic nature of the coal rejects has resulted in the formation of acidic drainage (AD), which has contributed to groundwater deterioration and threatens biota in down gradient wetlands. Establishment of a vegetative cover is being examined as a remedial alternative for reducing AD generation within this system. The low nutrient content, high acidity, and high salinity of the basin material, however, was prohibitive to plant survivability. As such, studies to identify suitable plant species and potential adaptations, and pretreatment techniques in the form of amendments, tilling, and/or chemical stabilization were needed. A randomized block design consisting of three subsurface treatments (blocks) and five duplicated surface amendments (treatments) was developed. The three blocks included: a) ripped and compost amended, b) ripped only, and c) control. Surface treatments were applied randomly to two 0.5-ha plots within each block. Treatments included: 1) 10-15 cm topsoil, 2) 10-15 cm bottom ash, 3) 10-15 cm flyash/wood mulch blend, 4) apatite (5 kg/ha), and 5) control. One hundred loblolly pines (*Pinus taeda)* inoculated with *Pisolithus tinctorius* (Pt) ecto-mycorrhizae were planted on each plot. Bahiagrass (*Paspalum notátum)* sprigs were also planted on half of the plots in duplicated 1-m^2 beds. After one growing season, seedling survival and growth was significantly greater in the ripped and amended block. Differences with respect to surface treatments were also evident. Topsoil and ash amended plots exhibited > 80% survival, while control plots showed over 75% mortality. Survival of the grass sprigs between blocks and among treatments was almost identical to that displayed by the seedlings.

Additional Key Words: pyrite oxidation, oxygen cover, mycorrhizal fungi.

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[1]Paper was presented at the 2002 National Meeting of the American Society of Mining and Reclamation, Lexington KY, June 9-13, 2002. Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502.

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https://doi.org/10.21000/JASMR02011019

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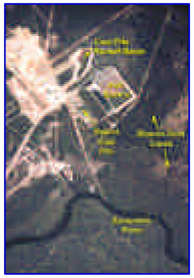
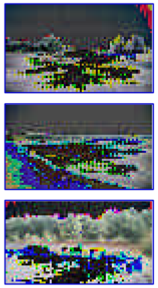


D-Area

INTRODUCTION

The 488-D Ash Basin is an unlined, earthen basin that contains approximately one million tons of dry ash and coal reject material at the U.S. Department of Energy's Savannah River Site. The pyritic nature of the coal rejects has resulted in the formation of acidic drainage (AD), which has contributed to groundwater deterioration and threatens biota in down gradient wetlands. Establishment of a vegetative cover is being examined as a remedial alternative for reducing AD generation within this system by enhancing the utilization of rainwater through evapotranspiration (FIG 1). The low nutrient content, high acidity (1:1 pH » 2.0), high salinity, and compacted nature of the basin material, however, required pretreatment in the form of amendments, tilling, and/or or chemical stabilization to fully maximize vegetation establishment and growth. As such, preliminary experiments were conducted to identify parameters that may lead to the successful deployment of a vegetative cover on the reject coal basin.



Reject Coal Basin

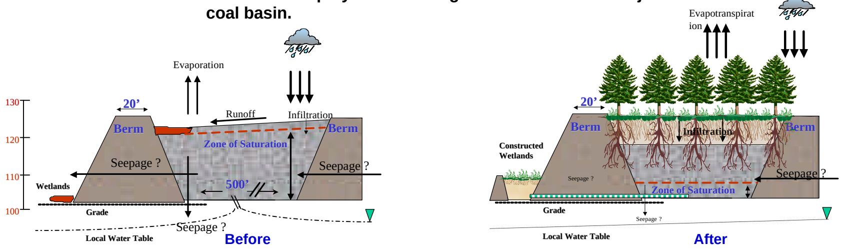


FIG 1. Conceptual Reclamation Plan

METHODOLOGY

A randomized block design consisting of three subsurface treatments (blocks) and five duplicated surface amendments (treatments) was developed. The three blocks included: a) ripped and compost amended (A), b) ripped only (B), and c) control (C). Surface treatments were applied randomly to two 0.5-ha plots within each block. Treatments included: 1) 10-15 cm topsoil, 2) 10-15 cm bottom ash, 3) 10-15 cm flyash/wood mulch blend, 4) apatite (5 kg/ha), and 5) control (FIG 2). One hundred *Pisolithus tinctorius (Pt)* inoculated loblolly pines (*Pinus taeda)* were planted on each plot. Bahiagrass (*Paspalum notátum)* sprigs were also planted on half of the plots in duplicated 1-m^2 beds.

Compost

Application

Ripping

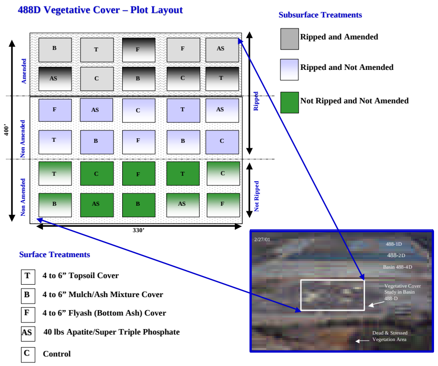


FIG 2. Plot Layout

RESULTS

Examination of the blocking effect on seedling survival (n = 1000 trees per block) revealed that block A exhibited the highest survival (70%) followed by blocks B (52%) and C (37%) (FIG 3). Growth characteristics of the loblolly seedlings within each block reveal a similar relationship, where plants from block A exhibited an elevated biomass and rooting volume over those from the other blocks (Table 1). Interestingly, the biomass of seedlings in block A was also elevated over those in a non-contaminated site with native soil. Infection of the seedling roots with *Pt* fungi contributed to enhanced survivability and growth on the basin.

Seedling surveys by surface treatment groups indicated that the ash and topsoil amendments greatly improved survivability on the basin (FIG 4). Mortality of less than 15% was exhibited in those treatments on blocks A and B. The apatite treatment was impressive in one plot on Block A with 97% survival, however, survival in blocks B and C did not differ significantly from that observed in the control. The mulch treatment exhibited the most consistent survival characteristics across the blocking units, varying less than 20% between blocks, and was the only treatment with a greater survival in block B than that observed in block A.

A grouping of the surface treatments across the three blocks (n = 600 seedlings per treatment group) indicated a similar scenario as discussed above (FIG 5). Comparing the treatment groups to surface pH revealed that the ash and topsoil plots were being maintained at levels consistent with, or slightly above, those of the native soils on the SRS (1:1 pH » 5.0). The apatite and control groups exhibited pH values in the 2 to 3 range, which was deleterious to plant growth and survival. The mulching treatment, on the other hand, exhibited a pH above 7.0. Although this pH level appears ideal given the preexisting conditions of the basin, some pines show developmental problems under alkaline soil conditions.

Survival of the grass sprigs between blocks was almost identical to that displayed by the seedlings (FIG 3). The effect of the surface treatments on grass survival were also very similar to that described for the seedlings (FIG 5). The one notable exception was the topsoil treatment where 100% survival was exhibited for all plots and blocks.

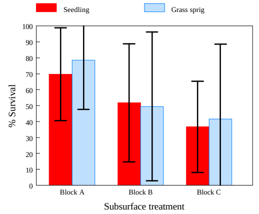


FIG 3. Survival x Block

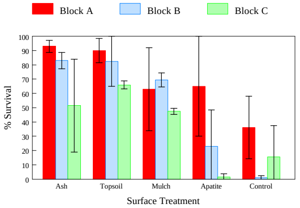


FIG 4. Survival x Treatment

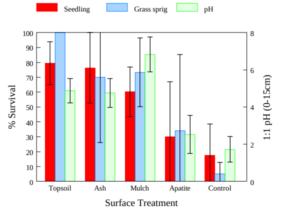


FIG 5. Survival x Block & Treatment vs. pH

CONCLUSION

Seedling (t = 8 months)

Preliminary results from the vegetation establishment study are encouraging. Ripping, amendments, and plant-root inoculation were essential for successful plant growth on the basin. Inferences to the role of vegetation on the basin's hydrology and surface chemistry are currently being examined. The use of monitoring wells, piezometers and time-domain-reflectometry allow us to examine changes in the basin's saturation state as the above-ground biomass expands. A sap flow system and an on-site weather station will be used to estimate evapotranspiration. Changes in water quality, as influenced by the soil amendments and litter layer development, are also being monitored.

Seedling roots (t =1 year)

Table 1. Mean growth characteristics from harvested seedlings (n=4).

Site	*Biomass (g)*	*Root Volume (ft^3)*	Inoculation Index (%)†		
			Pt	*Sc*	*Tt*
Block A	85.9	2.69	63	7	7
Block B	38.0	0.50	63	12	3
Block C	33.1	0.67	41	4	0
Native Soil*	18.7	1.27	3	8	0

†*Pt = Pisolithus tinctorius; Sc = Scleroderma cepa; Tt= Thelephora terrestris*
* planted in an uncontaminated area (n=2).

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