

Carbon Sequestration Surface Mine Lands

Quarterly Report

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ABSTRACT

An authorized budget was unavailable during this first 3-month working period of this project. Our ability to use the \$100K that DOE had dedicated to the project was frustrated by the internal problem of getting an account number issued to bill our expenses to. This has delayed the initiation of a portion of the tasks to be performed. However, enough has been accomplished to allow the project to meet the first years planting goals. This will also allow the initiation of several start-up activities that could not have been possible without established tree plantations.

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INTRODUCTION

Three demonstration areas will be established in the spring of 2003 to demonstrate low compaction surface mine reclamation techniques for high value tree production. One of the areas will be far eastern Kentucky, one in the vicinity of Hazard (near UK's research forest) and one in western Kentucky. Each area will contain approximately 50+ acres for a total of 150+ acres of new demonstration outdoor/classroom forests. The intent will be to establish half of the demonstration areas on fresh spoil that is loosely dumped using specific guidelines developed from over 30 years of research for the establishment of high value native tree species. The other half of the acreage will be on previously reclaimed land that is already compacted by the usual grading procedures. The compacted spoil will be mechanically ripped prior to planting. Favorable results have been achieved in Kentucky and surrounding states using various ripping methods. Ripping loosens the soil so that the tree roots can penetrate and produce a healthy tree.

The reclamation techniques involved in this demonstration preclude the initial development of herbaceous ground covers and there is a potential concern that reclamation without grass or protective cover may generate high off-site sediment loads thereby degrading streams. Water quality concerns are specifically addressed through a sediment control plan integrated with stream construction. While our previous research has shown that low compaction techniques did not generate significant off site sediments, a comprehensive water quality monitoring program will be established on the proposed demonstrations to verify and contrast runoff volume, peak flow, sediment concentration and sediment load among demonstration areas.

As the atmospheric concentration of carbon dioxide continues to rise, many scientists believe that there will be a concomitant rise in temperature. Research around the globe is addressing mechanisms by which we can reduce atmospheric concentrations of carbon dioxide. One mechanism that can offset carbon dioxide emissions is to sequester additional carbon in our terrestrial systems. Reclaimed mine lands provide an excellent opportunity to sequester carbon in both soils and vegetation because reclaimed areas are essentially devoid of carbon after reclamation. Through the planting of forests we expect to dramatically affect carbon processes on those sites leading to carbon accumulation in soils and in forest biomass. We will thoroughly investigate these processes on the newly established demonstration areas.

EXECUTIVE SUMMARY

At the time that the University of Kentucky was advised that the United States Department of Energy had approved the proposal for a research project entitled “Carbon Sequestration on Surface Mine Lands”, efforts were begun to notify cooperating land owners to expect to initiate the project on their properties. The securing of tree seedlings and tree planters was also started since the seedlings must be committed to in advance and the planters have to be scheduled.

Task 1.0 – Initiate staffing was not accomplished since an account number to access the budget was not approved until December 13, 2002, and all the research personnel were off for Christmas break until January 6, 2003.

Tasks 2.0 and 2.1 are complete for this year. the development of consent agreements to enter (2.2) and memorandums of understandings (2.3) are in process as are the development of site plans (3.0).

Base line data collection (4.0) will begin when weather permits. No permits require amendments for this years activities (task 5.0). Site preparation (6.0) is in process or complete. All areas will be ready for planting in February or March (task 7.0).

Monitoring (Tasks 8.0, 8.2, 8.3, 8.4, 8.5, and 8.6) will be a continuous activity beginning immediately after the tree planting has been accomplished. Wildlife habitat (8.7) will begin during the second year or one year after the trees were established. The economic analysis of carbon sequestration will begin after the first years trees have had one growing season and litter drop. Weather data monitoring (8.1) will begin as soon as two additional stations are purchased and installed. Budgets had to be approved prior to the authorization of these expenditures.

Project personnel (Richard Warner, Rick Sweigard, James Ringe and Don Graves) visited with US DOE personnel at Morgantown, WV on November 20 and 21 to discuss the planned research and present background data obtained from previous research. Additional scientific and industrial cooperators are being sought for future years activities.

EXPERIMENTAL

The study will take place in three distinct mining regions in Kentucky's eastern and western coalfields regions. Specific mining sites will be located in southeastern Kentucky near the West Virginia border, in southeastern Kentucky near Hazard and in western Kentucky.

Tree species selections are intended to provide a gradient of tree growth and litter quality. Candidate species include white ash, yellow poplar, and white pine although others are still being considered. Seedlings of each species will be planted in replicated plots on leveled loose-dumped spoil across all three sites. Spoil will be graded to a minimum depth of 3 m. The reforestation species will be established in both pure stands and in mixed-species plantings with the N-fixer, black locust. To control potential competition, black locust will be interplanted rather than direct seeded. Plots will be randomly located within an individual study block. Tree spacing, rate of black locust planting, plot size and number of replicates are still to be determined.

On a series of replicated randomized plots at each site we will vary leveled loose-dumped spoil depth with three treatments of spoil depth considered. Tentative depths are 0.5, 1.0, and 3.0 m. Tree spacing, black locust planting rate, replicates and plot size will be identical to the previous study.

At each site we will identify spoil types that vary in chemistry, mineralogy and possibly fragment size fractions. Sites in eastern Kentucky are dominated by acid sandstones and circumneutral shales. Sites in western Kentucky are dominated by circumneutral shales and siltstones. We plan to work with the mining operators to isolate the dominant geologic strata at a particular site and loose dump those materials separately.

As in the previous study, spoil depth will be a minimum of 3 m. Tree spacing, black locust planting rate, replicates and plot size will be identical to the previous studies. Blocks will be composed of similar spoil with replicates within blocks.

The methods are designed to measure treatment effects on aboveground and belowground C and nitrogen (N) pools and fluxes for the individual studies. It is critical to assess N cycling because of the influence N has on C cycling through litter quality inputs and soil development. Because the C cycle will be measured in each study, methods will be similar among studies. All sites will be instrumented with a weather station that will measure precipitation volume, temperature, relative humidity, wind speed and direction and solar radiation. The weather station will be centrally located among plots within each site.

Seedling height and diameter will be measured at planting and on annual basis for the duration of the project (a minimum of five years). Notes will be taken on seedling health, vigor, growth form and level of herbivory. Aboveground seedling biomass production will be estimated with allometric equations developed for individual species. Plots will be planted with enough seedlings so that some trees can be sacrificed for the analysis of C and N in stems, branches and roots. Clip plots will be used to measure herbaceous production with subsamples used to determine total C and N.

Litterfall biomass will be measured annually with litterfall traps. Forest floor biomass will also be measured annually as it develops over time. Litter and forest floor samples will be periodically analyzed for total C and N. Litter-bags will be used to measure litter decomposition rates for individual species and for the various combinations of species.

Soil characterization for chemical and physical properties and mineralogical

composition will be conducted prior to implementing treatments and periodically throughout the duration of each study. Soil C and N will be measured on each plot prior to implementing treatments and once per year for the duration of each study. Soil C and N will be measured on the bulk soil as well as on the aggregate level to determine the extent that C is being physically protected as the soils develop. Root biomass will be measured with sequential soil coring over an annual cycle. Root turnover rates are extremely difficult to quantify and will not be conducted in these studies. With sequential root biomass measures we will get an estimate of overall root production over time.

Carbon dioxide efflux resulting from C mineralization in the soil will be measured seasonally on each plot with a portable infrared gas analyzer. *In situ* incubations will be used to assess N mineralization rates within treatments. Soil C mineralization includes CO₂ effluxes from both root and microbial respiration. Greenhouse studies using soil with and without plants (roots) will be used to separate the influence of roots and microbial communities on field CO₂ efflux rates.

Bulk precipitation collectors will be used to collect incoming precipitation and dry deposition for analysis of total organic carbon (TOC). Suction-cup samplers placed below the rooting depth will be used to sample soil water for C (TOC) leaching from the system. Time domain reflectometry will be used to measure soil moisture at various depths to both characterize soil moisture conditions within plots and to allow us to calculate water flux through the soil profile.

Experimental methods may be modified as necessary after the project is established. There may be special situations that may require consideration as the trees begin to develop.

RESULTS AND DISCUSSION

No data at this time to present

CONCLUSION

No conclusions can be presented for the first three months of this grant since no action has been taken.

REFERENCES

None

BIBLIOGRAPHY

None

LIST OF ACRONYMS AND ABBREVIATIONS

None

APPENDICES

None