FACT SHEET FOR PARTNERSHIP FIELD VALIDATION TEST

Midwest Regional Carbon Sequestration Partnership (MRCSP)

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Terrestrial Sequestration Field Test: Reclaimed Minelands

Test Location: Various reclaimed mineland plots in West Virginia

Amount and Source of CO2: Not applicable due to this being a terrestrial field test to determine and validate rates of sequestration under different reclamation conditions.

Field Test Partners: West Virginia University

Summary of Field Test Site and Operations:

Soil samples from five mine sites in Monongalia County, West Virginia are being analyzed to satisfy the objective of assess soil carbon accumulation in mine sites reclaimed to grass and legumes. The Waynesburg coal seams for all five mine sites were contour mined beginning as early as 1982 and as late as 2007 using front end loaders. Mining operations ceased at different times for each of the sites (1990, 1998, 2000, 2005, and 2007. Overburden material placed on the disturbed land consisted of 70 to 80% sandstone with shale making up the remaining 20 to 30% of material. Three of the sites were backfilled with three inches of topsoil material, while the fourth site was backfilled with eight inches of topsoil. All sites used grass/legume mixes to reclaim the disturbed land

Research Objectives:

Reclaimed mine sites planted to trees, grasses, or legumes provide opportunities for removing CO_2 from the atmosphere through carbon accumulation in soils and above-ground biomass. The overall objective of this project is to estimate the amount of soil carbon that may be stored in mine sites reclaimed to grass and/or legumes. Soil samples from multiple mine sites where mining activities ended at different times are being

collected to assess the change in soil carbon over time. A mine site where reclamation activities just began is being used to assess the soil carbon content at the beginning of reclamation activities to establish baseline soil carbon content for reclaimed mine sites. This information, combined with soil samples collected from the same site over time, enhances estimates of the amount of carbon dioxide emissions that may be offset through the storage to be computed.

A second objective is to perform economic analyses to assess the tradeoffs between existing land management activities and those that enhance carbon sequestration. For reclaimed mine sites, the economic analysis entails estimating the difference in soil C accumulation rates in soils on sites reclaimed to grass/legumes and forest. Forests capture C in both aboveground (biomass) and belowground (soil) systems. The overall objective is to assess the economic viability of using the C accumulation on reclaimed mine sites as a greenhouse gas mitigation activity. Specifically, the soil C stocks and rates of change data collected on mine sites will serve as a baseline against which estimates of potential C accumulation in forests on reclaimed mine sites is compared. Results of these analyses may be used to provide information necessary for developing carbon trading schemes.

Summary of Modeling and MMV Efforts:

Measurement Technique	Measurement Parameters	Application
Dry combustion - LECO	Total Organic Carbon (%) Total Nitrogen (%)	Measure soil carbon and nitrogen content
Dry combustion - Loss on Ignition	Total Organic Matter (%)	Measure soil organic matter that is then adjusted by the soil bulk density to estimate soil organic carbon content
Flow Injection Analysis	Extractable nitrate and ammonia	Measure soil nitrate and ammonia content to assess availability for biomass production

Accomplishments to Date:

- Assessed the statistical variability in measured soil carbon from four mine sites in WV to aid in design of a rigorous and statistically viable sampling scheme that will maximize the information gathered with the minimum number of soil sample collections.

- Collected 918 soil samples from five reclaimed mine sites samples from 0-6 and 6-12 cm depth intervals from five reclaimed mine sites along a diagonal transect (for 2006-sampling year) and irregular grids (for 2007 & 2008-sampling years) for each terrain

from mine sites that were reclaimed in different years. Annual soil sampling from the same mine sites are continuing.

- Total carbon (C) and nitrogen (N) concentrations have been measured for 758 of the collected soil samples, and work is continuing to analyze the remaining soil samples that have already been collected in 2008. The process involves estimation of the *minimum* number of samples necessary to characterize and capture spatial variability of soil bulk density in these 'intensely heterogeneous' soils. The outcome is being used to assess the importance of volume based relative to concentration (%) based SOC-sequestration rates in chronosequence-based SOC-sequestration studies such as this one.

- Bulk density measurements estimated for the soil samples collected from the recently reclaimed mine site (WV01) and the Skousen (WVSK), Dent's Run, Mylan Park, and New Hill reclaimed mine sites are complete for 421 soil samples.

- Selective dissolution techniques to separate recalcitrant and/or labile soil organic carbon (SOC) have been implemented on a subset of soil samples collected from the Mylan Park, WVSK, New Hill and the newest reclaimed mine site, WV01 (25 soil samples from each reclaimed mine site were analyzed).

- Investigated carbohydrate types and contents in these reclaimed mined lands in order to gain insights into soil quality and 'freshness' (100 samples from 2007-sampling). Carbohydrates offer efficient building bridges between soil aggregates and in turn facilitate development of better soil structure.

- Implemented analyses using UV-Vis (ultraviolet-visible spectroscopic) and Fluorescence spectroscopic methods to understand degree of humification of soil organic carbon (SOC) molecules in order to gain an insight into SOC sequestration potentials of reclaimed mine soils. In general, the greater the degree of humification, the greater the aromatic nature and degree of substitution, the greater the stabilization of SOC and therefore potential for SOC sequestration on reclaimed mine land. To date, these analyses have been completed for a subset of soil samples collected from Mylan Park, WVSK, New Hill, and WV01 (25 soil samples from each reclaimed mine site).

- Implemented analyses using FT-IR (Fourier Transform Infrared) Spectroscopy to investigate the types of principal functional groups attached to the SOC molecules. This analyses is conducted because the presence of different groups hold the key to interaction of SOC with soil mineral matter (mineralogically stabilizes SOC pools) as well as biochemical recalcitrant nature of SOC. Treatments were compared with the control in order to ascertain the effects of removal of chemical moieties affected by the treatments as a key to understand SOC dynamics. To date, analyses have been completed for a subset of soil samples collected from Mylan Park, WVSK, New Hill, and WV01 (25 soil samples from each reclaimed mine site were selected).

- Estimated the Total Organic Matter (TOM) content from total of 524 soil samples when all three replications from each sampling site are included.

- Estimated nitrate (NO_3) content of 524 soil samples from two different depths.

- Obtained mining permit data documenting the area (acres) and date reclaimed mine sites in West Virginia satisfied Phase 1 (re-contouring), Phase 2 (vegetative cover established to control for soil erosion), and Phase 3 (vegetative cover density satisfies bond requirements – fifth year after reclamation). Entered 544 WV mining permit records into a database to aid in calculating the probability of an operator completing reclamation within the 5 year time span.

- Participated in the 2007 Mined Land Reforestation Conference hosted by Appalachian Regional Reforestation Initiative (ARRI) in Abingdon, Virginia to enhance our knowledge of proper techniques for reforestation activities on reclaimed mine lands.

- Developed carbon sequestration rate estimates that result from forestry activities using the US DOE 1605(b) report and the Carbon On-Line Estimator (COLE). These were combined with economic parameters to estimate the minimum carbon price required to encourage forestry as a mine reclamation activity.

- Used the estimates of the potential costs savings from reclamation with the Forest Reclamation Approach (FRA) recommended by Appalachian Regional Reforestation Initiative (ARRI) to develop a map of the minimum carbon prices necessary to encourage reforestation in the MRCSP research region.

- Presented preliminary results of different soil sample analysis at four different conferences. The presentations addressed a comparison of results from two mined sites, the mineral association and biological recalcitrance of SOC in reclaimed mine soils, the structural diversity of SOC in reclaimed mine soils, and the importance of bulk density to estimate carbon sequestration potential in reclaimed mine soils.

- Presented a selected paper at the Association of Resource and Environmental Economist Annual Meetings in Portland, OR. The presentation addressed the results of efforts to assess the increase in carbon that can be sequestered in the MRCSP Region through landowner adoption of reclamation practices that enhance forest productivity. The paper also assessed the economic consequences of adopting the Appalachian Regional Reforestation Initiative (ARRI) reclamation recommendations.

Summarize Target Sink Storage Opportunities and Benefits to the Region:

- The results of these analyses may be applied to most of the 576 thousand hectares of land permitted for mining activities in the MRCSP region where the predominant reclamation activity is grass/legumes (approximately 95% of reclaimed mineland is planted to grass/legume).

- It is expected that reclaimed mine land in the MRCSP region may store 11 – 22 million metric tons of carbon (40 – 81 million metric tons of carbon dioxide equivalents) over twenty years.

- The disturbed soil that results from mining activities may not absorb rainfall as well as undisturbed sites, resulting in increased soil erosion. Planting grass/legumes on reclaimed mine sites, in addition to storing soil carbon, also reduces soil erosion. This erosion reduction benefits nearby streams, lakes, and other waterways that may contain fish and other wildlife.

- Improved wildlife habitat: Reclaimed mine sites provided additional cover and food sources for wildlife that may not otherwise be available.

- As carbon markets become more fully developed, the stored carbon may be sold as a carbon dioxide offset, which will earn additional income for landowners. This is particularly critical in the Appalachian region where incomes are depressed.

Cost*:

Total Project Cost: $23,745,399

DOE Share: $17,458,272 (73.52%)

Non-Doe Share: $6,287,127 (26.48%)

(*) Costs are for overall MRCSP Phase II project