Proceedings of the

MARKET-BASED APPROACHES TO MINED LAND RECLAMATION & REFORESTATION: A TECHNICAL INTERACTIVE FORUM

Drawbridge Inn and Conference Center
Fort Mitchell, Kentucky
May 15 - 16, 2002

Edited by:
Kimery C. Vories
Dianne Throgmorton

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Contents

The Office of Surface Mining's Reforestation Initiative xiii
Mary Josie Blanchard, USDOI Office of Surface Mining, Washington, D.C.
Please note. The OSM Reforestation Initiative is no longer active. This paper is for historical purposes only.

Steering Committee Members ixx

Reforestation Steering Committee Recommendations xxii

What is a Technical Interactive Forum? .....
Kimery C. Vories, USDOI Office of Surface Mining, Alton, Illinois

Session 1: MARKET-BASED APPROACHES TO MINED LAND RECLAMATION
Chairpersons: Dr. Sarah Donnelly, OSM, Washington, D.C. and Sid Stroud, TXU, Dallas, Texas

The Administration's Global Climate Change Initiatives and Enhanced Opportunities for Carbon Sequestration on Mined Lands .....
Bob Kane, DOE, Climate Challenge Program, Washington, D.C. and Daniel Klein, 21st Strategies Inc., McLean, Virginia
Market-Based Case Studies Involving Eco-Asset Management on Non-Mined Lands .....
Doug Lashley, Greenvest, Cherry Hill, New Jersey
Incentives for Utilities to Invest in Reforestation – Limestone Run Project .....
Larry Myers, Allegheny Energy, Monroeville, Pennsylvania
The OSM/DOE/EPRI Joint Initiative on Market-Based Land Reclamation: Education and Outreach Efforts .....
Craig Diamond, Electric Power Research Institute, Palo Alto, California
Western Pennsylvania Watershed Protection Program .....
John Dawes, Western Pennsylvania Watershed Protection, Alexandria, Pennsylvania
Forest Product Trends and Legislative Initiatives .....
Ron Hufford, Texas Forestry Association, Lufkin, Texas
Enhancement of Terrestrial Carbon Sinks through Reclamation of Abandoned Mine Land in the Appalachian Region .....
Dr. Gary D. Kronrad, Ching-Hsun Huang, and Richard Bates, Arthur Temple College of Forestry, Stephen F. Austin State University, Nacogdoches, Texas
Application of an Eco-Asset Model at the TXU Monticello Mine .....
Gordon Hester, Electric Power Research Institute, Palo Alton, California; Stephen Smith and Carl Ivy, TXU, Dallas, Texas

Session 2: MARKET-BASED ECONOMIC AND MANAGEMENT CONSIDERATIONS
Chairperson: Dr. James Burger, Virginia Polytechnic and State University, Blacksburg, Virginia

Factors Affecting the Success of a Forestry Business Enterprise .....
Dr. Thomas R. Fox, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

The Regulatory Framework for Reclaiming Mine Land: Considerations for Forestry.....
Bradley Lambert and Benny Wampler, Virginia Department of Mines,Minerals, and Energy, Big Stone Gap, Virginia
Reforestation on AML and Bond-Released Grassland .....
John Sprouse, Ohio Department of Natural Resources, Division of Minerals Resources Management, Cambridge, Ohio
Reclamation Costs/Benefits for AREA MINING: Overburden Placement, Grading, Site Preparation, Reforestation, and Management .....
Bryce West, Bruce Evans, and Phil Leibering, Black Beauty Coal, Evansville, Indiana
Long Term Research to Develop Soil Handling Requirements for Reforestation of Large Scale Surface Mines in West Virginia .....
Laurence Emerson, Arch Coal, Inc., Huntington, West Virginia; Dr. Paul Ziemkiewicz and Dr. Jeff Skousen, National Mined Land Reclamation Center, West Virginia University, Morgantown, West Virginia
Achieving Forestry Goals on Mined Land: Mined Site Condition, Species Composition, and Stand Development of Economically Viable Hardwood Forest .....
Dr. James Burger, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

Session 3: REFORESTATION SUCCESS STORIES
Chairperson: Vic Davis, OSM, Knoxville, Tennessee

Forest Productivity and Values of Pre-SMCRA Mined Land.....
Jason Rodrigue, Bradford Ranger District, Allegheny Forest, USDA Forest Service, Bradford, Pennsylvania and Dr. James Burger, Virginia Polytechnic Institute and State University, Blacksburg, Virginia
Alabama's Reforestation of Abandoned Mine Lands .....
William C. Guyette and Walter E. Cartwright, Alabama Department of Industrial Relations, Abandoned Mine Land Reclamation Program, Montgomery,Alabama

Where Do We Go From Here? .....
Forum Participant Recommendations

Survey Results .....
Participant Statistics, Comments, and Individual Recommendations

Appendix 1: Recorded Discussions.....
Edited by Kimery C. Vories, USDI Office of Surface Mining, Alton, Illinois

Participants List.....
Addresses and Phone Numbers

Please note. The OSM Reforestation Initiative is no longer active. This paper is for historical purposes only.

THE OFFICE OF SURFACE MINING'S REFORESTATION INITIATIVE

Mary Josie Blanchard
Office of Surface Mining
Washington, D.C.

The Office of Surface Mining (OSM) is very interested in the concept of Eco-assets because it introduces addition benefits that have not previously been explored. Sound reclamation is a multi-faceted process involving a wide variety of people and interests. The people at this forum come from a broad range of interests representing State reclamation and forestry programs, land owners, environmental and community groups, mine operators, utilities, forest industries, academia, and Federal agencies.

The Mission of OSM

My objective here is to review the activities and accomplishments of OSM to date in the area of promoting reforestation of mined lands. I will begin by briefly describing the two major missions of OSM. In the creation of the Surface Mining Control and Reclamation Act (SMCRA), congress attempted to balance the need for a stable national coal supply with need to protect the public and the environment from the adverse affects of surface coal mining. It was the first Federal law that dealt specifically with coal. It has a program that provides funds for the reclamation of lands abandoned prior to the passage of the law in 1977 and a program for regulating active mining after 1977 to ensure that mining and reclamation proceed in an environmentally sound manner.

Recently, OSM has been looking for creative ways to promote partnerships that would increase the amount and quality of land reclaimed. Several initiatives that are active in this area include:

- the Clean Streams Initiative,
- a remining program,
- an acid drainage technology initiative,
- working the EPA on Brownfields in the coal fields to provide additional funding for reclamation, and
- working with Vista volunteers.

OSM's Reforestation Initiative

OSM's work with the reforestation initiative compliments the OSM mission by enhancing land and water quality and increasing economic benefits. The benefits of reforestation include:

- improving wildlife habitat and recreation opportunities,
- restoration of clean water resources,
- erosion prevention,
- carbon sequestration, and
- the creation of new economies based on forest products.

The Reforestation Initiative compliments OSM's abandoned mine land reclamation program. Since 1977, over 200,000 acres of abandoned mine land have been reclaimed leaving about 400,000 acres still in need of reclamation. An important goal of this reforestation effort is to look at how we can increase reforestation at a lower cost to the taxpayer. Primarily the States and Tribes do this work. OSM is looking for ways to encourage more reforestation efforts by expanding the participants such as the utilities and other organizations that could work in this area.

A survey in 1999 found that about 50 million trees had been planted on AML lands and about 500 million trees had been planted on SMCRA permitted sites. OSM's goal with the Reforestation Initiative is to increase the pace by encouraging new programs like eco-asset management. OSM has had numerous outreach efforts beginning with Earth Day of 1998 to promote reforestation. OSM is promoting the market-based approach to reforestation of mine lands to improve the development of more and better carbon sinks.

The primary activities and accomplishments of OSM in this area have been to:

- OSM signed an MOU with the Wildlife Habitat Council to encourage the reforestation and wetland establishment of AEP land in Ohio in October of 1998;
- conduct a Policy Outreach Symposium in Washington D.C., January 14, 1999, that provided clarification on current OSM regulations and policy on tree planting;
- conducted a Technical Interactive Forum with published proceedings March 23 & 24, 1999, to: (a) highlight information on successful reforestation efforts and technologies that are currently being used to enhance reforestation on active and abandoned coal mined lands, (b) identify region specific impediments to tree planting, and (c) review recommendations for removing unnecessary barriers to tree planting and promoting technologies with potential for enhancing tree planting efforts;
- conducted a public outreach to assess and make recommendations on potential revisions to OSM/State policy and regulations;
- the OSM director wrote a letter inviting individual State programs pursue public/private partnerships promoting reforestation and offered OSM technical assistance to any of these programs to develop a State specific Reforestation Team that could develop a plan for improving reforestation efforts in the fall of 1999;
- provide access to reforestation information, organizations, and services through an OSM Website;
- develop an annotated bibliography of Reforestation and Mining Publications,
- signed a Memorandum of Understanding with the U.S. Department of Energy to promote a market-based approach to reclaiming abandoned mined lands through reforestation;
- promote the communication of reforestation success stories through informational brochures and videos, and
- in January of 2001, began planning for the current technical interactive forum on "Market-Based Approaches to Mined Land Reclamation and Reforestation."

One of the things that OSM has consistently asked stakeholders during these outreach efforts was "Please identify any of the current OSM regulations that provide an impediment to reforestation?" An analysis of the responses by the OSM revegetation team, determined that most of the perceived regulatory impediments to reforestation were more a matter of interpretation rather than the actual language of the OSM regulations.

Promoting Carbon Sequestration

Specific OSM efforts related to promoting the reforestation of AML lands as carbon sinks include:

- October of 1999, OSM met the DOE Office of Fossil Energy and TXU to discuss the use of market-based incentives and public/private partnerships to encourage the reclamation of AML lands and increase of carbon sequestration through reforestation;
- In December of 1999, OSM met with DOE and researchers from Stephen F. Austin University where it was demonstrated that carbon sequestration on managed forests was 2 to 3 times greater on managed versus unmanaged forests;
- in March of 2000, during a meeting with OSM, DOE, conservation groups, miners, and utilities the Western Pennsylvania Watershed Protection Foundation volunteered to sponsor the first pilot project and develop an outreach packet;
- in the summer of 2000, OSM discussed with DOE the possibility of pilot projects with Allegheny Energy and Pennsylvania AML program;
- in June of 2000, OSM visited the AML reforestation sites in Ohio and met with the Ohio AML program and the American Electric Power staff to discuss potential projects;
- in September of 2000, the Secretaries of Interior and Energy signed an MOU that established a framework for cooperation between the two agencies for developing a market-based approach to the reclamation of AML lands through reforestation;
- in March of 2001, OSM met with the Electric Power Research Institute to discuss partnerships to encourage reforestation;
- in May of 2001, OSM attended a dedication ceremony at the Allegheny Energy Limestone Run revegetation project developed under the Interior MOU with Department of Energy where 7,000 trees native grasses had been planted on AML land;
- in October of 2001, OSM held a stakeholder outreach meeting to determine if there was a consensus on the benefit of promoting the use of eco-assets to encourage reforestation. An outcome of this meeting has been that OSM has developed a draft outreach packet to promote the market-based approach to reforestation.

Conclusion

I would like to conclude with a message from Secretary Norton that "Successful conservation is a partnership between the government and the people who live, work, and love the land." Our reforestation initiative has important environmental, economic, and social implications that meet this challenge and are in line with the Secretary's goals of

building an American with a healthier environment and a more secure economy. We believe that these efforts serve as a model for a new environmentalism by fostering the development of common grounds and promoting partnerships for conservation.

Mary Josie Blanchard is Assistant Director, Program Support at the Office of Surface Mining, U.S. Department of the Interior since 1993. She is responsible for developing OSM's regulations, policies, and technical guidance for active and abandoned mine land reclamation in order to implement the Surface Mining Control and Reclamation Act of 1977. In addition, she oversees the Applicant Violator System and technical training programs. Ms. Blanchard's other positions at OSM have included Special Assistant to the Director where she headed the agency's Interim Management Team. She has also held various branch chief and staff positions within the agency. She has an A.A. from Stephens College and a B.A. from the University of Texas.

STEERING COMMITTEE MEMBERS

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Appalachian Region
USDOI Office of Surface Mining

Dr. James Burger
Virginia Technical Institute and State University

MARKET-BASED APPROACHES
TO MINED LAND RECLAMATION & REFORESTATION

STEERING COMMITTEE RECOMMENDATIONS

1. The Reforestation Initiative is in need of a continuing effort by the Reforestation Steering Committee.
2. Many of the carbon credit incentives are perceived as futuristic rather than immediately available.
3. Explore ways to more fully implement the market -based options and make them readily available to landowners and mine operators.
4. Explore ways to communicate Reforestation options to landowners.
5. Explore ways to get State mining programs more actively involved with promoting reforestation efforts by mining operators.
6. Solicit more reforestation success stories for publication on the Website.

WHAT IS A TECHNICAL INTERACTIVE FORUM?

Kimery C. Vories
USDOI Office of Surface Mining
Alton, Illinois

I would like to set the stage for what our expectations should be for this event. This is the second technical interactive forum sponsored by OSM on issues related to reforestation of mined lands. The goal of the first forum in 1999 was to establish a national state of the art on technical aspects of mined land reforestation. The goal of this forum was to provide more specific information on economics and marketing issues as they relate to reforestation. The Reforestation Steering Committee began planning for this event over a year ago in January of 2001. Copies of the 1999 Forum Proceedings are available on OSM=s technology transfer CD and at the Reforestation Initiative Website at www.mcrcc.osmre.gov/tree.

The steering committee has worked hard to provide you with the opportunity for a free, frank, and open discussion on the state of the art in Market-Based Approaches to Mined Land Reclamation and Reforestation that is both professional and productive. Our rationale for the format of the technical interactive forum is that, unlike other professional symposia, we measure the success of the event on the ability of the participants to question, comment, challenge, and provide information in addition to that provided by the speakers. We anticipate that, by the end of the event, a consensus will emerge concerning the topics presented and discussed and that the final proceedings will truly represent the state of the art on the subject.

Therefore, one of the main purposes of this event is to bring as much scientific light and technical experience as possible to bear on this topic. It has been my personal experience, that the most progress I have seen, toward making advances in technical fields like this, has come when we have been able to work as a team of professionals toward a consensus on:

- the facts related to the topic, and
- the state of the science in terms of our most workable options and alternatives.

During the course of these discussions, we have the opportunity to talk about technical, regional, and local issues, while examining new and existing methods for finding solutions, identifying problems, and resolving controversies. The forum gives us the opportunity to:

- share our experiences and expertise concerning economics, marketing incentives and strategies,
- outline our reasons for taking specific actions, and
- give a rational for our actions on these issues.

A basic assumption of the interactive forum is, that no person present, has all the answers or understands all of the issues. It is also assumed that some of these issues, solutions, and concerns may be very site, regional, or species specific.

The purpose of the forum is to:

- present you with the best possible ideas and knowledge, during each of the sessions, and
- promote the opportunity for questions and discussion, by you the participants.

Our purpose is to empower you the participants with better knowledge, new contacts, and new opportunities for problem solving and issue resolution.

The format of the forum strives to improve the efficiency of the discussion by providing:

- a copy of the abstract and biography for each speaker that you may want to read before hand in order to improve your familiarity with the subject matter and the background of the speaker;
- We are tape recording the talks and discussions for later inclusion in the post forum publication so that you do not have to worry about taking notes. For this reason, we will require that all participants speak into a microphone during the discussions;
- In order for us to make the most efficient use of time, and ensure that you the participants have the opportunity to provide questions and comments, we require our session chairpersons to strictly keep to the time schedule;
- A *green light* will be displayed at the beginning of the talk. A *yellow light* will be displayed for the last 5 minutes of the talk. A *dim red light* will be displayed for 30 seconds followed by a *blinking red light* that will signal that the talk is over and the speaker has 5 minutes for questions.
- In the post forum publication, issues raised during the discussions will be organized based on similar topic areas and will not identify individual names. All registrants will receive one copy of this proceedings. This publication will be very similar to the proceedings of earlier forums conducted by OSM and are available for your viewing at the OSM exhibit.

It is important to remember that there are four separate opportunities for you the participants to be heard:

- 5 minutes will be provided for questions at the end of each speaker=s talk;
- 20 minutes of participant discussion is provided at the end of each topic session. The chairperson will recognize each participant that wishes to speak and they will be requested to identify themselves and speak into one of the portable microphones so that everyone can hear the question;
- At the end of the forum, we will conduct an open discussion on where we should go from here;
- and finally, a yellow forum evaluation form has been provided in your folder. This will help us to evaluate how well we did our job and recommend improvements for future forums or workshops. Please take the time to fill out the yellow evaluation form as the forum progresses and provide any additional comments or ideas. These should be turned in at the registration desk at the end of the forum.

One of the reasons for providing refreshments during the breaks and lunch is to keep people from wandering off and missing the next session. In addition, the breaks and lunch provide a better atmosphere and opportunity for you to meet with and discuss concerns with the speakers or other participants. Please take advantage of the opportunity at break time to visit the exhibits and posters in the break area. When the meeting adjourns today, all participants are invited to a social reception where refreshments will be provided.

Finally, the steering committee and I would like to thank all of the speakers who have been so gracious to help us with this effort and whose only reward has been the virtue of the effort. I would also like to thank each of you the participants, for your willingness to participate and work with us on this important issue. Thank you.

Session 1

Market-Based Approaches to Mined Land Reclamation

Session Chairpersons:
Dr. Sarah Donnelly
OSM
Washington, D.C.
And
Sid Stroud
TXU
Dallas, Texas

The Administration's Global Climate Change Initiatives and Enhanced Opportunities for Carbon Sequestration on Mined Lands
Bob Kane, DOE, Climate Challenge Program, Washington, D.C. and Daniel Klein, 21st Strategies Inc., McLean, Virginia

Market-Based Case Studies Involving Eco-Asset Management on Non-Mined Lands
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Enhancement of Terrestrial Carbon Sinks through Reclamation of Abandoned Mine Land in the Appalachian Region
Dr. Gary D. Kronrad, Ching-Hsun Huang, and Richard Bates, Arthur Temple College of Forestry, Stephen F. Austin State University, Nacogdoches, Texas

Application of an Eco-Asset Model at the TXU Monticello Mine
Gordon Hester, Electric Power Research Institute, Palo Alton, California; Stephen Smith and Carl Ivy, TXU, Dallas, Texas

THE ADMINISTRATION'S GLOBAL CLIMATE CHANGE INITIATIVE AND ENHANCED OPPORTUNITITES FOR CARBON SEQUESTRATION ON MINED LANDS

Bob Kane
USDOE, Climate Challenge Program
Washington, D.C.
and
Daniel Klein
21st Strategies Inc.,
McLean, Virginia

Abstract

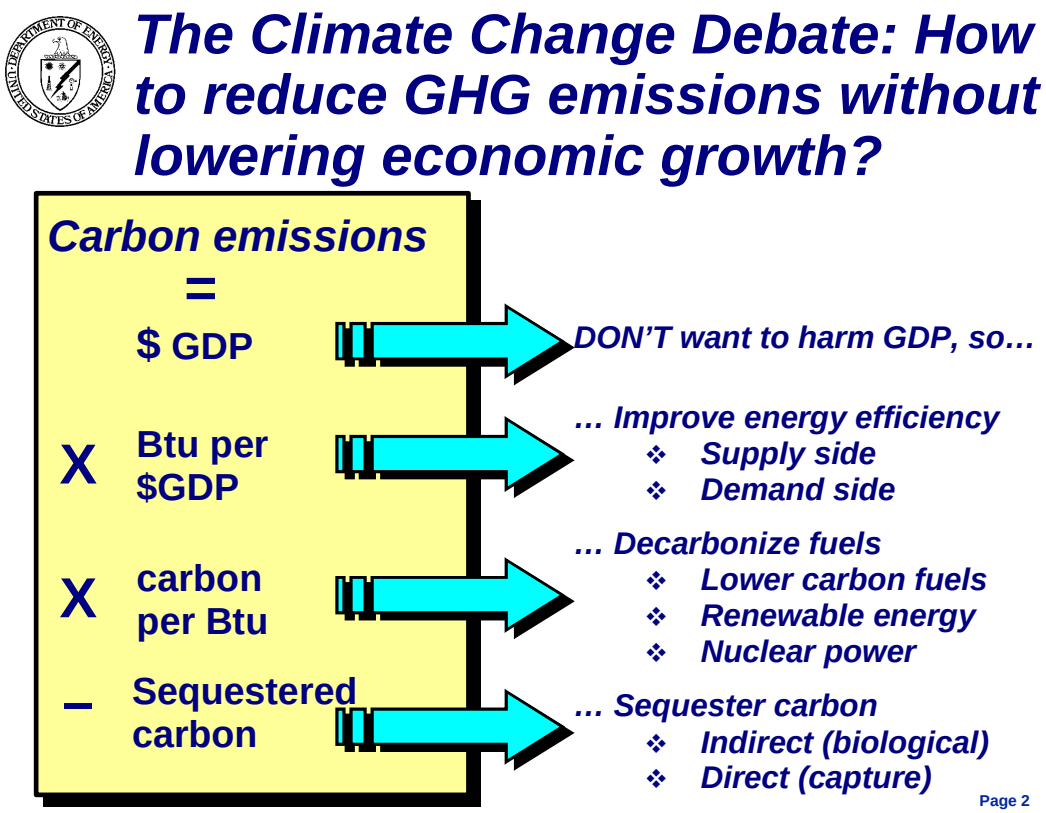
On February 14, 2002, President George W. Bush announced a new approach to the challenge of global climate change. This approach is designed to harness the power of markets and technological innovation. By setting a goal to reduce the greenhouse gas intensity by 18 percent over the next 10 years, the plan will permit economic growth while simultaneously encouraging greenhouse gas reductions and carbon sinks.

An important element of the President's plan is an improved Emission Reduction Registry. The U.S. Department of Energy is leading an effort to improve upon the current voluntary emission reduction registration program that was established under §1605(b) of the 1992 Energy Policy Act. In conjunction with this improved registry, the Administration will recommend actions to ensure that businesses and individuals that register reductions are protected on their baseline and not penalized under future climate policies. Additionally, it is proposed that companies that can show real emission reduction be given transferable credits that can be applied to future needs.

Carbon sequestration continues to play an important and growing component of the President’s plan. As the President stated on June 11, 2001, "We all believe technology offers great promise to significantly reduce emissions -- especially carbon capture, storage, and sequestration technologies." Already, under the §1605(b) Voluntary Reporting System for Greenhouse Gases, carbon sequestration projects are reported more often than any other project type. Many of these reforestation projects are on mined lands. Together with an expanding carbon sequestration program, an improved Emission Reduction Registry, and a proposal for credit for net greenhouse gas reductions, the benefits of carbon sequestration on mined lands look increasingly attractive.

Climate Change Debate

I would like to summarize the global climate change debate with the following equation.



GDP=Gross Domestic Product
Btu=British Thermal Unit (standard measurement of heat)

For the bulk of presentation today I will focus on the indirect approach or terrestrial sequestration component.

There has been a lot of attention on the Keoto Protocol that the US has not agreed with. This is an international agreement that has been ratified by 160 nations including the US called the Framework Convention on Climate Change. Its goal is to prevent damaging concentrations of green house gases in the atmosphere. Although this level has not yet been determined, we know that energy efficiency and lower carbon fuels alone cannot prevent a doubling of pre-industrial carbon dioxide concentrations. Carbon sequestration provides the additional tool necessary to achieve this goal.

Requirements for Carbon Sequestration Methods

These methods must be environmentally acceptable in that they protect existing ecosystems and do not leave any negative legacy for future generations. They must be safe to the public and not result in any large-scale discharge of carbon dioxide. Safety is not an issue with planting trees, however, some of the geologic methods proposed due have the potential for sudden discharge. We must have the ability to monitor and verify the amounts of sequestration taking place. These methods must also be economically viable if they are to be adopted.

Current Administration Plans

President Bush has been quoted as saying, "We all believe technology offers great promise to significantly reduce emissions – especially carbon capture, storage, and sequestration technologies." The administration has followed up with a more detailed statement where the President mentions two of the US DOE carbon sequestration projects. On February 14, 2002, the President announced his initiative on Global Climate Change. The key elements of that initiative are to: (1) reduce the Greenhouse Gas Emissions by 18 percent in 10 years; (2) improve the Energy Information Administration's Greenhouse Gas emission reduction registry; (3) provide transfer credits for emission reductions; (4) review progress in 2012 and take additional action if necessary; (5) increase support from climate science and technology; (6) provide possible business tax incentives and voluntary agreements; and (7) pursue new and expanded international agreements.

The global climate change initiatives that are specific to sequestration include: (1) improve the conservation title of the Farm bill by $3 billion over 10 years; (2) provide $40 million for "Debt for Nature" tropical forest conservation program; (3) extend the tax credit for biomass energy to 2004 and expand the credit to more types of biomass energy; and (4) direct the Secretary of Agriculture to recommend further targeted incentives for forest and agriculture Greenhouse Gas sequestration and help DOE and EPA develop sequestration accounting rules for improved Registry.

Electric Utility Participation in Supporting Forestry Carbon Projects

The Utilitree Carbon Company developed by the Edison Electric Institute began in 1995. They have committed $3 million to mitigate 3 million metric tons of carbon dioxide at 10 project sites both nationally and internationally. In addition, publicly owned utilities American Public Power Association began a reforestation project in 1991 that includes 170 participants with millions of trees planted.

Collaboration between US DOE and US DOI

OSM signed and a memorandum of understanding with DOE in 2000 to promote reforestation of mined lands and cooperate with enhancing market-based approaches to reforestation of abandoned mine lands. The benefits of reforesting AML sites include:

(1) higher quality reclamation; (2) increase in the number of sites reclaimed; (3) improved economic opportunities for local communities; (4) providing better aesthetic and recreational opportunities; (5) the increased economic value of forest products on the land; (6) and improved carbon reduction through by sequestration.

Greenhouse Gas emission reporting database

The three large contributors to these projects include: (1) American Electric Power; (2) American Forests; and (3) TXU. Details on each of these projects in terms of acres planted, tree species planted, the amount of carbon sequestered is available at EIA's Website at: www.eia.doe.gov/oiaf/1605/database.html.

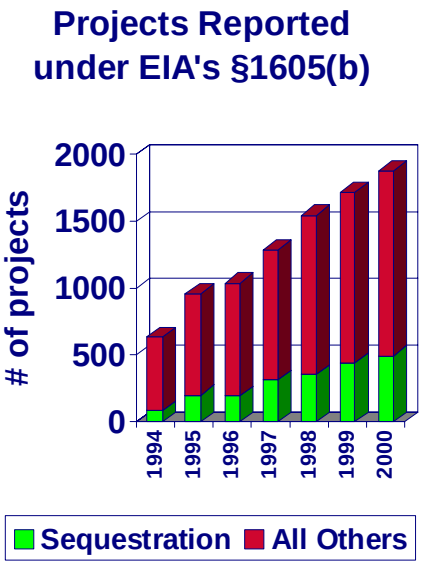
Allegheny Energy's Limestone Run Revegetation Project

A first of its kind partnership between OSM, DOE, and several local agencies and interests to enlist utility support to participate in the reclamation at abandoned mine sites where improved carbon sequestration will be a result of the efforts. At one site 7,000 seedlings have been planted after being amended with coal fly ash to improve the soil and increase plant growth.

Carbon Sequestration in EIA's voluntary reporting project

Carbon Sequestration projects in EIA's Voluntary Reporting System

- 494 carbon sequestration projects reported in 2000, more than any other type of GHG reduction
  - 69% were afforestation or reforestation
  - 11% urban forestry
  - 9% modified forest management
  - 8% forest preservation
- 55 out of 66 reporters were electric utilities
- Overall, over 9 MMT CO_2 sequestered

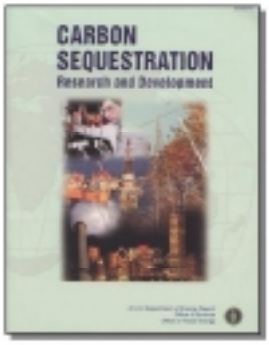


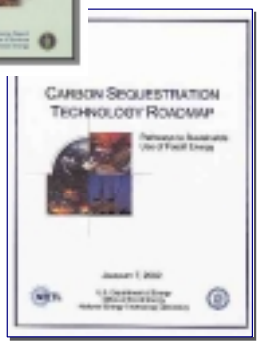
There were 494 carbon sequestration projects in EIA's 2000 report. This was the largest Greenhouse Gas reduction reported for that year. Of these projects: (1) 69 percent were afforestation or reforestation projects; (2)11 percent were urban forestry; (3) 9 percent were modified forest management: and (3) 8 percent were forest preservation. Electric utilities have been the primary sources of these reports with 55 electric utilities that reported out of a total of 66. In the year 2000, the total carbon sequestration achieved based on these reports was 9 million metric tons of carbon dioxide.

Technology Transfer related to Carbon Sequestration

DOE has developed a Roadmap for Carbon Sequestration R&D

- December 1999 DOE report
- On the Web at:
  www.fe.doe.gov/coal_power/sequestration
- hard copies: contact
  Robert.Kane@HQ.DOE.GOV
- Roadmap update in January 2002
  www.netl.doe.gov/coalpower/sequestration/pubs/CS_roadmap_0115.pdf





Internet resources include the:

- DOE Fossil Energy Website with program description, news, reports, and links at: www.fe.doe.gov/coal_power/sequestration
- NETL Carbon Sequestration Website with background, newsletter, references and more at: www.netl.doe.gov/coalpower/sequestration/index.html
- Carbon Sequestration Database including data on hundreds of research and development projects at:www.21st-strategies.com

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MARKET BASED CASE STUDIES INVOLVING ECO-ASSET MANAGEMENT ON NON-MINED LANDS:

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Abstract

Corporations and property owners have entered a decade that will radically alter industry's relationship with the environment. Tomorrow's business leaders are looking beyond enhancing returns from existing, conventional practices. The trend today and in the future will be to reward those who restore and protect our natural resources. What follows are two examples of enhancing the environment while creating a healthy economic return from that investment.

PROGRESS ENERGY - 2001 - A baseline assessment of ecological assets at the 3,000 acre site owned by Progress known as the "South River, Tract" in Bladen County, North Carolina demonstrates the opportunity to leverage a $600,000 conventional land value by creating over $4,000,000 in ecological asset values. This increase in value is based on the number of wetland mitigation and stream restoration credits that could be established on the property under North Carolina and Federal statutes. The North Carolina Department of Transportation (NCDOT) has estimated over $460,000,000 in wetland mitigation costs and over $200,000,000 in stream restoration requirements for wetland and stream impacts in that State between 2001 and 2011. The agricultural and forested acreage owned by Progress is within that watershed, and is identified as having the greatest wetland and stream impacts by DOT and other permit applicants. The entire 3,000-acre tract will be preserved as a conservation bank. The preservation of a significant loblolly pine stand will also help protect the Red Cockaded Woodpecker, a species protected under the Endangered Species Act. These ecological values will be sold to NCDOT and other permit applicants needing that type of mitigation.

RANCOCAS WETLAND MITIGATION BANK - 2000 - A 400 acre bottomland hardwood tract in Burlington County, near Mt. Holly, New Jersey was assessed for purposes of wetland mitigation planning and development. Sixteen acres of wetlands was restored to satisfy mitigation required by the New Jersey Turnpike Authority on a turnkey basis. A habitat conservation plan along with a wetland mitigation bank is in place for the balance of the 384-acre site. The increase in net value to the landowner is approximately $2.4 million. The ecological benefits are: (1) the restoration of prior converted agricultural land; (2) the elimination of use of pesticides, herbicides and fertilizers, which negatively impact water quality; (3) the re-establishment of habitat for wood turtle; and (4) the establishment of walking trails for community residents.

Introduction

We all depend on clean water, air and other natural amenities, which are often regarded as free. As the extent of environmental degradation becomes apparent, society is faced with increased pressure to improve upon environmental quality. Existing environmental policies have been designed to protect human health and welfare. However, quality of life improvements continue to be desired and new environmental control measures are needed to facilitate progress.

There are many regulatory controls that have been put in place to protect our environment. Incentive-based markets have developed to protect environmental assets or ecosystem services and now exist because of the following regulatory controls:

- Clean Water Act
- Clean Air Act
- Endangered Species Act
- Water Resources Development Act
- National Environmental Policy Act
- Mining Reclamation Act
- Natural Resources Damage Claim Act
- State Statutes – wetlands, water quality, flood control, rare species
- Montreal Protocol – SO_2 and NOx
- Kyoto Protocol and associated state and local statutes – CO_2

Because of the high cost associated with introducing new environmental controls, agencies are now turning to incentive-based, environmental management programs. These programs include bank and trade systems, tax incentives, and creative property easements, all of which encourage the private sector to become active in protecting and enhancing ecosystem services (EPRI, 2001).

Recent experience suggests that incentive-based environmental programs will likely play an increasingly important role in the United States (Newell et al., 2001). Currently, the approach to controlling pollution has been on a "point-by-point" or "pollutant-by-pollutant" basis, that has been very effective in specific situations, but has failed to provide cost-effective compliance options. A better approach is managing pollutants on a holistic or ecosystem-based approach (Frederick and Herd, 2001).

Since incremental improvement in existing environmental controls is both costly and politically difficult, agencies are now evaluating incentive based strategies that are: (1) capable of improving environmental quality, (2) satisfying regulatory requirements, (3) meeting community goals and standards, and (4) providing financial incentive to the stakeholder (Coleman, 2000).

Emission trading programs are one example of such approaches, with emission sources allowed to buy and sell tradable credits. Other examples include offset programs such as:

- Wetlands and Stream Banking
- Endangered Species Habitat Bank and Trade Programs
- NOx and SOx Trading Programs
- TMDL Trading Programs
- Watershed Based Effluent Trading Programs
- Carbon Sequestration Programs

These programs expand the scope and level of environmental performance achieved by economic factors by providing financial incentives for involvement in accomplishing tangible performance beyond that which is required as a baseline. Under them, firms may compensate for permitted activities that, destroy wetlands, release point source pollution to water bodies, increase air emissions, release non-point source pollution, and impact endangered species, by creating or purchasing wetlands mitigation credits, equivalent effluent or emission reductions, or endangered species credits. The common feature of these programs is that they work to augment, not replace, existing regulatory compliance requirements.

Ecological Assets

Development of ecological resource value (ERV) can be accomplished by establishing individual projects for specific ecosystem services, from which ecological resource value mitigation "credits" can be produced. Eco-asset mitigation credits can be earned by preserving, enhancing, restoring, or creating valuable land ecosystem services. The values from ecological asset bank and trade can come in the form of increased land appraisal value, developing tradable credits, or offsetting compliance obligations (Coleman, 1999).

Realizing the values associated with wetlands, riparian stream buffers, endangered / threatened / rare habitat, as well as the sequestration of nutrients, and atmospheric carbon involves proper identification of natural resource value in the context of local, state, regional and corporate goals. Preservation, enhancement, restoration, and/or creation of specifically valued areas within a property may then be accomplished via asset prioritization, enhancement and management programs. The benefit to the mining industry of creating these assets on their lands is to:

- Avoid real estate taxes on surplus land
- Mitigate their own environmental impacts at a lower cost
- Fix the costs of their environmental compliance requirements
- Develop ecosystem sustainability and management programs to satisfy consumer, regulatory and stakeholder demands
- Eliminate contingent liabilities associated with pending or threatened litigation
- Create a monetary return from underutilized real estate assets

- Structure liquidation of non-core assets on a tax advantageous basis(Frederick and Herd, 2001)

Growth of ecological assets as tradable commodities is attributed to the increased cost of environmental compliance ($155 billion for U.S. businesses in 1999, according to EPA estimates) and greater emphasis on preserving and enhancing clean air, clean water, clean soil and protecting plant, animal and bird habitats (GreenVest, 2001).

Case Studies

CANNAAN VALLEY, WV: Eco-Assets

Allegheny Power owns property in Canaan Valley that is located in Tucker County, West Virginia. Allegheny owns over 20,000 acres of properties in this region, that were purchased in the 1920's to build a hydroelectric facility. The company was forced to cancel the project after it failed to obtain a permit from the U.S. Army Corps of Engineers and find alternative uses for the land.

At an average elevation of 3,200 feet, the Canaan Valley is the most elevated lowland of its size east of the Rocky Mountains. The valley supports many unusual plants and animals, being home to 40 different wetland and upland plant communities and supporting more than 580 plant species. These habitats support equally interesting wildlife populations, with 290 species of mammals, birds, reptiles, amphibians and fishes known or expected to occur there. Home to one of the largest wetlands east of the Mississippi, the area contains habitat for the threatened Cheat Mountain salamander and potential habitat for the endangered West Virginia northern flying squirrel and Indiana bat.

Because of the great diversity and ecological importance of this land, the US Fish and Wildlife Service showed great interest in purchasing the properties. Allegheny Power was also interested in selling off some of the property. However Allegheny was not interested in a direct sale of the land. An innovative idea that incorporated ecological value into the land was used in order to place this land into conservation.

GreenVest, LLC, a leader in determining ecological values helped develop a report and subsequent ecological appraisal that resulted in recognizing additional ecological values for the land. A certified independent appraiser was hired to determine what the value of the land was worth. Unlike traditional real estate land appraisals, this appraisal took into account the worth of the land's ecosystems. The valuation estimated the worth of the property in terms of resort residential, upland-investment holding, wetland mitigation, habitat mitigation/open space, wetlands/open space, and carbon sequestration potential.

This approach used incentive-based strategies that go beyond traditional real estate market values. The mechanisms utilize the environmental credit market. Value can be created from the creation of "banks" which can be applied to wetlands, carbon sequestration, endangered species, nutrient trading, and others. For example, the

Allegheny properties included 253 acres of degraded wetlands and adjoining lands that were suitable for restoration. If given the opportunity to establish a wetland mitigation bank, these lands could have a net value of up to $8,000/ac.

The value placed on habitat mitigation was based on the appraiser's estimate of the value of these lands for threatened and endangered species habitat. Numerous threatened and endangered species were identified on the tract. The carbon sequestration values were based on managing existing forests for maximum carbon sequestration using long rotations plus establishing mixed species plantations on available open areas to sequester carbon. A price of $25/ton of CO_2 was used.

The official appraisal covered twenty-nine properties that totaled 12,380.19 acres. The following table summarizes the results of the appraisal.

Table 1. Valuation of the selected Allegheny Powers Canaan Valley properties:

Land Use	Parcel Size	No. Parcels	Overall Size	Value/Acres	Total Value
Resort Residential	50	5	250	10,000	2,500,000
Resort Residential	100	5	500	7,500	3,750,000
Resort Residential	200	5	1000	5,000	5,000,000
Upland-investment holding	4,212.39	1	4,212.39	1,500	6,318,585
Wetland Mitigation	253		253	8,000	2,024,000
Habitat Mitigation/open space	2,425.71		2,425.71	1,200	2,910,852
Wetland/open space	3,739.09		3,739.09	800	2,991,272
Carbon Sequestration					7,100,000
					32,594,709

In a sale, Allegheny would sell the land for $16 million, in line with prior estimates based on similar sales. Since the properties value was estimated higher than that amount, Alleghany would inform the Internal Revenue Service that its true market value was more than $32 million. The "bargain sale" of these lands would allow Allegheny to claim a charitable contribution of roughly $16 million. This in turn would save the company several million dollars in taxes.

The eco-asset approach allows properties to be put into conservation that would not otherwise. This movement in the market in the long run will lead to more conservation. Without this approach it is unlikely this parcel would be conserved.

Corporations such as Allegheny own vast amounts of property. These properties are part of ecosystems that generate a wide array of service critical to the human economy. Property owners are discovering ways of "capturing" a portion of the value of these services. The same theory can be used with abandoned mine lands. This approach used to create value in the Canaan Valley can be directly applied to the vast amounts of mine land that has not been reclaimed across the country.

RANCOCAS WETLAND MITIGATION BANK: Wetland Mitigation Crediting

A fourth case study focuses on the Rancocas Wetland Mitigation Bank (RWMB). The RWMB is comprised of 381 acres of forested, scrub/shrub and emergent wetlands and associated uplands in Burlington County, New Jersey. This project will permanently preserve a unique wetland ecosystem that will provide water quality improvements, flood flow attenuation, sediment control, and critical wildlife habitat in one of the most densely populated areas of New Jersey.

A total of 28.5 mitigation credits are assigned to the RWMB by the New Jersey Department of Environmental Protection (NJDEP) based on wetland creation and preservation. Any public or private development project can utilize credits to satisfy wetland mitigation permit conditions. The RWMB owner provided an additional16.5 acres of wetland mitigation on a turn key development basis to the New Jersey Turnpike Authority to satisfy wetland impacts caused by the construction of a new exit.

Although the RWMB does not directly relate to abandoned mine land sites, the same principals can be used for establishing wetlands on these lands. The operator in charge of restoration may have the opportunity to design, construct, monitor, and maintain these wetlands. If the restoration goes above and beyond the required reclamation guidelines, the restoration effort should receive "credits."

The credits could be used toward in-house needs, or sell to any developer, public or private. There are several benefits of purchasing wetland mitigation credits. Some of the examples are listed below:

- Eliminates the cost and time associated with acquiring, designing, constructing and maintaining your own mitigation site.
- The responsibility to provide mitigation is eliminated. No additional regulatory obligations or liabilities exist.
- Create added value to a project site by increasing development potential.
- Costly project overruns are avoided due to contingencies. Mitigation costs are defined up front and fixed.
- Economies of scale can make mitigation credits less expensive than singular wetland mitigation sites.
- Regulatory agencies save time approving mitigation because mitigation is already in place prior to wetland impacts.
- Contribution to the overall health of the watershed by protecting vital wetland functions and values

Like all mitigation banks, the "credit" assigned value is based on the activities undertaken to restore the site. The crediting system can provide an incentive for coal mining companies to reclaim mine lands to a high quality, fully functioning ecosystem that enhances the environmental characteristics of the area. Once these credits have been exhausted, the bank is permanently preserved for long-term protection and management.

The final result is an effective, environmentally responsible method of providing incentives to the mining industry for high quality reclamation while protecting vital wetlands functions and values.

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INCENTIVES FOR UTILITIES TO INVEST IN REFORESTATION LIMESTONE RUN PROJECT

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Abstract

In 2001, Allegheny Energy partnered with the U.S. Office of Surface Mining (OSM), U.S. Department of Energy (DOE), Pennsylvania Department of Environmental Protection and several local conservation groups and organizations to implement a unique carbon sequestration pilot project on previously mined land in Western Pennsylvania. It was the first application following the Memorandum of Understanding between OSM and DOE to encourage reforestation of abandoned mine lands (AMLs) for carbon sequestration purposes.

Allegheny's objectives in the project were threefold. First, the company wanted to test the technical feasibility of reforesting AMLs for carbon sequestration value since such sites are abundant in our region. Secondly, we wanted to test the effectiveness of beneficially using fly ash from our local coal-fired power station as a soil amendment for establishment of new vegetation and to enhance its growth. Thirdly, the project fit well with our environmental stewardship program by enhancing wildlife habitat and improving both land and water quality.

The pilot project covered seventeen acres. Fifteen acres were planted with three varieties of pine and spruce seedlings while two acres were planted with warm season grasses. Follow-up measurement of the carbon sequestered by the various species of trees and grass, as well as survival rate, will be necessary over the next several years to assess the project's success. The development of partnerships to implement these types of projects has proven to be invaluable. By making everyone a stakeholder that has an interest in the project, it distributes responsibility for the various components of the project and streamlines the process. By involving, not only regulators, but also local conservation groups, school students and farmers, the project encourages positive public relations and makes partners out of individuals or groups who might otherwise oppose it.

The project is being used to gain experience and gather information that can be applied toward future projects. Future projects may explore development of other ecological assets that will provide multiple, tradable credits, beyond those for carbon, that will serve as incentives for AML reclamation.

Introduction

While the debate continues over the science and public policy issues surrounding global climate change, several Federal agencies, industries and organizations are pursuing a proactive, no-regrets approach by implementing carbon sequestration projects. The Bush

Administration, while vowing not to ratify the Kyoto Protocol [1], has offered its own proposal for reducing greenhouse gas emissions and atmospheric build up in a voluntary and more cost-effective manner [2]. Sequestration of carbon dioxide (CO2) in vegetation has proven over time to be one of the more cost-effective and practical methods of controlling greenhouse gases (GHGs) and is expected to be a critical component of any domestic, voluntary or mandated reduction program.

Why should electric utilities invest in carbon sequestration?

Carbon dioxide, the most prominent GHG by volume, is emitted during the combustion of fossil fuels such as coal, oil, natural gas, diesel oil, and gasoline. Fossil fuels are consumed in large volumes for power generation, industrial processes and transportation. It is estimated that electric utilities in the United States emitted roughly 641 million metric tons of carbon equivalent [3] in year 2000 to meet the insatiable demand for electrical energy. Being large emitters of CO2, utilities understand they will be targeted for reductions in any national strategy to reduce GHGs. Recognizing their role, many utilities have been participating in voluntary programs to both reduce their emissions of GHGs and offset their CO2 emissions through sequestration projects.

In 1995, the Department of Energy (DOE) initiated a program called Climate Challenge [4] in which electric utilities were invited to voluntarily establish emission reduction targets for GHGs and report their progress annually through the year 2000. Allegheny Energy and numerous other utilities participated in Climate Challenge, meeting the program's goal of over 47 million metric tons of carbon equivalent. Allegheny has also participated in the UtiliTree [5] program since 1995, and as a partner has invested in ten carbon sequestration projects with potential sequestration benefits of three million tons of CO2. Even with a voluntary, domestic program to reduce GHGs there are many details that would have to be worked out before a party would receive credit for the reductions or offsets. Some of the projects to date have primarily been to demonstrate that utilities are willing to participate in voluntary GHGs reduction programs. Others have been more venturesome strategic business investments to actually generate emissions offsets thereby reducing future liabilities.

Utilities have also funded research efforts through the Electric Power Research Institute, the research arm of the electric utility industry, to develop the science and technologies needed to face this climate change issue head on. That research includes trying to better understand the variables influencing climate; developing better models to forecast potential climate changes while modifying variables; developing more efficient energy technologies; exploring best practices for carbon sequestration; researching new methodologies for storing CO2; and, finding more accurate means by which to measure carbon sequestration. We also need to continue the research to improve carbon monitoring and verification procedures necessary to produce credible reductions for a trading program. The bottom line on research is to make certain we have accurately identified the cause-and-effect relationship for the climate change phenomenon and are developing the science and technologies to address the problem in a cost-effective and publicly acceptable manner.

Carbon sequestration continues to be recognized as one of the premier methods for reducing atmospheric concentrations of CO2. The practices associated with sequestration through land reclamation projects offer other intrinsic benefits to the environment, such as reducing soil erosion, wildlife habitat development, watershed and water quality enhancements and improved forestry management and farming practices. Recently, the DOE and the Department of Interior (DOI)'s Office of Surface Mining (OSM) embarked on a new approach to carbon sequestration that is intended to amend the legacy of abandoned mine lands (AMLs) in the Appalachian region. On September 6, 2000, the DOE and OSM signed a Memorandum of Understanding to promote the reforestation of AMLs by encouraging third parties, such as electric utilities, to invest in such projects for their carbon sequestration value. There is an estimated 729,682 acres [(6)] of AML in the U.S. in need of reclamation to remediate acid mine drainage (AMD), to stop soil erosion and to restore the land to more productive use.

The prime driver for electric utilities to invest in AML projects is the expectation that they would own the carbon credits created through the reforestation efforts. While there are still many unanswered questions, such as baseline year, certification and registration of credits, and whether a program will be strictly voluntary or have mandated targets, many utilities are beginning to invest. In the event that target reductions and/or caps are imposed, industry and many governmental agencies have been advocating a market-based approach vs. the traditional command-and-control. By developing a market-based approach, carbon credits would be created and traded much like sulfur dioxide allowances [(7)] for the acid rain program initiated by the 1990 Clean Air Act Amendments. In addition to meeting their own CO2 credit needs, some utilities will create excess credits and sell them to those that find it more cost-effective to purchase credits than to reduce emissions or create credits on their own. As the acid rain program is proving, the sulfur dioxide emission reduction targets will be met if not exceeded and the cost to reach that goal will be significantly less than by mandating unit-by-unit controls. Market-based solutions to environmental problems do work and minimize negative socio-economic impacts.

In addition to the carbon credits, there are other incentives that can encourage utilities to invest in AML reforestation projects. One is to possibly create other tradable ecological-assets credits, such as for water quality, wetlands, timber and endangered species. For example, by reforesting AML, acid mine drainage can be abated thereby creating credits that can possibly be traded in the Total Maximum Daily Load (TMDL) [(8)] water quality program being implemented by the states. Wetlands can be created as part of the project and the credit banked for future use or sold to developers in the region for offsets. Wetlands banking and trading is a mature program. Furthermore, reforestation and proper site management provides opportunity for the land owner to introduce and propagate endangered species which, again through tradable credits, can be potentially sold to developers to offset destroyed habitat.

In addition to the monetary value of AML reforestation, there are other reasons that will peak a utility company's interest to participate. First, reclamation of AMLs may also be an opportunity for beneficial use of coal-combustion products (CCPs), such as fly ash.

Much of the fly ash produced from coal during the combustion process is high in pH and alkalinity, which works well to buffer the AMD and highly acidic soils common at these sites. The ash can help neutralize the soil, improve the soil to help establish new vegetation and enhance its growth.

Finally, but very importantly, AML reforestation projects fit nicely with an electric utility company's environmental stewardship program. Most electric utilities have some form of environmental stewardship program of working with their communities and conservation groups for altruistic benefits to the environment. Such programs foster good public relations in the communities we serve, gives us an opportunity to express our commitment to the environment and in so doing helps enhance the corporation image. Utilities are continually looking for a means to distinguish themselves from the competition in a positive manner. But, besides all the typical feel-good, nice-sounding images that environmental stewardship programs offer, AML reforestation can also provide quantifiable strategic value to a business as noted above in terms of carbon and other eco-asset credits and a new market for CCPs. Electric utilities, just like any business, are in operation to make a profit. AML reforestation can be part of that business strategy.

Project Objectives

Allegheny's objectives for the Limestone Run project were threefold. First, we wanted to test the technical feasibility of reforesting AMLs for the carbon sequestration value since we have so many sites available to us in our service territory. This included determining the degree of difficulty in preparing and planting the sites; ascertaining survival and growth rates compared to more fertile and manageable sites; and, how difficult it would be to acquire legal ownership of the carbon credits and control future land use. If carbon sequestration becomes a component of an eventual GHG reduction program, we want to know where the lowest-cost credits can be created in order to be a player in a nascent trading market.

Secondly, we wanted to test the feasibility of beneficially using CCPs to amend the soil thereby improving establishment of new vegetation and enhancing growth. We needed to better understand the appropriate CCPs application rate to sufficiently enhance the soil and determine if such application rate, given the ash characteristics, can be written into permits by the state agencies. We knew going in that many sites because of the terrain and lack of even basic soil cover would present nearly insurmountable challenges for using CCPs.

Third, the AML reforestation program, in theory, fits nicely with our established environmental stewardship program. Land reclamation, wildlife habitat development and water quality improvements were all activities we typically pursue as part of our in-house program. We fully support the concept of trying to reverse the legacy of AMLs left by previous generations of mining and to restore those sites to more productive and aesthetically pleasing real estate. Being the first utility to implement the recently signed MOU between the two federal agencies was another significant incentive. It would give

us an opportunity to distinguish ourselves from the competition in a positive manner. It would also provide an opportunity to develop relationships with new partners who we might collaborate with on future projects.

The overarching objective was to learn from our experience. Are AMLs reasonable sites to consider for future project? Is it practical to use CCPs and what are the benefits and drawbacks? Did we choose the optimum species of vegetation to plant? We wanted to be able to take what we learned from this pilot and, assuming it was successful, apply that knowledge to larger scale applications. The experience and knowledge is also expected to help us better manage our own corporately held real estate to maximize its value.

Partnership Development

The initial contact with Allegheny came from DOE's Global Climate Change and Carbon Sequestration Issue Manager, Bob Kane, following a carbon sequestration workshop in the fall of 1999 in Gaithersburg, MD. Bob in turn engaged Sarah Donnelly, Chief, National Technical Training Program at OSM in our discussions. They explained their respective interests in the AML reforestation program and how they were interested in seeking parties to implement the pending MOU between the two agencies. Allegheny expressed immediate interest and began exploring internally what our objectives should be and what geographical areas we might consider for a project.

We also decided early on that we wanted to create a partnership with other entities in the region that might have a vested interest in seeing a project such as this be developed. We wanted to identify the stakeholders and bring them on board early to be part of the decision-making process and even site-selection process. In addition to DOE and OSM, the other partners we engaged on the project were: PA Department of Environmental Protection, PA Game Commission, Armstrong County Conservation District, Pheasants Forever, and the local Lenape Vo-Tech school. As it turned out, we also made partners out of a contractor and local farmer. We wanted to involve a local watershed group, but there were none already established in the areas we were considering.

The rationale behind making this a partnership was that, rather than just seeking services from the various contributors, we wanted them to assume some level of ownership, thus making the chances of success more likely. Making everyone a stakeholder was relatively easy on this type of project because they not only had services to offer but something to gain as well. These types of reforestation projects provide for win-win situations. Certainly the environment and wildlife benefit…which is the altruistic goal of all of the stakeholders. The federal, state and local government agencies achieve many of their land management objectives in a friendly and productive atmosphere. Conservation groups and sportsmen are provided new habitat on which to stock and propagate wildlife. Local students and conservation groups are provided an opportunity to work on a stewardship activity and demonstrate their commitment to the environment. The project can provide income for local contractors and farmers. Local residents realize all the aforementioned benefits, plus an aesthetically more pleasing landscape. And of course the corporate sponsor, Allegheny Energy in this case, has generated potential tradable

carbon credits and helped stimulate a market for CCPs. Bottom line, with all potentially interested parties pushing the project…there's no one left to impede its progress. With a partnership, it's a win-win situation!

Site Selection

The first step in site selection was identifying all the stakeholders' needs. Obviously, some needs were more easily accommodated than others. While we tried seriously to find a true AML site, there were several controlling factors that would eventually cause us to compromise our site selection in order to be able to use CCPs and do the project in the timeframe we had developed. Since using CCPs was a prime objective, we needed to focus our attention on sites within a reasonable distance from one of our coal-fired power stations in order to control transportation costs. While the transportation costs were less critical for a pilot than it would be for a major site consuming large truckloads of CCPs, we still focused our search on approximately a 15-mile radius.

AMLs are so prevalent throughout the Appalachian region that finding sites on maps provided by the PADEP was not difficult. However, accessibility and determining ownership proved to be major hurdles. Concerning accessibility, few of the AML sites, because of when they were last used, have good access and many have some form of vegetation cover. We needed a site to which developing access for heavy equipment would not be prohibitively expensive.

Determining legal ownership of the prospective sites can usually be accomplished with minimal effort of title searching at the local courthouse. However, actually locating and contacting landowners or their heirs can, in some instances, require substantial investigation work. Even on those sites where the mining operation was abandoned and bonds, if any, forfeited, the title to the land may still belong to the original owner. And, of course once the owner(s) are found, a legal agreement would have to be developed to assure the newly planted vegetation would be adequately protected during the life of the project, which is typically 50 to 60 years. While gaining consensus for limitations on future land use from multiple owners is not impossible, sufficient time has to be built into the process. Even right-of-way access for adjoining properties can be time consuming. The most critical issue is being able to acquire and manage the carbon credits generated from the project. In instances where the state has acquired ownership of the site, credit ownership may be less of an obstacle. This is an area that may require some further exploration. Perhaps shorter-term leases of carbon credits may prove more attractive to landowners.

We also found it counterproductive to have to clear existing vegetation in order to plant new. Certainly the issue of incremental benefit would present a philosophical if not technical problem if the site had to first be cleared of vegetation. We also discovered that many of the AMLs had high walls that would not be conducive to planting without first doing major excavation work requiring additional permits. Finally, we decided early on that if this pilot was to be the maiden project for the soon to be announced MOU, it should probably be implemented within one year. Having established these limiting

criteria we directed our attention more toward relatively modest terrain and sites that had some form of established access.

We focused the site selection process on northern Westmoreland and southern Armstrong counties in Western Pennsylvania. Using mining maps provided by PADEP, the partners conferenced by telephone several times to screen the area and met face-to-face for the first time in late July 2000 to search for a site. By the end of the day we had identified one very attractive site and a few that might be acceptable. During subsequent investigation of the prime candidate site, we discovered that contiguous to it was another previously mined site with easy access. Additionally, it was actually owned by Allegheny. The site, mined in the late 1970s, was subject to the 1977 Surface Mining Control and Reclamation Act regulations and had been reclaimed and covered in grass. This was a critical decision for the group because it was not the AML site we were originally pursuing. However, it did have the characteristics we felt would be necessary for a pilot.

While the site had been reclaimed, the soil was marginal but typical of what would be considered for reforestation projects on previously mined lands. Allegheny had decided that the types of previously mined sites that would attract us for carbon sequestration value would have to be in relatively decent condition to plant without a lot of preparatory work. As noted later on, true AML sites that can utilize high volumes of CCPs for reconstruction and excavation of high walls can also be prime candidates when time is not a limiting factor. But we needed a site with less challenging terrain for the pilot. With one more conference call in early August, we all agreed that the site last selected would be the best choice for the pilot. Illustration (a) is a topographical map of the site selected.

Project Development

Once the site was selected, we needed to develop an action plan and timeline that would lead us to a completed planting project by late spring of the following year. We wanted an approximately 20-acre area to work with and asked Allegheny's surveyors to lay out a plot. With losses to the access road, restrictive terrain and trying to avoid disrupting established vegetation, the final plot was roughly 17 acres. See illustration (b). Allegheny's forestry group recommended three species of conifer seedlings that typically do well in such terrain and climate. They are red pine, white pine, and white spruce. As a note, orders for seedlings should be placed with nurseries at least six months in advance. We also worked with Pheasants Forever, an organization that has developed a warm season grass mixture suitable for the area.

We needed to go over the entire plot with a brush hog before planting, so we lined up a local farmer for early spring. We also made arrangements with the farmer to spread cow manure on select test plots to measure its effectiveness in establishing new growth for both the trees and grasses. Because the land had been previously mined and reclaimed, we expected the soil would be compacted and difficult to work without at least heavy-duty farm equipment. We made arrangements with a local contractor that had experience

in plowing and disking reclaimed land and sufficient equipment. Arrangements were also made with the contractor for spreading fly ash on selected test plots prior to plowing. Late winter arrangements were made with a second contractor for mechanically planting the seedlings. During late winter we had a consultant take soil and fly ash samples to determine the best mixture to enhance plant growth.

Using the brush hog on the site went smoothly, but subsequent spring rains delayed plowing several times. We were eventually left with a narrow window of opportunity for planting. The soil had to be dry enough to get the plows through and leave it friable after disking for planting. The nursery agreed to keep the seedlings in cold storage after they were lifted from their beds, but only for a short period of time. Because of the droughts in the region the previous two summers, we didn't want to go much beyond the first of May for fear of not having enough moisture to establish the root structures. Fortunately we had a break in the weather for one week, which allowed us to spread the fly ash and plow the entire site within a two-day period. A second break in the rain allowed us to disk and plant the 7,000 seedlings. Pheasants Forever sprayed the two-acre plot for warm season grasses with an herbicide to kill the established cover and seeded the site several weeks later. As a finishing touch, the PA Game Commission, with the help of students from the nearby Lenape Technical School, planted 150 fruit and nut trees around the site perimeter for wildlife. See Illustration (c). A dedication ceremony with all partners was held on site May 8, 2001, and a 4-foot-by-8-foot billboard recognizing all the partners was erected on the site. See illustration (d).

Project Assessment

Overall, we consider the project to be a success. We gained valuable experience about planting on reclaimed land, including contingencies that need to be anticipated and built into project timelines. Developing the rapport with potential partners requires an investment of time up front and typically some modifications to the project in order to meet the various needs of the groups. But ultimately, once the Partnership is developed, the project tends to be pushed along quickly with everyone carrying a fair share of the load. Being a stakeholder means more than simply being a cheerleader for the project… everyone has a responsibility and accountability for its success. Each stakeholder has a vested interest in the project to make certain his/her specific need is met.

Specific lessons learned include:

- Low-hanging fruit type projects will be those with modest terrain features and at least minimum soil coverage. The more site preparation needed…the more risk assumed in carbon credits being profitable.
- Arrangements need to be worked out well in advance with the state environmental regulatory agency to be able to apply an adequate rate of CCPs that will enhance soil quality and make the beneficial use at least as cost-effective as land-disposal. Because of the limits on arsenic in Pennsylvania's beneficial use regulations, we were restricted to ~18.6 tons of fly ash per acre [(9)].
- If a higher application rate is approved, fly ash may be tailgated, which would reduce the application time drastically. Otherwise a heavy-duty lime spreader is

needed and will take considerably more time. In either case, the site surface will need to be relatively dry to allow access for equipment.

- Find a general area with multiple candidate sites so that the same partnership can be utilized. Lead times necessary for developing new partnerships each time can be eliminated and subsequent projects will be implemented more efficiently as technical experience and working relationships improve.
- Heavy-duty or industrial equipment will be necessary on most applications. Use of typical farm equipment should be limited to mowing and spreading of manure or other fertilizers.
- Fall, just prior to the wet season, may be a more optimal season for planting in some regions. Spring planting can be complicated by waiting for the soil to drain, while still being able to plant before potential droughts and summer heat.
- Farmers typically have limited time available to help with the project during the spring period. Equipment failures and repairs can also restrict a farmer's availability since, unlike contractors, few will have backup machinery.
- Place order with nurseries for seedlings well in advance and line up a commercial planter. Spring and fall are busy times for both.

Next Steps

The site may need to be maintained for weed control for the first several years until the trees are well established. Herbicide application can be done by helicopter, tractors, ATVs or manually using backpack type sprayers. Trees are actually planted spatially to anticipate less than 100 percent survival rate, recognizing that some mortality will occur. Deer browsing may cause additional mortality especially during the first year. If large pockets are identified where survival rate is low, we will likely attempt to replant by hand.

Warm season grass success won't be fully determined until the second year. Occasionally, second plantings are necessary. Warm season grasses typically do better when mowed once during the second year. Thereafter no maintenance is necessary. Survival rates for both evergreen and fruit/nut trees, as well as for warm season grasses, will be monitored for several years and replanting done by hand as needed. Survival rate records, as well as other notes relating to growth, will be maintained for at least 5 years. Test plots will be monitored to ascertain the benefits, if any, of using cow manure and fly ash for establishing new growth. Application rates on this project were too light to expect any benefit beyond the first year. Carbon sequestration rates will be assessed for both evergreens and grasses starting in the 5th year after planting.

With the lessons learned from the pilot project, we are pursuing a similar project in the Cheat River basin in northern West Virginia. Once again we are doing it in partnership with similar government agencies and conservation groups. The site this time will truly be AML, last mined in the mid-1960s with only marginal soil cover. We plan to use fly ash as a soil amendment but at a higher application rate. We're also attempting to generate other ecological assets, such as wetlands and tradable water quality credits as

part of the new project. The additional eco-assets and use of CCPs will hopefully make these projects more profitable, less risky, and even more attractive to all stakeholders.

A second project being considered is just a few miles from the Limestone Run site and is more involved with reclamation of an abandoned high wall mining operation. The reclamation is expected to take 15 years to complete and consume 1.8 million tons of CCPs from our Armstrong Power Station. The intended final phase of the reclamation will be planting of trees and grasses for sequestration value. We are still attempting to acquire the necessary permits, which will determine whether or not we proceed with the project.

There are several externalities that will influence the attractiveness of reforesting AMLs for electric utilities. First, any CO2 reduction program, whether voluntary or mandated, must be flexible in its application, follow a market-based approach with tradable credits and include sequestration as part of the strategy. The more certainty that carbon sequestration will be credited, the more industry will be willing to pursue these projects. With sequestration expressly excluded, industry will have little, if any, interest in pursuing sequestration projects of any kind.

Secondly, if federal or state funds can be made available for reclaiming the more challenging sites and for water quality treatment, third parties may be more willing to invest in the more environmentally damaging and unsafe sites instead of just the low-hanging fruit. Thirdly, states must be agreeable to higher application rates of CCPs in order to have any measurable influence on vegetation growth and to make AML sites an economical alternative to land-disposal.

Finally, controls installed on coal-fired boilers to reduce nitrogen oxides (NOx) and mercury have the potential to render CCPs unusable for reclamation projects. Ammonia formed during the NOx removal process is captured in the ash. Depending upon the ammonia concentrations of the ash, it may be unacceptable for some beneficial use projects. Similarly, mercury, which attaches to the ash particles and is captured from the flue gas, can also pose risks for beneficial use of CCPs. It's a matter of how much mercury is removed from the gas and whether or not it leaches from the ash. That, in and of itself, is not likely to cause utilities to stop investing in reclamation projects, but it will make some potential sites less attractive economically.

Conclusions

Carbon sequestration must be part of any voluntary or mandated CO2 reduction program in order for electric utilities to have an interest in AML reclamation projects. Electric utilities or entrepreneurs looking solely to generate low-cost carbon credits through sequestration are not likely to pursue AML reforestation projects as their prime investments. Certainly plantings on more fertile and less challenging terrain in areas that receive more rainfall and have longer growing seasons make for a much better investment. However, as noted above, there are several other incentives, that when considered collectively, will entice utilities to pursue these types of reforestation projects

and provide strategic value to the corporation. Finding a new local market for CCBs, development of tradable eco-assets in addition to carbon credits and being recognized in the community for their stewardship efforts can provide the incentives necessary to attract utilities to invest in AML reforestation projects.

Footnotes

(1) The Kyoto Protocol was adopted by the Third Conference of the Parties to the United Nations Framework Convention on Climate Change in late December 1997, in Kyoto, Japan. The Protocol, if ratified, would require the U.S. to reduce greenhouse gas emissions by 7% below 1990 levels by the period 2012-2018. To enter into force, the Protocol requires signatures from at least 55 Parties to the Convention representing 55% of the total 1990 carbon dioxide emissions of developed countries. The same year the U.S. Senate passed a resolution vowing not to ratify the Protocol unless developing nations participated as well, and that our participation would not seriously harm our national economy.

(2) On February 14, 2002, President Bush announced his Administration's commitment to address climate change by proposing to reduce the U.S. greenhouse gas intensity by 18% by the year 2012. Greenhouse gas intensity is the ratio of emissions to economic output. The proposal would lower the rate of emissions from 183 metric tons per million dollars of Gross Domestic Product in 2002, to 151 metric tons per million dollars GDP in 2012 – a reduction of ~ 500 million metric tons of greenhouse gases over the ten year period.

(3) Reference: Emissions of Greenhouse Gases in the United States 2000; Report # DOE/EIA-0573 (2000), November 9, 2001.

(4) The Climate Challenge program was a successful, joint, voluntary effort of the U.S. Department of Energy and electric utilities to reduce greenhouse gas emissions through nine specific initiatives. The program involved 124 Participation Agreements between the parties and exceeded its goal of 47.6 million metric tons of carbon equivalent in the year 2000.

(5) The non-profit, UtiliTree Carbon Company, was established by 41 electric utility companies in 1995 to sponsor a collection of forest projects (ten to date - eight in the U.S. and two external) that reduce carbon dioxide from the atmosphere through sequestration. Projects include new plantings as well as preservation and management of existing forests.

(6) Reference: The U.S. Department of Interior, Office of Surface Mining, Abandoned Mine Land Inventory Report, April, 2002.

(7) Under the 1990 Clean Air Act Amendments, Congress established a sulfur dioxide (SO2) reduction program whereby EPA would issue credits or "allowances" to qualifying generators to cover their SO2 emissions up to a permissible limit. One allowance is needed to cover each ton of SO2 emitted. Allowances are issued by EPA annually. Units that over-control their emissions and don't need all their allowances, can trade or sell them to others that find it more cost-effective to purchase allowances than to install SO2 controls or otherwise lower emissions themselves.

(8) Total Maximum Daily Load (TMDL) is a program established under section 303 of the Clean Water Act and mandates a written plan for an impaired water body

be developed by the state to ensure that water quality standards will be attained and maintained throughout the watershed or specific segments thereof. The concept is to determine the loading of specific pollutants, from both point and non-point sources, that will allow compliance with the water quality standards, including a margin of safety, and to assign load and waste load allocations accordingly.

(9) Arsenic concentrations in the fly ash from Armstrong Power Station ranged from 170 to 201 mg/kg. Under 25 Pa. Code Sections 287.662-664, a cumulative, arsenic, loading rate of 36 lbs/acre is allowed for this type of beneficial use. That limit translates to approximately 18.6 tons of fly ash per acre.

Larry Myers is the Environmental Policy Director for Allegheny Energy Supply located in Monroeville, Pennsylvania. Over his 29-year career with Allegheny he has held various technical, advisory and management positions in the environmental area. Current responsibilities include developing corporate environmental policy and compliance strategies, working with Federal and State regulatory agencies to develop science based and cost-effective environmental regulations, and directing policy-relevant, environmental research. In 2000, Allegheny's Carbon Sequestration Task Force began exploring means by which they might invest in projects that would position themselves to generate low-cost carbon credits and to fill some of the knowledge gaps associated with carbon sequestration projects in the Appalachian region. He has championed the effort to initiate a pilot carbon sequestration project on previously mined land in Western Pennsylvania which included planting of evergreen seedlings and warm season grasses.

He holds a Bachelor of Science degree in Environmental Administration from the University of Pittsburgh and is certified as a Qualified Environmental Professional (QEP) through the Institute of Professional Environmental Practice. He serves as an advisor on numerous organizations' environmental committees including those of the Electric Power Research Institute, Southeastern Electric Exchange, Southwest PA Ozone Action Partnership, Edison Electric Institute, and just recently joined the Board of Directors of UtiliTree. UtiliTree is a non-profit organization consisting of approximately forty electric utilities across the country that has invested in reforestation projects with carbon sequestration potential of 3 million tons to date.

Illustration A

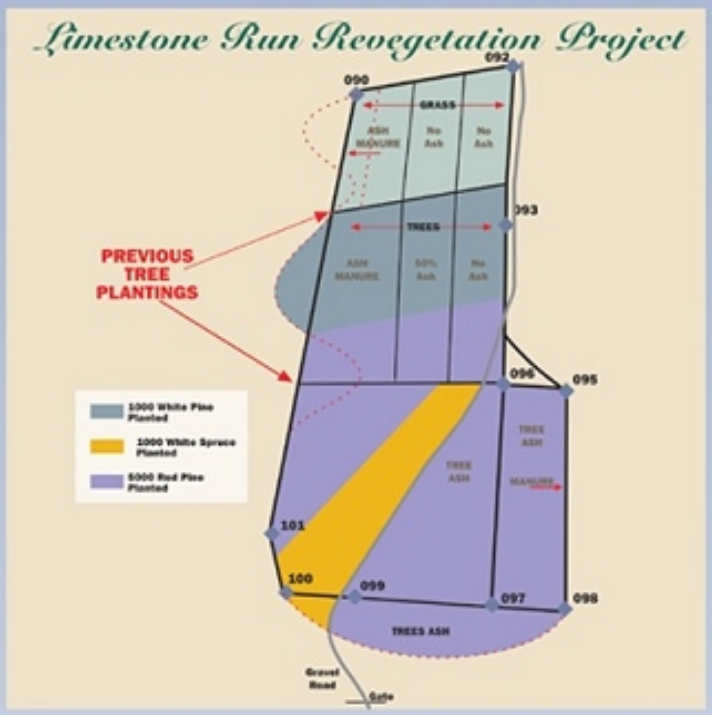

Illustration B

Illustration C

Illustration D

THE OSM/DOE/EPRI JOINT INITIATIVE ON MARKET-BASED MINE LAND RECLAMATION: EDUCATION AND OUTREACH EFFORTS

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Introduction

This paper provides an overview of the OSM/DOE/EPRI joint initiative on market-based mine land reclamation. First, an overview is provided on education and outreach efforts to date, with a brief description of a primer and outreach packet under development. Second, there will be a discussion of efforts to encourage the development of public-private partnerships to apply a market-based approach to reclamation.

The Department of the Interior, Office of Surface Mining (OSM), the Department of Energy (DOE) Office of Fossil Energy and National Energy Technology Laboratory, and the Electric Power Research Institute (EPRI) launched a joint initiative in the spring of 2001 to promote a market-based approach to reclaiming mine lands through reforestation and other reclamation techniques. This approach is based on the emerging field of ecological asset management, in which ecological resources (such as trees, wetlands, and endangered species) are developed and treated as financial assets to their owners.

The OSM/DOE/EPRI effort builds upon a Memorandum of Understanding between OSM and DOE signed in September 2000 that encourages a market-based reclamation approach through reforestation.

Background

For over two decades, OSM has helped landowners and mine operators improve the environmental quality of mine sites by helping them develop post-mining reclamation plans and by funding the reclamation of abandoned mines. OSM's programs have achieved considerable successes; however, challenges remain. There has not been sufficient funding to reclaim all abandoned mine lands (AML) identified (there are approximately 400,000 acres of unreclaimed AML in OSM's national database), and most stakeholders recognize that reclamation on active sites since 1977 has often failed to return sites to productive forest or other ecosystems.

One promising approach to addressing these challenges is the development of ecological assets on mine lands through reforestation and other reclamation techniques. *Ecological assets* are tradable credits that reflect the economic value that stakeholders have assigned to an environmental "service." Today's emerging ecological asset markets include carbon sequestration credits, stream and wetlands restoration credits, water quality credits, and endangered species habitat credits. When the future value of these assets is taken into account, many landowners and operators can find that reclamation practices focused on reforestation and ecological assets are also the most economically sound options.

OSM, DOE, EPRI, and many other stakeholders see significant promise in bringing together these new ecological asset concepts with existing mine land reforestation efforts. The hopeful result will be that more landowners and operators find both economic and environmental opportunity in this approach that will lead to more active and abandoned mines being returned to forest or other productive ecosystems. The joint OSM/DOE/EPRI initiative is encouraging this approach through a variety of activities. These activities are described below.

Education and Outreach

EDUCATIONAL MATERIALS

Two educational documents will be disseminated to all interested stakeholders. This represents the first major effort to bring together mine land reforestation sound practices with the emerging concepts of ecological asset management. Both were created with input from a wide variety of stakeholders.

The first document, a 50-60 page primer, will discuss in some detail how the concept of ecological assets can be applied to the reclamation of Title IV and Title V mine lands. The primer, which will be published in the summer of 2002, will contain the following sections:

- Mine land reclamation background
- Economic value of reforestation
- Overview of ecological asset markets
- Creating ecological assets through reforestation and other reclamation techniques
- Evaluating the potential for ecological asset value on mine land
- Ecological asset case studies on non-mine lands

The second document, an outreach packet with color inserts, will cover the same concepts as the primer, but at a higher level that will be of interest to a broader audience. The outreach packet will be published in May or June of 2002.

An important element of both documents will be the results of a study in which a new EPRI ecological asset decision tool was piloted on TXU mine lands. EPRI's Strategic Ecological Asset Management (STREAM) Model was developed to help landowners compare the costs and potential revenue streams of various land management options that take ecological assets into account. The STREAM model was used to compare various ecological asset options on two TXU mined sites. One site had been previously reclaimed to pastureland; the other site is in the process of being reclaimed. For both sites, the study showed that stream and wetland mitigation credits, carbon sequestration credits, and resulting timber value could potentially produce significant value.

Outreach Efforts

In October 2001, OSM, DOE and EPRI hosted an all-day stakeholder outreach workshop in Washington, D.C. The objectives of the workshop were to inform key stakeholders of the OSM/DOE/EPRI joint initiative and to receive feedback on the initiative and the overall approach. Stakeholders that attended this workshop included: EPRI, OSM, DOE, State mine land reclamation programs, academic institutions, environmental and watershed groups, utilities, and coal companies.

On May 15-16, 2002, the concepts of market-based mine land reclamation was discussed with a much larger and broader group of stakeholders at OSM's interactive forum in Fort Mitchell, KY.

Public-Private Partnerships

Outreach efforts will continue to encourage State/Tribe mine reclamation programs, coal and utility companies, environmental and community groups, academic institutions, and other interested parties to form public-private partnerships to develop projects on both abandoned and active mine lands to share in and demonstrate the potential benefits of a market-based approach.

There is a particularly strong opportunity to apply a market-based approach to AML. One of the major requirements established by the Surface Mining Control and Reclamation Act (SMCRA) was the implementation of a federal tax on coal mining (per ton) to fund the reclamation of AML. Currently, approximately $200 million of these funds are appropriated annually to reclaim AML. Although this is a substantial amount, it is estimated that the total cost of reclaiming the 400,000 remaining acres of AML is in the range of $7 billion.

To help increase the number of AML acres reclaimed over time, the private sector must be provided with incentives to help fund AML reclamation. A market-based approach offers just such an incentive through the potential for developing ecological asset credits with significant value. Thus, encouraging AML reclamation public-private partnerships now likely will lead to more and better AML reclamation in the future.

Craig Diamond is the Product Line Leader in the Environment Division of the Electric Power Research Institute. The Electric Power Research Institute (EPRI) is a 501(c)(3) not-for-profit organization that conducts research & development on a wide range of electricity-related issues. At EPRI, Craig is responsible for exploring and developing new environmental products and services for the electricity sector. Over the last year, Craig has managed the development of EPRI's market-based mine reclamation program, in addition to other new business areas including biomass management and water quality and availability. Craig has over ten years of experience in environmental policy and strategic environmental consulting. He has a Masters in Public Policy from the University of Michigan, and an undergraduate degree in biology from Tufts University

WESTERN PENNSYLVANIA
WATESHED PROTECTION PROGRAM

John Dawes
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Abstract

The purpose of the Western Pennsylvania Watershed Protection Program is to protect or restore Pennsylvania's unique water resources on an ecosystem basis and to foster separate technologies used to preserve and reclaim watersheds.

The Western Pennsylvania Watershed Protection Program started as a donor advised fund through the Heinz Endowments. The purpose was to leverage agency dollars, meaning State programs and Federal programs, through the Departments of Environmental Protection, Conservation and Natural Resources, and Agriculture. Federal grants are from EPA, US Army Corps of Engineers, and the Department of Interior. Each of these entities has grant programs for environmental preservation and restoration, some of which were unused.

At the time of the program's inception, passive technologies to treat abandoned mine drainage were just being developed. Previously, the departments were utilizing industry-designed treatment of Acid Mine Drainage. These installations were very costly and required large budgets for maintenance. Watershed association volunteers can maintain passive treatment systems.

Project Areas

FRENCH CREEK PROJECT

The French Creek Project is a large -scale preservation effort in partnership with the Western Pennsylvania Conservancy and the Pennsylvania Environmental Council. Brian Hill has led this project to promin ence through the garnering of local and national resources to preserve what the Nature Conservancy calls its "Last Great Places."

One of the Nature Conservancy's "Last Great Places" because of its biodiversity and endangered species

Volunteer hours are part of the leverage formula in this project and Brian has received a Kellogg Foundation grant to complete an unfunded roster of agricultural BMPs in the watershed. This program has won numerous State and national awards. The biodiversity of the watershed is unique, with 86 species of fish and 26 species of freshwater mu ssels and clams including Clubshell Mussels, a Hellbender Salamander, and a Snail Darter.

CLARION RIVER

Headwaters Charitable Trust was among the first of the environmental groups to utilize passive treatment systems for the remediation of abandoned mine drainage. They were successful in leveraging agency dollars with small grants from the Program and their designation of the Clarion as a Wild and Scenic River gave them notoriety among those reviewing proposals. The remediation of AMD along tributa ries to the Clarion brought back to life miles of this great river.

Aluminum discharge

Grant funded a demonstration of passive treatment of Acid Mine Drainage on a tributary to the Clarion.

Construction of SAPS
(Successive Alkalinity Producing System)

View of SAPS after completion

Program Grant leveraged $200,000 from RAMP, DEP and local private foundations

WILSON RUN

Sewickley Creek Watershed Association has taken on a variety of restoration projects, which affect the citizens of this area around Greensburg, Donegal, and Youngwood, PA. Rather than acid mine drainage, many of the discharges in this watershed are alkaline, and the technology used for remediation requires aeration. Tom Keller aptly leads the watershed association.

Alkaline discharge on Wilson Run

Type of discharge requires aeration device
to oxygenate the water.

Need for settling pond
Baffle system provided by Bayer Corporation

POWDERMILL NATURE RESERVE

Loyalhanna Watershed Association is well organized and, being thirty years old, is a good example to newly forming groups. They have been instrumental in the preservation of the Ligonier Valley and took on a restoration project at the Friedline Mine, which was ironically located on the grounds of Powdermill Nature Reserve. This highly toxic discharge impacted seven miles of Loyalhanna Creek. A passive treatment system is working well after some design changes and has leveraged much support from the organization's membership.

Constructed SAPS to remediate small but toxic discharge Grounds of Carnegie's Powdermill Nature Reserve

PA CLEAN WAYS

PA CleanWays had a unique start in 1989, when founder Sue Wiseman was out riding her horse and couldn't get him to cross some debris, which was on their trail. The cleanup resulted in the loading of 16 truckloads of trash being taken to a landfill in Westmoreland County. Since then, county chapters have been formed, mainly throughout the western part of the state. Program grants are for $10,000 for the starting up of chapters, and this includes funds for office setup and liability insurance for cleanups. R.K. Mellon Foundation has set up a large grant for the statewide office to distribute to county chapters for ongoing support.

most illegal dumps are streamside

volunteers and members pull debris from streams

PINE CREEK VALLEY

Pennsylvania Environmental Defense Foundation does its best work in the beautiful Pine Creek Valley, home of Pennsylvania's Little Grand Canyon. Ably led by Robert McCullough and Jim Barr, this group has done an outstanding job of leveraging DCNR funds in particular. AMD abatement along Babb Creek was done through a very large constructed SAPS (Successive Alkalinity Producing System) as the chosen technology. The fact that this watershed is not under development pressures allows for the uniq ue opportunity to completely restore the waters of the region.

construction of large SAPS

accompanying limestone diversion wells of Swedish design

ST VINCENT COLLEGE

AMD remediation design, campus of St. Vincent College

Monastery Run flows through the grounds of St. Vincent College, and for yea rs the degraded waters from underground mining deposited iron oxide and other heavy metals in this watershed. The settling ponds for this treatment system allow for a unique biological outdoor classroom for the students of St. Vincent. The various cells host sequentially acid-tolerant plant material and these species can be identified and tested by the student body. Skills in water quality monitoring have been incorporated into their curriculum.

Mesocosm - settling ponds with diversion cell and acid tolerant plantings

The students came up with the unique vocabulary for the treatment system—mesocosm, which I suppose means "intermediate world" or could mean intermediate treatment system.

INDIAN CREEK HEADWATERS

Mountain Watershed Association is a good example of a citizens group, w hich has formed around an immediate issue. Located in the headwaters to Indian Creek, this group has tackled horrendous issues of subsidence and the after -effects of underground and surface mining in the watershed. These activities have not only undermin ed the watershed, but also land and property values and in some ways the cultural heritage of the region. Led by Beverly Braverman, a lawyer by training, this group has accessed every funding resource, from departmental agencies to citizen's coal councils to Catholic Charities. They have taken ownership and the liability of high - flow discharges, which they are successfully addressing through a variety of unique technologies.

once a field, now an AMD bog

The windmill installation for the ae ration of iron oxide in their settling pond was done prior to the availability of sustainable energy funds, and I'm sure that they will access this resource in the future.

Alkaline discharge needs aeration device – windmills

DICKINSON COLLEGE

The Alliance for Aquatic Resour ce Monitoring (ALLARM) is located on the campus of Dickinson College, Carlisle, PA, and is a significant resource provider in the Statewide Keystone Monitoring Network. Protocols to address specific problems are set up by this organization and lab support provides quality assurance and control (QA/QC). The group provides training in stream characterization, biological assessment, and water chemistry monitoring. Our grant to them specified that they work to provide training to grantees of the Western Pennsylvania Watershed Protection Program, helping one group in particular with their DCNR Rivers Conservation Plan.

PROJECT GRASS

Working with farmers on a county-by-county basis, Project Grass teaches and implements rotational grazing systems for livestock . They emphasize spring development and streambank stabilization, and they have demonstrated that a longer grazing season cuts down on feed costs and that clean water accessed from springs leads to better animal health. This group is similar to PA CleanW ays in that they are organized structurally on a county-by-county basis.

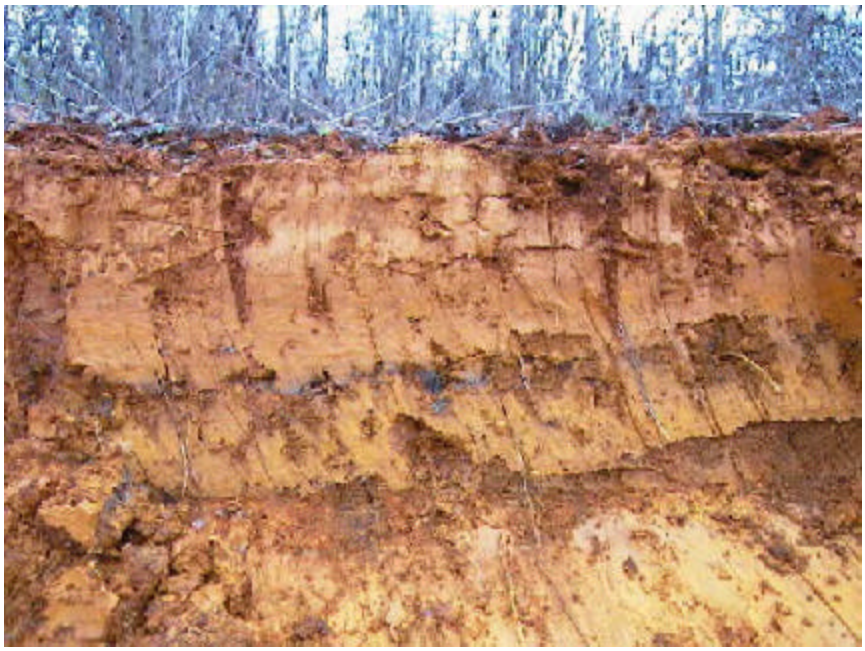
RESOURE RECOVERY CONFERENCE

Resource Recovery is an example of collaborative grant making with a larger entity. Heinz Endowments made a large grant to the Southern Alleghenies Conservancy and Concurrent Technologies Corporation (CTC) for the assessment of metals loadings on the 101 worst discharges in the western part of the state. This inventory, utilizing AmeriCorps staff, revealed that 26 trace elements are in abandoned mine drainage, including of course iron oxide and aluminum, but more obscure metals including gallium, strontium, and gold. The small grant for the conference provided the setting for technologies to be demonstrated from around the world for metals separation from abandoned mine drainage. To offset the operations and maintenance costs for treatment systems, it is hoped that one day these separated metals will have real commercial value.

IRON ORE RECOVERY AT LOWBER DISCHARGE

As an example of Resource Recovery at work, Sewickley Creek Watershed Association, in partnership with Hedin Environmental, has tackled the Lowber Discharge, which has resulted in a 70-year deposition of iron oxide next to Sewickley Creek. This is a 1700-gallon per minute discharge that dumps 600,000 pounds of dissolved iron per year, which seriously degrades Sewickley Creek. There is a 600-foot ditch, 40 to 60 feet wide and 3 to 4 feet deep, filled with iron oxide. While this iron oxide is very wet, it is of the quality that it can be used by industries needing mined iron oxide and needs only to be de-watered. The group is in receipt of a Growing Greener grant, and Secretary Dave Hess made this site one of his stops on his 48-county tour of GG projects.

Cross section of iron sludge deposit



50% solids filter cake
Delivered to pigment company

Cleaned out
Lowber Channel

600,000 pounds of iron per year prevented from entering stream

BOALSBURG MILITARY MUSEUM

Clearwater Conservancy is another issue -based watershed association, which is addressing water quantity and quality issues in the community around State College, PA . Erosion in the headwaters of Spring Creek resulted in the degraded stream banks at the Boalsburg Military Museum. The replanting of the riparian zone at this highly visible site provided the opportunity for volunteers to keep sedimentation out of the s tream, keeping this a reproducing trout fishery. This work has led to other projects, including a complete characterization of the entire watershed, and it is interesting to note that water supply issues do not allow for continuance of the rate of develop ment of growth in this watershed.

Streambank stabilization project along the headwaters to Spring Creek, a native trout fishery

OVEN RUN PROJECT

Oven Run Project in Somerset County was the largest budget passive treatment system built. This series of SAPS (Successive Alkalinity Producing Systems) were constructed after the removal of enormous spoil piles, bony piles, and gob piles, whatever they might be called. It must be remembered that these gob piles produce AMD themselves each and every time it rains. Angelo Ciotti, who previously had worked on the artful T win Stupas project in Butler County, led the project. This was another large -scale abandoned mine land reclamation project.

COOKS RUN

Cooks Run is located in the Kettle Creek watershed, and a surface mine has severely degraded the stream, which, upstrea m, is a reproducing trout fishery. Trout Unlimited members and members of the Kettle Creek Watershed Association are determined to bring this stream back to life once again. Utilizing a unique design for a SAPS, a consulting firm designed a unique system utilizing wood chips mixed with limestone, instead of using mushroom compost in a layer for the carbon source. A program grant paid for the bench scale test of this design, so as to leverage $130,000 for implementation from the Department of Conservation and Natural Resources. This project came to the Program through Dr. Colson Blakeslee, who fishes in the region and was one of the original founders of Pennsylvania Environmental Council.

Cook's Run in Sproul State Forest

CHESAPEAKE BAY DRAINAGE AREA

Alliance for the Chesapeake Bay is concerned primarily with the Chesapeake Bay drainage area, needless to say. This project is located in the Juniata watershed, under the purview of the DCNR Rivers Conservation Plan conducted by the Juniata Clean Water Partnership. This riparian planting project has two components: (1) to implement agricultural best management practices on dairy farms, keeping cows out of the stream through stream bank fencing; and (2) a riparian planting project, utilizing plants that can

be used by the flower trade for arrangements. Both of these practices keep sediment out of the stream, ultimately improving the health of the watershed and the Bay.

Funding

The Western Pennsylvania Watershed Protection Program received the Three Rivers Environmental Award in 2001 in the Environmental Organization category. In its eight years of existence, the Program has made over $2 million in small grants, resulting in $22 million in environmental restoration projects. There are over 70 grant making programs in DEP alone, and WPWPP has been most successful in helping watershed organizations to access these funds. Growing Greener – $650 million in state funding — has been an enormous boost to environmental organizations in their cleanup efforts. Since Growing Greener's beginning up to now, the Western Pennsylvania Watershed Protection Program has been the largest single source for match money for this program.

The Program also received a Governor's Award for Watershed Stewardship in June, 2001, along with 12 grantees of the Program. This was in the category of Partnerships. Each of these successful projects spoke well of the Program. With the cost of reclaiming Pennsylvania's abandoned mine lands estimated at $15 billion, WPWPP funds unique installations to improve current technologies or invent new ones to treat abandoned mine drainage. Through passive treatment systems, the group hopes to eventually reduce the cost of treating abandoned mine drainage.

With leveraging of funds being a key component of the Program, WPWPP was instrumental in having DEP fine money donated to POWR, the Pennsylvania Organization for Watersheds and Rivers. Both POWR and the Western Pennsylvania Watershed Protection Program were chosen to introduce the Growing Greener initiative to watershed associations, municipalities, schools, and other potential grantees.

Abandoned mine drainage continues to be an important part of the Western Pennsylvania Watershed Protection Program's budget. To date, Program grants have brought back to life 305 miles of stream. Riparian planting projects by volunteer groups have resulted in 120,000 feet of natural stream buffers.

Coldwater Heritage Fisheries grants will continue to be an emphasis of the Program, in partnership with DCNR. Working within the guidelines of the Clean Water Act, the goal is nothing less than to return Pennsylvania waterways to swimmable, fishable, drinkable status.

John Dawes is the Administrator of the Western Pennsylvania Watershed Protection Program. He has supervised small grants to over 100 environmental restoration and preservation projects throughout the region. The intent is to provide seed money to allow a local group to access agency funding through the Dept. of Environmental Protection, the Dept. of Conservation and Natural Resources, the Environmental Protection Agency and the US Army Corps of Engineers. This has resulted in over $22 million in project cost.

Previously he was a consultant to the Heinz Endowments Environment Program where he supervised grants to regional watershed groups pursuing a DCNR Rivers Conservation Plan. Other duties included participation in sustainable forestry round tables, and the facilitation of a Statewide watershed advocacy group called POWR-the Pennsylvania Organization for Watersheds and Rivers. His professional affiliations include: Commissioner on the Governor's 21st Century Commission on the Environment; Board member on Penn Future; Board member on the Progress Fund; President of the Board of the Pennsylvania Organization for Watersheds and Rivers. He is the author of a research paper on the value of planted riparian zones resulting in the funding of the largest privately funded initiative for streamside planting in the State. He is a graduate of Pennsylvania State University with a M.Ed.

FOREST PRODUCT TRENDS AND LEGISLATIVE INITIATIVES

Ron Hufford
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Abstract

The forests of our thirteen southern States continue to represent over 50 percent of the land area in the South. The largest ownership is in the hands of private non-industrial landowners who own 142.6 million acres. These are individuals who own forestland and who are not in the business of manufacturing the raw material into paper or wood products. The timber industry owns 36.9 million acres, and 25.3 million acres are in the hands of Federal, State and local governments.

In the early 1900s, the southern forests had been cut without regard to the future of the resource. Since then, extensive planting and research efforts have restored the forests; they are now being grown and harvested on a sustainable level. Programs such as the American Tree Farm System and the Sustainable Forestry Initiatives program are stewardship programs that require landowners, the forest industry, forest land managers, and logging contractors to harvest responsibly, reforest promptly following a harvest, and include environmental decisions in land management practices.

Changes have occurred over the past century in the way we grow and harvest our forest resource; in the quality of the production of paper and wood products that are consumed on a daily basis; in our domestic and international markets; and with increasing Federal, State and local regulations. The forestry community across the South has risen to the call for change in the past and will continue to meet the long-term needs of a viable forest-products industry while also providing wildlife habitat, watershed protection, and recreational opportunities for generations to enjoy.

Questions

- How is our industry doing?
- Are we running out of trees and how many trees are we planting annually?
- What are the critical issues facing forestry in the new century?
- What Stewardship programs are in place to ensure healthy forests for the future?
- In Texas, I get asked what State laws are in place to provide stewardship incentives for landowners?
- Are we good stewards of our forest resource?
- Can a landowner make money grow on trees?

Southern Commercial Timber Resource

The largest ownership of our forest resource is in the hands of the Private Non-industrial Landowners who collectively own 70 percent of the 205 million acres of forestland in the Southern US. Industry owns 18 percent and public ownership is 12 percent. The forest management decisions of the private sector are the foundation of the south's future forests.

Southern Forest Resource Assessment

This is the first in-depth study that provides an up to date and an accurate look at the status of our Southern Forests. This was a 2 and a-half year study that involved hundreds of scientists and researchers and again this reports findings show that the forests of the future rest with the decisions that will and are being made from the private sector.

Good News

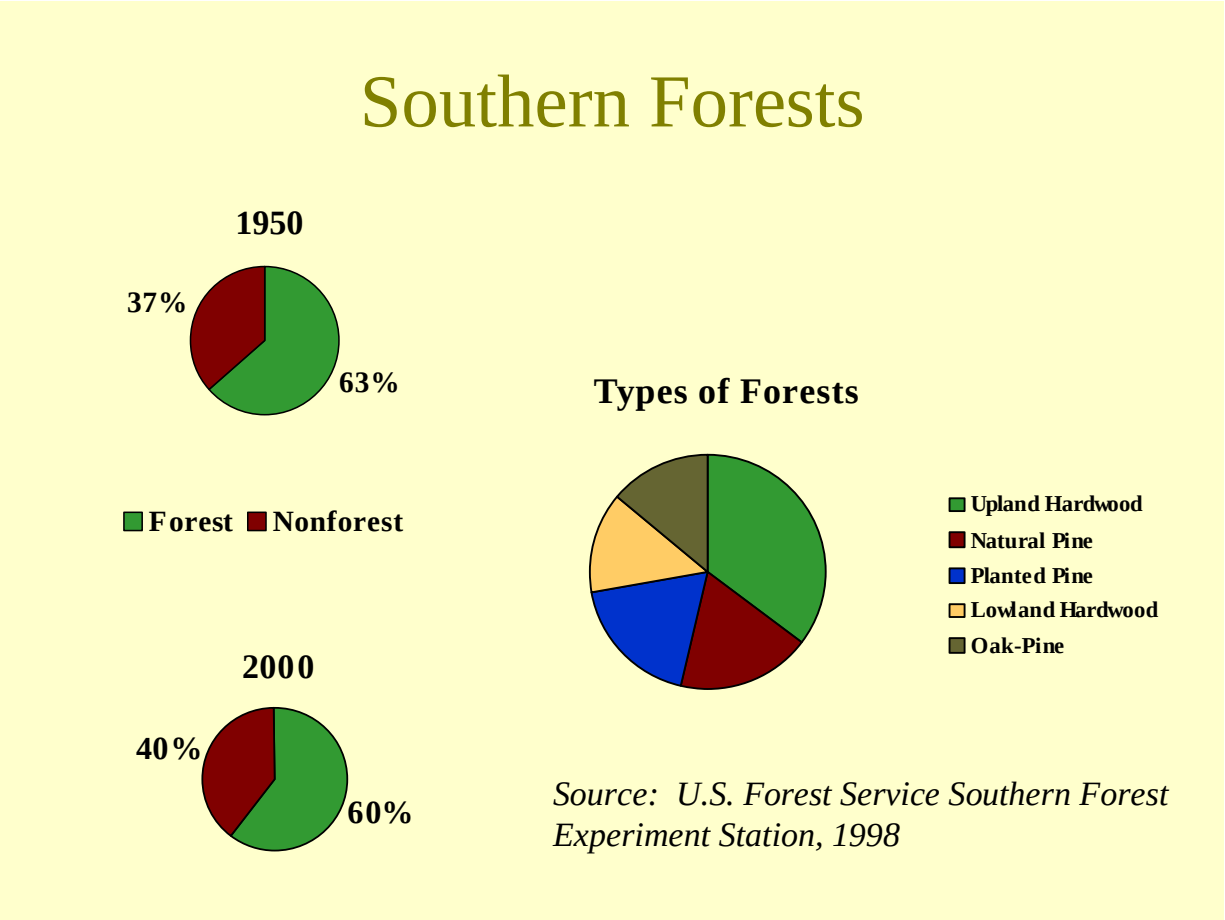
The Southern Forests are healthy and in many States they are reclaiming farmland and expanding. Forest regeneration and growth have expanded inventories by 73 percent since the 50's and inventories are projected to increase through 2040 as growth is expected to exceed the annual removals.

The report also points out that economic incentives for landowners are needed to discourage the conversion of land to non-forest uses.

Areas in the eastern southern States will see expanding urbanization as threats to forests not harvesting as some of the preservation groups pretend.

Southern Forests

Our southern forestland base has remained relatively stable over the past 50 years with a relatively even distribution of the forest type.



Forestry Tax Incentives Passed in Texas

Texas has a timber productivity and agricultural productivity tax and in the past landowners who converted agricultural lands to forest lands saw a four to five fold increase in their taxes the year following tree planting. In 1997, the Texas Legislature passed a bill allowing landowners to maintain the lower agricultural values for 15-years on open-spaced land that was converted to trees. This has already shown an increase in the acres being planted. The first year the bill was in effect over 20,000 acres of open land planting was accomplished which was a 50 percent increase over previous years.

In 1999, the Texas Legislature passed a bill to provide tax incentives to landowners to plant following a timber harvest. This bill provides a 50-percent tax reduction for 10 years from the date of harvest thereby encouraging landowners to reforest. Other provisions of the bill include

changing the State law to give timber the same tax advantages as agriculture and other incentives that will be discussed later in the presentation.

Tree Planting Success

This chart shows the success of the trees planted up to 1995. The Soil Bank program of the mid to late 50's and the Conservation Reserve Program acres planted in the late 80's were certainly programs that provided incentives for landowners to invest in the tree growing business. Tree planting on public lands is decreasing and while industry and private individuals continue to lead the way with tree planting successes. However, while this chart does not contain the most recent years the Texas tree planting numbers show a decrease due to back-to-back years of drought and uncertainty in the markets.

Farm Bill

The newly passed Farm Bill includes for the first time a section for forestry.

The Stewardship Incentives Program (SIP), which was never adequately funded, and the Forestry Incentives Program (FIP) are replaced with a new title -- Forest Land Enhancement Program (FLEP) that provides over $100 million in spending over the next 6 years.

The new legislation expands the forest landowner's eligibility to participate in Federal programs such as Environmental Quality Incentives Program (EQIP).

FLEP will cost share with tree planting management plans, protection of Streamside Management Programs (SMZ's), wildlife enhancement, and the health of the forest.

TRe Foundation

TRe was established in 1981 to assist private landowners with their tree planting. This is a private foundation which is supported by the wood processing industry and others such as TXU Services who are interested in the need to help private landowners with the up front expenses. TRe has planted over 177,000 acres contributing over $7.8 million. Requirements are that the person receiving the funding not be in the lumber manufacturing business, not own more than 1,000 acres of forestland or less than 10 acres and agree to maintain the acres planted in trees for 10 years. The Board of Directors is made up of a representative from all of the contributing industries, private landowners, the State Forester, and the Executive Vice President of the Texas Forestry Association.

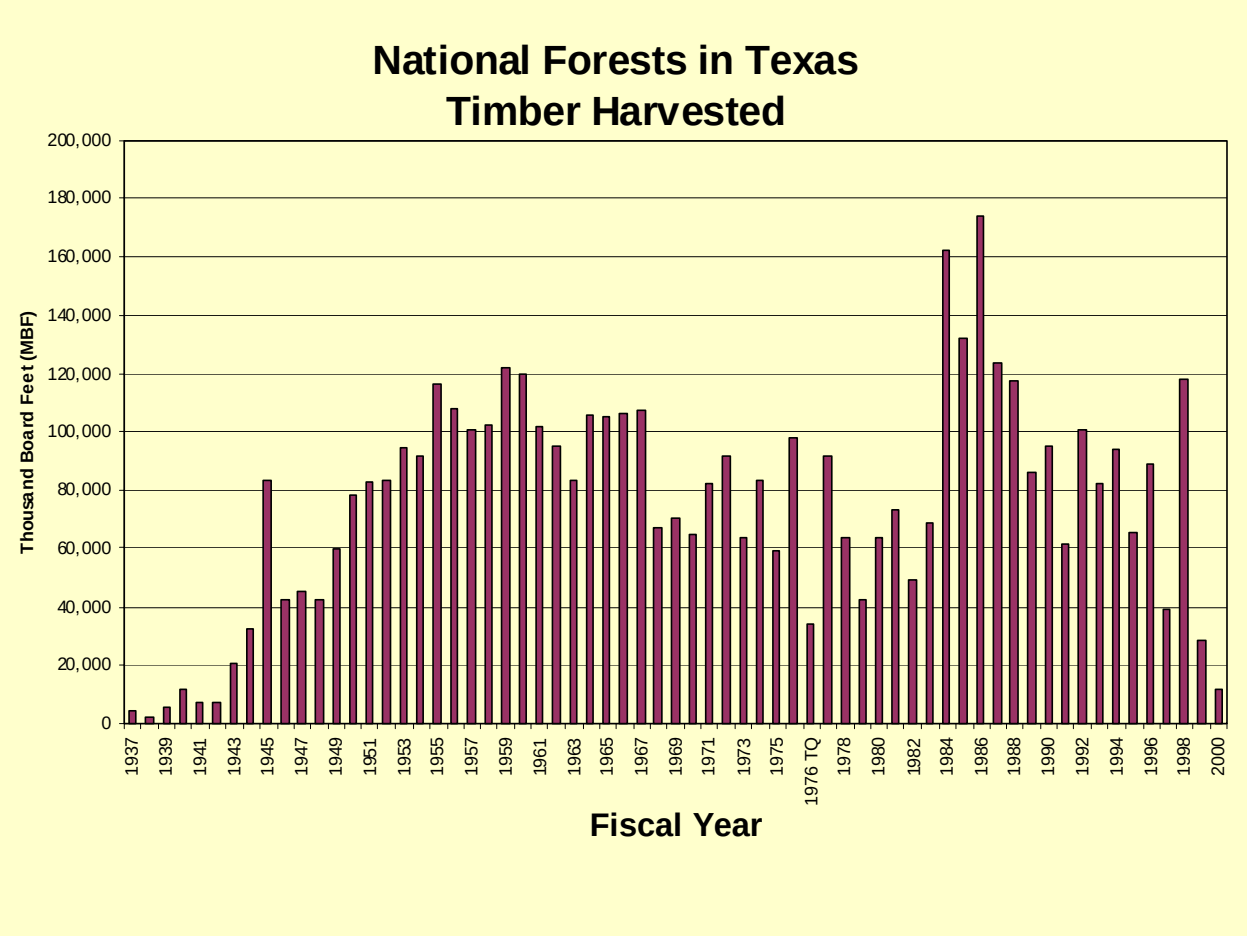
Public Ownership

Forestlands under public ownership have become the pawns of the preservationist groups through increased Federal laws and regulations. Texas' NF's have all but been shutdown over the past 5 years and the forest supervisor is under one Judge's Order to manage for the Red Cockaded Woodpecker (RCW), while another Federal Judge has called a halt to all timber sales on Texas' NF. Meanwhile the health of the public forests as well as adjoining private forests are at risk as has been seen with the devastating wild fires across the country and the insect damage that has destroyed tens of thousands of acres of Wilderness that the preservationists fought to set aside just 10 years ago.

Spotted Owl

The placement of the Spotted Owl on the endangered species list in the early 90's basically brought a halt to logging on the public lands in the Pacific North West as 75 percent of the timber sale program was discontinued. How did that impact the Southern forests? In '91 the delivered log prices in Texas were $455 million and the stumpage prices around $288 million. In '92, post Spotted Owl, stumpage prices increased in Texas 39 percent to $402 million and delivered values were up 63 percent to $726 million. Over the past 2 years, the delivered values have exceeded $1 billion.

National Forests In Texas



This chart shows the volume of timber harvested off the Texas National Forest over the history of those lands. These lands where cut over and poorly stocked. As you can see the inventory has grown and, with management, the National Forests were able to harvest timber and return revenues to the counties. In the 90's, the Texas National Forests netted between $7 million and $11 million of which 25 percent was returned to the counties. The line in 1998 that shows a definite increase in the timber sale program is not because of an aggressive timber sales program. It is, however, the end result of a sever and devastating windstorm that in the course of one afternoon blew through portions of East Texas and leveled over 500 million feet of timber. In the storm's path were trees on the National Forests that accounted for around 300 million board feet of lumber. As you can see almost half of the fallen timber was harvested at a sale of $22.7 million and a return to the government of over $10.4 million. Again 25 percent went to the counties.

With the locking up of the public lands, that has reduced revenues, local governments have turned to Congress for help and a bill was passed last year that allows the counties to take the

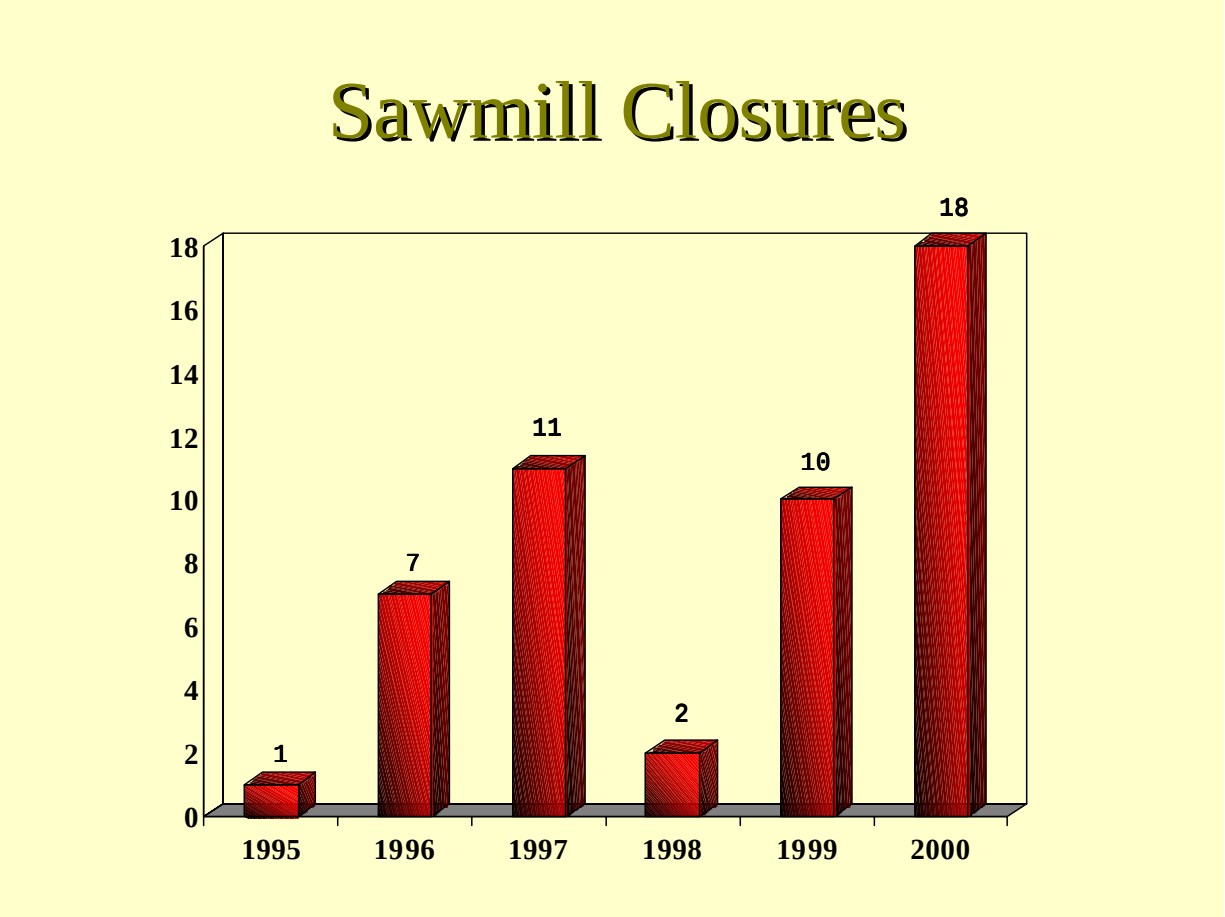
average of the best 5 years. Funding comes from the Federal treasury. The loss of jobs and the health of our public forests are on the losing end of this legislation.

Sawmill Consolidation

The South accounts for 58 percent of the total US wood production and almost 16 percent of the World's production. In 1997, there were more than 700,000 jobs and $118 billion in industry output from the forestry community.

Sawmill Closures

Why are we seeing today's mill closings? Uncertainty of future markets, increasing environmental regulations, and associated costs. In Texas, we have almost lost our pulpwood industry and the uncertainty of the National Forests for future supply does not lend to encouraging investments by the independent mills.

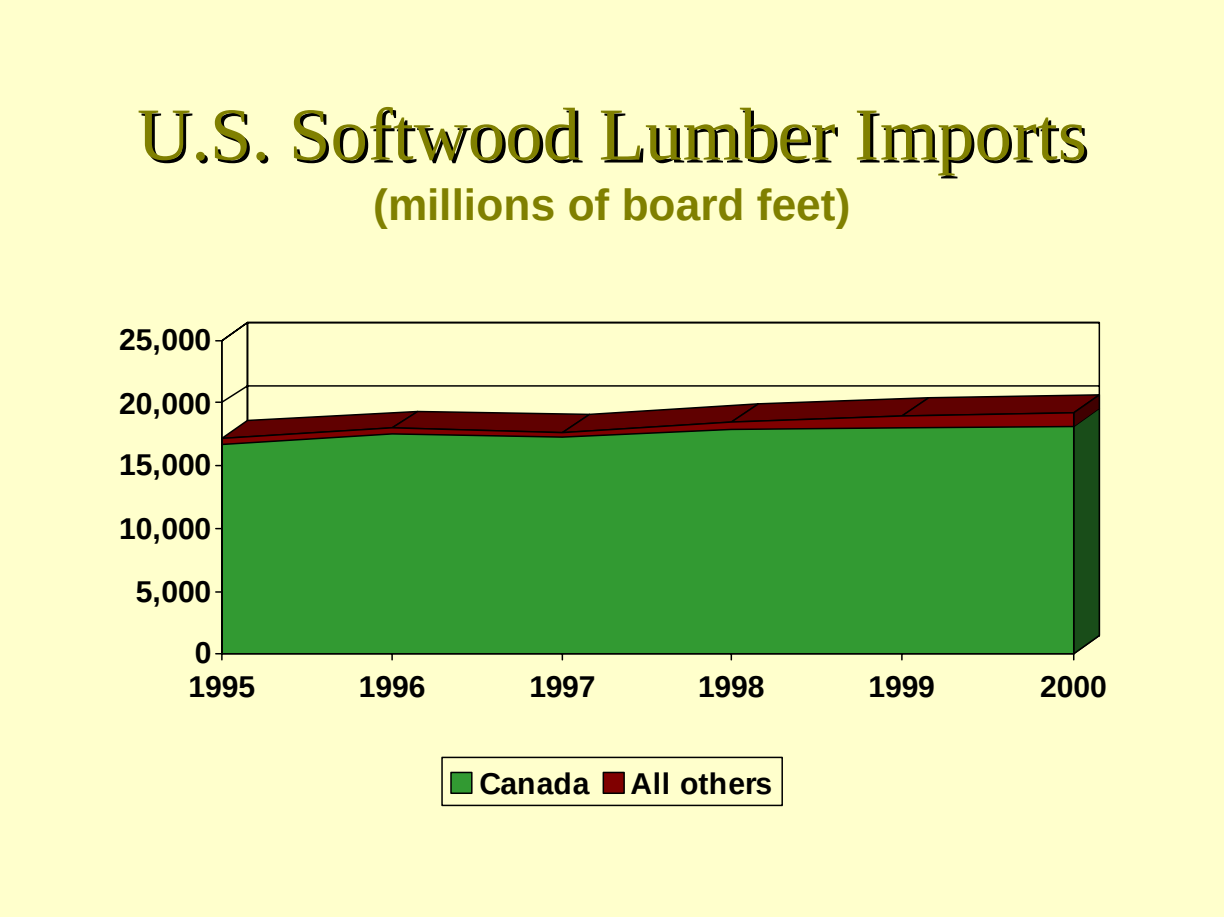


Production Capacity

Current lumber production capacity is 18.5 billion board feet. By 2004, capacity will rise to a projected 20 billion board feet.

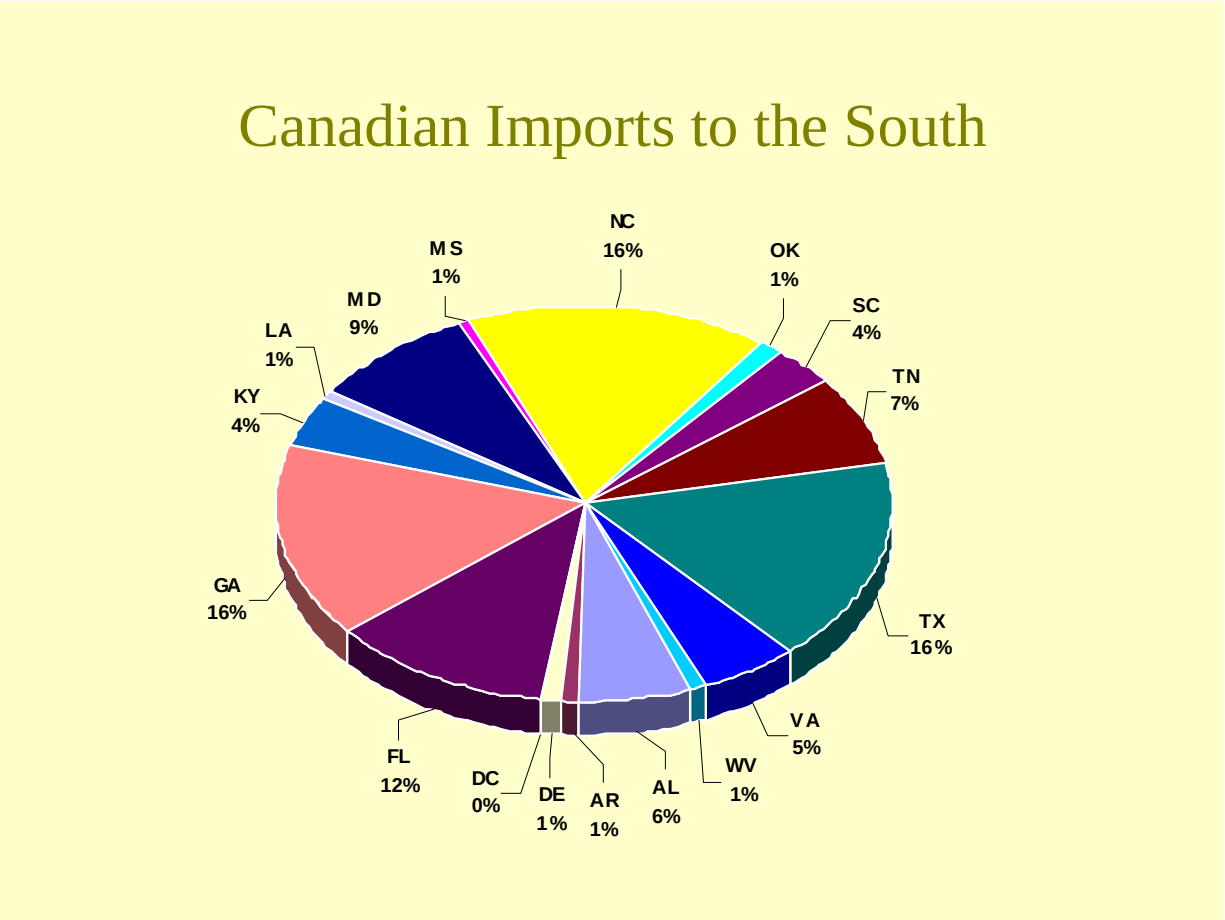
U. S. Softwood Lumber Imports

Canada supplies about 33 percent of the lumber used in the US. The Softwood Lumber Agreement (SLA) in 1996 stopped the imports at this level and helped maintain stability. The agreement expired in 2001 and recently the Department of Commerce has ruled that unfair trade practices exist and has placed a 27 percent tariff on Canadian Softwood Lumber.



Imports to the South

In 99, Canada exported 5.8 billion board feet that represented 32 percent of the total volume. In Texas, Florida, Georgia and North Carolina the imports totaled 60 percent.



CCA Treated Lumber

Chrome, Cooper, Arsenate is a water treatment that has been approved by EPA for over 40 years. Over the years, CCA has been used increasingly in the home improvement markets for decks, fencing, playground equipment, and other uses where lumber is exposed to weather conditions. In 2000, 6.6 billion board feet of Southern Pine went through the treating process. This represents approximately 40 percent of the annual Southern Pine lumber production. The future of this chemical is non-existent, as the chemical companies and EPA have agreed to phase the use of CCA treated lumber from all non-industrial applications. At this time, there are a couple of alternatives that are being marketed, however, the performance of these new products and the associated cost are still very much in question. At issue is a legal challenge that product labeling has not been conducted properly to notify the consumers of potential hazards of CCA.

Stewardship Programs

So what are we doing to be good stewards of our forest resource?

Sustainable Forestry Initiative

The Sustainable Forestry Initiative (SFI) program is a land stewardship ethic program that was initiated in the mid '90's by the American Forest & Paper Association. AF&PA requires all of their member companies to sign on and agree to the guidelines and the principles of the SFI program. SFI also requires an annual report to measure the accomplishments of the program.

TRAINING PROGRAMS

In Texas, Texas Forestry Association serves as the State coordinating committee to oversee the SFI program. The committee is made up of the participating companies, State forestry commission, landowners, consulting foresters, loggers and conservation organizations. Forest managers, and logging contractors and their employees attend workshops to be recognized as trained in the SFI principles. These workshops include training in Best Management Practices, Silviculture/Wildlife/Wetlands and Endangered Species, Safety and Aesthetics & Communication. Once a logger or forester complete all of the classes, they are presented a Pro-Logger Certificate and in order to maintain that designation must attend a required number of hours of continuing education credits on an annual basis. While each State's program may vary, the core components of the training are standard. How is the program working? The Texas Forest Service has just completed their 4th Best Management Practices monitoring report that shows 88.6 percent compliance. The USFS was on top with 97.9 percent compliance. Industry was next with 94.2 percent compliance and the private landowner followed with 81.2 percent compliance. The Texas Forestry Association also maintains all of the training data on the associations web site where foresters and landowners can check on a person's training status 24 hours a day.

INCONSITENT PRACTICES

The SFI program is educational and not regulatory however we have developed an inconsistent practices program to respond to any calls about poor logging practices. The Texas Forestry Association maintains this program and a 1-866 number is publicized.

Texas Laws

In '99, the Texas Legislature also passed provisions to provide tax incentives to private landowners who leave SMZ's along streambeds, leave critical wildlife habitat, leave aesthetic areas and leave historical or special areas. The law provides for up to a 50-percent tax incentive and all requests receive final approval from the Texas Forest Service if the local appraisal district has a problem with the request of the landowner. These areas may allow for timber harvesting however they are not to be intensively managed.

Tree Farm Program

The Tree Farm Program began in 1941 in Washington State on land owned by Weyerhaeuser Co. In 1942, Alabama became the first State to initiate a Statewide tree farm program and in 1944 the program came to the lone star State. The program requires landowners to have a forest management plan, provides and requires training for the inspector foresters, and requires that tree farms be reinspected every 5 years.

Case Study

In 1982, the Texas Reforestation Foundation funded a 243-acre tract of land just outside of Kirbyville, Texas. The ownership of the land is in the name of L. Cartwright Production Co. and is managed as a family estate. The total ownership is 3,572 acres. The stand was approximately 60 years old in 1980. In 1981, the 243-acre tract in this study was clear-cut and the site received a site preparation burn prior to planting the seedlings in 1982. A total of 716 trees were planted per acre and, in 1984, it was determined that the survival rate was 551 trees per acre.

LOGGING - CLEARCUT

1982 PLANTATION IN FALL 1982

1982 PLANTATION IN 1989

In 1995, the stand was 13 years old with a standing pine inventory of 10,117 cords or 41.6 cords per acre. The average diameter of the trees was 7.4 inches DBH. A cord of wood is 4-foot x 4-foot x 8-foot or 128 cubic feet. The average size home of 2,000 square feet uses 15,824 board feet of lumber (about 32 cords of wood) and 10,893 square feet of panel products (about 12 cords). The initial investment to site preparation and planting the site was $16,000 from the Cartwright's and $7,937 from TRe Foundation for a total of $23,973 or $98.65 per acre.

The site was thinned in 1995, 16.2 cords of wood per acre was harvested and 312 trees per acre removed. The remaining volume of timber following the harvest was 6,205 total cords or 25.5 cords per acre and 220 trees per acre. The Cartwright's received $481 per acre for their timber from this initial thinning.

HARVESTING 1982 PLT. 1995

1982 PLT. LOGS

1982 PLT. AFTER HARVEST
1995

A second thinning was performed in 2001, 19 years from planting. The average diameter after 19 years of growth was 9.8 inches DBH and at the time of the second harvest there were 218 trees per acre with a standing pine inventory of 8,510 cords or 37 cords per acre. This stand grew 11.5 cords of wood over the 6-year period from the initial thinning in 1995. The second thinning operation removed over 10 cords per acre. The result was approximately 90 trees per acre and returned $387 per acre of income to the landowner.

1982 PLANTATION IN 2001

In summary, the 243 acres of natural standing timber that was harvested in 1981 at 60 years of age had a total volume of 535 million board feet. In 1995, the standing inventory after the first thin was 322 million board feet. In 2001, the estimated standing inventory after the second thin was just over 1 billion board feet. The point is that after just 19 years the inventory of saw timber volume doubled from the original natural stand. The remaining inventory will be managed for a final harvest that is projected for 2017.

Ron Hufford is the Executive Vice President of the Texas Forestry Association. Previously he was affiliated with Southern Forest Products Association, New Orleans, Louisiana; joined SFPA as Mid-Western Field Representative, elevated to director of Field Services, and later named as Vice President of SFPA's Forest Resources and Environmental Division. He holds a B.S. Degree in Forestry from Southern Illinois University and is a graduate of the Institute for Organization Management in Norman, Oklahoma.

ENHANCEMENT OF TERRESTRIAL CARBON SINKS THROUGH RECLAMATION OF ABANDONED MINE LAND IN THE APPALACHIAN REGION

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Nagodoches, Te xas

Abstract

The increase of carbon dioxide in the atmosphere and its possible greenhouse effect on global climate has become one of today's major environmental issues. Industries that emit high levels of carbon dioxide are interested in mitigating the damage by having private landowners sequester carbon in trees. Analyses were conducted to 1) calculate the profitability of planting and managing forests on abandoned mine lands for the dual products of timber and carbon storage, 2) calculate the total am ount of carbon that can be stored and 3) determine the average cost of sequestering carbon. Red oak (*Quercus rubra*) was selected for investigation because it is well -suited for these sites and is commercially valuable. Variables included site indices ra nging from 40 to 80 (base age 50), alternatives rates of return ranging from 2.5 to 15 percent, and a range of costs for site preparation and values for each ton of carbon stored. Stumpage prices of saw timber and pulpwood varied by state. Analyses were performed for Pennsylvania, Ohio, West Virginia, Kentucky, Tennessee, Virginia and Maryland. Results indicate that as site quality increases and real alternative rate of return increases, the average cost of sequestering carbon decreases. The profitability of forest management increases as the assumed market price of carbon increases.

Background

The Earth's climate is predicted to change because the combustion of fossil fuels is adding greenhouse gases to the atmosphere. The major greenhouse gases are c arbon dioxide, methane, and nitrous oxide. Since the beginning of the industrial revolution, CO_2 has increased nearly 30 percent, methane has doubled and nitrous oxide has increased 15 percent. If greenhouse emissions are not curtailed, the effects on th e United States could be significant. Global temperature could increase 1.5 ^{0}C to 6^0 C by 2100, soil moisture is likely to decline in many regions, evaporation will increase, intense rainstorms are likely to become more frequent, sea level is predicted to rise almost two feet along most of the U.S. coast, and deserts are expected to expand into existing rangelands. If regional climates do change, it could alter forests, crop yields, and water supplies.

Protecting our ecosystems from the negative effects of global warming is critically important, especially to agriculture and forestry. Analyses have shown that agricultural losses caused by global warming could exceed $14 billion per year, and forestry losses could exceed $4 billion.

The United States contributes 25 percent of global carbon dioxide emissions and has only 4 percent of the world's population. The country needs to reduce the amount of carbon dioxide in the atmosphere. This can be done in four ways:

1) Pass laws and regulations to restrict the use of fossil fuels.
2) Severely tax the use of fossil fuels.
3) Develop technologies that will reduce CO_2 emissions at their source.
4) Remove CO_2 from the atmosphere and store it.

Drastically limiting the use of fossil fuels will cause higher prices for energy, massive unemployment, inflation, and the potential disruption of the U.S. economy. Imposing high taxes on fossil fuels also will disrupt the economy. Developing alternative energy sources and ways to more cleanly burn fossil fuels is a solution to the problem. Yet, until those sources and technologies are developed, we must search for ways to remove carbon dioxide from the atmosphere and store it somewhere.

Carbon can be stored efficiently and in great quantities in living trees, forest floor detritus and in the soil. When the trees are harvested, a large portion of the carbon remains sequestered if the wood is used to make long-lived products, or if paper products are disposed of in capped landfills. Companies who are interested in mitigating their CO_2 emissions are investigating and investing in growing forests.

Carbon Credit Trading Market

If storing carbon in forests is cheaper than paying a carbon tax or government regulations, companies will either grow their own "carbon storing" forests or pay others to sequester carbon for them. In a carbon credit market, each ton of carbon sequestered is called a "carbon credit." It can be used to offset emissions, traded by one company to another company, or sold on the open market.

Sequestering carbon will allow companies to continue to use fossil fuels while CO_2 in the atmosphere is stabilized and then, over time, reduced. The establishment of a carbon credit market between companies and private landowners will benefit both companies and landowners. Companies will offset their carbon emissions while landowners will get paid for growing their trees and storing carbon. Ultimately, this will benefit the economy and the environment.

Carbon credit trading has the potential to become one of the major industries in the 21st century. The global demand for carbon credits may be almost one billion tons of carbon per year. The World Bank estimates that the market value of a ton of carbon sequestered could range between $30 to $40 per ton in the American market, and as high as $70 to $100 per ton in European and Japanese markets. This means that the carbon credit

market could be worth $30 to $100 billion per year. Carbon credits are now being certified and traded in Europe. The Chicago Climate Exchange is being organized to trade carbon credits in the U. S.

Sequestering Carbon in Forests Planted on Abandoned Mine Land

Many American companies are sequestering carbon in trees and have funded forestry projects in the U.S. and other countries. Planting new forests may be a cost-effective and environmentally sound method to sequester carbon, increase timber production and improve local economies.

There are approximately 148,500 hectares of abandoned (unreclaimed) mine land (AML) in the Appalachian coal region which provide little or no economic value. Mine reclamation, afforestation and forest management can provide two major benefits. The first is financial: revenue generated from growing forests, job creation and economic enhancement of the local economies. The second is environmental: reducing the negative effects of global warming by storing carbon in the trees, enhancement of wildlife habitat, improvement of air and water quality, reduction in soil erosion and increased recreational opportunities.

In a carbon trading market, landowners who plant forests will be able to sell carbon credits and timber products. However, before landowners will spend money to plant trees on abandoned mine lands, they will want to know two things: 1) how profitable is timber management on abandoned mine sites, and 2) how profitable is it to sell timber *and* carbon credits on these sites. Before companies will pay landowners to sequester carbon on abandoned mine lands, they want to know: 1) how much carbon can be stored on an acre of land, and 2) how much it will cost to store each ton of carbon. These are some of the questions that this research project is attempting to answer.

Assumptions

Forest landowners want to manage their forests for timber production, or a combination of timber production and carbon sequestration, in a manner that will earn them maximum financial return. Maximum profit is earned by employing the optimal financial thinning and harvesting schedule. To do this, one must calculate the optimal time to thin the stand, the number and intensity of the thinning(s), and the optimal time to conduct the final harvest. This calculation is affected by the quality of the soil, the landowner's alternative rate of return, the costs of production, and the value of the forest products.

In order to determine the optimal thinning and harvesting schedules, millions of possible thinning and harvesting schedules were evaluated. This study used the Forest Vegetation Simulator (FVS) to simulate growth and yield of red oak (*Quercus rubra*) in the Appalachian region. Using a dynamic programming approach, FVS was linked with economic models and the newly developed FVS companion program, the Keyword Iteration Navigator (KIN). Results were used to determine how profitable timber management is on abandoned mine land, how profitable it is to sell timber and carbon

credits on these sites, how much carbon can be stored on an acre of abandoned mine land, and the cost of sequestering carbon on these lands.

The geographic areas studied included abandoned mine lands in Pennsylvania, Ohio, West Virginia, Kentucky, Tennessee, Virginia, Maryland and North Carolina. Five site indices, 40, 50, 60, 70, and 80 (base age 50), which span the range of soil quality found on abandoned mine lands, were used in these analyses. It was assumed that bare land would be site prepared and planted with 500 trees per acre, and there would be 350 trees per acre at age 10. The maximum possible rotation length was limited to age one hundred.

Six alternative rates of return (ARR), which span the range of before-tax earning rates available for most landowners, were chosen for the economic analyses. They were 3.5, 5.5, 7.5, 10.0, 12.5 and 15.0%. For West Virginia, the price of sawtimber was assumed to be $357 per thousand board feet (Doyle) and the price of pulpwood was assumed to be $6.75 per cord. Labor costs were assumed to increase at a real rate of 1.12% per year. Management activities, frequency and labor costs are presented in Table 1. \

Five thinning intensities were employed: 20, 25, 30, 35 or 40% of basal area removal. The number of possible thinnings was zero, one or two. The same thinning intensity was used for all thinnings for a specific optimal solution regardless of the number of thinnings or age of thinning.

In these analyses, the price (or value) of carbon was assumed to be $10, $50 or $100 for each additional ton of carbon that landowners sequester. These prices were used because they span the range of prices most often discussed in the literature. In addition, economic analyses of timber production only ($0 carbon value) were conducted; results establish baseline data which show how much is earned from timber production only assuming there is no market for carbon credits.

In order to conduct this research, it was necessary to determine the optimal timing and intensity of thinnings and harvests for red oak trees growing on AML sites. More than four million combinations of possible thinning and harvesting schedules were analyzed. For each combination, economic analyses were performed to determine net present worth and soil expectation value.

Results for West Virginia

In this paper, only the results for abandoned mine lands in West Virginia planted with northern red oak are presented. Because this study used the management costs and stumpage prices prevalent in West Virginia, the results of this study are applicable to West Virginia only. Table 2 shows how much landowners can earn, in net present worth terms, by managing their abandoned mine lands for timber production only. Profitability is affected by the quality of the soil and landowner's ARR. This table provides only a sample of our data by presenting three soil qualities (site index 40, 60 and 80) and four alternative rates of return (3.5, 5.5, 8.0 and 10.5%). Under each site quality there is a

"low cost" and "high cost", referring to low site preparation costs ($300) and high site preparation costs ($1325).

Results show that if a landowner has money invested at 5.5% and has abandoned mine land that has relatively good soil (site index 80), by investing in forestry he would earn 5.5% return plus an additional $80.22 per acre. However, if a landowner has abandoned mine land with poor soil (site index 40), and has money invested earning 10.5%, by investing in forestry he would not earn 10.5% but rather earn $336.56 less than 10.5%. Table 2 shows that as soil quality increases, profitability increases. As the rate of return increases, forest investment becomes less attractive.

Table 3 shows how much landowners can earn on poor, medium, and good site quality land by managing abandoned mine lands for the combination of timber products and carbon credits. Assuming a poor site, if a landowner is earning 5.5%, and there is no market for carbon credits, he will lose $307.85 by investing in forestry. Yet, if he can sell carbon credits for $50 per ton, he will earn his 5.5% plus an additional $73.74 per acre. If he could sell the credits for $100 per ton, he'll earn 5.5% plus an additional $455.33 per acre. As the price of carbon increases, forest management becomes more profitable.

Companies Want to Know

Table 4 presents the total tons of carbon that can be stored during a rotation and the average number of tons that can be stored per year. The number of tons that can be stored is affected by the number of thinnings and the length of the rotation, which are affected by site quality and the landowner's ARR. A landowner who has medium site quality land and whose ARR is 5.5% would store 53 to ns over one rotation with an average of 0.55 tons stored per year. These figures are "net carbon storage" which is defined as carbon that goes into long-lived wood products.

Revenue Earned from Every Ton of Carbon

Table 5 shows how much net revenue is e arned from the sale of timber only or the combination of timber and carbon credits by storing one ton of carbon in the forest. For example, if there is no market for carbon credits, it costs $1.56 per ton to store carbon on a poor site using an ARR of 3.5 % and low site preparation costs. However, if a landowner sells his timber and is paid $10 for every ton of carbon stored during the rotation, he will earn $4.14 for every ton stored, in net present worth terms.

If the rate of return is 5.5%, and there is no market for carbon credits, selling only timber is not profitable on medium quality sites. Yet, if he can sell his carbon credits at $10 per ton, the landowner earns his desired rate of return plus an additional $0.21 for each ton of carbon stored. As the value of a ton of carbon increases, forest management on these abandoned mine lands becomes more profitable.

On good quality sites, if the rate of return is 5.5%, and the market pays $10 per ton for carbon credits, landowners will earn $4.76 on each ton of carbon stored, given low site preparation costs. Using high site preparation costs, the landowner's cost to sequester each ton of carbon is $13.74 per ton.

This data can be used to calculate how much a private landowner will earn or lose for each ton of carbon sequestered. In addition, the data can be used by a utility company who owns land to calculate how much each ton of carbon sequestered will cost or earn for them in terms of profit.

Conclusions

Analyses of red oak planted on abandoned mine land sites across the Appalachian Region have led to several conclusions. First, investors should consider southern States before northern States. Although timber prices in Pennsylvania are higher than in Kentucky, it is more profitable to grow trees in Kentucky because the growth rate is faster, and the value of the timber is increasing at a more rapid rate. Therefore, it is also cheaper to sequester carbon in the Southern States. Second, investments should be made in projects on the highest quality sites first and in projects that require the lowest site preparation costs. Third, companies should be willing to accept a lower rate of return on investments in carbon sequestration projects on AML sites. Profit is not the only criteria that a company should consider when they invest in carbon sequestration. The value of corporate goodwill should be included in the analysis as well.

Even though this study applied the concept of net carbon storage, it is not a complete, accurate carbon accounting. The appropriate amount of carbon that should be counted is "net-net carbon", where carbon emitted from equipment used in forest management and timber production is subtracted from the total amount sequestered. Data is lacking on calculating net-net carbon. It is one of our current research projects.

Dr. Gary Kronrad is the Bone Hill Foundation Distinguished Professor of Economics in the Arthur Temple College of Forestry at Stephen F. Austin State University. He has published more than 60 scientific articles on forest economics and management and written extensively during the last few years on carbon sequestration. He has presented papers at many conferences in the U.S. and Europe and was a guest lecturer at Cambridge University on carbon sequestration. He spent five years as a researcher at the School of Forestry at North Carolina State University and two years as a private consultant in New York. He received his Master's degree from the University of Massachusetts at Amherst in forestry and his Ph.D. degree in resource economics.

Table 1. Summary of management activities, costs, and frequencies used.

Activity	Cost[1]	Starting Year	Frequency
Boundary location	$20	Year 0	Only once
Boundary maintenance	$2	Year 10	Every 10 years
Management plan (initial)	$10	Year 0	Only once
Management plan (update)	$5	Year 10	Every 10 years
Site Preparation		Year 0	Only once
Ripping	$35		
Herbicide	$40		
Liming[2]	$225		
Hydroseeding and fertilization[2]	$800		
Planting and Seedlings	$225	Year 0	Only once
Mark and administer timber sale (percentage of gross)	10%	As Needed	As Needed

[1]All costs on a per acre basis.
[2]Used only with high reclamation cost scenario.

Table 2. Net present worth per acre, using low and high reclamation costs, on abandoned mine lands in West Virginia planted with red oak.

	Alternative Rate of Return			
	3.5%	5.5%	8.0%	10.5%
Poor Site-				
Low Costs	$67.28	($307.85)	($343.59)	($336.56)
High Costs	($957.72)	($1,332.85)	($1,368.59)	($1,361.56)
Medium Site-				
Low Costs	$1,056.66	($129.85)	($302.74)	($327.85)
High Costs	$31.66	($1,154.85)	($1,327.74)	($1,352.85)
Good Site-				
Low Costs	$1,820.30	$80.22	($239.95)	($305.59)
High Costs	$795.30	($944.78)	($1,264.95)	($1,330.59)

Table 3. Net present worth per acre of timber management and carbon credits, for low and high reclamation costs, on abandoned mine lands in West Virginia planted with red oak.

	Alternative Rate of Return			
	3.5%	5.5%	8.0%	10.5%
Poor Site				
C=$0/ton				
Low Costs	$67.28	($307.85)	($343.59)	($336.56)
High Costs	($957.72)	($1,332.85)	($1,368.59)	($1,361.56)
C=$10/ton				
Low Costs	$178.74	($231.53)	($302.14)	($315.20)
High Costs	($846.26)	($1,256.53)	($1,327.14)	($1,340.20)
C=$50/ton				
Low Costs	$624.58	$73.74	($136.35)	($229.76)
High Costs	($400.42)	($951.26)	($1,161.35)	($1,254.76)
C=$100/ton				
Low Costs	$1,181.88	$455.33	$70.89	($122.96)
High Costs	$156.88	($569.67)	($954.11)	($1,147.96)
Medium Site				
C=$0/ton				
Low Costs	$1,056.66	($129.85)	($302.74)	($327.85)
High Costs	$31.66	($1,154.85)	($1,327.74)	($1,352.85)
C=$10/ton				
Low Costs	$1,257.32	$11.13	($227.18)	($277.52)
High Costs	$232.32	($996.80)	($1,252.18)	($1,302.52)
C=$50/ton				
Low Costs	$2,059.98	$575.03	$75.08	($76.21)
High Costs	$1,034.98	($432.90)	($949.92)	($1,101.21)
C=$100/ton				
Low Costs	$3,063.30	$1,279.90	$452.91	$175.44
High Costs	$2,038.30	$271.97	($572.09)	($849.56)
Good Site				
C=$0/ton				
Low Costs	$1,820.30	$80.22	($239.95)	($305.59)
High Costs	$795.30	($944.78)	($1,264.95)	($1,330.59)
C=$10/ton				
Low Costs	$2,084.61	$263.76	($123.17)	($226.06)
High Costs	$1,059.61	($761.24)	($1,148.17)	($1,251.06)
C=$50/ton				
Low Costs	$3,141.86	$997.94	$343.96	$92.06
High Costs	$2,116.86	($27.06)	($681.04)	($932.94)
C=$100/ton				
Low Costs	$4,463.41	$1,915.66	$927.88	$489.72
High Costs	$3,438.41	$890.66	($97.12)	($535.28)

Table 4. Total tons of carbon stored and average number of tons stored per year for abandoned mine lands in West Virginia planted with red oak.

	Alternative Rate of Return			
	3.5%	5.5%	8.0%	10.5%
Poor Site-				
Total Tons of Carbon	43	43	43	38
Average Tons / Year	0.43	0.43	0.43	0.79
Medium Site-				
Total Tons of Carbon	53	53	47	47
Average Tons / Year	0.54	0.55	0.75	0.75
Good Site-				
Total Tons of Carbon	58	55	53	51
Average Tons / Year	0.64	0.79	0.93	1.04

Table 5. Net revenue (or cost), per ton of carbon stored, earned from selling ti mber and carbon credits on abandoned mine lands in West Virginia planted with red oak, calculated using low and high reclamation costs.

	Alternative Rate of Return			
	3.5%	5.5%	8.0%	10.5%
Poor Site				
C=$0/ton				
Low Costs	$1.56	($7.13)	($7.96)	($8.79)
High Costs	($22.19)	($30.87)	($31.70)	($35.55)
C=$10/ton				
Low Costs	$4.14	($5.36)	($7.00)	($8.23)
High Costs	($19.60)	($29.11)	($30.74)	($34.99)
C=$50/ton				
Low Costs	$14.47	$1.71	($3.16)	($6.00)
High Costs	($9.28)	($22.04)	($26.90)	($32.76)
C=$100/ton				
Low Costs	$27.38	$10.55	$1.64	($3.21)
High Costs	$3.63	($13.20)	($22.10)	($29.97)
Medium Site				
C=$0/ton				
Low Costs	$20.03	($2.47)	($6.44)	($6.98)
High Costs	$0.60	($21.66)	($28.25)	($28.78)
C=$10/ton				
Low Costs	$23.84	$0.21	($4.83)	($5.90)
High Costs	$4.40	($18.98)	($26.64)	($27.71)
C=$50/ton				
Low Costs	$39.05	$10.95	$1.60	($1.62)
High Costs	$19.62	($8.24)	($20.21)	($23.43)
C=$100/ton				
Low Costs	$58.07	$24.37	$9.64	$3.73
High Costs	$38.64	$5.18	($12.17)	($18.08)
Good Site				
C=$0/ton				
Low Costs	$31.27	$1.45	($4.56)	($6.03)
High Costs	$13.66	($17.05)	($24.02)	($26.25)
C=$10/ton				
Low Costs	$35.81	$4.76	($2.34)	($4.46)
High Costs	$18.20	($13.74)	($21.80)	($24.68)
C=$50/ton				
Low Costs	$53.97	$18.01	$6.53	$1.82
High Costs	$36.36	($0.49)	($12.93)	($18.41)
C=$100/ton				
Low Costs	$76.67	$34.58	$17.62	$9.66
High Costs	$59.07	$16.08	($1.84)	($10.56)

APPLICATIONS OF AN ECO-ASSET MODEL AT THE TXU MONTICELLO MINE

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Introduction

TXU Energy has long been a leader in the reclamation of Title V mine lands. The company recently decided to explore new opportunities to develop multiple ecological assets on current mine sites and previously reclaimed sites. To accomplish this, TXU worked with the Electric Power Research Institute's (EPRI) Eco-Solutions Program to identify existing and potential ecological assets. EPRI's STREAM (Strategic Eco-Asset Manager) model was used to identify the most financially promising opportunities. This paper describes the application of this approach to two properties that are part of TXU's Monticello Mine. Forest, streams, and wetlands were identified as eco-assets that could potentially be developed on this land. The STREAM analysis demonstrated that these have the potential to provide value to TXU equaling or exceeding that of reclamation of the properties for pasture or of post-reclamation sale of the properties. Planning reclamation with eco-asset development in mind and dividing properties into parts best suited to development of different eco-assets were identified as two strategies for maximizing potential value. Use of the STREAM model provided a means of taking a business-oriented approach to eco-asset development.

Background

Ecological assets such as forested wetlands, emergent wetlands, upland forest, restored streams, riparian habitats, habitat for threatened or endangered species, or forests suitable for carbon sequestration are seldom maximized in reclamation efforts.

In addition to the ecological and societal values of these assets, they also may have monetary or "credit" value. State and Federal regulations mandate that permitted impacts to wetlands, streams, threatened and endangered species plus other ecological assets be compensated for through mitigation. For example, Section 404 of the Clean Water Act requires that impacts to wetlands, streams and waters of the United States be mitigated after impacts have been avoided or minimized. Likewise, impacts to threatened or endangered species and nutrient loads in streams and lakes may require mitigation in the form of credits that can carry a high value, depending on the type of ecological asset and local or regional markets for mitigation credits.

This project with TXU was developed to study methods to develop ecological assets on two mined areas. These areas were selected to evaluate 1) a site that has been reclaimed in the past for use as pasture and 2) a newly mined site in which reclamation is still incomplete.

TXU operates three surface coalmines in East Texas and has reclaimed nearly 50,000 acres since it began surface mining in 1971. About half of this acreage has been reclaimed to forests. TXU mines approximately 1,800 acres each year. Much of this reclamation initially involved establishing pastureland with some reforestation for commercial forestry programs or wildlife habitat. Most recently, reforestation has been significantly increased. The company is taking this effort to a new level by evaluating and prioritizing the development of additional ecological assets on its reclaimed mining lands.

Project Approach

This project consisted of two primary activities. The first was to identify and characterize the potential ecological assets on the two sites. This was done by performing an initial assessment through on-site examination combined with application of knowledge regarding regional conditions such as soil types, meteorology, natural plant communities and ecosystems, etc. The second activity was to perform a financial analysis of the options available to the company for developing eco-assets on the two sites. This required gathering data on the costs of developing the eco-assets on the sites, the quantities of these eco-assets that could be developed, and the revenues that TXU could obtain for these assets in the future. Similar data were also gathered regarding the continued use of reclaimed lands as pastureland that appears to be the primary alternative to developing eco-assets. The STREAM model was then used to analyze the potential uses of the two sites in terms of the net present value of the streams of costs and revenues to TXU over a 30-year period. This analysis will enable the company to evaluate the potential uses of these sites in a way that is comparable to the approaches widely used by businesses to evaluate investments in productive assets.

Potential for Developing Ecological Assets on the Two TXU Sites

The first of the sites consists of older mined lands reclaimed to pasture (the "pastureland site"). The second site consists of newly mined lands that have not yet been reclaimed (the "newly-mined site").

The pre-mining site condition at the 1,294-acre pastureland site was a mixture of cleared cropland, pastureland and remnant, scattered natural forested areas. There were numerous small streams and intermittent tributaries throughout the area along with narrow, riparian wetlands adjacent to the streams. Elevations in the area ranged from 300 to 600 feet with gently rolling to hilly topography.

The current post-mine uses include 1,114 acres of upland pastureland, 8.6 acres of forested wetlands, 62.8 acres of non-forested wetlands, 2.7 acres of stream and 105.9

acres of open water. The open water, streams and wetlands were created as part of the original reclamation process. This site was intensively graded to maximize its use for pasture. Therefore, it has very gentle topography to facilitate mowing and harvesting of hay. This pastureland is currently being leased to local farmers.

The eco-assets that could be developed on this site consist of hardwood and/or pine plantations on approximately 1,100 acres on the upland sites and expansion by 15-20 percent of the existing wetland areas in and around the drainage ways and open water areas. Expanding these areas would add approximately 10 – 15 acres of emergent and forested wetlands at this site. This is a significant increase in wetland area with minimal earth moving. Another asset that could be developed on this site is a stream. Most of the streams or drainage ways on this tract are r elatively straight in contrast to the meandering channels bordered by riparian wetlands that would be expected of natural streams. Stream evaluation, design and restoration could add several thousand feet of stream channel and provide additional wildlife habitat along these forested riparian corridors. Stream length would be extended following restoration because the streams would assume a more meandering pattern similar to natural streams in areas where mining has not occurred.

Wetlands and streams co uld be combined on the lowland portion of this site; that is, both types of eco-assets could be developed simultaneously without reducing the area of wetlands or linear feet of streams as a consequence. The company could continue to use the upland portions for pasture or convert them to pine plantation. Uses of lowland and upland areas could largely be pursued independently.

The pre-mining site conditions at the 70-acre newly mined site consisted of a mixture of pastureland and remnant, scattered natural forested areas. There were portions of small streams and intermittent tributaries on the site along with some narrow, riparian wetlands adjacent to the streams. Elevations ranged from 300 to 600 feet with gently rolling to hilly topography. This site has recently been mined and is composed of unconsolidated mining spoil. There are no eco -assets present. The site has been rough -graded, contoured and stabilized with wheat.

Given the watershed associated with this site, a minimal amount of water will be available for wetlands, open water, and streams. Therefore, on this 70 -acre site, the majority of the reclaimed land will be uplands. Our best estimate would be that approximately 60 acres of uplands, 3 acres of open water, 4 acres of forested wetlands, 2 acres of non-forested wetlands and 1 acre of stream and adjacent floodplain could be created on this site. The proportion of wetlands, open water and stream could possibly have been increased by 10-20 percent at a minimum during the leveling process. However, there must be an economic incentive for this either because of possible credit sales for wetland or stream mitigation or through a need for these eco -assets by TXU for permit compliance.

Potential Market Values for Ecological Assets and Timber

The Corps of Engineers, Fort Worth, TX District Office stated that wetland mitigation credits are in demand in this region of East Texas and that there are at least 4 wetland mitigation banks in operation, with two of the banks open to the public and two bank s serving specific industries. The Corps stated that there is a demand for wetland credits primarily for impacts to forested wetlands as a result of the utility and mining industries, but other industries and the Texas Department of Transportation may also be customers. The Corps indicated that the service area for wetland banks is very large in this region of Texas so credits may be used far away from the actual bank. The major types of wetlands being impacted in east Texas are forested wetlands, with les ser amounts of emergent or open water areas. The Corps emphasized that the largest emerging demand for wetland credits will be for satisfying compliance requirements for the mining industry. The Corps will be requiring very high quality and functionally su ccessful mitigation in the near future. The Corps indicated that the mining companies have a unique opportunity to develop high quality wetland mitigation for permit compliance for their own operations and that wetland creation associated with mine reclama tion may be an excellent opportunity for creating bank credits as well. Wetland credits developed in this manner could possibly be sold on the open market. Credit value in this region of Texas range from $3000 - $5000+ per credit (acre).

Stream mitigat ion is another eco-asset that can be developed on this site in association with the wetlands. Stream restoration involves the design and implementation of new, naturally functioning stream sections that have the appropriate pattern and profile of a natural stream. A well-designed stream will maximize the length of stream segment over a given distance. Stream mitigation credits are usually measured in terms of the linear distance of restored or created stream channel. Credit prices can range from $100 - $200 per linear foot.

The value of carbon sequestration using forests is another potential ecological asset that could be developed on this tract. TXU already participates in the Climate Challenge Program that quantifies the carbon and /or carbon dioxide seq uestration value of trees planted for commercial forest plantings on mined sites, company-wide. No measurements for hardwoods or wildlife plantings have been made. The cumulative amount of C02 sequestered in commercial pine plantations since 1991 when the program began is over 71,000 tons with over 6,432 acres planted. This is a cumulative value reflecting increased planting each year.

Information about the potential for sites in this general area of East Texas to provide carbon credits and valuable fore st products was provided by Dr. Gary Kronrad of the Arthur Temple College of Forestry at Stephen F. Austin State University. Dr. Kronrad has assessed planting and harvesting regimes that maximize the value expected to be received for both forest products and carbon sequestration credits from a site planted to Loblolly Pine. This assessment included consideration of future prices for forest products and indicates that an acre of East Texas pine plantation could yield, over a 30 - year period, net carbon cred its equivalent to 117 tons of CO2 plus forest product

revenues equivalent to $3,817 in year 30. Future carbon credit prices are highly uncertain, as they will be affected by regulatory, technological, and other developments that are difficult to anticipate.

Approach to the Financial Analysis

Utilizing information from the land assessment described above, information provided by TXU on the costs of managing reclaimed mine lands for different uses, and additional information gathered by EPRI, an analysis was performed of the potential financial value to TXU of different options for managing the two sites. EPRI Eco-Solutions' STREAM model was utilized for this analysis.

STREAM is an analytic model developed for use in conjunction with eco-asset assessment, management, and valuation. It is designed to analyze the financial value of eco-assets and other potential land uses so that decisions about land management can be made on a basis consistent with a company's conventional business processes.

A STREAM analysis begins with information from a "Phase 1" analysis of the potential for development of eco-assets and other land uses, as described in the previous section. Such an analysis will identify and define a slate of eco-assets and other land uses that can be created on a specific property or tract of land.

Following the Phase 1 analysis, additional information is collected so that the following quantitative information can be provided as inputs to STREAM:

1. The cost of the management activities necessary to create the eco-assets or to support other land uses. These costs include land acquisition costs (if the land is not already owned) and initial development costs. They also include ongoing costs, such as any regularly incurred management or maintenance costs, property taxes, and the cost of verifying the eco-assets.
2. A "production schedule" that provides estimates of how much of an eco-asset (e.g., acres of wetlands) or other land use (e.g., acres of pastureland or forest products from growing trees) will be created and when (i.e., what year) they will be available.
3. Market prices, both current and future, for the eco-assets or other land uses. These prices, along with the production schedule, provide the basis for calculating future revenue that can be received. Because future market prices are often expected to be different than current prices, and because there is usually uncertainty about them, STREAM employs a "price lattice." The price lattice approach, which is drawn from applications of real options analysis, reflects both an expected trajectory of future prices and price variability. STREAM also is capable of incorporating uncertainty about whether there will even be a market for some eco-assets in the future, because markets for some eco-assets (e.g., carbon sequestration credits) are not yet fully developed.
4. Discount rates for both costs and revenues. Discounting is a standard financial analysis technique for calculating the "present value" of future costs and revenues associated with an investment. Discounting reflects the time value of money (i.e., the preference for receiving money now rather than in the future). Equivalently,

discounting can be thought of as reflecting the foregone opportunity to earn interest on money that is invested for other purposes. Different discount rates can be used depending on levels of risk or uncertainty. Generally, higher risk/uncertainty is reflected in a higher discount rate.

The production of eco-assets, and the choices faced about their production, can be complex. For example, if TXU is considering the development of wetlands on a mined land site, its choices will not consist simply of spending X dollars to create Y acres of wetland. It will probably find that there is a range of possible expenditures, and that the amount or quality of the wetlands created will vary according to how much it spends. This choice will have to be based on information at a level of detail that goes well beyond that gathered for the Phase 1 analysis, and seems most likely to be made as part of the process of developing very specific reclamation plans.

More importantly for the analysis described here, the greatest value for these sites may come from utilizing them for some combination of the options identified. Combining options may be accomplished through "stacking" eco-assets by having both streams and wetlands on the same part of a site, or by simply using different parts of a site for different purposes. The approach to assessing these choices using STREAM is to first analyze the value of each option alone, and then analyzing promising combinations of the options that have high value. Where there are ranges of possible expenditures that lead to creation of different amounts of eco-assets (or other land uses), those choices can be addressed either through sensitivity analysis or analyzed as separate options.

Results of the Analysis

Results of the STREAM analysis for TXU indicated that development of streams and wetlands for marketable mitigation credits would be the highest-value uses for the lowland areas of the two properties. Streams and wetlands are compatible uses in that each can occupy parts of a lowland area. On the pastureland site, streams and wetlands created were estimated to provide revenue with a net present value of $1,413/acre of lowland area. On the newly mined site, a much higher net present value, estimated at $14,263, could be realized for the lowland area. The wide difference in the value of streams and wetlands between the two sites is due to the fact that there are already streams and wetlands on the pastureland site, thus, no mitigation credits can be claimed for these. This greatly limits the potential for creating new streams and wetlands. In contrast, all streams and wetlands created on the newly mined site will be eligible for mitigation credits.

For the upland areas, which occupy about 85 percent of each of the properties, planting trees would provide greater value than leasing the land for grazing cattle. For the upland areas of both the pastureland and newly-mined site, net present value of the expected revenues from forest products (saw timber and pulpwood) amounts to about $350/acre more than the cost of site preparation and tree planting.

The base case estimate of net present value for carbon sequestration credits on the pastureland site was about $375/acre; on the newly mined site it was about $400/acre. (In calculating the value of carbon sequestration credits, the fact that some of the credits would be lost as a result of harvesting the trees was taken into account.) These base case estimates were predicated on an assumed current price for carbon credits of $3/ton of CO2, rising at 5 percent annually so that it would reach $13/ton in 30 years (in constant dollars). However, sensitivity analyses on carbon credit prices showed that under several plausible alternative price scenarios growing trees on the two TXU sites could provide substantially greater revenue from carbon credits that would increase the attractiveness of the option of planting trees on upland portions of both sites.

Other factors not fully captured in the STREAM analysis will also probably enter into the decision about how to manage each of these sites. For example, growing trees on the upland portions of the sites may enhance the value of streams and wetlands created on the lowland portions. The fact that expected revenue from forest products would more than offset the cost of site preparation and tree planting could also be a decisive factor, since it means that there is little risk of actually losing money by planting trees on the site. Given today's uncertainty about carbon credit prices, it is entirely possible that they will be substantially higher than even the highest price trajectories considered in the STREAM sensitivity analyses, so there is considerable "upside risk" for TXU in the tree planting option.

Conclusions

The results of the STREAM analysis at TXU also suggest potential lessons that may be applicable to many mine sites.

The Advantages of Early Assessment

There are substantial advantages associated with assessing the potential for ecological asset development on a site *before* the initial reclamation is completed (or even begun). Some activities undertaken as part of the initial reclamation (e.g., planting grasses) may increase the cost of developing ecological assets (e.g., grasses might have to be treated with herbicide before trees cold be planted). In addition, it might have been possible to create even more acres of wetlands on the pastureland site during the process of re-grading the site for reclamation by making more of the site a lowland area. Because wetland mitigation credits in East Texas currently have a higher value than either carbon sequestration credits or pasture lease fees, this could have increased the total value of the site. (However, when TXU originally reclaimed this site, there was no market for wetland mitigation credits, so TXU had no incentive to create more wetlands than it needed at the time.)

The Value of Assessments Based on Land Suitability

Dividing a site by land type *before* doing an analysis of the value that could be derived from different uses will make the analysis easier and minimize the chance that valuable opportunities will be overlooked.

For example, both of the TXU sites include both upland and lowland areas. When either site is viewed as a single parcel—subject to a single decision—the development of streams and wetlands appears unattractive because it makes use of only part of the site. But if the 15 percent lowland portion of a site is treated as if it were a separate parcel, it becomes much more readily apparent that developing streams and wetlands on it provides the highest value.

The Importance of Doing Systematic Financial and Sensitivity Analysis

The STREAM analysis provided a means of combining the information about what ecological assets could be created on the sites with cost and revenue data. This will allow the decision about what to do with the sites to be made from a business perspective. Decisions about ecological assets also involve some uncertainties that are greater than those commonly encountered in many other business decisions. The most important of these is probably the future market prices for ecological assets. STREAM not only provides a means of projecting future prices (given the necessary input assumptions), but also a way of easily doing sensitivity analyses on those prices. These sensitivity analyses can incorporate not only uncertainty about what future price levels will be, but also whether there will even be markets for specific ecological assets. The value of this is most apparent in the case of carbon credits.

While there are markets in which transactions can be made for carbon credits today, they are not yet well organized, and the definition of a carbon credit is not always consistent. The future development of carbon credit markets in the U.S. will be dependent on developments in regulatory policy, carbon control technology, and the science of climate change. This makes it important to be able to consider future developments through flexible analysis that can reflect a range of future scenarios. In cases where reforestation of sites is a "close call" from a financial perspective, this could be a crucial factor affecting decisions about how to manage reclaimed mine lands in order to maximize future value.

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Session 2

Market-Based Economic and Management Considerations

Session Chairperson:
Dr. James Burger
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Blacksburg, Virginia

Factors Affecting the Success of A Forestry Business Enterprise
Dr. Thomas R. Fox, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

The Regulatory Framework for Reclaiming Mine Land: Considerations for Forestry
Bradley Lambert, Virginia Department of Mines, Minerals, and Energy, Big Stone Gap, Virginia

Reforestation on AML and Bond-Released Grassland
John Sprouse, Ohio Department of Natural Resources, Division of Minerals Resources Management, Cambridge, Ohio

Reclamation Costs/Benefits for AREA MINING: Overburden Placement, Grading, Site Preparation, Reforestation, and Management
Bryce West, Bruce Evans, and Phil Leibering, Black Beauty Coal, Evansville, Indiana

Long Term Research to Develop Soil Handling Requirements for Reforestation of Large Scale Surface Mines in West Virginia
Laurence Emerson, Arch Coal, Inc., Huntington, West Virginia

Achieving Forestry Goals on Mined Land: Mined Site Condition, Species Composition, and Stand Development of Economically Viable Hardwood Forest
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FACTORS AFFECTING THE SUCCESS OF A FORESTRY BUSINESS ENTERPRISE

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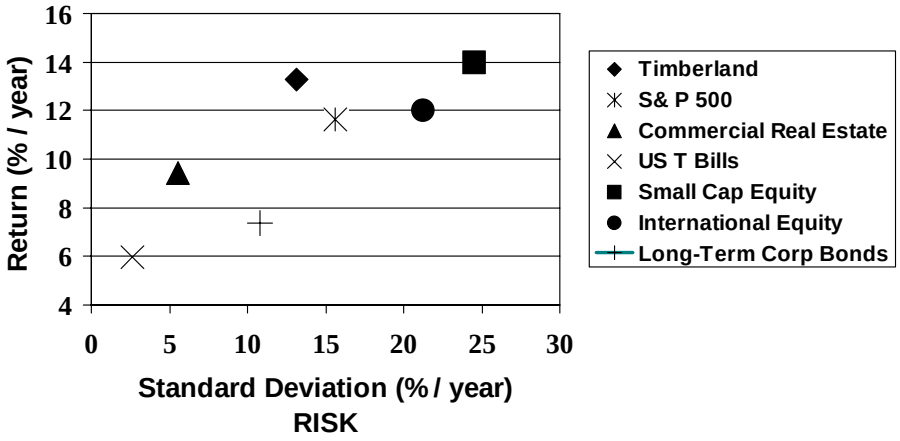
Abstract

Forest management offers attractive financial returns that compare favorably with many alternative investment vehicles. Consequently, numerous organizations include forest management investments as a stable, relatively low-risk component of their portfolio. A successful forestry enterprise must balance three sometimes conflicting aspects of management: 1) biological factors affecting tree growth; 2) financial considerations of discounted cash-flow analysis for forest management regimes; and 3) regulatory requirements and social considerations affecting forest practices. Biological factors such as the ecological characteristics of the specific tree species, climatic conditions and soil properties that determine site productivity, and the impact of silvicultural practices such as thinning, interact to influence the growth rate and quality of the timber produced, which in turn determines the value of the timber. The principles of discounted cash flow analysis determine the financial returns obtained from a forest management enterprise and depend on the cost of the management regime, the revenue generated, and the length of time between when expenditures are made and when the revenues are generated. Regulatory requirements such as Best Management Practices used to protect water quality and organizational policies and social considerations designed to improve wildlife habitat and visual aesthetics, also influence forest management practices. Judicious attention must be paid to each of these factors to assure financial success of forestry enterprises. Several case studies will be presented illustrating these elements and their contribution to successful and unsuccessful forestry enterprises.

Introduction

Timberland investment and forest management offers attractive financial returns that compare favorably with many alternative investment vehicles (Figure 1). Over the period from 1961 through 2000, investments in timberland earned an average annual rate of return of just under 14 percent. This is comparable to the returns from equities over the same period. However, the risk associated with timberland investments, as measured by the standard deviation in annual returns, was generally lower than that of equities.

Figure 1. Risk and Return of Alternative Financial Investments 1961-2000

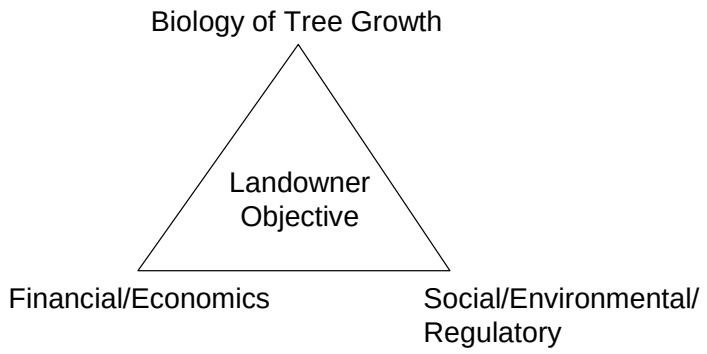


Data from Hancock Timber Resource Group , 2001

In addition to financial returns from timber production, managed forests produce numerous social and environmental benefits to the landowner and society as a whole. Forests reduce soil erosion, improve water quality, sequester carbon, create wildlife habitat, provide recreational opportunities, and improve aesthetics. Consequently, forestry is often a preferred land use in most regions of the country.

The goal of forest management is to meet the owner's objectives for the land. Although many individuals own timberland for non-economic reasons, financial returns are an important component of forests that are part of a business enterprise. A successful forestry business enterprise must balance three sometimes-conflicting aspects that constrain the objectives of landowners (Figure 2). These include biological factors affecting tree growth, financial considerations of discounted cash-flow analysis, and social, environmental, and regulatory aspects affecting forest practices.

Figure 2. Landowner objectives are constrained by biological, economic and environmental/social factors



Biological Factors

Biological factors set the limits on what is possible. They determine which species will survive and grow at a specific site, what the growth rate will be and how the forest will respond to silvicultural treatments. Biological factors such as the ecological characteristics of the specific tree species, climatic conditions and soil properties that determine site productivity, and the impact of silvicultural practices such as thinning, interact to influence the growth rate and quality of the timber produced, which in turn determines the value of the timber

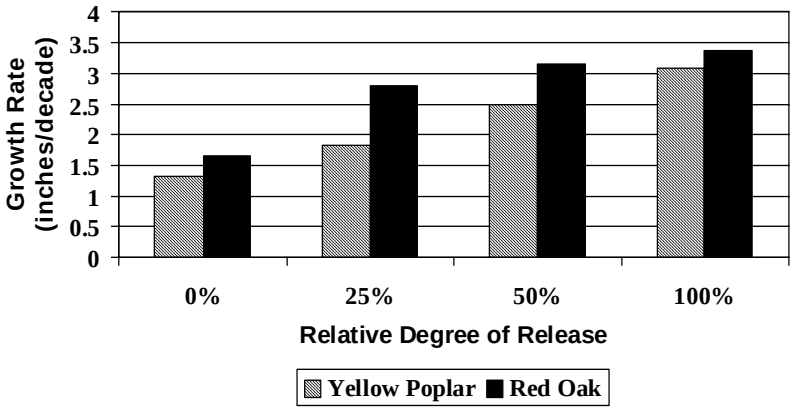
Site quality is the sum of the climatic, geologic, and edaphic factors that influence tree growth at a specific location. These factors determine the availability of water and nutrients. Good quality sites tend to be moist and nutrient rich whereas poor quality sites are dry and infertile. Site index (SI), which is the height of dominant and codominant trees at a specific age, is the most common measure of site quality. The impact of site quality on tree growth is dramatic. Fully stocked stands on poor quality sites in the Appalachian Mountains (SI_{50}=55) may grow 150 board feet per acre per year while fully stocked stands on good quality sites (SI_{50}=75) may grow 235 board feet per acre per year.

Site quality also affects the species of trees that occur in a forest. For example, good quality sites in the Appalachians are moist and fertile and tend to support stands of mixed mesophytic hardwoods including high-value timber species such as basswood (*Tilia Americana*), black cherry (*Prunus serotina*), black walnut (*Juglans nigra*), northern red oak (*Quercus rubra*), sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*) and yellow poplar (*Liriodendron tulipifera*). Poor quality sites, which are dry and infertile, tend to support stands dominated by tree species with lower timber value such as black gum (*Nyssa sylvatica*), chestnut oak (*Quercus prinus*), mockernut hickory

(*Carya tomentosa*), red maple (*Acer rubrum*), scarlet oak (*Quercus coccinea*), and white oak (*Quercus alba*).

Silvicultural treatments can be used to manipulate the availability of light, water, and nutrients in a forest. When silvicultural treatments increase the availability of a limiting resource in a stand, growth is likely to increase. Growth of various species may be affected differently, based on their individual silvical characteristics of the particular species. Shade tolerant species such as sugar maple, basswood, black gum and red maple survive and grow well in the shade of a residual overstory. Intolerant species such as black cherry, black walnut and yellow poplar require full sunlight for adequate survival and growth. Regeneration treatments are designed and implemented in the forest to create the light regime required by specific groups of species. Even-age silvicultural systems such as clearcutting and seed tree, remove most of the overstory canopy at one time and enable full sunlight to reach the forest floor which favors the growth of intolerant species. Uneven-age systems such as singletree and group selection leave a partial to nearly full residual canopy on the site, which reduces the amount of light reaching the forest floor. Only the more shade tolerant species are able to grow in this environment. Silvicultural treatments may be implemented throughout the rotation in an effort to influence light, water, and nutrient availability and thus alter growth of the desired crop trees. Forest fertilization is routinely used in many stands, particularly southern pine plantations, to increase nutrient availability and thus increase growth. Herbicides are also used to control competing vegetation, which improves resource availability to the remaining crop trees. Thinning and crop tree release treatments reduce the density of trees in a stand and thereby increase light levels to the residual trees. The available soil water and nutrients in the stand are also redistributed among fewer trees. Both of these factors tend to accelerate growth of the residual trees (Figure 3).

Figure 3. Effect of Crop Tree Release on Diameter Growth in Appalachian Hardwoods



Perkey and Onken, 1993

Financial Factors

The principles of discounted cash-flow analysis determine the financial returns obtained from a forest management enterprise. The key financial factors include the cost of the management regime, the revenue generated and the length of time between when expenditures are made and when the revenues are generated. The net present value (NPV) of a series of cash flows (both revenue and expenditures) is given by the formula:

$$NPV = \sum_{t=0}^{n} \frac{C_t}{(1+i)^t}$$

Where NPV is the discounted net present value, [C_t] is the net cash flow (revenue –cost) in year [t], [i] is the interest rate, and [n] is the total number of years in the investment period. When the calculated NPV is positive, then the future revenue generated by the timberland is large enough to pay the management and treatment costs and the interest paid on these costs.

Costs of forest management include those associated with land ownership such as taxes and management fees, the amortized portion of capital investments in roads and equipment, and the silvicultural costs associated with planting, growing, and harvesting timber.

Many of the costs associated with forest management occur early in the rotation during the establishment phase, which then means that these costs must be carried for the entire rotation before any revenue is generated. This can significantly affect the NPV of a forestry investment because the rotation length may exceed 50 years for some species. Because of the impact of time on NPV, most forest management plans attempt to minimize costs early in the rotation. The costs of silvicultural treatments, such as thinning, that are applied later in the rotation must be carried for a shorter period of time and are often at least partially offset by revenue from the timber harvested. Therefore, the financial return from these investments is often better than those from investments made during the establishment phase.

Revenue from forest management includes the stumpage value of the timber, which is determined by the size, quality and species of the trees. Trees below a specific size are not merchantable and have no value. The value of trees generally increases as a step function based on tree size. The following table illustrates how the stumpage value for southern pine in Virginia varied by tree size in 2001.

Product	DBH	Stumpage Value
Pulpwood	4-6 in	$9.87/ton
Chip-n-Saw	7-11 in	$24.69/ton
Sawtimber	> 11 in	$35.80/ton

Species vary greatly in their stumpage value, based on their end use and relative scarcity. As illustrated below, the stumpage value of Appalachian hardwoods varies from less than $150 per thousand board feet (mbf) to over $900 per mbf depending on the species.

Species	Stumpage Value ($/mbf)
Yellow Poplar	$145
White Pine	$176
White Oak	$266
Northern Red Oak	$460
Black Cherry	$900+

Tree quality will strongly modify the value of an individual tree. For example, a high quality (Grade 1) white oak sawtimber tree may be worth $386/mbf while a low quality white oak (Grade 4) of the same size might be worth only $81/mbf.

The discount rate and the investment period have an overwhelming effect on the financial returns from forest management investments because of the length of time required to grow trees to their desired size. Rotation lengths in pines may be 20 to 30 years, while the rotation length in upland hardwoods may be 50 to 80 years or longer. When the investment period is this long, it is difficult to achieve acceptable financial returns on all but the best sites.

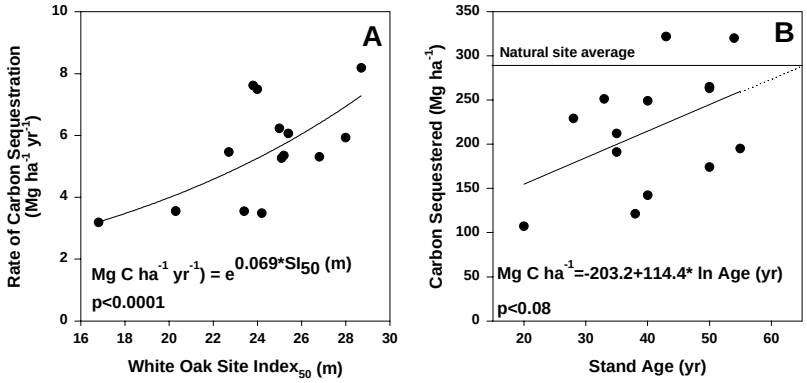
Site quality has a dramatic effect on the value of timber in a forest because it influences the species composition, quality and growth rate of the stand. As previously mentioned, the species that occur on high quality sites are generally more valuable than those that occur on poor quality sites. The individual stem quality is also usually better on high quality sites. Growth rates are faster on higher quality sites, which leads to shorter rotations. These factors contribute to increased stumpage revenue and decreased rotation lengths on good quality sites, which will increase the NPV of the forest.

Non-timber revenue can have a significant impact on the financial returns from timberland management. Fees for recreational use of the land such as hunting and horseback or ATV riding can be substantial. Leasing small tracts of timberland for cell phone towers has become very lucrative in recent years. Harvest of non-timber crops such as food, medicinal, and ornamental plants can generate additional income. In some areas of the South, revenue from these miscellaneous sources is sufficient to cover property taxes and other fixed management costs associated with land ownership. Unfortunately, many of the positive benefits to society produced by forests, such as clean water, clean air, aesthetics, and even forest recreation activities in many regions, are not fundable in the marketplace. In many cases, providing these eco-benefits actually adds to the cost of landownership and forest management. Although these eco-benefits are clearly valuable to society, landowners are not compensated financially for them.

Carbon credits are another potential source of revenue from timberland that has receive considerable attention recently. Landowners may be able to earn credits for forest management practices that sequester carbon in forests. This opportunity has sparked the

interest of certain landowners, regulators, specific industries such as electricity generators, and environmental NGOs in management practices that increase the carbon sequestered in forests. Although there is no question that forests accumulate carbon in biomass as they grow (Figure 4), there is considerable uncertainty regarding the effect of forest management on carbon sequestration rates. Forests may be net carbon sinks, net carbon sources, or carbon neutral depending on their age, growth rate, and the accounting methods used. Therefore, carbon credit accounting will undoubtedly be a complicated process, largely determined by the provisions of international agreements such as the proposed Kyoto accord on climate change. A major issue surrounding carbon credits for forest management is the certification and auditing of forests established and used for this purpose.

Figure 4. Carbon accumulation in Appalachian hardwood forests following strip mine reclamation



Rodrique and Burger, 2002

At present, a viable market for carbon credits does not exist. Consequently, it is impossible to know the true economic value of carbon credits, even though various amounts are frequently mentioned. Until the market for carbon credits is firmly established and readily available to the majority of landowners, determining the true value of carbon credits will be problematic. Most landowners find it difficult, if not impossible, to make sound long-term forest management investment decisions in the face of such uncertainty. This is the main reason that large-scale reforestation and afforestation projects based solely on the value of carbon credits have yet to be established in the United States.

Social/Environmental/Regulatory Factors

Successful forestry enterprises must be sustainable, both financially and environmentally. In this context, management activities must address the social and environmental concerns that society has with forests, because forests provide a wide variety of social and environmental benefits that must be protected and preserved. The non-timber goods services and benefits from the forest valued by society include clean water and air, productive soils, aesthetics, recreation, solitude, habitat for threatened and endangered species, wildlife and fish habitat. Forest management practices have been modified to protect and preserve these features of the forest.

Forested watersheds produce some of the purest water available. Forest management activities are generally classified as non-point sources of pollution. Under the Clean Water Act, streams, rivers, and lakes must be protected from non-point pollution arising from forest management activities. Best Management Practices (BMPs) were developed to protect water quality (Virginia Department of Forestry 2002). BMPs for timber harvesting, site preparation, streamside management zones, road construction, and pesticide application have been developed and are widely applied. A large body of research has shown that forestry BMPs protect water quality.

The aesthetics of forest management are an important issue, particularly in mountainous terrain where forestry operations are highly visible. The perception by the general public of whether a forest management practice is "good" or "bad," often depends upon how it looks. Therefore, forest operations must be conducted in a aesthetically acceptable manner. Guidelines have been developed to improve the aesthetics of forest management activities (Lucas 1991).

Because forests provide habitat for numerous species of wildlife, including some that are threatened and endangered, management practices must preserve appropriate habitat on the landscape. Forest management practices are often modified to improve wildlife habitat. Examples include leaving den trees and wildlife habitat trees during harvest. The size of harvest areas is often limited and stands of various ages are maintained on the landscape to provide a variety of wildlife habitats. Travel corridors are used to connect areas with different habitats on the landscape. Harvesting, site preparation and other forest management practices may be restricted or prohibited entirely in forests containing certain threatened and endangered species.

Forestry as a Post Mining Land Use

Forestry is a desirable post mining land use in the Appalachian and Midwest coalfields. The principles required to establish a successful forestry enterprise on reclaimed land are the same as for the native forests discussed above. An important factor to remember that coal operators can significantly affect future forest site quality, and thus the ultimate success of the forestry enterprise, depending on the methods used to reclaim the land

following mining. Research has shown that productive forest can be restored on reclaimed mine soils if the appropriate "forestry reclamation approach" is employed. Burger and Torbert (1992) summarized the requirements for successful forestry reclamation:

1. cooperation among coal operators, landowner, and regulatory authority to develop a mining permit that details and describes reclamation procedures specifically for forestry land use;
2. replacing desirable topsoils or mixing recoverable soil with slightly acid, brown, weathered sandstone overburden and applying it a minimum of 4 feet deep;
3. loosely-graded, noncompacted topsoil or topsoil substitutes that include woody debris and native seed pools;
4. using native and noncompetitive domestic ground covers that quickly protect the site from erosion, encourage forest meso- and micro-fauna, and serve a noncompetitive, facilitative role in plan, animal, and forest succession;
5. planting a proper silvicultural mix of crop trees for their commercial value along with nurse trees for wildlife and soil improvement.

Site Specific Management: The Key to a Successful Forestry Enterprise

Successful forestry enterprises must be conducted in a site-specific manner. Uniform management practices across a range of sites will seldom adequately accomplish landowner objectives. The key to success is to identify and classify sites according to their growth potential, and then develop a management regime appropriate for that specific site.

Acceptable financial returns are more likely to occur on good quality sites as opposed to poor quality sites. Therefore, forest management activities should be focused on the best sites. Reclamation practices should follow the forestry reclamation approach and create the highest quality sites possible. The appropriate species or group of species on each site must be determined and established. The financial returns from a forestry enterprise will vary considerably depending on site quality and the species occurring in the stand. The following table summarizes the growth and financial returns possible from timber production over a 50-year rotation in the southern Appalachians for a variety of sites and stand types. The interaction between stumpage value and growth rate of the various species has a dramatic effect on total timber value.

Site Index	Species	Basal Area (ft^2/ac)	Sawtimber Volume (bf/ac)	Stumpage Value ($/mbf)	Total Timber Value ($/acre)
52	Scarlet Oak Chestnut Oak	90	3,860	$266	$1026
72	White Oak Black Oak	103	10,550	$266	$2806
86	White Oak Northern Red Oak	108	16,300	$363	$5917
100	Yellow Poplar	172	32,150	$145	$4662
82	White Pine	201	35,964	$176	$6329

Summary

Forest management offers attractive financial returns that compare favorably with many alternative investment vehicles. Consequently, numerous organizations include forest management investments as a stable, relatively low-risk component of their portfolio. A successful forestry enterprise must balance three sometimes conflicting aspects of management: 1) biological factors affecting tree growth; 2) financial considerations of discounted cash-flow analysis for forest management regimes; and 3) regulatory requirements and social considerations affecting forest practices. Biological factors such as the ecological characteristics of the specific tree species, climatic conditions and soil properties that determine site productivity, and the impact of silvicultural practices such as thinning, interact to influence the growth rate and quality of the timber produced, which in turn determines the value of the timber. The principles of discounted cash flow analysis determine the financial returns obtained from a forest management enterprise and depend on the cost of the management regime, the revenue generated and the length of time between when expenditures are made and when the revenues are generated. Regulatory requirements such as Best Management Practices used to protect water quality, and organizational policies and social considerations designed to improve wildlife habitat and visual aesthetics, also influence forest management practices. Judicious attention must be paid to each of these factors to assure financial success of forestry enterprises. Site-specific management with emphasis placed on the best quality sites, is the key to establishing a successfully forestry enterprise.

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THE REGULATORY FRAMEWORK FOR RECLAMING MINE LAND: CONSIDERATIONS FOR FORESTRY

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Abstract

The Virginia Department of Mines, Minerals, and Energy (DMME) continues to look for new and innovative ways to reclaim mine lands. DMME has found that one of the best ways to accomplish this is by forming partnerships with other agencies and groups. DMME's Division of Mined Land Reclamation (DMLR) is responsible for issuing coal surface mining permits and enforcing the Virginia Coal Surface Mining Control and Reclamation Act (Title 45.1) (the Act). The Act requires, among other things, that surface coal mine operators reclaim mine land so it will support the post mining land use that has been designated by the landowner and approved by DMLR. Each land use has standards that must be met before the reclamation performance bond can be released by DMLR. DMLR has recognized the need to promote forestry as a beneficial post mining land use for several reasons and has begun working with operators and landowners to encourage reforestation. Even though trees were being planted, survival rates and tree growth was only sufficient enough to meet bond release requirements. Working with partners such as Virginia Tech's Powell River Project, The Nature Conservancy, U. S. Office of Surface Mining, landowners, and operators, DMLR has amended regulations and implemented procedures that encourage operators to select forestry as a post mining land use.

Introduction

Successful reclamation of surface mine land is the responsibility of the mine operator. While it is a requirement of the operator, the regulatory authority has a responsibility to make certain the approved permit plans and the applicable regulations are followed. Reclamation plans are approved by the regulatory agency before mining can begin. Different post mining land uses do not have to meet the same criteria in order to meet bond release requirements. For instance, a hayland/pasture post mining land use must have a 90 percent ground cover and an acceptable level of productivity at the end of the liability period. The productivity can be measured by either weight of clippings or by number of animals supported per acre. An unmanaged forest post mining land use has different standards. At the end of the liability period, a minimum of 90 percent ground cover and 400 woody plants per acre with 80 percent of the trees having been in place at least 3 years must have been obtained. All trees must be at least one foot tall at the time of bond release. This also includes 40 food-producing shrubs that may be distributed throughout the reclaimed area. A commercial forestland use has the same requirements as unmanaged forest land use except that all countable trees must be of commercial species and well distributed over each acre stocked. The number of trees, shrubs, and ground cover must meet a 90 per cent confidence level.

Reclamation Bond

Virginia regulations allow for two types of reclamation insurance bond. An operator may use the cost bond method or may opt to use an alternate pool bond. Release of a reclamation bond under these bonding systems differs. If a site is cost bonded, 60 percent of the bond may be released after the operator has completed the required backfilling, regrading, and drainage control of the subject area. This release is referred to as a Phase I release. After two growing seasons and the required establishment of vegetation on the regraded area, an additional amount of the bond may be released under Phase II. For the Phase II release, DMLR requires an amount of $125.00 for each acre disturbed or $2,500.00 whichever is greater to remain on the permitted area. Finally, once the operator has successfully implemented the reclamation plan and met the applicable liability obligation, an application to release the remaining bond may be submitted. The bond may not be fully released until the reclamation requirements of the Act and the permit have been fully met. The bond release application must include a final vegetation survey to document that the standards of success have been met.

A site that is bonded under the pool bond option has different release requirements. The first release requires that 12 months must have elapsed from the establishment of the post mining land use. Establishment of the post mining land use is considered after one year (12 months) from the date the operator submits completion materials for the area. At this point, the bond may be reduced to the minimum amount. This can be $40,000.00 for an underground permit and $100,000.00 for a surface permit. After the second full growing season, the operator may request an additional reduction of the bond. The same requirements as in the cost bond Phase II will apply to this release. Once the operator has successfully implemented the reclamation plan and met the liability obligation, an application for release of the remaining bond may be submitted. The bond may not be fully released until the reclamation standards of success have been met.

Remining

Remining is defined as "conducting surface coal mining and reclamation operations which affect previously mined areas" and previously mined areas are defined as "land affected by surface coal mining operations prior to August 3, 1977 that has not been reclaimed to current standards." Remining sites have different standards for release of a performance bond. If the post mining land use on a remining site is unmanaged forest, the liability period for release of the performance bond is two years. For the forestry land use, the trees do not have to achieve the one-foot height limit to be eligible for release. Ground cover to control erosion and the tree and shrub count will be established at 90 percent similar to other mining .

Remining sites eligible for a two - year liability period.

The operator may elect to have an existing reference area that shows the tree and shrub count and percent ground cover using approved transect methods. Using the reference area, the operator is required to show the vegetation after mining at the site is as good as the vegetation prior to mining at the end of the two - year period.

Landowners and Land Use

In Virginia, there may be many small landowners within a proposed permit area. The operator must include a letter from each landowner that indicates his request for the proposed post mining land use. Without the landowner approval, the DMLR permit cannot be approved. The operator and landowner must work together to determine a mutually beneficial post mine land use, a land use that can be reasonably achieved by the operator while meeting the needs of the landowner. The reclamation plan contained within the application is based upon the request of the landowner. Also, the application must include a plan on how the post mining land use will be achieved. The landowner can request a change in the post - mining land use at any time before the end of the reclamation liability period. Both the landowner and the operator must agree to the proposed change and the change must be approved by the DMLR. This requires a revision to the approved mining plan.

DMLR has tracked the land uses contained within permit applications. It can be shown that there is not a large change in the land use pre - and post- mining. Landowners and operators have worked together in restoring much of the mine land back to forest.

Based on 619 Records	Forestry	Hayland/Pasture	✍✍Public Use
Pre-mining Land Use	94%	2%	4%
Pos-mining Land Use	86%	9%	5%

✍✍Public use – recreational, residential, commercial and/or industrial

There is a slight increase in the number of permits that request a post -mining land use of hayland pasture. The increase in hayland/pasture acres in the post mining land use could be attributed to one or both of the following: 1) there is a need for hayland/ pasture, and 2) in the past operators found that it was easier to achieve a post mining land use of hayland /pasture because of planting cost and productivity surveys. Some landowners require a higher land use in order to graze cattle or for hay productio n. There are cases of a landowner not properly managing the pastureland after bond release and it returns naturally to forest. Since DMLR jurisdiction is terminated after bond release, no numbers are available to accurately reflect this acreage.

Typical site that has had the reclamation performance bond released as hayland/pasture but landowner failed to manage area for specified land use.

The mission of the DMME is to enhance the development and conservation of energy and mineral resources in a safe and environmentally sound manner to support a more productive economy. DMLR is the regulatory authority within DMME for surface and underground co al mining and reclamation operations and is responsible for enforcing the provisions of the program under Chapter 19 of Title 45.1 of the *Code of Virginia, as amended;* (§ 45.1-226 et seq.). For many years DMLR has been developing innovative tools for mine land reclamation. DMLR is participating in the Federal Office of Surface Mining's Reforestation Initiative to examine methods that would enhance post mining land use plans by promoting the planting of trees.

DMLR has recognized the importance of returni ng mine lands to forests and has worked closely with coal companies, landowners, special interest groups, and academia to encourage reforestation of mine lands. As a result of research conducted by the Powell River Project, DMLR has published Memorandum to Operators (3-96) illustrating proper husbandry and reclamation practices that are appropriate for reforestation of mine lands. The memorandum identifies three problems with past reclamation practices concerning reforestation and timber production. The problems identified include: 1) compacted minesoil, 2) inappropriate spoil material, and 3) competition from herbaceous ground covers established to control erosion. The memorandum emphasizes DMLR's commitment to the reforestation of mine lands. Two area s of particular concern are the compaction of regraded areas and competition of ground cover. The research from the Powell River Project has shown that soil compaction and groundcover have a direct effect on tree growth. In the past, regulatory authoriti es have not been concerned with the timber growth once a reclamation bond has been released on a site. Instead, the issues of slope stability and groundcover to control erosion were of primary concern. To achieve stability,

operators were encouraged to make several passes over a regraded area with a dozer or other track equipment. Operators grew accustomed to this type of regrading and it was used over the entire permit area. Regulatory authorities encouraged operators to obtain a quick ground cover in order to control erosion. Little thought was given to competition between the fast growing grasses and the trees and shrubs that were to be planted later.

Enhancing Reforestation

After reviewing the data provided by research from the Powell River Project, DMLR began encouraging alternative regrading methods and the use of tree compatible groundcover. Memorandum 3-96 outlined procedures for grading the final layer of overburden placed on regarded areas. The final layer is to be placed in plies close together. A dozer is then u sed to level the piles with only one or two passes. This practice works best in areas where the slope ratio is 2:1 or less. The memorandum also outlined measures for establishing a groundcover that is compatible with a reforestation post-mining land use. Tree compatible groundcover should be sparse the first year after planting and become heavier the second and third year. This method allows tree seedlings to grow above the ground and ensures their survival. Some of the appropriate groundcover species include weeping lovegrass, perennial ryegrass, orchard grass, ladino clover, kobe lespedeza, and birdsfoot trefoil. Tree species recommended include various crop trees and nitrogen-fixing nurse trees and shrubs such as red oak, white oak, yellow popular, white ash, black locust, black alder, and bristly locust. Research from the Powell River Project indicates that not only will the environment be improved by implementing these methods but the operator can gain economically by using them as well. The grea test cost savings can be on the grading work using a D-9 dozer. The study states that just leveling areas and not tracking can save four hours of work per acre. The average cost of a D -9 dozer can exceed $70 per hour. According to the study, almost $300 dollars per acre can be saved when using the guidelines. The study also shows that a post mining land use of forestry is less expensive than hayland/pasture. Indications are that seeding and planting costs are lower for a forestry use than a hayland/ pasture post mining land use.

DMLR held several meetings over the last 5 years with representatives from the coal industry and mining consultants designed to inform interested parties of the procedures to promote reforestation and to emphasize DMLR's support for the new reclamation techniques. DMLR also held in-service training sessions for agency enforcement personnel to inform them of these reclamation techniques and encouraged them to work with coal mine operators to use of these techniques.

For many year s, DMLR has been involved in the development of innovative tools to further the efforts of returning mine lands to forests. In addition to adopting the research from the Powell River Project, DMLR has formed partnerships with other special interest groups and organizations to develop and promote reforestation incentives for operators of mine sites. In September of 2001, a Memorandum of Understanding (MOU) was signed between DMME/DMLR and The Nature Conservancy to promote carbon sequestration by encouragin g tree planting on mine lands. The purpose of the MOU is to promote the missions of both organizations through the reforestation of mine lands in the coalfields of Southwest Virginia. In the MOU, DMME/DMLR agreed to: 1) conduct training sessions to educa te its staff and

operators on carbon sequestration and forest banking, 2) encourage and promote carbon sequestration through implementation of the post mining land use of unmanaged forest on permitted mining operations, 3) develop and maintain a listing of permitted operations and abandoned mine lands that may be reclaimed through carbon sequestration cooperative operations, 4) along with The Nature Conservancy, pursue special funding initiatives and partnerships for carbon sequestration cooperative projects, 5) undertake other work that becomes necessary for implementation of cooperative projects, and 6) meet with The Nature Conservancy and other parties as necessary to review ongoing work to explore new carbon sequestration partnering opportunities.

Meetings have been held with representatives of DMLR, The Nature Conservancy, mine operators, and the utility industry to promote the MOU and encourage cooperation among the parties that would enhance mine lands by returning them to a forestry land use for the development of carbon sinks. Site selection for areas to be used for carbon sequestration is a most important criterion. Generally, a good site should be in excess of 500 acres. DMLR has begun to develop an inventory of potential sites that could be marketed for reforestation and carbon sequestration. This inventory will be placed in a GIS database and will be available to any parties interested in entering into an agreement for carbon sequestration. DMLR will coordinate the initial meetings between the parties and furnish any data related to the mine areas while the agreement is being developed.

Other initiatives to promote reforestation on mine lands that DMLR has taken include the creation of a committee called the Permit Streamline Committee. The workgroup consists of representatives from DMLR and the coal industry and consultants that prepare permit applications for mine operators. Meetings are held once a quarter to discuss changes in DMLR policy and procedures and to accept comments from industry and consultants about permitting issues. These meetings are used to emphasize items such as reforestation of mine lands. As a result of one Permit Streamline Committee meeting, mine operators expressed a concern that DMLR was not committed to the reforestation guidelines in Memorandum to Operators 3-96. Guidance Memorandum No. 2-01 was issued to re-affirm the DMLR position and to further encourage operators of mine sites to implement the husbandry practices outlined.

Another partnership that has worked to promote forestry post mine land use is the Virginia Remining Ad Hoc Advisory Work Group, formed by DMLR in 1996. The group is made up of representatives from DMLR, educational institutes, coal companies, the Office of Surface Mining, The Nature Conservancy, and mining consultants. The group has been recognized nationally for its work in the area of remining. The primary focus of the Work Group is to develop and implement incentives to encourage operators to remine and reclaim abandoned mine lands to current reclamation standards. Reforestation is a main consideration when developing incentives for operators. When adding research from the Powell River Project dealing with regrading and soil compaction and use of alternate ground covers to other incentives, abandoned mine sites become more attractive to remine. Remining sites are Abandoned Mine Land (AML) Priority 3 sites that probably will never receive the needed funding to be reclaimed under the AML program. Remining remains as the best alternative for reclaiming the sites. Some of the incentives that were implemented as a result of the work group include the No-Cost agreement, the AML Enhancement Rule, and the use of the experimental practice to reclaim abandoned

mine lands. Each of these incentives is in place and working in the Virginia program, and as a result, many of Virginia's abandoned mine land sites are being returned to forestry.

Conclusion

While DMLR regulates the mining and reclamation of permitted sites, it does not have the authority to require an operator or landowner to designate a land use. This is up to the discretion of the operator or landowner. DMLR does have the authority to assure the land is returned to the post mining land use designated to meet the requirements of the Act. The Virginia Department of Mines, Minerals and Energy's Division of Mined Land Reclamation has taken an active role to encourage operators and landowners to implement a post mining land use of unmanaged forest or commercial forest. Partnership have been formed and incentives have been developed that ensure that landowners and mine operators understand the environmental and economic benefits of returning mine lands to a forestry land use.

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REFORESTATION ON ABANDONED MINE LAND (AML) AND BOND RELEASED GRASSLAND

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Abstract

The State of Ohio, Department of Natural Resources, Division of Minerals Resources Management realized in 1982 that funding constraints and priority restrictions would limit reclamation of abandoned mine land (AML) by the 1977 Federal Act and the 1972 Ohio Law. Therefore, DMRM began to develop a low-cost reforestation alternative to traditional earthwork reclamation methods. The qualifying funding parameters for these sites were initially pre-law sites, but these parameters were expanded to include sites reclaimed under Ohio law up to the permanent Federal program date of September 1981. These had to be located in watersheds listed in the AML inventory as impacted by flooding. This effort has evolved over 20 years to become one of the largest and most successful AML reforestation programs in the nation. This paper highlights some of the considerations of site selection, species selection and costs, bidding considerations, costs of herbicide treatment, logistical costs and problems, site preparation, planting methods, and evaluation of plantings. Also discussed are maintenance planting costs and problems that occur after planting.

Introduction

In 1972, the State of Ohio passed its strip mine and reclamation law in the form of Section 1513 of the Ohio Revised Code. This was essentially the first backfill law in Ohio where coal operators were required to return strip mined land to approximate original contour. This legislation also coincided with similar legislation in the early 1970's in other States in the Appalachian area inclusive of Pennsylvania and West Virginia. A unique part of Ohio's legislation was the creation of a severance tax on coal that was to be the used for the restoration of orphaned strip mine land. This State program continues today along side the abandoned mine lands program created by the Federal Surface Mining Reclamation and Control Act (SMCRA) of in 1977. The Office of Surface Mining and Enforcement approved Ohio's permanent program in September of 1981.

The State of Ohio, Department of Natural Resources initially inventoried the State by watersheds to review the impacts from strip mining. The "Land Reborn" study, which was an inventory of the affects of mining, was a part of the requirement of Ohio's new mining law and pre-dated SMCRA. It was soon after the Surface Mining Reclamation and Control Act was passed that the Ohio Department of Natural Resources, Division of Minerals Resources Management (DMRM) realized that it would be almost impossible to obtain reclamation of all its abandoned mine lands. The inventory of abandoned mine land sites were in excess of 600,000 acres. Also, many of these acres were priority three sites under the SMCRA system and would not be

funded until priority one and two sites were completed. Therefore DMRM developed the reforestation program. The reforestation program goal is to foster reclamation of abandoned mine lands by using a low cost approach to provide re -vegetation, watershed protection, and reduce the erosion from low priority two and three coal abandoned mine land sites and abandoned industrial mineral sites.

Site Selection

Since 1982, DMR has planted over 5 Million trees on 4,500 acres on 413 Abandoned Mine Land sites (Table 1). The majority of these sites are qualified as Clogged Stream Lands (CSL) by the Abandoned Mined Land Inventory System (AMLIS). These sites consist of abandoned spoil banks from strip mines and abandoned coal refuse piles. A significant percentage of abandoned mine lands sites where trees are planted are barren spoils and mine refuse or gob with a soil p H of 3.0-4.0.

Additional plantings may occur after conventional reclamation by the abandoned mine lands program when: (1) it would benefit the watershed, and (2) land use conflicts are not a problem. These sites are planted using normal planting techniques or special site species depending on the initial goal of the project. In most instances, the reclamation program goal was to seal and isolate acidic material by clay seals and reduce the formation of acid mine drainage the site will not be planted trees.

Plantings are now beginning to occur on sites mined between 1972 and the Federal approval date of Ohio's Regulatory program in 1981. These planting sites are targeted on sites that are found in watersheds that exhibit frequent flooding and are lis ted in the abandoned mine land inventory. These sites exhibit poor to good vegetative cover due the reclamation laws under which they were reclaimed. Most of the time, these sites have been re -mined sites. Initially the sites were forested and mined prior to 1972 when backfilling and drainage control requirements were at a minimum. This increased sedimentation and flooding in most cases. (The Clogged stream and Frequent flooding of the AMLIS)

Between 1972 and 1981 parts of these watersheds were re-mined. With this re-mining, the new mining removed the pit impoundments by advancing the old highwall, grading, and resoiling the site. In many cases, the resoiling was done with pan scrapers. Some of these sites left moderate to severe compaction of the soils, depending on the soil type and method of resoiling. This increased runoff and reduced natural succession of tree species. These sites, to a limited extent, are being targeted for reforestation. The land treatment for these sites may include som e form of ripping and subsoiling depending on the degree of compaction. In addition, herbicide is spayed to assist in the survival of the tree seedlings. These sites are also are more likely to be able be machine planted. Some of the land was area mined and converted to grasslands and has been left fallow for years. Undesirable species such as Autumn Olive have taken over some sites and makes reforestation very difficult.

The Abandoned Mine Lands project officers in the field complete the process of se lecting sites annually, with review by the reforestation coordinator. In some cases, the project officers have developed a three year plan. The best method for efficiency is to cluster the sites to reduce right of entry work, oversight costs, and travel. This also reduces planter/contractor cost since

remobilization of crews are kept to a minimum. Some of the selection criteria include the following:

1. Programmatic Eligibility- Dates when mining was conducted and AMLIS inventory
2. Consideration that the site will not be re-mined.
3. Land Use Considerations or conflicts--Grazing, Development, Oil and Gas re-affectment
4. Ability to obtain right of entries for reforestation
5. Special conditions to the planting such as fencing and barricades for ORV traffic.
6. Soils testing and problems

Once the sites are selected: (1) they are reviewed and approved, (2) species are selected, and (3) location and site maps are made. The information is placed in the database and then placed in a bid package in late fall. Please note the site information form. Attachments 1.

Species Selection and Right of Entry

Approximately 50 percent of the trees planted have been inoculated with Pisolithus tinctorius (P.t.). P.t. is an ectomycorrhizal fungus that forms a symbiotic association with the fine feeder roots of tree seedlings. This association enables the host tree to tolerate a low soil pH, drought conditions, and high spoil temperatures. It also increases the tree's ability to absorb water and nutrients. This has resulted in an excellent survival rate, estimated to be 75 percent for all planting to date. These species are placed only on sites that have acidic spoils.

P.t. inoculation was developed as the result of an OSM-funded research project in 1981, between the U.S. Forest Service and the States of Indiana and Ohio. P.t. is a naturally occurring fungus that is introduced to seedling roots while still in the nursery environment. Dr. Charles E. Cordell of Plant Health Care has assisted in the implementation and evaluation of the P.t. trees grown for Ohio. The Ohio Department of Natural Resources (ODNR) nursery at Marietta is and has been one of a few facilities in the eastern United States producing P.t. innoculated seedlings. Ohio's AML Reforestation Program has grown from planting small-scale research plots to using reforestation as a low cost, low maintenance reclamation method (see tree planting listings by year). Ohio has found that it can successfully grow Virginia Pine, White Pine, Pitch-Loblolly Pine, Red Pine, Scarlet Oak, Sawtooth Oak, Northern Red Oak, Chinkapin, Burr and Black Oaks using the P. t. technique. These species along with American Chestnut are excellent host species for Pisolithus tinctorius (P.t.)

In addition to the P.t. inoculated species, Ohio also plants: Black and Bristly Locust, Black Alder, Green Ash, White Ash, Sawtooth Oak, Red Oak, Bald Cypress, Sweetgum, Red Cedar, Butternut, River Birch, Bur Oak, Tulip Poplar, Shumard Oak, White Oak, and several other shrub wildlife species. These are planted primarily on areas that have been reclaimed using conventional regrading and resoiling techniques. The purposes of these plantings are to increase wildlife habitat and diversity and reducing runoff and sedimentation from these reclaimed sites.

Photo 1. P.t. Virginia Pine planted on No 9 Meigs Creek Sandstone derived spoil with a pH of 3.5 Jefferson Twp , Noble County

Photo 2. P.t. Virginia and P.t. Red oak planted on No. 5 Coal Acid Spoil in White Eyes Township, Coshocton County

Table 1. Number of Sites, Acres, and Seedlings Planted by Year

The program has progressed steadily in the last 18 years. Annually the Division of Minerals Resources Management plants a minimum of 180,000 P.t. inoculated Red Oaks, Virginia pine, Chinkapin Oaks, and White Pine on low ph soils. Approximately 50 percent of the trees planted are mast-producing trees. DMRM is now averaging approximately 300,000 seedlings planted per year. To date, we have planted over five million trees on 4,000 acres of groun d. Survival rates of P.t. trees have average 75 percent.

YEAR	NUMBER OF SEEDLINGS	NUMBER OF SITES	ACRES PLANTED
1982	59,000	8	33.5
1983	120,000	10	72.4
1984	125,095	9	69.5
1985	149,250	15	166.3
1986	327,400	14	245.0
1987	311,400	19	223.1
1988	305,750	12	195.5
1989	342,250	19	235.0
1990	295.600	21	181.5
1991	324,500	18	190.5
1992	268,700	22	164.0
1993	334,000	26	222.7
1994*	287,000	25	196.1
1995	291,500	22	205.7
1996	357,844	30	298.0
1997	327,000	52	290.0
1998	339,375	34	242
1999	315,225	33	225
2000	550,000	22	550
2001	450,000	21	400
2002	295,000	17	241
TOTALS	**5,430,887**	**413**	**4,656 AC**

Species selected for grassland areas and reclaimed abandoned mine land projects include: White Ash, Green Ash, Sweetgum, Black Locust, White Pine, Tulip Poplar, Silver Maple, Red Maple, and other pioneer species. We also plant Sawtooth Oak, Red Oak, White Oak, Bur Oak, Butternut, Black Oak, and Shumard Oak. White Ash and Green Ash have the highest survival rates of these species, at 93 percent, as measured by the U.S. Forest Service. Species for wet areas and along stream banks include: River Birch, Box Elder, Bald Cypress, and Black Alder. Interspersed with this mix we plant: American Plum, Indigobush, Paw Paw, Persimmon, and other wildlife species. Grassland planting costs can also be cheaper at times. It lends itself to mechanized planting, depending on slope considerations and whether subsoil ripping is necessary to reduce compaction.

Many times private landowners may desire species that may not be suited for the site. Our project staff will work up a mixture that we feel will: (1) best be able to survive, (2) be readily available from the nursery, and (3) meet the site characteristics. We will then work with the landowners on the tree species. Frequently the small private landowners are just happy to get the site planted.

As part of the right of the entry, the landowner agrees not to use the land within the tree planting area in a manner that would be detrimental to the growth of the trees for a period of 7 years. It also will expire within 2 years if the trees are not planted. In addition, the right of entry describes the time that the mining was conducted, as part of the programmatic condition for funding of the reforestation effort (See Attachment 2). Dealing with absentee landowners of both private and corporate property is the most difficult and time-consuming part of obtaining right of entries. We have not had much success trying to identify some landowners for carbon sequestering plantings being conducted by American Electric Power. The long-term agreements of 30 to 70 years that these type plantings require are not popular with private landowners.

Bidding Costs and Problems

One problem with bidding is that it has been difficult to maintain a diverse number of planters, since much of the planting the ODNR-DMRM does is on very rough ground and involves hand planting. As an average approximately 50 percent of our planting are P.t trees in which the conditions for planting are steep spoil banks and some moderate benches. We have seen the number of planters drop off in recent years blamed in part on the inability to keep workers.

In order to help with logistics, we have tried to group sites as much as possible in a geographical area. This helps to reduce the down time and remobilization for planters and to maximize our actual planting effort. This reduces travel for both the planter and our oversight staff evaluating the work.

It is in our best interest to develop both large and small plantings to broaden the list of competitive bidders. The large plantings allows us to attract the large-scale planter who can reduce the time needed to complete the work and minimizes our administrative time. Yet we must maintain small sites for the small planter who is only interested in planting 10,000 to 12,000 trees or less but bids year after year. Therefore, the assembly of our bids should be arranged in this manner so that a good mix is maintained. We have many sites on orphaned mine land that are small in comparison to large sites.

Another way to bid is to have the planter supply the trees and land treatment. This is an alternative method of bidding that we have not done. This type of bidding has been done by American Electric Power on sites they have planted involving carbon credits. Such large sites may cost only $180-$200 per thousand for land treatment, seedlings, and planting. These plantings have normally been greater

than 500,000 trees. Such large sites require less demobilization and mobilization of planting crews and reduce costs.

Table 2 - Average Bid Cost Range Last 5 Years

Year	Average Cost per Thousand Seedlings Hand planting	Cost Range Bids per acre on herbicide application	Cost/acre Ripping with Tilth winged subsoiler	Cost per acre on general Agricultural Ripping.	Average Cost per Trees per 1000
1998	**$120/1000**	**N/A**	**N/A**	**N/A**	**$293**
1999	**$128/1000**	**N/A**	**N/A**	**N/A**	**$296**
2000-	**$138/1000**	**$27--$29/acre**	**N/A**	**N/A**	**$298**
2001	**$140/1000**	**$29--$55/acre**	**$85/ac**	**$36/ac**	**$298**
2002	**$192/1000**	**$30-$45/acre**	**N/A**	**N/A**	**$608****

**** Price increase from nursery of 40 percent on P.t. seedlings 50 percent for other species**

Table 2 above gives you a representa tive example of our costs over the last 5 years. Maintenance plantings will have a higher cost. This is understandable since much of the work is more time consuming than planting a new site. The table does not list transportation, cold storage, planting evaluation costs, or P.t. seedling evaluation costs, flagging, and root dip, which are also part of the total costs.

Logistics and Transportation

The Division of Minerals Resources over the last 6 years has placed all its trees in a cold storage in a central location to assist with the distribution of the seedlings. The seedlings are normally ready from the Marietta and Zanesville nursery by March 1. The date is dependent on the weather as to when they can complete pulling of the seedlings. Marietta seed lings, which includes all the pine and P.t. treated seedlings usually is available early due to the sandy nature of the soil.

The price of semi refrigerators has been investigated but rental of a large walk in cooler near Cambridge at New Concord has been very efficient. This location is near the junction of Interstate 70 and Interstate 77 for good access north and south to planting sites. Once seedlings are available at the nursery, most of the trees are hauled there by staff from our Civilian Conserva tion Corp and

distributed on a site-by-site basis by the planter and/or DMRM staff. If larger sites were done, requiring large number of seedlings, rental of semi refrigerators would be necessary.

Planting usually occurs in Ohio from March 1 to April 20 th to optimize survival prior to budding. The distribution of seedlings must keep pace with the planters. It helps to minimize the downtime spent picking up seedlings.

Storage and transportation of oversized seedlings is a problem that occurs for some sp ecies. If it occurs generally across the range of your tree mix, your transportation costs and storage are pushed to their limit. Packaging by bags takes up more space than needed. Placement of seedlings in bundles or jelly-rolls optimizes storage in the cooler during transportation and hauling to the planting site by four wheelers and pick up trucks. The trees also stay fresher and have less likely to dry out. Bags also are more of a problem of disposal.

Planting and Site problems and Site preparation

As indicated previously, some large nursery stock will cause planting problems. Root pruning and top pruning can remedy some of this but it is better to have the proper size seedlings. This is better controlled at the nursery. Large nursery stock slows down the planting as well as increases the bid costs. Continual problems with larger seedlings will also stop some planters from submitting bids. This increases costs. This should be watched closely and seedling stock selected where the best size can be purchased.

One problem with our strip mine sites is the difficulty in planting out -slopes versus bench slopes. Many of the out-slopes on these abandoned strip mines can be as steep as 1.5 to 1. There should be a mix of terrain type to even out the planting plan for the site. This helps the planter as well as your ultimate bid cost.

In addition, many of the P.t. treated trees do not grow well on poorly drained soil. Setting up pre - planting meetings with the contractor to review planting methods and the planting plan helps reduce the likelihood that some species will be located in the wrong site condition.

At many sites, we have problems with deer browse. This is expected. We plan a heavy stocking in the initial planting to provide for the expected loss of seedlings. The reforestation program goal is to get as much cover as quickly as possible to reduce erosion. It is not uncommon to place as many as 1,250 trees per acre to achieve this result. Another source for the loss of trees are off road v ehicles by four wheelers. The strip mine sites we plant are often remote and attractive for this kind of activity. We try to obstruct entrances and place barriers up at some locations. Barrier or fencing is done on the more high profile sites to a limited extent. This of course adds to your costs.

On grasslands that were strip mined in the 1970's and early 1980's, the vegetation can be quite thick. In order to optimize the seedling survival on these sites, it is wise to herbicide. We usually spray a 2 foot row spaced 8 feet apart with "Oust." This can be done in the fall or spring. The application rate per acre is ¾ oz for the spring application. The fall application is 11/4 oz of "Oust" per acre. This was based somewhat on the manufactures recommendation and the success that American Electric Power was having with the extensive tree seedling plantings they were completing in Ohio. If done in the spring, we require a dye marker to be placed with the herbicide to help delineate the row. The herbicide equipment also leaves a mark on the ground for the sprayed row. Planting in the spring is

usually done prior to actual greening up of these areas, therefore it may be difficult for the planter to distinguish the spayed area unless he can follow the dye mark and/or equipment marking. The costs for the herbicide spring applications have been bid separately or in conjunction with the planting. When we did bid with the planting we separated the actual planting costs and herbicide application. As can be seen in Table 2, this has an average close of $30 per acre. Herbicide applications by AEP on their lands have averaged $26-27 per acre due to the larger number of acres involved.

Photo 3. Herbicide Equipment on John Deer Tractor

On grassland sites being converted to forestland, there may be problems with compaction. Some of the sites reclaimed to pasture where done so by pan scrapers with rubber tires spreading the topsoil or traversing over the spoil. This may have lead to extensive compaction . This depends on: (1) the soil type, (2) the time of year the soils were placed, and (3) weather conditions. You need to be aware that this problem can affect your seedling survival. One such site we planted showed extensive compaction. The Crown City site consisted of clay material that had been compacted, as indicated by our testing. CTL engineering was hired to test for compaction at different depths in the profile. Ten test pits were taken. Compaction testing was done prior to planting using the Tilth winged subsoiler and normal agricultural ripping and then after this ripping was completed. Based on the results of this testing, the compaction was only improved by 20 percent. Some control areas were left on the site and not ripped at all. We then planted the trees by hand on sites with both ripped and non-ripped soils. We contacted the Ohio Division of Forestry and the USFS out of Morgantown, West Virginia to set up test plots in order to evaluate the success of the planting over time. Unfortunately, this spring an arsonist set the area on fire and destroyed much of the planting. However, Table 2 gives you an idea of the costs associated with this type of land treatment. Table 3 gives some examples of the compaction prior to and after the work on this site.

Table 3. Example of Soil Compaction before and after soil fracturing at the Crown City site

Site ID	Depth	Compaction %Pre-Treatment	Compaction %Post-Treatment	Average % Difference
Site 3-1	Surface	82	77	
	1 Foot	96	94	
	2 Foot	104	76	**-11.7**
Site 3-2	Surface	90	70	
	1 Foot	92	84	
	2 Foot	100	90	**-12.7**
Site 3-3	Surface	90	84	
	1 Foot	87	76	
	2 Foot	100	96	**-7.0**
Site 3-4	Surface	83	72	
	1 Foot	86	85	
	2 Foot	97	87	**-7.3**

For each testing location, a one -point proctor test was conducted in the field, in order to determine the optimum compaction. A nuclear densometer gauge was then used at each location to determine the percent compaction of each test. The testing was not conducted immediately after the Tilth Soil Fracturing. Due to the elapsed time for follow up testing, winter freezing and thawing, and heavy precipitation, the test results may not show as great a decrease in density as it would have shown immediately after the fracturing. CTL Engineering indicated that the actual net decease in density as a result of the fracturing would have been approximately 20 percent.

Photo 4. Tilth Winged Subsoiler working on the Crown City Site Lawrence County, Ohio

Funding and Evaluation

The funding source for the reforestation program in Ohio is the State Abandoned Mine Lands Funds that was created by the severance tax established by the 1972 Strip Mine Law and amendments. Additionally, approximately $30,000 to $75,000 has been funded through the Federal Abandoned Mine Lands Program. The Industrial Minerals Program (Section 1514 Ohio Revised Code) has funded the reforestation program only when seedlings were planted on abandoned or forfeited Industrial Minerals sites. The actual cost per year to run the program is approximately $250,000 for approximately 300,000 to 320,000 seedlings. Any more planting over this number of seedlings would require additional funding.

In our 2002 Federal Abandoned Mine Lands Grant, we choose a small watershed that was strip mined prior to 1970, in which a combination of reforestation and sediment controls with limited designs will be used to achieve reclamation. This may be more expensive that just reforestation, but far less than the standard earthwork reclamation and will extend the AML funds further. One the goals of this site (Elba) will be to measure the reduction of sediment loading due to the reforestation effort.

In order to evaluate the program success, the Division of Minerals Resources has had the U.S. Forest Service set up various test plots measuring the results of our 1999 planting. Previous plots were done in the 1980's. These plots where set up on sites planted with P.t. Virginia Pine on old spoil and sites planted on grasslands using herbicide treatment. Plots should be set up every year to evaluate a sampling of the sites. These evaluations should be done in house, if possible, but also with outside review to substantiate the success of the program.

Conclusion

Reforestation for reclamation of abandoned mine lands and for grassland reclaimed sites is a viable method of reclamation. Reforestation by itself or in combination with enhanced erosion and sedimentation structures on severely-eroded, abandoned mine lands sites can extend the AML dollars to achieve more reclamation and maximize the use of this funding. Traditional reclamation practices of partial backfill or full backfill of old strip mine sites can costs as high as $6,500 to $8,000 per acre. By comparison, reforestation by itself on these sites costs approximately $600 per acre. Reforestation

in combination with alternative drainage protection and sedimentation controls may approach $2,000 per acre. Reforestation is a good strategy to extend the AML funding dollar.

Conversion of mined grass lands to forests land use by planting seedlings is an excellent land use goal. Large watersheds that were extensively mined from the 1970's to the present have increased runoff significantly producing enough scouring and sedimentation to increase flooding and impacting nearby infrastructure such as roads, culverts, bridges, homes, and streams. Reforestation reduces this runoff and watershed characteristics. Many times these grassland have not been mowed, pastured, or made into hay. They are basically fallow and out of production. Sometimes, this leaves these lands open to plant succession by undesirable species. Planting trees diversifies the site for wildlife and recreation and provides watershed protection. Over time, it will produce a timber product in the form of pulp or saw logs. The price of the conversion even with ripping and herbicide treatment approaches only $680 to $700 per acre. This can be reduced depending on the seedling source, bid arrangement, and size of the project. With known tax incentives and write offs for forestland, reforestation becomes an attractive strategy for management of these lands.

John Sprouse is employed by the Ohio Department of Natural Resources, Division of Mineral Resources Management, in Cambridge, Ohio. He is the field supervisor for the Abandoned Mine Land Program (AML) in Southeastern Ohio. He also coordinates the AML Reforestation Program Statewide. In prior capacities with the Division, he coordinated Ohio's Forfeiture Reclamation Program, served as district coal regulatory supervisor and held positions as a coal regulatory inspector, a training officer, and was a project officer for the Abandoned Mine Lands Program. He earned his Bachelor of Science degree in Natural Resources in 1976 from The Ohio State University. Prior to working for the State of Ohio, he worked as a Geological Technician with the Wyoming and Eastern States Office of the Bureau of Land Management. He also worked in the Engineering Section with the U.S. Forest Service in Arizona and as a Coal Lab Technician with the Coal Industry.

Attachment 1

Ohio Department of Natural Resources
Division of Minerals Resources Management

Project Name_____

Project Location Section___ Township_____ County_____

7.5 Minute Topographic Quad _____
(please attach a topo with the site outlined)

Landowner(s)
Name_____,_____ ,_____
Add_____,_____,_____
City_____,_____,_____
State,zip_____,_____,_____
Phone_____._____,_____

Has the right of entry been obtained _____yes _____no (If so attach, If not comment)
Comment_____

Project Type____unreclaimed Strip Mine ____Coal Refuse ___ Unreclaimed IM site ___ Other
Comment_____

Total Acres_____ Plantable Acres_____
Percent Vegetative Cover_____ Primary Vegetation Type_____
Spoil Type (GOB, ACID SPOIL, ALKL. SPOIL, S&G)_____
Soil Compaction _____Soil Test Taken __ yes___ no
Aspect or Slope facing_____
% Outslope_____% Bench or relatively Flat_____
Soil Sample_____(Please attach if results received.)
Evidence of p.t. Fuiting bodies (Acid Sites)_____yes_____no
Special Site Preparation
Recommedations_____
_____
Special Seedling Arrangements or
Spacing_____
_____

Species Desired and number :

Comments_____
_____

Date Prepared_____ Prepared By _____

Attachment 2

REFORESTATION
CONSENT FOR RIGHT OF ENTRY

THIS CONSENT TO ENTER given to the State of Ohio, Department of Natural Resources, Division of Minerals Resources Management (the "State"), this day of , 20 by _____ , hereinafter referred to as the "Landowner."

WHEREAS, landowners are the recorded owners of approximately ____acres of land located in Section ____ ,_____ Township, _____ County, Ohio; and

WHEREAS, such land has been affected by mining before April 10, 1972 and has been left in an inadequately reclaimed condition or was reclaimed prior to Sept 28, 1981 ; and

WHEREAS, the State desires to undertake a reclamation project involving the planting of trees on the project area outlined on the map attached hereto, which project area is approximately acres in size.

NOW THEREFORE, in consideration of the benefits which will insure to Landowners and to the general public and intending to be legally bound hereby:

1. Landowners hereby grant and convey to the State, its employees, agents servants, contractors and subcontractors, a right of entry upon all of Landowner's land within the project area outlined on the map attached hereto. The right of entry shall include necessary and convenient right of ingress, egress, and regress, with all necessary and convenient personnel, materials, equipment, and a right to do any and all things as may be necessary or convenient for the planting of trees on the project area and the observation and monitoring of the growth rates of the trees.

   If the State does not commence the planting of trees within the project area within two (2) years after execution of this Consent to Enter, this Consent to Enter shall expire at the end of the two years.

2. Landowners understand that the State is not committed to perform the planting of trees and other reclamation work or otherwise compensate Landowners for this right of entry.

3. Landowners agree not to use the land within the project area in a manner detrimental to the growth of the trees for a period of seven (7) years after completion of the planting.

4. Landowners release, discharge and hold harmless the State from any and all claims, demands or causes of actions, against the State for any damage, loss or injury arisin g from or connected with the reclamation project.

IN WITNESS WHEREOF,
Landowner(s), _____ have caused this Consent to Enter to be duly executed as of the above written day and year.

Name: _____ Name: _____

Address: _____ Address: _____

City: _____ City: _____

State: _____ Zip: _____ State:_____ Zip: _____

Phone: _____ Phone: _____

Witnessed By: _____Witnessed By: _____

Revised 1/93

RECLAMATION COSTS/BENEFITS FOR AREA MINING; OVERBURDEN PLACEMENT, GRADING, SITE PREPARATION, REFORESTATION AND MANAGEMENT

Bryce West and Bruce Evans
Black Beauty Coal Co.
Evansville, Indiana
and
Chris L. Liebering
Leibering & Sons, Inc.
Lamar, Indiana

Abstract

Black Beauty Coal Company has been a part of the coal mining industry in Indiana and Illinois for the past 25 years. Black Beauty utilizes hydraulic excavators, end dump trucks, and low ground pressure dozers for all soil removal and replacement operations. Final spoil grades are established with dumped shale or rock that is then graded by large dozers. Desirable soils are removed by the excavator ahead of the active pit and placed in end-dump trucks, which haul and dump the soils on the graded spoil behind the active pit. Depending on the approved soils handling plan for the particular site, the dumped soil may be final graded with low ground pressure dozers or graded for the placement of a layer of topsoil. Whether topsoil is removed and replaced separately, or whether it is removed and replaced as a single lift with the subsoil is determined by the dominant land use and soil characteristics of each individual mine site. Depending on the amount of desirable soil available on a mine site, the replaced soil thickness ranges from approximately 2 – 8 feet, with average depths being in the 5 – 6 foot range. In late winter, a legume or legume mixture is frost seeded into wheat sown the previous fall. Seedlings are planted into the standing wheat when ground conditions allow. Factors that determine the success of reforestation include: (1) seedling quality and species selection; (2) seedling care after leaving the nursery; (3) soil conditions; (4) weed control; (5) seedling placement; and (6) follow up competition control. Over the years, Black Beauty, as well as other area operators, tried many alternative methods of restoring forestlands. Some experimental methods proved successful under certain conditions while others were not so successful. Economic incentives and increased regulatory flexibility can be two very important factors that can improve and increase acreage of new forests on reclaimed coal mine lands.

Introduction

Black Beauty Coal Company has been a part of the coal mining industry in Indiana and Illinois for the past 25 years. Leibering & Sons Woodland Management has been an independent forestry contractor since 1956 and plants over 1 million trees annually on reclaimed coal mine lands for numerous mining companies, including Black Beauty, in Indiana and Illinois. The collective methods of reforestation found to be most successful by Black Beauty and Leibering on Black Beauty mines are discussed below.

Soils Handling, Replacement, and Initial Site Preparation

Black Beauty Coal Company utilizes hydraulic excavators, end dump trucks, and low ground pressure dozers for all soil removal and replacement operations. Final spoil grades are established with truck dumped shale or rock that is then graded by large dozers. Desirable soils are removed by the excavator ahead of the active pit and placed in end dump trucks, which haul and dump the soils on graded spoil behind the active pit. Depending on the approved soils handling plan for the particular site, the dumped soil may be final graded with low ground pressure dozers or graded for preparation of placement of a layer of topsoil. Generally, whether topsoil is removed and replaced separately or whether it is removed and replaced as a single lift with the subsoil is determined by the dominant land use and soil characteristics of each individual permitted mine site. If a mine site predominantly consists of prime farmland where topsoil must be segregated during removal and replacement, then the soil removal and replacement for the forest areas of this mine site are accomplished in a similar fashion. If on the other hand, a mine site consists primarily of forest and/or wildlife land uses then approval to use a soil horizon mixing plan is sought from the appropriate regulatory authority. Generally, once timber, stumps, and other woody debris are removed from a heavily wooded area, the remaining layer of topsoil is very thin and difficult to remove separately. A more favorable soil environment is created for tree survival and growth by removing and redistributing the topsoil and rooting media as a single lift. Depending on the amount of desirable soil available on a mine site, the replaced soil thickness ranges from approximately 2 – 8 feet, with average depths being in the 5 – 6 foot range on Black Beauty's mines. Soils are not only compacted during replacement, but they can also be greatly compacted during removal. There are many tillage tools available to alleviate compaction; however, the best practice is to minimize compaction during the necessary handling processes. Deep tillage has shown no apparent advantage on the sites where an A/B soil horizon mix has been utilized. The most successful tree plantings on Black Beauty mines, have occurred on sites where the single lift of A/B soil horizons have been used.

Benefits of Utilizing Soil Horizon Mixing Plans on Forest Lands

The benefits of utilizing soil horizon mixing plans on forestland are:

- More Efficient Utilization of Mining Equipment.
- Decreased Exposure Time of Bare Soils.
    - Less Sediment and Nutrient Loss.
- Decreased Compaction
    - Increased seedling survival rates.
    - Increased initial growth rates.
    - Timely Bond release.

Compared to other land uses and soil capabilities, Black Beauty's cost of soil removal and replacement for a non-prime or non-cropland capable forest is somewhat less than that for prime farmland or high capability land uses and similar to the cost of non-prime or non-cropland capable wildlife or pasture/hay land.

Once final grading of the replaced soils is accomplished, the reclaimed area is evaluated for erosion control needs. If permanent erosion control structures are needed, then design plans are developed and the structures are built. Fertility needs are determined and applied as needed. Depending on the season when the soil is replaced, a quick cover crop of oats, millet, or wheat is planted. If an oat or millet crop is sown in spring or summer, then wheat is no-tilled in the fall to provide a dense winter cover. In late winter, a legume or grass/legume mixture is frost seeded into the standing wheat. Seedlings are planted into the standing wheat when ground conditions allow. The wheat will, of course, die in June, but still provide erosion control and assist in moisture retention during the critical first months after seedling transplanting. The frost-seeded legumes generally do not become prevalent until late summer. Following this type of general plan has proven to be effective in balancing the needs for erosion control, moisture retention, and minimal vegetative competition to the seedlings during the first growing season. The costs of initial vegetative seeding and erosion control is similar to other land uses and soil capabilities with the costs associated with prime or high capability croplands being slightly higher, due to a more precise fertility program being implemented.

When considering the total costs of removing and replacing soils, erosion control, revegetation and proof of productivity until final bond release, prime cropland has been the most expensive land use for Black Beauty to reclaim. The next highest reclamation cost is re-establishing forest lands. Wildlife and pasture/hay land uses have been the least expensive land uses for Black Beauty to successfully re-establish. One important factor in minimizing the cost of reforestation is to plan for and implement adequate erosion control measures prior to seedling planting. The replanting of trees necessitated by grading of erosional areas is extremely expensive when compared to the replanting of herbaceous vegetation associated with other land uses under similar circumstances. Approximately 80 percent of the reforestation cost is associated with the initial tree planting. Re-planting would obviously double this cost.

Alternative Methods & Aids to Reforestation/Regulatory Assistance

Economic incentives and increased regulatory flexibility can be two very important factors that can assist the improvement and increased acreage of reforestation on reclaimed coal mine lands. Over the years, Black Beauty, as well as other area operators, have tried many alternative methods of restoring forestlands. Some have proved to be successful under certain conditions while others have been not so successful. Throughout the successes and the failures, many things have been learned that have changed the way sites are prepared and seedlings are planted. Direct seeding of acorns and smaller tree seeds, varying levels of ground cover, the influence of adjacent invasive seed sources and natural regeneration are all aspects that have the potential to change the methods of reforestation on reclaimed mine lands. As with the transplanting of seedlings, ground cover seems to have an immense, direct effect on the alternative methods of reforestation described above. As ground cover or competition increases, the success rate of establishing trees decreases. Promising results have been achieved with direct seeding of acorns and reliance on invasive species in areas where minimal ground cover or bare soils have been purposely created. With the current State and Federal requirements for ground cover and erosion control, it is difficult to implement any of these alternative methods in a substantial manner, but it should be noted that the use of methods that decrease the cost of reforestation, would serve as an incentive to increase reforestation acres. Additionally, added flexibility of where trees can be

planted on reclaimed lands would help to insure trees are kept and maintained after final bond release. Currently, many States do not allow planting of trees on prime farm land; however, many landowners with reclaimed prime farm land would prefer to have trees planted on all or a portion of their land. In States where test plots are allowed to prove productivity on prime farm land, trees could be planted on some of the areas represented by test plots without interfering with the prime farm land productivity requirements. On the other hand, where a State or Federal requirement limits the loss of forest acres, some acres are planted to trees when the landowner does not wish to have them and thus removes the trees immediately after final bond release. Increased flexibility should help to increase the number of acres of reforestation, as well as, increase the likelihood that reforested mine land will remain as such well beyond the time of final bond release.

Potential Aids to Increasing and Improving Reforestation on Mined Lands

Potential aids to increasing and improving reforestation of mined lands include:

- Reduce Tree Re-establisment Costs
    - Allowing decreased ground cover or bare ground.
    - Is a 450 live stems per acre standard necessary?
- Plant Trees Where They Are Wanted.
    - Allow trees on prime farmland.
    - Off site mitigation.
- Role of Carbon Sequestration Credits?
- More Research?

Reforestation Experience by Chris Leibering
Dealing With the Known, the Unknown, the Unfamiliar, and the Less Obvious

Allow me to discuss some known basic tree-planting principles and then ponder the unknowns.

1. **Seedling quality**: If there is one element in the whole process that is more important to survival than seedling quality I have yet to find it. A seedling with a large, healthy, fibrous root and as large a caliper of stem within reason is what we should be looking for. A desirable root to crown ratio cannot be over emphasized.

   There are a limited variety of seedlings that do not respond well on reclaimed mine land planting and herbicide use, tulip poplar, and some of the wildlife shrubs come to mind. Since the more desirable species are often not available and you are compelled to use what is available, resulting in less then desirable seedling survival**. Competition from less desirable species and a penchant for regulators to require those less desirable species then becomes a problem**.

2. **Seedling Care After They Leave the Nursery:** I believe seedlings must be kept in refrigeration as soon as they leave the nursery until they are in the ground. We have two diesel refrigerator trailers; this allows us to have a load ready to go to the field as soon as soil conditions permit. On a rain out day or evenings we are back to the nursery or to our

shop to prepare another load for planting. **Unknown to our clients is the amount of time and effort needed for our crew to prepare your seedlings for planting, often times requiring another crew at the shop.** Competition for qualified part time labor to do the job is also a problem. Because the weather has been so wet and disagreeable this year our refrigerators have run since the last week in February. We have worked only two or three days each week. This is costly and is another one of the unknowns.

3. **Soil Conditions and soil placement**: Soil conditions are more critical for mechanical planting than for hand planting. Early in the season we can get by with somewhat more disagreeable soil conditions than later in the planting season when the temperature begins to heat up. Wet conditions later in the season become more intolerable because the wet compacted soil, after a day or two in the hot sun, begins to resemble brickbats, rip rap, or similar aggregates. Under such circumstances, soil to root contact is virtually impossible.

4. **Soil placement is equally important.** My experience with machine planting has been more satisfactory planting later in the season and waiting on favorable weather and soil conditions, rather than trying to mud them in too early. I would be the first to agree that, in a hand planting application, "the earlier the better." It is nearly impossible to dig a hole large enough and deep enough for proper seedling placement when the reclaimed soil dries later in the season. **Here again we may need to change the social architecture, our way of thinking about our industry practices.** Extending the planting season would certainly be beneficial to the planting contractor. You are well aware of the fact that a good rain in July or August hides a lot of mistakes and has more of an impact on planting **than every thing else we do that is controllable.**

5. **Herbicide or Weed Control v/s no control:** The improper selection and **over use** of herbicides have destroyed many seedlings. Selecting the proper amount is the key to survival. **Equally important is the type of vegetative cover. Perhaps we may not need any cover on the more level sites.** Several years ago we made a mistake setting our electronic scales. We ended up using only one-third the suggested rate of herbicide. We watched the field with interest and by summers end could tell no difference in weed and grass control from where we were using nearly triple the amount of the recommended mixture. We did not see the usual herbicide damage to the seedling. Seedling damage in test plots is far more obvious as the rate of herbicide increases, **in many cases with no noticeable increase in weed control,** especially where unfriendly herbicides to seedlings are used. **Second year herbicide application** is another issue we must consider. In a dry summer with a heavy vegetative cover, many seedlings are lost. In many cases where we do second year spraying, many small seedlings that would have been lost are released and survive. Larger seedlings also respond favorably. Here again you reclamation managers must have accurate survival numbers and figure the cost effectiveness of second year herbicide control v/s replanting.

6. **Seedling placement and density:** The equipment we use to plant your tree seedlings is expensive. Less than desirable field conditions such as: rocks, wood, steel, discarded cable, steep inclines, and wash outs cause excessive wear and breakage of that

machinery. We attempt to upgrade and change our operation as your requirement mandates. The issue of safety and liability are always on our mind.

We started with a four-inch planting shoe to accommodate the largest root system possible. We could not get proper closure with that large shoe. We soon changed to a two and one half inch shoe and installed sod cutters on our press wheels to get better root to soil contact, this made a noticeable difference in our survival rate. We also cut two of our machines down and converted them to a heavy three-point hitch machine, with hydraulic leveling, for better maneuverability and placement. One of our machines is a split axle planter, pulled with a crawler track tractor. We use this on the steeper slopes and hard to plant areas.

As you can see, we have much more invested than a hoedad and tree bag, therefore a higher planting cost is also reflected in our higher cost of investment. **You too should expect better survival, resulting in earlier bond release.** I maintain it is better to do it right the first time and certainly more economical for our clients. There is always extreme competition for the dollars you have to invest, subsequently this is reflected on how effective the tree planting crew can be. I believe that larger blocks of forest plantings would be beneficial, thereby reducing the edge effect. By doing so, we create small microclimates, for we know that the woods are 10 degrees cooler in summer and 10 degrees warmer in winter.

7. **Carbon Sequestration:** Foresters are now learning to mark timber in a way to balance the carbon cycle. Most of you are aware of carbon sequestration. That equation will now enter into the reclamation process. This was **unknown** by most of us several years ago. We must always keep alert for beneficial changes based on accurate scientific information.

Summary

Some follow-up is necessary throughout the cycle. Competition from excessive rodent damage, animal browse, and keeping the center of the rows clean to conserve moisture may be of benefit to you. This could keep you from the necessity of replanting. Grass control is more crucial than broadleaf control. Often times though, the decaying plants you mowed earlier in the season provide hiding places for various rodents also highlighting the rows of seedlings for browse. **A different stroke for different folks is the name of the game**. Because of varying conditions, what works for you this year may not be in one's favor next year. What is successful on your mine may not be favorable on another mine. Periodic visits to the planting site could save you dollars in the future. The most effective methods of reforestation are still to be discovered**. There is always a better way. It is yet to be found. Most importantly, develop a good attitude about tree planting,** our planet will respond graciously, preventing a detrimental repeat of history experienced by ancient and more recent developing nations. Lead your group and expect something to happen. Do it right the first time, and help find the better way.

Bryce West is Director of Reclamation for Black Beauty Coal Company headquartered in Evansville, IN. Bryce holds a B.S. degree in Agronomy from the University of Kentucky.

LONG TERM RESEARCH TO DEVELOP SOIL HANDLING REQUIREMENTS FOR REFORESTATION OF LARGE SCALE SURFACE MINES IN WEST VIRGINIA

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Arch Coal, Inc.
Huntington, West Virginia
and
Dr. Paul F. Ziemkiewicz and Dr. Jeff Skousen
National Mined Land Reclamation Center
West Virginia University
Morgantown, West Virginia

Abstract

Returning reclaimed mined lands to a productive forest cover is one of several post mining land uses permissible under the 1977 Federal surface mine act. However, reforestation of large surface coal mining operations in central Appalachia presents several obstacles to successful tree planting. Important obstacles include: economically salvaging and redistributing sufficient quantities of appropriate growing media; compaction; and providing adequate erosion control on steep slopes. Nonetheless, it is in the best interest of all concerned to promote the return and commercial viability of native forests on reclaimed lands.

Catenary Coal Company operates the largest surface coalmine in the East. It has entered into a long-term reforestation research fellowship with West Virginia University and the National Mine Land Reclamation Center to develop economical soil handling requirements for reforestation of large-scale mining operations in the steep topography of southern West Virginia. The primary objective is to develop a manual of best management practices for conversion of surface mined land to forest and ultimately to formulate an index of carbon sequestration potential for various reforestation practices. Specific objectives include identifying the range of seedling performance on existing reclaimed sites with grass/legume cover and identifying soil reconstruction requirements for establishment of forests on new reclamation sites. The experiment will test the growth potential of two types of subsoil and three types of topsoil. The experimental design will permit determination of tree seedling survivorship and growth as a function of subsoil and topsoil type. The results will allow the company and the industry to predict and select a subsoil/topsoil combination that meets its requirements in terms of cost and performance.

Introduction

Arch Coal, Inc. is the second largest producer of steam coal for the electric utility industry and operates three large-scale surface mines in southern West Virginia. Large electric shovels and walking draglines are employed to efficiently recover deeper coal

seams. Complex mine plans are necessary to accurately project, economically remove, transport and revegetate millions of cubic yards of rock and soil materials. Because the scale and complexity of these operations require many months, and in some cases several years to see through to completion, timing and sequence limitations have played a role in the types of post-mining land uses pursued at these sites. Additionally, steep slopes, limited native topsoil, compaction issues and the high costs of salvaging large quantities of weathered rock and soil materials have presented obstacles to reforestation efforts. As a consequence, post-mining land uses at these and other mining sites have historically tended to focus on pasturelands and wildlife habitat that utilized alternate topsoil handling plans that are permissible under the Surface Mining Control and Reclamation Act. In recent years however, a renewed emphasis on reforestation has highlighted the inherent difficulties to successful reforestation of large Central Appalachian mine sites. Research efforts to date have provided some general reclamation practices that work well for smaller scale mining and are proving highly successful. But cost and technical difficulties still remain for larger operations that have become more commonplace due to industry consolidation, improved mining technology, and ever-depleting coal reserves. Consequently, it was determined at Arch Coal, Inc., that a fresh look at these realities requires a fresh approach to the known difficulties.

In a mutual effort with the National Mine Land Reclamation Center and West Virginia University, Arch Coal has entered into a long term research fellowship that is structured to develop a body of science that will provide a sound basis for practical and economically achievable techniques to establish healthy forest cover on large scale surface mined lands. The fellowship will provide for 10 years of funding and research at Arch Coal's Catenary Coal division located near Eskdale, Kanawha County, West Virginia. Catenary Coal Company operates the largest surface coalmine in the east and has mined and reclaimed over 6,000 acres since 1994. The authors and principal investigators of this research fellowship are Dr. Paul F. Ziemkiewicz, Director of the National Mined Land Reclamation Center and Dr. Jeff Skousen, Division of Plant and Soil Science at West Virginia University.

Overall Objective

To develop a manual of best management practices for reclamation of large-scale surface mined lands to forest cover and formulate a method to determine an index of carbon sequestration potential for various reforestation practices.

Specific objectives include:

(a) Methodologies to convert areas previously revegetated in a grass/legume cover to forest cover. This will entail steps to identify seedling performance by monitoring the survival and growth of hardwood seedlings planted and volunteering in existing herbaceous cover established primarily for erosion control purposes. Study sites will range from recently reclaimed to mature areas from 10 to 25 years old.

(b) Develop soil reconstruction techniques for the purpose of establishing long-term forest cover on newly reclaimed sites. This objective will be achieved through a number of differently constructed test plots, designed to objectively evaluate the effects of various subsoil and topsoil types on hardwood seedling survival and growth rates. A comparison of seedling performance on weathered brown sandstone subsoil versus un-weathered gray sandstone subsoil will be a primary focus amongst the test plots.

Study Design

The treatment plots shall be designed and replicated in order to generate sufficient data to apply standard statistical analyses. It includes three replications and relatively large treatment plots of one acre each. Each replicated treatment unit shall require about six acres and shall be placed on nearly flat ground in locations where there will be minimal extraneous activity.

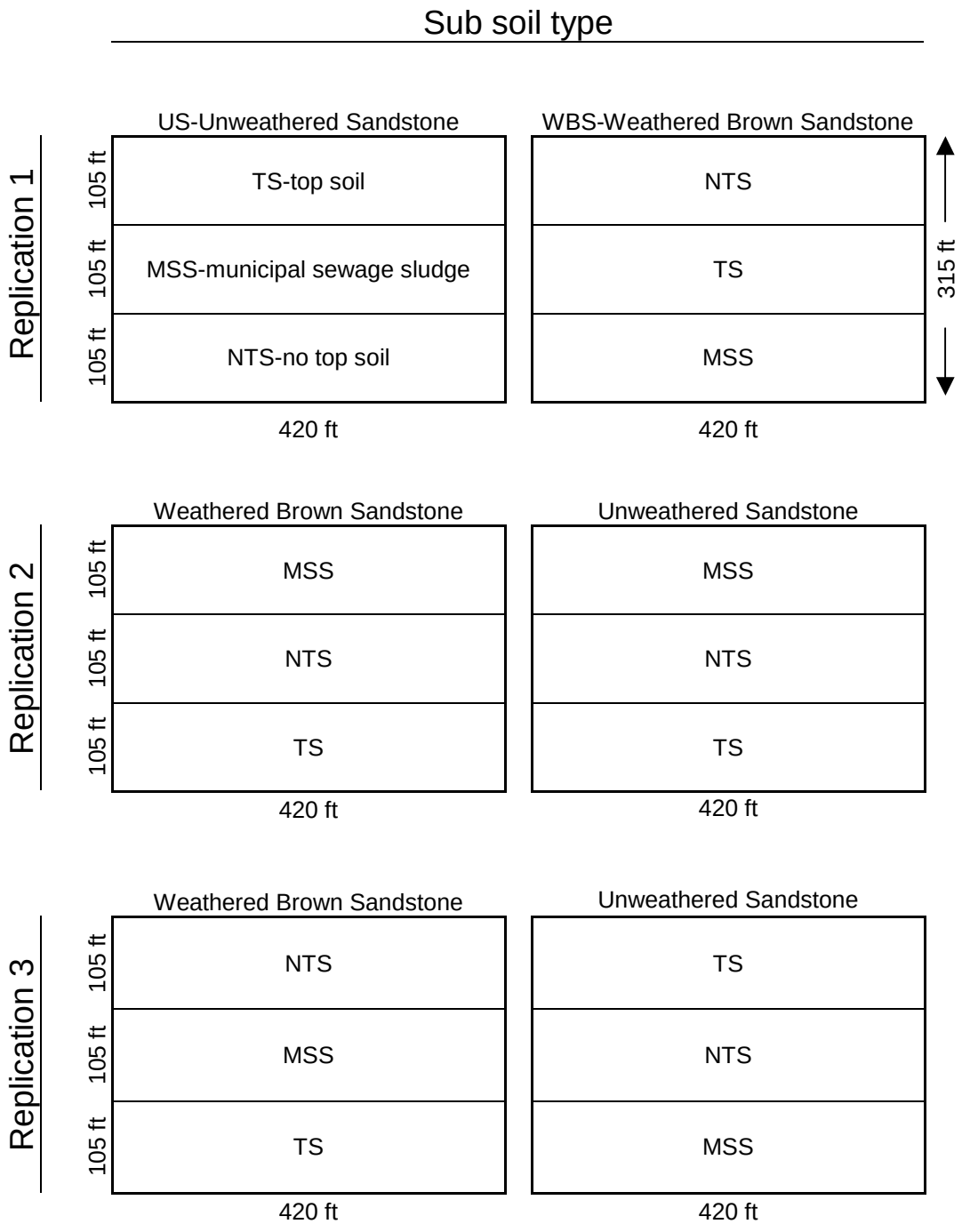
The study will test the growth potential of two types of subsoil and three types of topsoil:

- Subsoil – Un-weathered Sandstone (US) and Weathered Brown Sandstone (WBS)
- Topsoil – Top Soil (TS), No Top Soil (NTS) and Municipal Solid Waste (MSS)

The study design will allow determination of tree seedling survival and growth rates as a function of subsoil and topsoil type. The intent is to provide site specific (and perhaps regional) information that will provide the basis for the selection of a subsoil/topsoil combination for various tree species that meets post-mining objectives, within the context of acceptable growth performance, practicality, and costs.

Table 1 illustrates the various plot treatments in a statistical design known as Randomized Block Design with Split plots. The whole plots are either the Weathered Brown Sandstone (WBS) or Un-Weathered Sandstone (US).

Table 1. The following diagram shows the experimental layout of the Reforestation Demonstration Plots, Catenary Coal Company. Treatment locations within plots have been randomized. Note, each 105 x 420 ft plot constitutes an experimental unit.



Each of the two subsoil treatments (Weathered and Un-Weathered Sandstones) will be constructed of at least four feet of the tested material. Each test plot is subdivided into three units consisting of three topsoil treatments: Topsoil (salvaged from current mining areas being prepared for mining), No topsoil and Municipal Sewage Sludge (obtained from a nearby residential public treatment facility). All of the treatments are replicated three times and each unit is 105 X 420 feet (44,100 square feet), or slightly larger than one acre. Each whole plot replicate is about six acres (315 X 850 feet). Construction of the plots shall be done in such a way as to avoid compaction. Top Soil and Municipal Sewage Sludge dressings will be spread to a depth of six inches and disked into the subsoil. The No Top Soil treatment units will not be top-dressed but will be disked. None of the plots will be seeded and every attempt shall be made to prevent grasses and legumes from invading the study plots.

Tree Planting

A mixture of eight different native tree species shall be planted, including oak, ash, yellow poplar and white pine. They shall be planted on a six-foot by six foot spacing, at a combined planting rate of 1,200 stems per acre. It is acknowledged that this is a robust planting rate, however it is intended to take into account some assumed mortality, deer browse damage, and sampling losses. Each plot shall be planted in an identical mixture of seedlings. The total number of seedlings shall be 20,800 or 2,600 of each of the eight species. In order to facilitate planting and monitoring, each species shall be planted parallel with the long axis of each plot. At 6 X 6 spacing, each plot will accommodate 16 rows with 70 seedlings in each row. Each of eight species will be planted in two rows requiring 140 stems for each species per plot. Rows will be randomized within each plot.

Performance Monitoring

On the older reclaimed sites with existing herbaceous and some tree cover, the standing tree crop will be evaluated by species composition, density, annual growth increment (as measured by increment borers) and height. These data, along with the topographic site attributes will assist in establishing site indices for various tree species commonly used in reclamation of surface mines in central Appalachia. A site index projects the years required to achieve a specific tree's height with reference to its commercial value. At these sites, soil pits will be dug to characterize parent material, the rate of soil development, and root penetration. On the subsoil/top soil treatment plots, monitoring will include survival rates, leader growth, and total height.

Ultimately, a manual of best practices for converting existing reclaimed lands from grass land to forest cover will be developed. The manual will also include vegetation management, hardwood selection, subsoil/top soil management, and grading recommendations. Metrics will include hardwood seedling establishment and growth as well as an index of carbon sequestration potential for various reforestation practices. A management team comprised of Arch Coal and WVU personnel will also monitor progress and make adjustments in the research plans as necessary.

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ACHIEVING FORESTRY GOALS ON MINED LAND: MINED SITE CONDITION, SPECIES COMPOSITION, AND STAND DEVELOPMENT OF ECONOMICALLY-VIABLE HARDWOOD FORESTS

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Abstract

Forestry is a long-term enterprise. Forest production in the Appalachian region involves growing native hardwoods on 60-year cycles for a variety of solid wood and pulp-based products. Total yield and return on investment of a harvest cycle depends on the natural quality of the forest site, native species composition, and the quality of the trees. After harvesting, the native hardwood forest regenerates itself for the next cycle of growth via seedling and stump sprouts with little or no forest regeneration cost to the landowner. The forestry enterprise on mined land is very different at the beginning of the cycle because forest sites must be properly prepared and trees must be carefully planted in compositions that will result in a valuable forest. The extent to which this is accomplished determines the economic viability of the new forest. The cost of site preparation, tree planting, and forest establishment (first 5 years) must be borne by the mining enterprise. This cost is not an economically feasible cost for a competitive forestry enterprise given that surrounding non-disturbed forests regenerate naturally. Just before mining, the landowner relinquishes control of the land to the coal operator who is responsible by law to restore the forest after mining. The coal operator re-builds the forest site, selects the species for planting, and hires the planter to plant the trees. Yet, seldom does the coal operator own the land or have any vested interest in the new forest after receiving his performance bond. Within the requirements of the law, which are fairly broad as they pertain to re-vegetation, coal operators have little incentive to produce good forest sites or spend money on quality seedlings or planting. However, research shows that site preparation for forestry and the cost of tree planting and establishment is no greater than reclamation costs for other post-mining land uses. Reforestation of productive forests is most successful when landowners, coal operators, and regulators collectively: (1) plan for reforestation at the mining permit stage; and (2) when a reforestation plan becomes an integral part of the mining permit.

Forests Provide Many Products and Services

The forests of the Appalachian region are composed of a diverse mix of hardwoods and conifers and many species of shrubs and non-woody plants. Forest productivity varies spatially across the undulating landscape, but overall, the eastern deciduous forest is one of the most diverse and productive temperate hardwood forests in the world. Its functions are many, and include, but are not limited to: (1) timber production for paper and solid wood products; (2) watershed control of surface runoff; (3) filtering rainfall for high-quality, potable water; (4) sequestering carbon dioxide from the atmosphere to soil organic matter and woody biomass; (5) providing habitat for

wildlife; (6) providing hunting and recreational experiences ; (7) maintaining the biodiversity of the region; and (8) diversifying the local and regional economies. These forest products and services greatly benefit landowners, adjacent communities, and the public at large.

Surface Mining Coal Removes the Forest and Rearranges the Landscape

Surface mining coal in the Appalachian Region totally removes the predominantly forested ecosystem, including the native plants, animals, and soil, and rearranges the land's topography, hydrology, and surface geology. The goals of mined land reclamation and reforestation are to return the land to its original use and capability after the coal is extracted, and to restore the forest as closely as possible to its original composition, productivity, and function. Federal law as interpreted in the code of Federal regulations (CFR 30 Mineral Resources Part 700-950, 1997) states:

> *"... disturbed areas shall be restored in a timely manner to conditions that are capable of supporting the uses they were capable of supporting before any mining; or higher or better uses." "Higher or better uses may be approved... if there is a reasonable likelihood for achievement of the use, and use will not be impractical, unreasonable, or inconsistent with applicable land use policies or plans."*

Most States with regulatory primacy make a distinction between *managed forestland* (italics are used to designate recognized post-mining land uses that are defined and regulated) and other post-mining land uses that include some trees and woody shrubs as part of the vegetation mix. The post-mining land use, *managed forestland*, sometimes referred to as *commercial forestland*, usually requires a minimum stocking of commercial species. Post-mining *managed forestland* will have silviculturally compatible mixes of native species that will result in valuable timber products within a normal growth cycle of 50 to 80 years. The *managed* or *commercial forestland* post-mining land use will restore the native forest and its products and values. Other post-mining land uses recognized in State regulations, such as wildlife habitat or unmanaged forestland, do not require the species compositions or stocking levels that will provide forest products and services equivalent to pre-mining forests.

Few Forests Are Restored on Mined Land

In spite of the potential benefits that would accrue from restoring managed forests on mined land, the record shows that very few acres have been restored to productive forests since the Surface Mining Control and Reclamation Act (SMCRA) was put in place in 1978. U.S. Department of the Interior Office of Surface Mining (OSM) statistics (OSM, 1999; OSM http://www.osmre.gov, 2002) show that approximately 3.35 million acres have been permitted for mining activities in the States of Illinois, Indiana, Kentucky, Ohio, Tennessee, Virginia, and West Virginia, of which about 30 percent, or 1 million acres, have been disturbed by mining since the implementation of the SMCRA in 1978. Based on inquiries of State regulatory agencies, I estimate that less than 5 percent of these disturbed lands have been restored to *managed forestland* that will provide products and services equivalent to those provided by pre-mining forests. Over this period of 25 years, most mined land has been reclaimed for *hayland/pasture*, *wildlife habitat*, or *unmanaged forest land*. These post-mining land uses are largely abandoned after miners receive their reclamation performance bonds, usually after five

years. As a result, most of the recently-reclaimed (past 25 years) mined land consists of an assemblage of domestic grasses and legumes mixed with invasive species (e.g. , serecia lespedeza, coltsfoot, autumn olive, crown vetch, kudzu) and a few planted shrubs and trees, with some early-successional native plants whose progress is severely retarded by invasive and planted exotic species. Given enough time (centuries), a functional forest will establish itself, but it will likely not be as productive as the pre-mining forest due to compacted mine soils made up of hard, unweathered rock.

So why are so few productive forests restored on mined land? In a nutshell, the costs of reforestation and benefits from restored forests are not accruing among stakeholders in ways that make reforestation economically feasible. Furthermore, using current mining procedures and interpretations of the regulations, most reclaimed mined sites in the Appalachians are not suitable for productive, economically-viable, native forests. This poor record of reforestation in the past 25 years is due to: (1) a lack of economic incentives for the miner and landowner; (2) a lack of knowledge of basic silvicultural procedures for establishing and growing forest trees; (3) inadequate reclamation and preparation of mine soils for forestry land uses, and (4) improper interpretation, application, and enforcement of reclamation regulations as they pertain to forest land uses.

There Is More To It than Planting Trees: Reclamation Is Complicated

Successful post-SMCRA reforestation depends on four requirements or inputs: adequate economic incentives, good engineering and operational procedures, application of known principles of forest biology and silviculture, and knowledge of and adherence to regulations (Figure 1). Just as the four-legged stool depicted in Figure 1 would be dysfunctional with one or more missing legs, the process and potential of mined land reforestation becomes dysfunctional if one or more of these reclamation requirements is missing or poorly done. At present, the record shows that none of these four requirements is fully met, which is why mined land reforestation in the eastern and Midwestern coalfield regions has been largely unsuccessful. Without successful reforestation, broader goals of "stacking" eco-assets on mined land will not be realized. Given the conference theme of "market-based incentives for mined land reforestation," my objective is to identify the economic constraints and recommend solutions that would allow us to realize the benefits of forests restored on mined land.

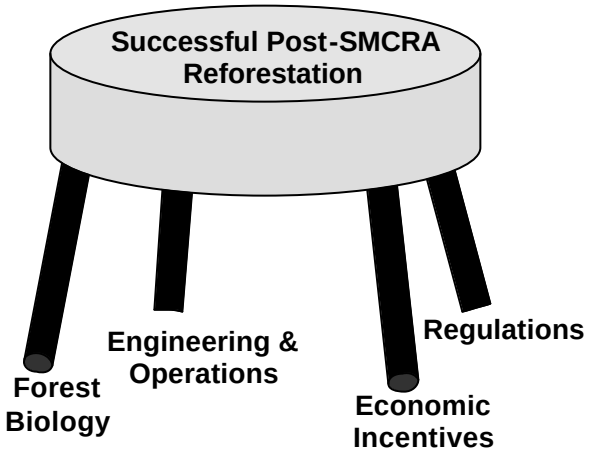

Figure 1. Successful post-SMCRA reforestation requires economic incentives to apply engineering and forest biology principles while meeting the requirements of State and Federal regulations.

Market-Based Economic Incentives for Post-Mining Forestry

Market-based mined land reforestation and post-mining forestry require four conditions: (1) there must be sufficient incentive for the miner to plant trees in the first place as part of the mining and reclamation process; (2) the trees must grow at an economically acceptable rate when planted on mined land in order for the landowner to justify management investments; (3) by rotation age or management maturity, the forest must be made up of trees with commercial and economic value; and (4) all stakeholders must pay for the products and services received from reforestation (carbon sequestration, wildlife habitat, watershed control, water quality, biodiversity) through tax, carbon, water, and biodiversity credits to the landowner. These conditions can only be met if all stakeholders in the reclamation process -- miners, landowners, regulators, and the public -- are properly invested in the process.

Are There Economic Incentives to Plant Trees in the First Place?

Mining and reclamation are influenced by several stakeholders -- the miner, the landowner, and the public (represented by State and Federal regulators). As shown in Figure 2, the post-mining landscape and the presence or absence of a productive, restored forest are ultimately determined by the mine operator, who is required by law to reclaim the land disturbance. The landowner can provide input during the planning and permitting process, but usually does not become involved in the operations. State and Federal regulators review the plan and permit and inspect the mining operation and the reclamation of the mine to ensure all provisions of the law are followed. Unfortunately, this operational arrangement has not been conducive to mined land reforestation due to the lack of economic incentives for the miner and landowner, and the real or perceived added risk of using a forestry post-mining land use compared to alternative uses.

The **mine operator** is in the business of mining coal and usually has no interest in the long-term post-mining use or value of the land. Nonetheless, the miner is responsible under the law for reclaiming the land to its original use and capability or one of higher value (SMCRA, 1977). It is in the miner's interest to reclaim the land as cheaply as possible, as the miner will accrue no benefit from future uses of the land. It is also in the miner's interest to use low-risk procedures that will most easily satisfy regulators and ensure timely release of the performance bond.

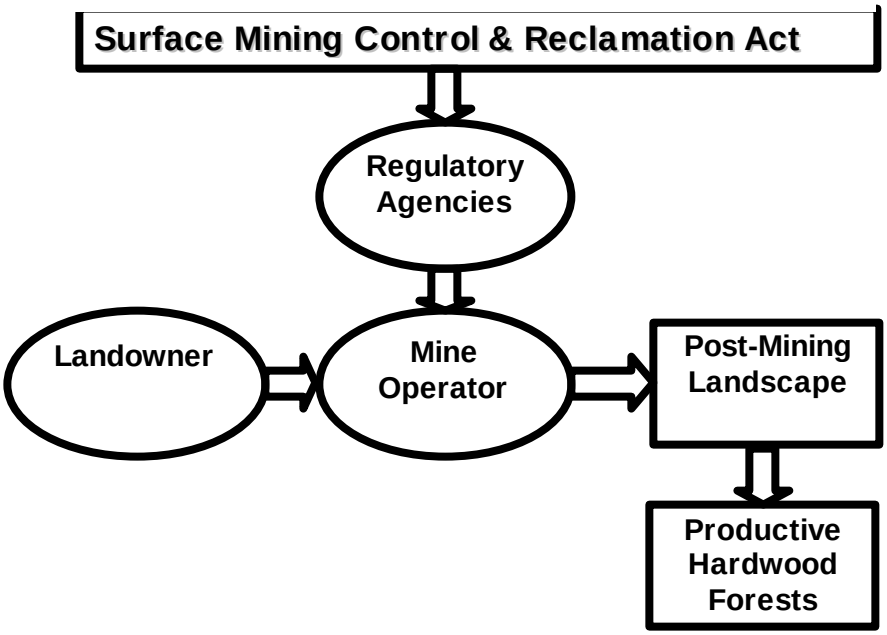

Figure 2. The order of influence of various stakeholders on the outcome of reclaimed mined land. The miner ultimately determines the nature and productivity of reclaimed land.

To minimize risks and reclamation costs, miners usually choose a post-mining land use of *hayland/pasture*, *unmanaged forest*, or *wildlife habitat*. These uses are easily achieved by smoothly grading the reclaimed landscape and hydro-seeding agronomic grasses and legumes that provide erosion control required by State and Federal regulations. For *wildlife habitat* or *unmanaged forest*, regulations require the additional planting of a certain number of early-successional shrubs and trees, but there are no provisions or expectations of future land management on the part of the miner or landowner. While easy to achieve with little risk, these unmanaged land uses will not result in an economically viable forest, nor will they provide forest products and services at pre-mining levels.

Post-mining land uses of *managed forest* or *commercial forestry* would best achieve the multiple functions and benefits of pre-mining forests, but the *managed forest* land use is perceived as being more expensive and more risky. Compared to the *wildlife habitat* post-mining land use, *managed forest* requires a minimum number of commercially valuable species as part of the woody plant mix. The major disincentive for planting trees is the risk of not achieving adequate tree survival. Tree survival is compromised by the aggressive herbaceous ground cover that most regulators require as part of any post mining land use. Grasses and legumes are extremely

competitive, making it very difficult for tree seedlings to survive and grow. Standard silvicultural procedure, practiced by foresters for decades, is to mechanically or chemically remove competing vegetation as the first step in any reforestation process. Planting trees in aggressive ground cover, as required by most regulators, has resulted in repeated reforestation failures, discouraging miners from using forest trees in their post-mining reclamation plans. All involved with reclamation must understand common reforestation practice and adjust reclamation procedures by using non-competitive ground cover species at lower densities. Furthermore, regulators must get used to the idea that sparse ground cover is a "good thing" and necessary for native hardwood establishment. Torbert (1995) has shown that minimizing ground cover greatly increases tree survival and growth without significantly increasing soil erosion.

Despite the perception of higher cost and risk, Zipper et al. (2002) have shown that regulators in some States (but not all) accept less surface grading and less ground cover because these conditions are consistent with reforestation practice and forestry land uses. Less grading means less soil compaction, which increases tree survival and growth. Less grading and less cover make the cost and establishment risks of managed forests no greater than those of other land uses. Burger and Zipper (2002) estimate that reduced grading and seeding saves $200 to $500 per acre, which is approximately the cost of buying and planting mixed commercial hardwood tree seedlings. Therefore, cost should not be a factor limiting the miner's selection of *managed* or *commercial forestry* as the post-mining land use.

Can Trees Grow at an Economically Acceptable Rate on Mined Land?

The **landowner** benefits greatly from coal royalties in the short term. The landowner also has a long-term stake in the land and the post-mining land use by virtue of ownership, but landowners usually defer post-mining land use decisions to the miner because it is the miner who must do the reclamation and post the performance bond. Furthermore, forestry investments on mined land cannot compete with investments on non-mined forestland, where reforestation is cheaper, less risky, and uncomplicated by regulations. During the last 25 years, landowners have been reluctant to invest in forestry operations on mined land, even though they are usually unhappy with post-mining land uses, conditions, and opportunities.

In a few cases, landowners have inserted themselves in the mine planning and permitting process to influence the post-mining land use and reclamation procedures. Some have paid part of the costs associated with the *managed forest* land use, and have accepted some of the risk of delayed bond release and replanting in the event it became necessary. Landowners willing to participate at this level are usually in the forest products business and have determined that reforestation is in their economic interest, given that they will continue to pay property taxes. Probert (1999) has shown that managed forests on mined land may be economically viable on well-reclaimed mined sites when growth rates are adequate and valuable species make up the forest composition.

The rate of tree growth has a dramatic effect on the value of a forest and the products and services it provides. And the rate at which trees grow is a function of site quality (Carmean, 1975; Avery and Burkhart, 1994). Table 1 depicts a site quality gradient ranging from site quality class V (poor) to I (excellent). On class V sites, the average height of the Appalachian oak forest canopy is 40 feet after 50 years of growth, compared to 80 feet on class I sites. The

value of the timber increases exponentially as site quality increases , because wood volume increases disproportionately on better sites, and the uses to which w ood is put are more valuable (e.g., firewood versus veneer). As a result, the return on forestry investments range s from a negative rate of return on class V sites to a very respectable 10 percent rate of return on Class I sites. Only Class I, II, and III sites would warrant landowner investments in forestland.

Table 1. Influence of mine site quality on commercial forest value.

	Site Quality Class				
	V	**IV**	**III**	**II**	**I**
Oak site index (ft_{50})	40	50	60	70	80
Commercial use	none	firewood	ties	sawtimber	veneer
Return on investment (%) (Probert, 1999)	-5	0	3	7	10

Site quality is the sum of all factors (climate, topography , and soil) that influence tree growth. On reclaimed sites, ground cover and surface soil compaction most influence tree survival, while mine soil quality, the physical, chemical, and biological condition of the entire mine soil, has an overriding effect on tree growth. A shallow, alkaline mine soil made up of topsoil substitutes of unweathered rock from deep in the geological profile will produce a poor, Class V site. A deep, slightly acid minesoil made up of weathered soil and rock from near the surface can produce a Class I site if left loose and non -compacted. The rapid rate of growth on Class I sites will result in forest value many times that produced on poor Class V sites. To be economically feasible, reclamation must create a combination of Class I to III sites.

Unfortunately, research shows that forest sites are being degraded in the process of mining and reclamation. In a study of 78 mined sites in Kentucky, West Virginia , and Virginia, Andrews (1992) and Torbert et al. (1998) found that the quality of most mine soils ranged between Class III and Class V. The capability of the land after mining, on average, is less than it was prior to mining. Most mine soils do not have the productive capability to support tree growth rates that would make forestry economically feasible. A different reclamation approach is needed that considers the mine soil needs of trees instead of temporary ground cover grasses.

Is There Economic Value in the Species Composition of Forests on Mined Land?

The wood products industry in the Appalachians is based on mixed hardwood products derived from mid- to late-successional sawtimber species such as red and white oaks, sugar maple, black cherry, white ash, and hickory. These species grow in mixed stands thr oughout the forests of the coalfields. Although there is increasing interest in early successional species such as sycamore, green ash, red maple, cottonwood, and pine for oriented s trand board and paper pulp, sawtimber species grown in mixed stands will continue to be the most valuable in the future.

Most woody species used for reclamation for wildl ife habitat and unmanaged forest are early-successional shrubs and trees that have low value or no value for forest products. Species such as black locust, black alder, white and Virginia pine, sycamore, green ash, autumn olive, and

bicolor lespedeza are commonly used. They are used because they can better tolerate the poor physical and chemical conditions of the mine soils being placed on the surfaces of most reclaimed mine sites throughout the Appalachian region. They will eventually be replaced by more valuable native species through the process of natural succession, but given established rates of natural forest succession, it will be 200 to 300 years before a commercially valuable species composition similar to the adjacent native forest will occur. Therefore, given today's wood products market, current reforestation practice on mined land will not produce economically valuable forest stands in the foreseeable future.

Research by Virginia Tech scientists and Rapoca and Red River Coal Companies in Virginia is showing that a valuable mixture of mid- to late-successional native hardwoods can be established immediately after active mining. However, mid- to late-successional species require mid- to late-successional soil (Torbert et al., 1998), which is provided by mixing existing soil with blasted weathered rock taken from within 10 feet of the surface (Burger et al., (2002). Several feet of this material is placed on the surface and serves as the new forest soil. By mixing native soil with weathered overburden, the new mine soil is inoculated with the soil organisms with which most native woody species share symbiotic relationships and on which their growth depends. A mixture of five mid- to late-successional hardwoods, including red, white, black, and chestnut oak, white ash, tulip poplar, and sugar maple , are planted along with 50 trees per acre of wildlife species such as dogwood, black alder, and bristly locust. Seeds of early-successional species, including sourwood, black birch, red maple, sumac, and black cherry, are carried in or blown in by birds or wind and can, with a sparse ground cover, become established. Other native forbs and woody plants volunteer to create a diverse mix of native species not unlike the adjacent, undisturbed forest. Having been planted as seedlings, which gives them a head start, the slower-growing commercial species remain part of the stand composition through time and dominate toward the end of the 50- to 80-year stand growth cycle. This reforestation procedure eliminates the need for the 200-year primary successional growth period required when blasted unweathered rock is used as the growth medium.

The success of planted, mid- to late-successional species was demonstrated in a study by Rodrigue et al. (2002), who inventoried the composition of fourteen 20- to 56-year-old forest stands planted on mined land. The data showed that commercially valuable mid- to late-successional species survived, grew at a rapid rate, and have become important components of the forest stands. Figure 3 is a photo of a 54-year-old site planted to tulip poplar and white oak. The two planted species dominate the site, with about 2 percent of the basal area consisting of volunteer black cherry. This stand will be harvestable by age 60 with a projected value of $2600/acre.

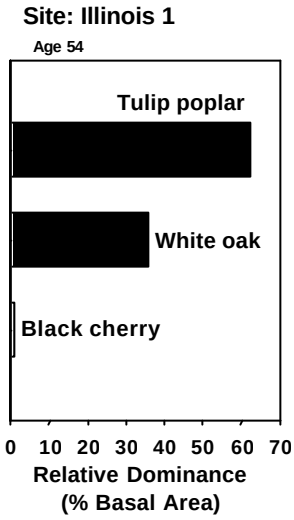

Figure 3. A 54-year-old forest on mined land dominated by tulip poplar and white oak that were planted after mining.

Figure 4 is a photo of a 35 -year-old stand in western Kentucky. It was planted with a mi x of northern red oak, tulip poplar, sweetgum, and cottonwood, which together make up 90 percent of the basal area. Only 10 percent of the basal area was made up of volunteer species, 8 percent American elm, and 2 percent shingle oak. Forty percent of the basal area was made up of northern red oak, one of the most valuable timber species in the region. By age 60, the projected timber value of this stand is $3160/acre. These data show that red and white oak can be planted with other compatible valuable species and grown as components of new forests that bring great value to landowners. However, these hardwoods must be planted on good -quality mine soils, relatively free of competing vegetation, and they must be planted in silviculturally compatible species mixes.

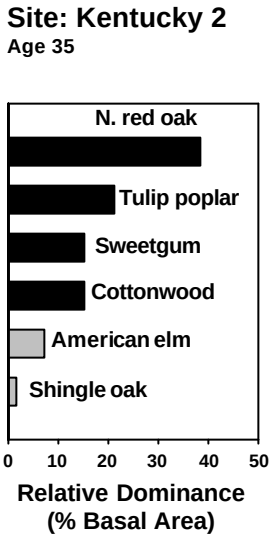

Figure 4. A 35-year-old forest on mined land in Kentucky dominated by northern red oak, a mid- to late -successional species planted after surface mining.

Do All Stakeholders Pay for the Benefits Received from Reforestation?

Removal of the forest increases r unoff and decreases water quality (Neary, 2002). Forest removal for coal extraction for power generation increases atmospheric CO_2 due to land use change and combustion of fossil fuel. The bio-reserve and recreational uses of forests are lost if they are not restored. Therefore, it is clearly in the public interest to reforest mined land, and it is not unreasonable to expect the public to pay for the services that accrue to them. The **public** has invested indirectly in the reclamation process by doing its part to enact Federal and State laws that regulate mining and reclamation. However, regulations are primarily directed towards human safety and environmental quality. As the regulations are currently interpreted and enforced, the potential for forestland to produce products and services is usually degraded in the process of mining (Burger, 1994; Andrews et al., 1998; Ashby, 1998), in spite of the requirement that *"...all disturbed areas be restored to conditions that are capable of supporting the uses they were capable of supporting before any mining"* (CFR 30, 1997). If productive forests were restored, it would be reasonable to expect the public to pay for watershed protection, good water quality, carbon sequestration, and biodiversity by providing tax, carbon, and biodiversity credits to miners and landowners to help establish productive forests.

At this point, there are no mechanisms for landowners to receive credit or payment for reforesting mined land. There are several proposals for tax, carbon, a nd biodiversity credits, but at this time none have come to fruition , with the exception of a West Virginia property tax provision that taxes forest land at a lower rate than agricultural or other commercial land uses. Good models for landowner reforestatio n assistance are the Conservation Reserve Program, the Forest Land Incentives Program, and other programs that help landowners with the cost of planting trees for conservation services. Several types of landowner assistance would provide important incentives to plant trees on mined land and is justified given that growing trees is a long-term investment with benefits accruing to the public at large.

Take-Home Messages

The concept of developing multiple eco-assets on mined land for the benefit of landowne rs, local communities, and the public at large is good; this concept has been practiced in managed forests for decades, except that landowners usually received no revenue or credit for the eco -services their forests provided the public. Surface mining completely removes the native forest s, along with the free public services they provided. Functional forests are not being restored due to insufficient economic incentives for the miner to build good quality forestland, and insufficient economic incentive fo r the landowner to invest in long -term management of restored forests. Miners create the post-mining landscape, but they have no economic interest in it, thus no incentive to make it a productive forest in the long term. Successful reforestation requires loose, non-compacted mine soils and sparse ground cover , which are less expensive than the requirements for alternative land uses . This may be sufficient incentive for the miner , provided that regulators allow it . Given that it is consistent with the pos t-mining land use of *managed forestland,* it is consistent with Federal and State regulations.

Providing tax, carbon, watershed , and biodiversity credits to the landowner for reforestation could be important mechanisms for restoring eco -services provided by forestland. Even if various forms of credits are provided for forest esta blishment, good quality mine soils and fast

growing managed forests made up of valuable species are needed to justify continuing, long-term management. Good-quality sites growing productive forests are the foundation upon which other eco-assets can be developed. All forestland stakeholders need to share in the costs as well as the benefits that productive managed forests provide.

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Session 3

Reforestation Success Stories

Session Chairperson:
Victor Davis
Office of Surface Mining
Knoxville, Tennessee

Forest Productivity and Values for Pre-SMCRA Mined Land
Jason A. Rodrigue, Bradford Ranger District, Allegheny Forest, U.S.D.A. Forest Service, Bradford, Pennsylvania and Dr. James A. Burger, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

Alabama's Reforestation of Abandoned Mine Lands
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FORESTRY PRODUCTIVITY AND VALUES FOR PRE-SMCRA MINED LAND

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Abstract

Restoration of productive forests on mined land can provide multiple economic and amenity values to landowners and surrounding communities. We characterized fourteen mature, pre-law (SMCRA 1977), reclaimed forests and compared them to adjacent non-mined forests in terms of five values: site productivity, forest productivity, commercial timber value, site carbon capture, and commercial species diversity. These relatively-old, reforested mined sites allowed us to test if reforested mined systems were capable of producing similar values to non-mined forests and providing a baseline for measuring values on post-law mined land. Restored site productivity was similar to non-mined site productivity on all but two sites. The forest productivity of seven mined sites was greater than their non-mined counterparts. Only one site was lower in forest productivity. Eight out of 14 mined sites produced more commercial value than non-mined sites over a 60-year period. Combined commercial saw-timber and pulpwood produced mined site values that ranged from $1,500/acre^{-1} to as high as $8,000/acre^{-1}. Conservative estimates of site carbon storage indicated that mined sites carried an average of $345/acre^{-1} after 60 years of growth, increasing the value of reforested land by roughly 10 percent. Planting multiple commercial hardwood species appeared to increase the recruitment of commercially valuable regeneration of future rotations. On sites planted to pine species, commercial hardwoods were present in lower layers but were of lower value and fewer in number. We concluded that these pre-law, reclaimed forests had similar values to those of non-disturbed forests, but the value of post-law forests has not yet been determined.

Introduction

Well-established forests have the potential to provide both economic and ecologic benefit as they develop on mined land including the sale of the standing timber at rotation age. Growing forests capture and store carbon from the atmosphere offsetting the original coal that was burned after extraction. Developing forests also provide varying degrees of wildlife habitat for forest fauna as the forest grows and matures (Morton, 1999). Planted forests may also support a diverse population of plant species; further facilitating invasion of plants from nearby sites as the original planted forest grows.

In the Appalachian region and a number of midwestern areas, commercial forests commonly represent the highest and best post-mining land use (Burger, 1999). Many land holding companies in these areas do manage the land for commercial forestry. However, return of post-mining land to non-managed hayland/pastureland or wildlife habitat results in the landowner not realizing the full potential of the reclaimed land (Plass and Burton, 1967; Burger et al., 1998).

The development of commercially valuable forests on mined land would certainly be the highest and best use for landowners involved with forest based products. The potential value of pre-SMCRA forest plantings is becoming evident as those sites reach maturity. Therefore, a comparison of the forest value of pre-SMCRA mined sites to non-mined forests may provide us with insight into the multiple values that may develop. The objectives of this paper were to measure and compare site and forest productivity, commercial timber value, captured carbon value, and woody diversity between non-mined and pre-law mined forests in the Midwestern and eastern coal mining regions.

Methods

Sites were selected over a wide environmental gradient that exists in both the midwestern and eastern coalfields. Fourteen mined sites were located in eight groupings within seven States. Within each grouping, a non-mined reference site was located and used for comparison (Figure 1).

On each site, measurements were taken above ground (woody species) and below ground (soil) to gather information on values identified above. Site productivity was measured through site index, which was standardized to a single species (white oak, *Quercus alba L.*) for comparison between sites. Forest productivity was estimated with average yearly wood growth (per acre). Commercial value was estimated by cruising the timber and projecting the growth of these stands to commercial rotation age. Carbon sequestration was also estimated using this data. Woody species diversity was measured by an inventory of the canopy, understory, and woody ground layer. Comparisons were made between non-mined and mined sites in each group.

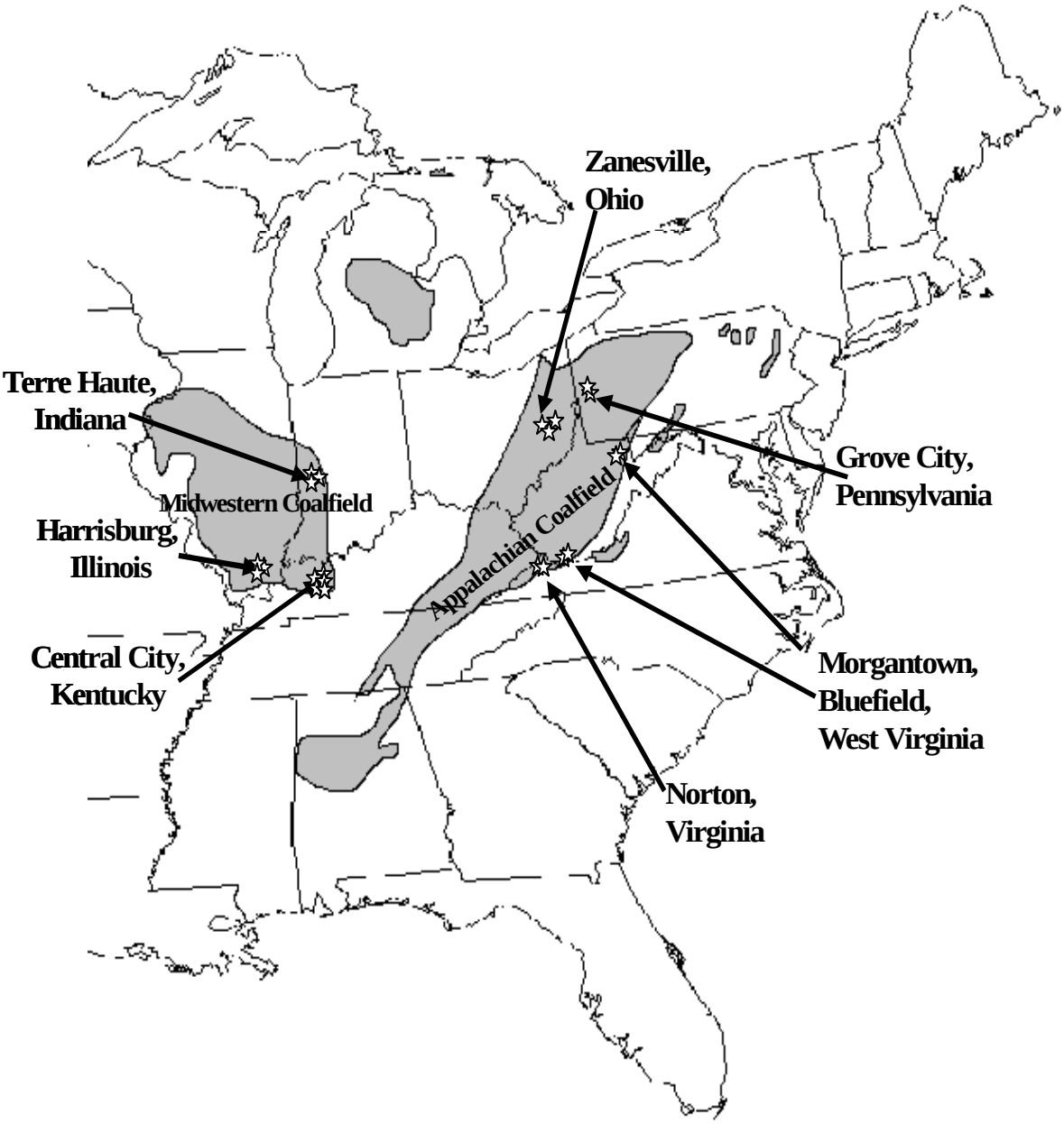

Figure 1. General location of study sites in the Midwestern and Appalachian coalfields.

Results and Discussion

SITE PRODUCTIVITY

Figure 2 provides a comparison of site productivity as measured by site index between non-mined and mined study sites. Each bar represents the percent difference in site index between the non-mined site and the mined site. The actual site index (feet) for each mined site is located under the listing of mined site labels.

Differences between non-mined reference sites and mined sites were not evident in the midwestern region. This trend was found on four out of six sites in the eastern region. However, two eastern mined sites were lower in productivity than their non-mined counterparts. Low-productivity mined sites had a shallow rooting depth, high coarse fragment content, low available water, high degree of acidity/alkalinity, and low nutrient status. Mined sites where productivity was comparable to non-mined sites had few limitations.

These findings indicate that most pre-law sites were as productive after mining as they were before. This is great news for landowners that are interested in the ability of their reclaimed mined sites to produce commercial crops of trees in the future. If done right, the mine operator and landowner can receive the dual benefit of coal mining and commercial forests after reclamation is completed.

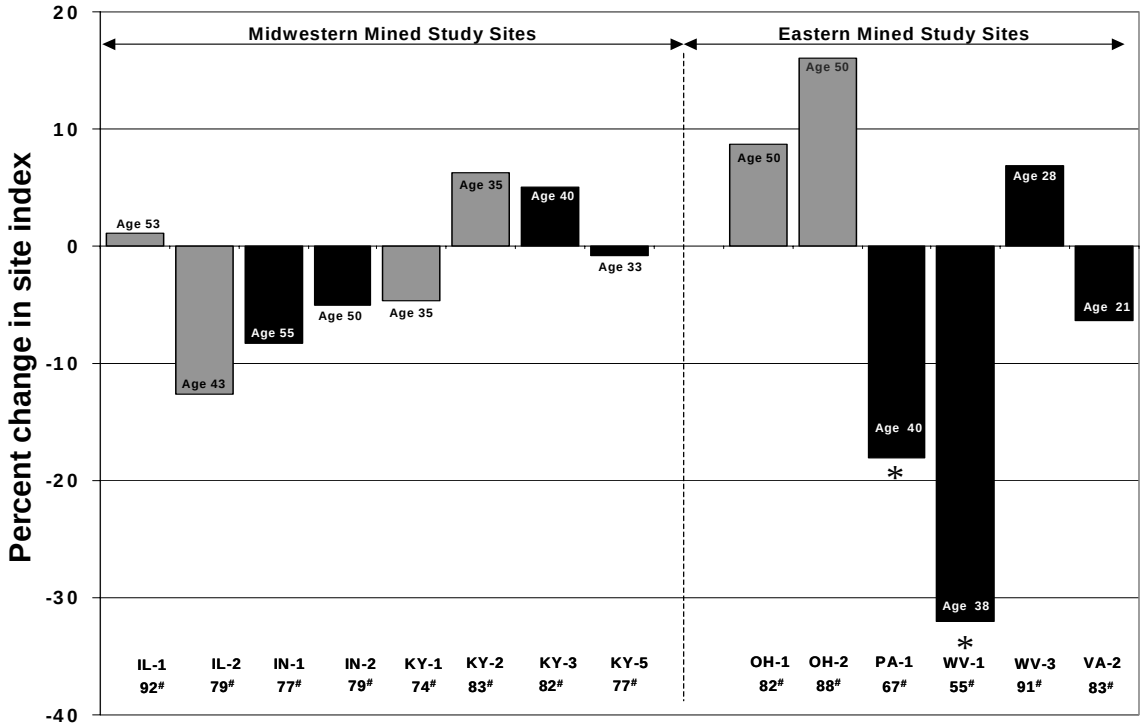

Figure 2: Relative site productivity of mined sites in the Midwestern and eastern coalfields.

(Productivity of non-mined references sites set to zero baseline. *Significantly different at 0.10. #Site index based on white oak at age 50.)

FOREST PRODUCTIVITY

Figure 3 presents comparisons of average annual growth over a species-specific rotation age (30 years for conifers and 60 years for hardwoods). In the Midwestern region, four sites were similar in forest productivity to their non-mined comparisons. Four others

were greater in forest productivity. In the eastern region, two sites were more productive, one site was less productive, and three were similar in productivity.

Forest productivity incorporates both reclaimed site productivity, which is apparent in general site-specific trends between Figures 2 and 3. For example, WV-1, which is lower in site productivity, is also lower in forest productivity. However, forest productivity also accounts for management changes such as planting different species. Species have different growth rates because they use reclaimed mined site resources differently. In most cases, conifers mature faster than hardwoods resulting in greater forest productivity compared to native hardwoods on non-mined sites. For example, site PA-1 had lower site productivity but forest productivity was similar to its non-mined counterpart. The fast growing conifers masked the lower site productivity with faster growth rates compared to the hardwoods they replaced.

This suggests that careful selection of species, melded with proper restoration of site productivity, allow forest sites to meet future landowner objectives. In most cases, (all but one) stands with similar site productivity result in similar or greater forest productivity over non-mined sites, resulting in greater future value.

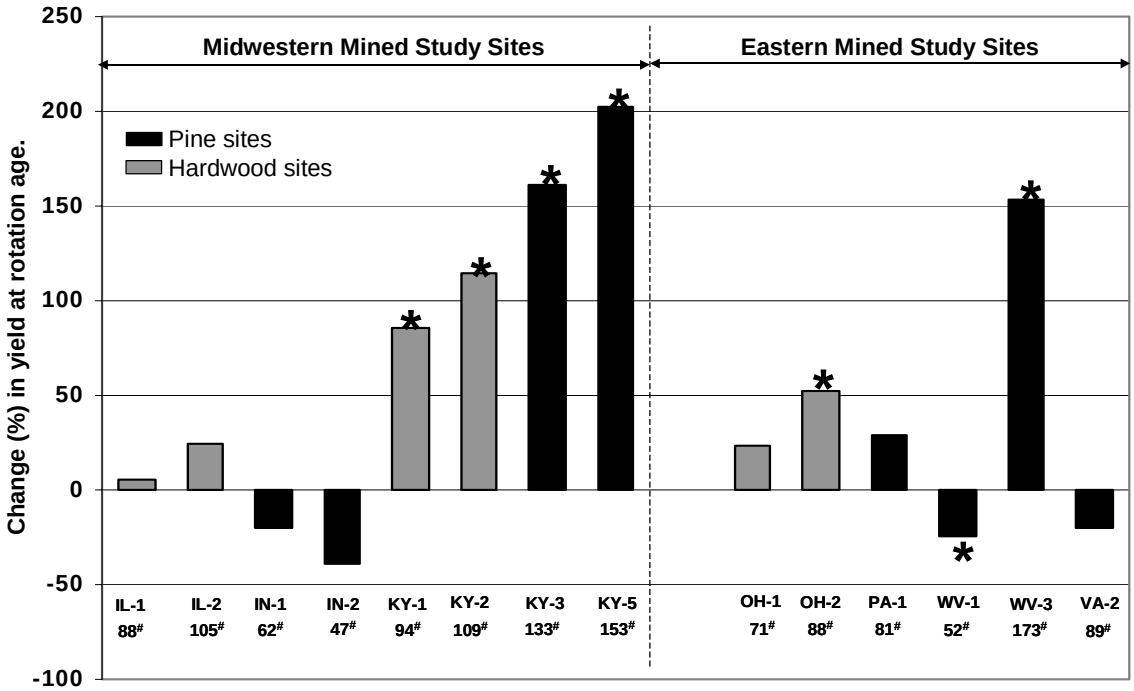

Figure 3: Comparison of forest productivity between non-mined and mined sites in the Midwestern and eastern coalfield region.
(*Significantly different at $\alpha \leq 0.10$. #Mean annual increment in $ft^{-3}\ ac^{-1}$.)

COMMERCIAL VALUE

Figure 4 presents a comparison of non-mined and mined value across all study sites within the two regions. The dollar values listed are for pulpwood and sawtimber grown by a site over a 60-year period. Pine sites can grow two rotations of commercial forest products in the same time as one hardwood stand. In the Midwest, three out of the eight forested sites were significantly more valuable than their non-mined comparisons. One site (IL-2) was lower in commercial value. In the East, every mined site except WV-1 was greater in value that the non-mined sites. Forests on the most productive sites averaged roughly \$6,000 to \$8,000/acre^{-1}, while lower productivity sites produced lower than \$2,000/acre^{-1}.

The productivity of restored sites (both forest and site productivity) played an important role in the commercial timber value that developed. The most productive sites had the highest timber product value. In most cases, two rotations of fast growing pine species on mid to high quality sites produced more product value than a single rotation of hardwoods. However, value estimates in this study did not account for special hardwood uses such as oriented strand board. Regardless of the species planted, if reclamation and reforestation are done properly, forest product value should be equivalent to or greater than that of non-mined forestland.

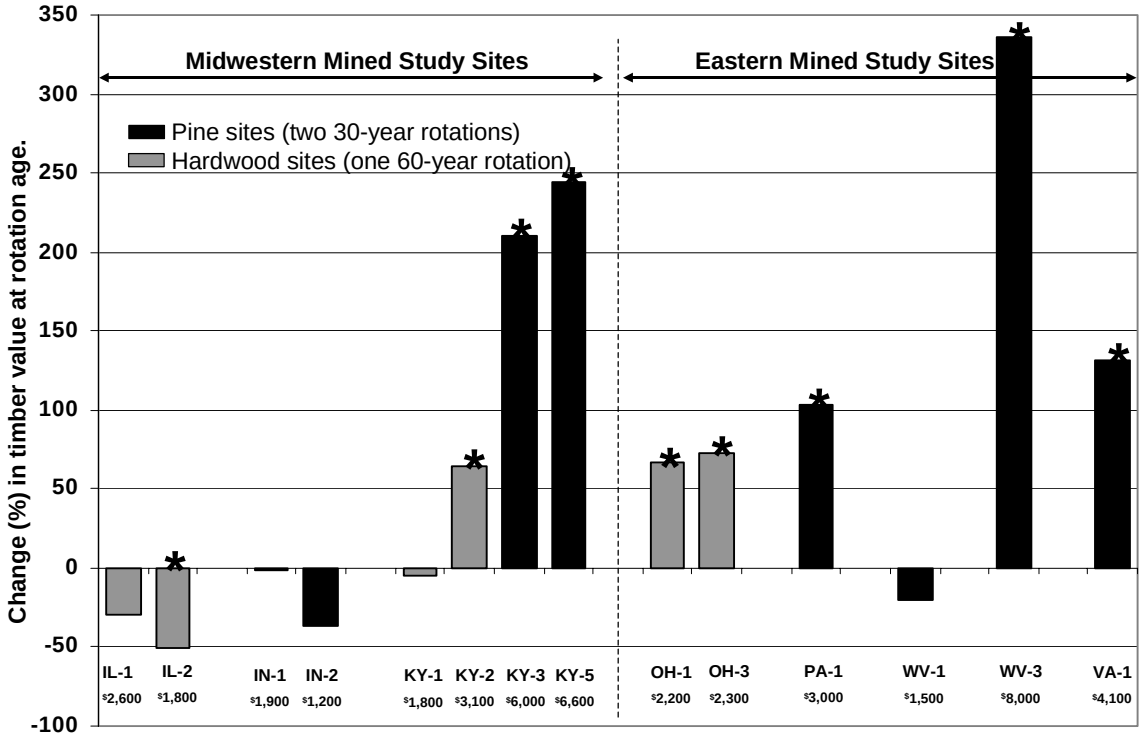

Figure 4: Relative dollar value of wood products on mined sites. (Dollar value of non-mined reference sites set to zero baseline. *Significantly different 0.10. \$ Stand value in \$ acre.)

CARBON SEQUESTRATION

Carbon accumulation increased as a function of stand age (Figure 5). This increase in carbon approached average non-mined carbon levels after approximately 60 to 65 years, corresponding with the rotation age of a commercial hardwood stand in the southern Appalachians.

Conservative estimates of potential sequestered carbon prices are approximately \$3.00 ton^{-1} of carbon accumulated. Based on Figure 5, we estimated that the average carbon accumulation of mined sites would approach the average non-mined levels after 60 years. For our example, this equates to an average of \$345/$acre^{-1}$, or a 10 percent increase in revenue over that generated by wood products alone at a 60-year rotation age. If this value was estimated in terms of sequestered CO_2 than the additional benefit would likely increase.

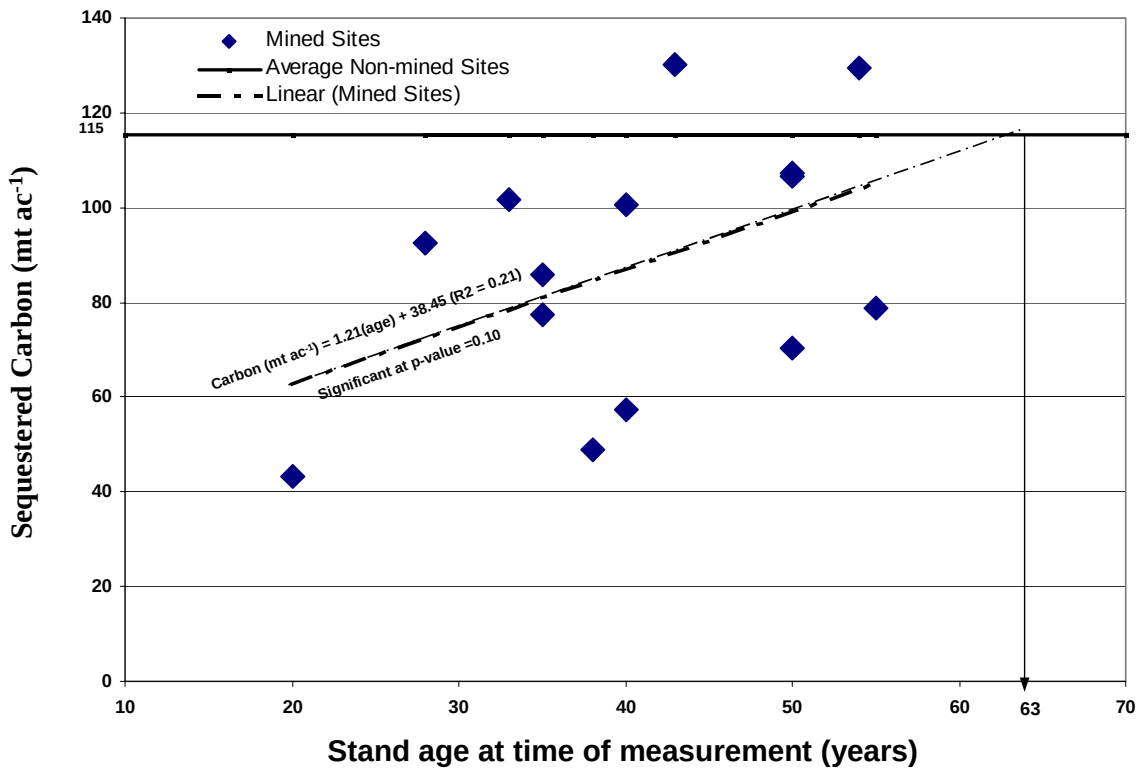

Figure 5: Relative dollar value of wood products on mined sites. Dollar value of non-mined reference sites set to zero baseline. (*Significantly different $\alpha \leq 0.10$. $^{\$}$Stand value in \$ acre-1)

Table 2: Carbon sequestration averages and values by ecosystem component.

Forest Type	Soil	Litter Layer	Tree Carbon	Total
Current potential value: mined at \$3 T^{-1} (age 41)*	\$57	\$18	\$216	\$291
Current potential value: mined at \$3 T^{-1} (age 60)*	\$96	\$12	\$270	\$378

*Value estimate in \$ ton^{-1} of carbon. Use of value estimates in \$ ton^{-1} CO_2 would increase the return on the investment.

WOODY SPECIES DIVERSITY

Figure 7 shows a comparison of woody species diversity between woody ground layers on mined and non-mined sites in the Midwestern region. This general trend was found in the eastern region as well. Mined sites are developing woody species diversity similar to non-mined levels.

The woody ground layers were made up of species that are present as a result of invasion and succession (gray bars) and those that regenerated from that mature planted canopy (black bars). In any case, natural succession mechanisms are apparent on reforested mined sites. Midwestern sites had eleven species in common in their woody ground layers. The data show that mined sites are developing woody species diversity similar to non-mined levels.

The planting of commercially valuable species has ensured that valuable species will be present in future developing stands (black bars, Figure 7). This is most apparent on sites planted to multiple hardwood species. In the Midwest, the non-mined and mined sites share six commercial species. Though this trend was similar on eastern sites, those that were planted to moderately shade tolerant pine species contained fewer commercial hardwood species in the ground layer.

The presence of commercial tree species in the woody ground layer is important to the landowner that is interested in long-term commercial forestry. The commercial species present in the ground layer during harvest will likely be the principle components of the future stand. The information provided by this study suggests that forest systems are capable of regenerating themselves on properly reclaimed mined land. Planting commercial species enhances the value and aids succession of these self-perpetuating systems.

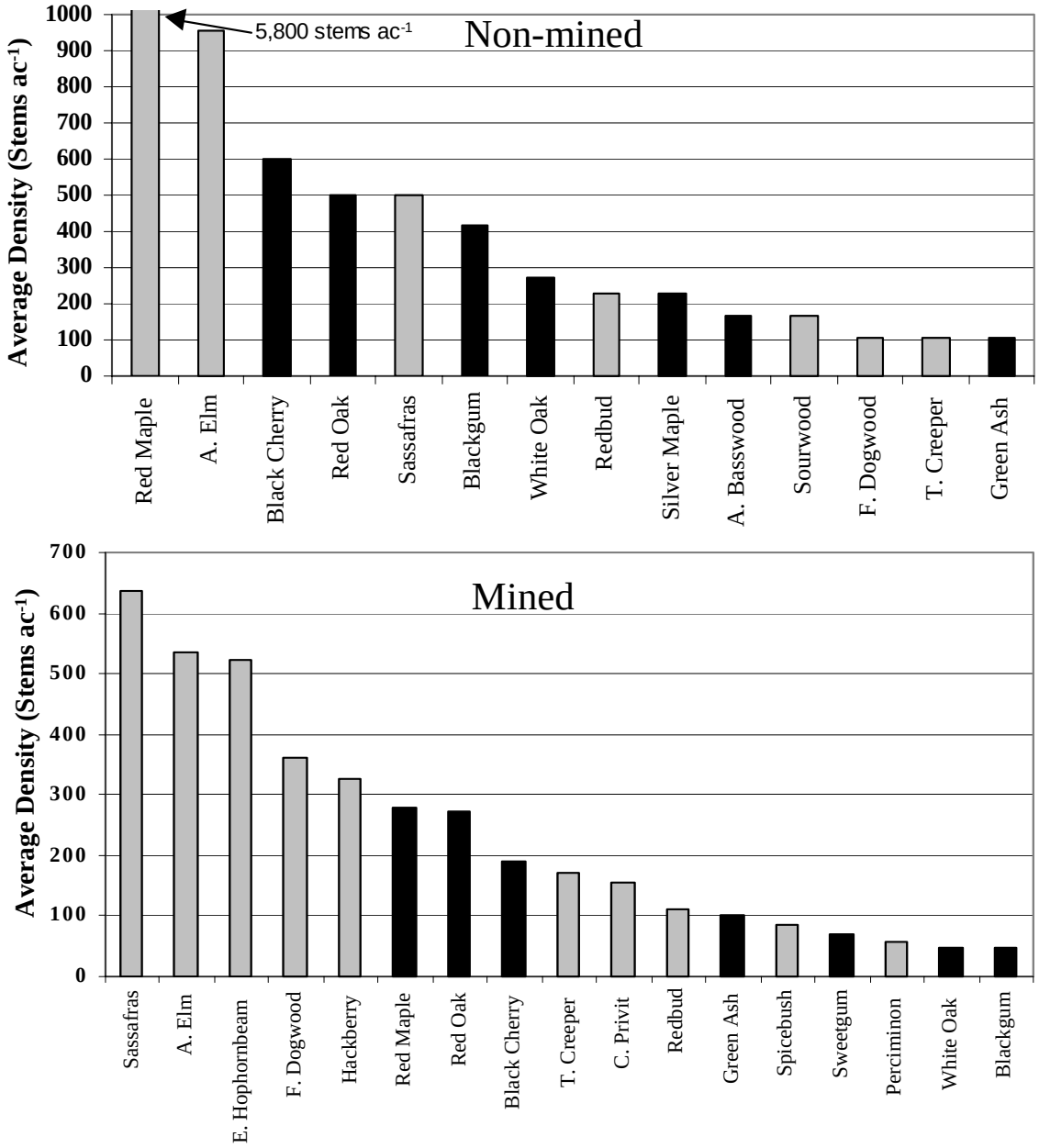

Figure 7: Average species density of the woody ground layer of Midwestern non-mined and mined sites. (Black bars represent commercially valuable species. Gray bars represent invading species.)

Conclusion

The development of forests on pre-SMCRA sites has demonstrated that commercial forests on reclaimed mined land can provide many values for landowners. The development of productive forest sites results in comparable or greater value of timber products. Additional value may result from carbon sequestration in the soil, litter, and woody vegetation. In addition to economic gain, reclaimed forests provide biologically

diverse sites for future forest rotations while enhancing wildlife habitat and other non-commodity values.

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ALABAMA'S REFORESTATION OF ABANDONED MINE LANDS

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Abstract

As administering agency for Alabama's Abandoned Mine Land Reclamation Program, the Department of Industrial Relations has been in the tree planting business for over 25 years. Its nationally recognized reforestation program has evolved from hand-planting orphan (ungraded) abandoned mines to state-of-the-art techniques involving soil testing, ripping (to loosen heavily compacted spoils), spraying (to reduce competition), mechanical planting, and use of genetically improved seedlings. Over 8 million seedlings have been planted to date.

Reforestation is a long-term commitment. Once you've made that commitment, our photo-tour will show you how to get the job done, from choosing the right nursery, through proper care and handling of seedlings, boosting survival rates, overcoming problems with excessive soil compaction and competition from herbaceous vegetation, to long-term management. We'll also recommend setting up partnerships with local soil and water conservation districts to make sure the job gets done right.

Reforestation of abandoned mine lands not only provides long-term soil stabilization, but provides cover and habitat for many wildlife species, while increasing land productivity and enhancing property values.

Introduction

Since 1977, Alabama's Abandoned Mine Land Program has been committed to reclaiming and revegetating previously mined lands, with 87 percent being reforested. Loblolly ines account for 85 percent, with the remaining trees consisting of autumn olive, sawtooth oak, bicolor lespedeza, cherrybark oak, sycamore, yellow poplar, and other wildlife shrubs.

Over the past 100 years, large draglines ripped through the earth and rock to create huge spoil piles of overburden, left to erode and be inhabited with grass, weeds, non-commercial shrubs, and some pines and hardwoods. Most sites consist of rough, ungraded spoils, water impoundments, dangerous highwalls, coal refuse "gob" piles, and industrial and residential waste piles. Spoil piles are compacted by heavy equipment, heavy noxious weeds invade the site, and large rocks are spread throughout the piles. Naturally, all unwanted vegetation must be cleared, impoundments drained, and waste buried or removed to a solid waste landfill. Compaction must be reduced, especially in rows where trees will be planted.

Over the past years, Alabama has developed a recipe for reforestation success:

- $ Proper site preparation
- $ Adding needed soil amendments
- $ Proper soil composition and moisture
- $ Rip and spray to reduce compaction to control competing vegetation
- $ Purchase quality seedlings from superior nurseries and take proper care of seedlings
- $ Use proper planting techniques and practice quality controls
- $ Plant seedlings with good soil moisture and cold weather

These ingredients must be discussed in some detail to explain how critical each and every one is to final tree survival and growth.

Site Preparation

All impoundments are drained using approved dewatering procedures, unwanted vegetation is cleared and burned, trash and waste buried on-site, or transported to an approved landfill, then grading of spoils begins. All highwalls are backfilled with on-site spoil material, including impoundments, then sloped to a 3:1 or flatter slope. Slopes are stabilized by adding terraces at necessary intervals, which are protected by erosion control fabric or limestone riprap.

Soil Amendments

A comprehensive soil analysis is performed by certified soils laboratories to determine the type of amendments needed and quantities necessary for proper plant growth. In Alabama, large amounts of lime and high nitrogen fertilizer are required on most sites. These chemicals are spread, disked into the graded soils, and heavy layers of hay mulch are spread and crimped to create a prime seedbed. A mixture of native grasses and legumes is spread to germinate and stabilize the site until trees can be planted during the following winter. Some areas are hydro-seeded with a mixture of wood pulp fiber, fertilizer, and grass seed.

Soil Composition and Moisture

Careful attention is devoted to the upper layer of soil in which roots of grasses, legumes and seedlings must develop and survive, adding to the organic material and re-establishing topsoil.

Hay mulch is added not only to hold seed and soil in place, but provides the initial head start on organic buildup in the soil. Proper amounts of mulch hold moisture in the soil and reduce sun and wind dehydration and erosion.

A mixture of Pensacola Bahia grass, hulled common Bermuda, hulled sericea lespedeza, browntop millet, and crimson clover are planted in spring and summer. A heavier mixture is planted in fall and winter, consisting of the same seed, plus unhulled common Bermuda grass, unhulled sericea lespedeza, Kentucky 31 fescue, common annual ryegrass, and inoculated crimson and ladino clover. The mix of grasses work together to establish a thick root mass in the upper six inches of soil, while the legumes fix nitrogen in the soil, further promoting root growth

and aiding soil micro-organisms in colonizing and building up organic matter over time. Site conditions vary across Alabama, so the mixture of grasses, legumes and soil amendments is also tailored to each site, based on the comprehensive soil analysis.

Rip and Spray

As we have already discussed, soil compaction, competing vegetation and rocky soils are three limiting factors to successful revegetation and reforestation of graded mine spoils. We developed a subsoiler with a spray attachment to spray a four (4) foot swath along the ripped row where trees will be planted during the winter. Each row is ripped to a 14-inch depth, and a 55-gallon herbicide mixture of 2.5 gallons of Roundup Pro, 10 ounces of Oust, and water is sprayed two (2) feet on each side of the row. Ripping is done in October each year and opens a channel for planting bare root seedlings, moving rocks out of the row. Herbicide controls competing vegetation to an acceptable level, allowing seedlings room to grow and develop a good root system during that critical first year. Rows are ripped on 10-foot spacings where possible, even in areas that must be hand-planted, to allow trees to be planted on a 6-foot x 10-foot spacing to achieve 726 trees per acre. In Alabama, this step is critical to control weeds and grasses for good seedling survival. The soil amendments and mulch almost always produce a lush carpet of grasses to stabilize each site until trees can be planted and grow to produce a forest to permanently hold the site in place.

Seedling Quality and Care

Now that the site is prepared, stabilized with grasses, and ripped and sprayed, the next step is to procure quality tree seedlings that have an excellent chance of survival. Of course, trees must be ordered six months to one year prior to actual planting to allow tree nurseries to grow what their customers need. Almost all tree nurseries in the Southeast are members of a pine plantation cooperative, which continually produces superior seedlings from genetically improved seed orchards across the region. Seedlings are grown in soil mediums consisting of sand clay loam, decomposed sawdust, and pisolithus tinctorius bacteria. The bacteria attaches to the feeder roots of seedlings in a symbiotic relationship, which greatly increases the plant's ability to uptake moisture and nutrients. Genetic improvement results in trees that are fusiform rust and root rot resistant, and increased growth rates, resulting in good form and right-angled limbs that prune with the least amount of bole exposure.

Seedlings at superior tree nurseries are undercut in August of each year to force root systems to branch out. This produces a really fibrous root system to support seedling growth during that critical first year along in the environment. Most nurseries also grade seedlings to discard trees with Cronartium cankers (fusiform rust), forked trees, and weak seedlings.

Trees are planted in January through March of each year, so trees are picked up at tree seedling nurseries, transported in covered trucks, vans or trailers to prevent dehydration from wind and sun exposure. Then, trees are stored on racks in a humid cold storage building designed to keep temperatures 40-45 degrees Farenheit. This keeps seedlings dormant and moist until transported to the site and planted. As trees are brought to the site, they are kept in shade and covered to protect from sun and wind exposure, preserving moisture. On warm days, trees are simply kept

moist in the shade.

All this care is necessary to nurture seedlings until they are planted, for each tree should be green, dormant, and healthy. They are, after all, baby trees and must be pampered somewhat. As we often say around planting sites, the best way to boost survival rates of trees planted is to 'plant live trees." This may sound ridiculous but seedlings may be green and look fine and be completely dead.

Most pine trees planted are loblolly pine, but some sites are planted with longleaf pines at the owner's request. All trees planted are bare root, and include hardwood trees and wildlife shrubs.

Planting Techniques

In the beginning, contractors were hired to plant trees on reclaimed AML sites, which afforded little control over seedling quality, care, planting techniques, and quality control over planting. So, in 1987 we decided to take control of our reforestation program, and plant good seedlings, properly, on all reclaimed sites. The Walker County Soil and Water Conservation District Board began planting seedlings under a long-standing cooperative agreement with the Department. Survival rates improved dramatically, then, in 1991, we purchased a Reynolds F-050 split-axle tree planter. The planter foot and colter were modified and strengthened for harsh soil and rock conditions. Frequent care and maintenance have kept the planter functioning properly, and we anticipate many years of operation on mine spoils. A dual-wheeled farm tractor is used to pull the planter along previously ripped rows. Workers riding in the planter place trees on 6-foot spacings, and another worker follows to straighten trees and plant skips in rows. Steep slopes are hand-planted with dibble bars, using proper planting techniques. A professional registered forester oversees all tree planting, and performs quality-control checks on planted trees to guarantee proper planting, packing, spacing, and seedling care.

Soil Moisture and Weather

Cold weather and good soil moisture are critical to seedling survival and growth. Sites are monitored to check for proper planting conditions, then trees are planted during optimum conditions from daybreak to dark. Tree planting season is the number one priority when conditions are right, but planting will be suspended if soils become dry or the weather gets too hot. Seedlings are returned to cold storage where they remain until adequate moisture and cold weather conditions return. Conditions vary widely across Alabama, so crews can usually move to another location to continue planting, then move back to a previous site as necessary. If soil amendments, mulch and grasses have been added to graded mine spoils, then organic matter will buildup to hold soil moisture and provide much-needed nutrients for bare-root seedlings. Moisture, organic material and nutrients are concentrated in ripped trenches that have closed during the months prior to planting.

Seedling survival surveys are performed during the fall following planting to determine survival rates, health, growth, and if replanting is necessary on any areas. Such surveys are essential in monitoring any reforestation program and help identify problems, such as poor planting techniques, weak seedlings, poor soil conditions, acid soils, and too much competing vegetation.

If all of the above ingredients are added to your reforestation recipe, then you will have a successful program with good to excellent survival rates. Even during drought conditions, seedlings will survive and establish deep root systems to catapult them upward during the next spring growth season.

We have also surveyed older pine plantations for survival rates, growth and stand density. Site index is good to excellent after reforestation and shows all indication that the new site index will be as good or better than pre-mined site index. For example, many 11-year-old trees are 30-40 foot high and 6-8 inches in diameter at breast height. Projections to age 50 would not be reliable at this point, but all indications are excellent to show improvements over the original site index.

A recent study by Dr. E. Sam Lyle, Jr., and Jim L. Kitson of the Walker County Soil and Water Conservation District Board in Boldo, Alabama, was completed in 1999 on twenty-seven sites chosen at random. The results showed survival ranges from 77.0 to 99.7 percent, with an overall average of 86.1 percent. The study also showed decreased survival rates with age; however, stands naturally prune unhealthy and undesirable trees, allowing the survivors opportunity to grow better without the added competition. Forest industry in Alabama establishes an average 726 trees per acre during planting and desires an average 500 trees per acre at age 5. Studies have shown that the maximum basal area of tree volume can be achieved at that stocking rate. Dr. Lyle's study showed that we had more than 500 trees per acre surviving at age 5.

Landowners have the option to thin plantations at ages 10-12 years, 20-25 years, and final harvest at age 30. We have no control over their timber stand management, but provide them with a healthy, quality forest to manage for wood production, recreation and wildlife management. Many landowners are now having their forests certified through the Tree Farm Program and Treasure Forest Program, which requires frequent and professional management.

Alabama Leads the Way in Reforesting Abandoned Mine Lands

Alabama's reforestation of abandoned mine lands not only heals scars created by past surface coal mining to fuel the nation's wars and the Industrial Revolution, but establishes young forests for many uses. As trees grow, carbon dioxide is removed and oxygen is added to the atmosphere, carbon is stored in wood tissue, raw material is grown for forest products, soil is stabilized and enhanced, water quality is improved, and widely varied wildlife habitat shelters many terrestrial and aquatic communities.

Another successful tree planting season has been completed by the Alabama Department of Industrial Relations on the State's abandoned mine lands. During the 2001-2002 tree planting season, 47,000 seedlings (loblolly pine, sawtooth oak, and various wildlife-food shrubs) were planted on 124 reclaimed acres across 7 counties. The seedlings were planted by the Walker County Soil and Water Conservation District Board through a cooperative agreement with ADIR. The table below shows that since ADIR began reclaiming abandoned mines in 1976, over 7 million trees have been planted on 9,391 acres of reclaimed lands in 14 north Alabama counties.

TREE PLANTING SUMMARY

TVA ORPHAN MINE LAND RECLAMATION PROGRAM (1976 - 1980)
- AND -
ABANDONED MINE LAND RECLAMATION PROGRAM (1983 - 2002)

County	Acreage Treated	Pines	Wildlife Shrubs	Other*	Total Seedlings
Bibb	195	105,630	14,300	12,230	132,160
Blount	1,244	505,529	214,300	13,850	733,679
Cullman	389	96,300	167,300	4,300	267,900
DeKalb	40	25,450	0	200	25,650
Fayette	58	43,125	400	1,200	44,725
Franklin	27	19,650	1,450	1,600	22,700
Jackson	283	53,000	67,000	0	120,000
Jefferson	624	384,013	45,600	32,300	461,913
Lamar	29	11,800	1,500	1,800	15,100
Marion	1,383	567,100	221,100	2,400	790,600
St. Clair	152	82,000	6,200	9,810	98,010
Tuscaloosa	835	491,600	69,100	52,300	613,000
Walker	2,578	1,684,349	656,200	27,560	2,368,109
Winston	1,554	900,184	419,100	6,350	1,325,634
TOTALS	9,391	4,969,730	1,883,550	165,900	7,019,180

*Sawtooth oak, cherry bark oak, white oak, sycamore, yellow poplar, etc.

As part of the reclamation process, all sites in Alabama are planted in permanent, native grasses and legumes to stabilize the soil after grading. Then, during the following fall, rows are ripped with a subsoiler on 10-foot intervals, and the herbaceous vegetation sprayed simultaneously to reduce competition for new seedlings. Seedlings become available for planting in late November or early December. The Board utilizes a customized machine planter that follows the rows established during the rip and spray operation. All areas are machine-planted where possible; steep slopes and wet areas are hand-planted. Seedling survival surveys are conducted during the following fall, and any areas with less than adequate survival are replanted. Routine maintenance of reclaimed projects ensures soil stability and successful tree growth. Reforestation of reclaimed abandoned mine lands not only stabilizes the soil, but provides cover and habitat for many wildlife species, while increasing land productivity and enhancing the taxable value of property.

A recent survey by the Interstate Mining Compact Commission of States' reforestation efforts indicated that Alabama leads the nation in both number of trees planted on abandoned mine lands, as well as highest survival rate after planting. This achievement is due to the availability of top-quality, genetically-improved seedlings, proper care and handling, supervision by qualified reclamation inspectors, and superior tree planting methods employed by the Board.

Bill Guyette is the Director of State Programs Division of the Alabama Department of Industrial Relations. He has 25 years reclamation experience in the State of Alabama, including

supervising tree planting crews under TVA - sponsored Orphan Mine Land Program, authoring Alabama's State Abandoned Mine Land Reclamation Plan, and serving as agency head planner and deputy administrator prior to his present position. During this time over 8 million trees were planted on Alabama's abandoned mines. He has been involved in all aspects of reforestation on mine lands, from care and handling of seedlings to setting up partnerships with local soil and water conservation districts. He currently serves as president of the National Association of Abandoned Mine Land Programs. He holds a B.S. in Environmental Science and Forestry from Syracuse University and is a licensed forester.

WHERE DO WE GO FROM HERE?

FORUM PARTICIPANT RECOMMENDATIONS

1. Develop a region or State specific pamphlet for landowners to explain the benefits of reforestation and how to develop a forest plan for mined land.
2. Explore all the possible incentives such as e co-assets that will promote fully successful forest ecosystems.
3. Revise the Federal regulations to include a specific forest productivity standard.
4. Provide a way to have an interactive discussion on an Internet Website to capture the evolution of the topic.
5. Explore interpretations of regulations that are inhibiting reforestation efforts on a State specific basis.
6. Learn how to sell the market-based approaches so that landowner can see the benefits.
7. Focus more on getting the individual landowner up to speed on reforestation options.
8. Find a way to get the new OSM reforestation outreach packet into the hands of individual landowners.
9. Expand the reforestation outreach effort to include consultant agencies, farm bureaus, forest associations, and other related agenc ies with connections to landowners.

SURVEY RESULTS

MARKET-BASED APPROACHES
TO MINED LAND RECLAMATION & REFORESTATION:
A TECHNICAL INTERACTIVE FORUM

PARTICIPANT COMMENTS AND RECOMMENDATIONS

CATEGORY OF PARTICIPANTS	# OF REGISTRANTS	% OF REGISTRANTS
TOTAL REGISTRATION	114	
TOTAL COMPLETING THE SURVEY	30	100
LEVEL OF SATISFACTION WITH THE FORUM		
EXTREMELY SATISFIED	8	29
VERY SATISFIED	16	57
SATISFIED	3	11
DISSATISFIED	0	0
VERY DISSATISFIED	1	3

COMPLIMENTS:

1. **Great to see academics, government and industry working together!**
2. **One of the best forums I've seen in a long time!**
3. **The combination of Market-Based and Economic Practices along with the case studies made this an interesting and meaningful forum. Participants got to hear some things they may not have considered otherwise.**
4. **Forum was very educational and thought provoking!**
5. **The forum was great! The spacing of breaks was well thought out.**
6. **Excellent topic selection!**
7. **Very glad to be here!**
8. **Outstanding conference in all respects!**
9. **Forum format excellent as is!**

WHERE DID THE PARTICIPANTS COME FROM
AND WHO DID THEY REPRESENT?

PARTICIPANT AFFILIATION	# OF REGISTRANTS	% OF REGISTRANTS
State Mining Agency	21	18
Coal Industry	21	18
Office of Surface Mining	18	16
University	13	11
Electric Utility Industry	12	11
Forestry Consultant	9	8
Forestry Agency	7	6
Other Federal	5	4
Conservation Organization	4	4
Fish & Wildlife Agency	2	2
Engineering Consultant	2	2

REGIONAL REPRESENTATION	# OF REGISTRANTS	% OF REGISTRANTS
EAST	69	60
MID-CONTINENT	40	35
WEST	6	5

PARTICIPANT RATING ON USEFULNESS OF TALKS
4.0=EXCELLENT
3.0=GOOD
2.0=FAIR
1.0=POOR

SESSION 1 MARKET-BASED APPROACHES TO MINED LAND RECLAMATION

PRESENTER	AVERAGE RATING	RATING RANGE
Sarah Donnelly	**2.8**	**4-1**
Bob Kane	**3.1**	**4-1**
Bill Coleman	**3.3**	**4-2**
Doug Lashely	**3.5**	**4-2**
Larry Myers	**3.2**	**4-2**
Craig Diamond	**2.9**	**4-1**
John Dawes	**3.0**	**4-2**
Ron Hufford	**3.0**	**4-2**
Gary Kronrad	**3.2**	**4-1**
Gordon Hester	**3.3**	**4-2**

SESSION 2 MARKET-BASED ECONOMIC AND MANAGEMENT CONSIDERATIONS

PRESENTER	AVERAGE RATING	RATING RANGE
Thomas Fox	**3.1**	**4-1**
Chris Stanley	**2.4**	**4-1**
John Sprouse	**3.0**	**4-1**
Bruce Evans/Chis Leibering	**3.2**	**4-1**
Laurence Emerson	**3.3**	**4-2**
James Burger	**3.6**	**4-2**
Dan Williamson	**3.4**	**4-2**

SESSION 3 REFORESTATION SUCCESS STORIES

PRESENTER	AVERAGE RATING	RATING RANGE
Jason Rodrigue	**3.5**	**4-3**
Bill Guyette	**3.4**	**4-2**
John Tate	**3.2**	**4-2**
Dave Blankenship	**3.1**	**4-2**

SUGGESTIONS FOR IMPROVEMENT

CARBON SEQUESTRATION AND CARBON TRADING

- $ How can the Market-Based Approach be marketed to Landowners?
- $ Need a speaker from the financial community who buys carbon credits.
- $ Session 1 would have been more credible if there was more technical information on growth rates of trees on reclaimed mined land.
- $ More detailed information on carbon sequestration.
- $ How do you broker and exchange eco-credits?
- $ Have a forum on how to enter into carbon trading agreements with landowners that would assist with reforestation with talks by individual State electric utilities and prospective carbon credit purchasers.
- $ Need to have more people and companies actually get involved with reforestation and carbon trading rather than just discussion.
- $ Need a practical exercise in emissions trading.

TECHNICAL INFORMATION ON TREE PLANTING AND SOILS

- $ More information on tree species selection. How to choose what species to plant. Importance of soil types for reclamation.
- $ Need more technical information on types of trees to plant, planting methods, and soil conditions.
- $ What is a suitable rooting medium for trees?
- $ How will soils develop on mined land?
- $ Is there any data on the success/failure of reforestation on post-SMCRA land in the Midwest?
- $ Need more information on the status of post-SMCRA tree plantings.

IMPROVE LANDOWNER PARTICIPATION

- $ Need a private landowner and small timber company representative to talk on their successes, failure and concerns in this area.
- $ Need more landowner and public agency input.
- $ Need more participation by landowners and local soil and agriculture agencies.
- $ Need additional speakers representing a cross-section of landowners (both large and small).

INCREASE EDUCATION

- $ How can we educated landowners on the benefits of forests and reforestation?
- $ Need to provide a mechanism to educate regulators, inspectors, landowners, and equipment operators.

FORUM IMPROVEMENTS

- $ Needed more opportunity for discussion.
- $ Add a field trip.
- $ Develop and on line forum.
- $ Having multiple speakers giving a presentation is confusing.
- $ Invite State Forestry associations and timber buyers to future forums in order to learn how they promote reforestation and solicit their assistance.
- $ Start forum at noon the first day and end at noon the last day in order to keep more participants to the end.
- $ Need more time for questions and discussion.

- The natural tendency of all speakers is to cram multiple years of research/opinions/observations into 30 minutes, because they never know when/if the chance will come again to speak. The result is that even the most attentive and capable listener is overwhelmed with data and must deal with multiple subjects. Too often in this conference it was a blizzard of information. Tell presenters that no one is interested in a summary of their life work. Pick a point, make a point, then be ready to explain and defend that position. A more casual presentation atmosphere might be helpful and appreciated. Some of you participants left this forum exhausted.
- The speakers should have been more focused on their session topic.
- These forums are only crying sessions about the problems.
- Promote a contest on the best post-SMCRA reforestation projects.
- Need more information on land taxes and taxes on private timber sales.
- Repeat this forum with an update of market conditions and new reforestation technology.

APPENDIX 1: RECORDED DISCUSSIONS

Edited by
Kimery C. Vories
USDI Office of Surface Mining
Alton, Illinois

The following are the edited discussions that took place at the end of each speaker presentation and at the end of each topic session. The actual comments have been edited to translate the verbal discussion into a format that more effectively and efficiently communicates the information exchange into a written format. The organization of the discussion follows the same progression as that which took place at the forum. A topical outline has been developed to aid in accessing the information brought out in the discussions.

The topic of each question is shown in alphabetical order in **bold.** The individual speaker questions are listed in outline format under the appropriate topic session and presentation title. Questions during the twenty-minute interactive discussion are listed at the end of the session in the following format:

SESSION # AND TOPIC AREA
- Presentation Title
  - **$ Subject of Question or Comment**
- SESSION # INTERACTIVE DISCUSSION
- **Subject of Question or Comment**

OUTLINE OF DISCUSSION TOPICS

SESSION 1: MARKET-BASED APPROACHES TO MINED LAND RECLAMATION

1. OSM/DOE Joint Reforestation Initiative
2. The Administration's Global Climate Change Initiatives and Enhanced Opportunities for Carbon Sequestration on Mined Lands
   - **$ Adjustment for Site Specific Conditions**
   - **$ Landowner Inquiries**
   - **$ Promotion Efforts with Farm Groups**
3. Market-Based Reclamation of Mined Lands-Real Value from Investing in Nature
   - **$ Small Landowner Opportunities**
4. Eco-Asset Management Case Studies
5. Incentives for Utilities to Invest in Reforestation-Limestone Run Project
   - **$ Advertising the Project**
   - **$ Effects of Deer Browsing**
   - **$ Estimating Sequestration Rates**
   - **$ Impact of Mercury in Fly Ash**

6. Overview of OSM/DOE/EPRI Joint Initiative on Market-Based Land Reclamation: Education and Outreach Efforts
   - **Eco-Asset Banks**
7. Watershed Assets
8. Traditional Forest Product Trends and Legislative Issues
9. Enhancement of Terrestrial Carbon Sinks through Reclamation of Abandoned Mine Land in the Appalachian Region
10. Application of an Eco-Asset Model at the TXU Monticello Mine

SESSION 1 INTERACTIVE DISCUSSION
How much Mined Land would be Eligible
Outreach to Landowners
Policy Incentives
Who Pays for AML Reforestation
Who Pays for the Assets

SESSION 2: MARKET-BASED ECONOMIC AND MANAGEMENT CONSIDERATIONS

1. The Elements of a Forest Management and Economic Plan for a Typical Forestry Business Enterprise.
2. The Regulatory Framework for Reclaiming Mine Land: Considerations for Forestry.
   - **Remining Permit Bond Release Requirements for Forestry**
   - **Types of Trees Planted Relative to Timber Values**
3. Economic Analysis for Reforestation on AML and Bond-Released Grassland Conversions.
4. Reclamation Costs/Benefits for AREA MINING: Overburden Placement, Grading, Site Preparation, Reforestation, and Management.
   - **Productive Forests versus Getting Bond Release**
   - **Use of Tree Planting Machines in Rock**
   - **Vole Control**
5. Reclamation Costs/Benefits for STEEP SLOPE MINING: Overburden Placement, Grading, Site Preparation, Reforestation, and Management.
6. Mined Site Condition, Species Composition, and Stand Development of Economically Viable Hardwood Forest.
7. Cost of Tree Planting, Site Preparation, and Maintenance.

SESSION 2 INTERACTIVE DISCUSSION
Landowner Incentives
Regulatory Approval for Planting Trees First

SESSION 3: REFORESTATION SUCCESS STORIES

1. Forest Productivity and Values for Pre-SMCRA Mined Land
   - **Age of Volunteer Species**

- **$ Carbon Values**
- **$ Contour and Area Mines**

2. Reforestation on AML Reclamation Projects
   - **$ Cost of Reclamation & Reforestation**
   - **$ Landowner Response to Trees**
   - **$ Property Liens**
3. Total Ecosystem Approach to Terrestrial Carbon Sequestration: Coal Industry Perspectives
4. A Tennessee Case Study of Reforestation on Active Mine Sites
   - **$ Landowner Response to Roughness**
   - **$ Need for Seeding Grass**
   - **$ Problems with Harvesting Timber**
   - **$ Rodent Problems**

SESSION 3 INTERACTIVE DISCUSSION

DISCUSSION BY SESSION

SESSION 1: MARKET-BASED APPROACHES TO MINED LAND RECLAMATION

1. OSM/DOE Joint Reforestation Initiative Dr. Sarah Donnelly, OSM, Washington, D.C. and Bob Kane, DOE Climate Challenge Program, Washington, D.C.

2. The Administration's Global Climate Change Initiatives and Enhanced Opportunities for Carbon Sequestration on Mined Lands Bob Kane, DOE Climate Challenge Program, Washington, D.C. and Daniel Klein, 21st Strategies Inc., McLean, Virginia

Question: **(Adjustment for Site Specific Conditions)** Do these calculations have a way to factor in the site index that would be dependent upon the soils type and condition?

Answer: These calculations provide a range of values that include a maximum, minimum, and median value that could be correlated to the existing site conditions. You would to be familiar with the site-specific conditions in order to estimate the most likely carbon sequestration potential of the site. We are not yet at the point, however, where we could determine in any absolute way the potential for a specific site to sequester a specific rate of carbon. It is an estimate.

Comment: It seems to me that this is why we are having this forum. We need to develop a method that we can take to a landowner that would be a cook book approach for the landowner to calculate the value of his land in terms of eco-assets and how best to realize that value.

Question: **(Landowner Inquiries)** How could a landowner find out what the potential his property had for carbon sequestration and what economic value that represents?

Answer: He could access the Energy Information Administration Database where there are guidelines for making these calculations. If you were planting 100 acres to trees, you would able to calculate the number of tons sequestered by the tree species in that geographic region.

Question: **(Promotion Efforts with Farm Groups)** Are you working with the consolidated farm service to promote these initiatives?

Answer: We have not worked with that group specifically but would be happy to work with them.

3. Market-Based Reclamation of Mined Lands-Real Value from Investing in Nature Bill Coleman, Electric Power Research Institute, Palo Alto, California

Comment: **(Small Landowner Opportunities)** You made a statement that land is under utilized. At least in Pennsylvania, the large landowners have specific interests and management programs, but there are a large number of small landowners, that once the land has been mined and reclaimed, will allow their land to sit idle. These landowners are not aware of the options that are available for their properties. If these land owners where aware that environmental credits were available as an incentive to return their land to forestry, there would be a much larger interest in doing that.

Comment: There is as much opportunity in this area for the small 50-acre tract as there is for the large 50,000-acre tract. Size really does not make a difference in terms of the opportunities. The Mom and Pop property can benefit in scale as much as the large land owner.

4. Eco-Asset Management Case Studies Doug Lashley, Greenvest, Cherry Hill, New Jersey

5. Incentives for Utilities to Invest in Reforestation-Limestone Run Project Larry Myers, Allegheny Energy, Monroeville, Pennsylvania

Question: **(Advertising the Project)** How has your company advertised this project?

Answer: The local newspapers, several magazines, and Websites covered the project. We think the reason that we received the good news coverage is because we did it as a part of a cooperative partnership. This was tremendous exposure for a small pilot project.

Question: **(Effects of Deer Browsing)** How did you protect the trees from deer browsing?

Answer: We did not protect the trees from browsing. We planted 7,000 trees and discovered that the deer browsed the White Pine trees heavily. I would estimate that we had a 70 percent survival rate on the White Pine. We had much higher survival rates on the Red Pine and the White Spruce. We put tubes around the fruit and nut trees that were

planted around the perimeter of the project.

Question: **(Estimating Sequestration Rates)** Did you estimate the sequestration rates for the project area prior to planting the trees?

Answer: We have used an estimate of 4 tons of CO2 per year per acre for this region for this type of reforestation project. We have 16 acres that we have put in trees that would total 64 tons per year for the project area assuming adequate tree survival. Due to deer browsing, we may have to replant some of the trees at a future date.

Comment: **(Impact of Mercury in Fly Ash)** EPRI has put together a multi-disciplinary team to look at issues related to the presence of Mercury in Fly Ash. Based on our initial data, we do not think there will be significantly leaching of mercury from fly ash but will continue working on this issue until we have more definitive data.

6. Overview of OSM/DOE/EPRI Joint Initiative on Market-Based Land Reclamation: Education and Outreach Efforts Craig Diamond, Electric Power Research Institute, Palo Alto, California

Question: (**Eco-Asset Banks**) When you set up the asset management system, are those assets inventoried and then banked by some public agency so that they would become available for another organization that is planning some type of construction activity in need of mitigation?

Answer: The Army Corp of Engineers will handle wetland credits, some State agencies will handle TMDLs, and EPA may handle some TMDLs. There has not been any agency bank set up for carbon credits. It has been on an individual basis and in some cases has been approved the Internal Revenue Service. We have seen one overseas project worth $5 million that has been banked in Bob Kane's Climate Challenge Program.

7. Watershed Assets John Dawes, Western Pennsylvania Watershed Protection, Alexandria, Virginia

8. Traditional Forest Product Trends and Legislative Issues Ron Hufford, Texas Forestry Association, Lufkin, Texas

9. Enhancement of Terrestrial Carbon Sinks through Reclamation of Abandoned Mine Land in the Appalachian Region Dr. Gary D. Kronrad, Ching-Hsun Huang, and Richard Bates, Arthur Temple College of Forestry, Stephen F. Austin State University, Nacogdoches, Texas

10. Application of an Eco-Asset Model at the TXU Monticello Mine Gorden Hester, Electric Power Research Institute, Palo Alto, California; Stephen Smith and Carl Ivy, TXU, Dallas, Texas

SESSION 1 INTERACTIVE DISCUSSION

Question: **(How much Mined Land would be Eligible)** How much mined land is eligible for these types of transactions?

Answer: In the Appalachian region, there is a lot of demand for the ecosystem service values. In West Virginia, can track how many permits are issued and how many wetlands are impacted and how much mitigation is granted.

Question: **(Outreach to Landowners)** Who should take the lead to outreach to private landowners to make them aware of these Eco-Asset benefits?

Answer: In Texas, the Texas Forest Service takes the lead and gets the word out to the appropriate landowners. Some one does need to take the lead but it may differ in different States as to the most appropriate agency that can best get the word to the landowners.

Question: **(Policy Incentives)** What kind of policy incentives can we create to persuade miners who relate to short term economics and plant grass to get their bonds back quickly to start thinking long term and planting trees for forestry production and carbon credits?

Answer: OSM has been preparing its outreach packet and the Reforestation Video in order to create some better tools to try to persuade current mining operators to develop productive forest rather than pasture in regions of the country where forestry make sense.

Answer: The creation of wetlands and stream restoration is a shorter-term method to realize a profit from Eco-Asset creation that carbon sequestration from forestry.

Question: **(Who Pays for AML Reforestation)** Who would pay for reforestation of abandoned mine lands?

Answer: A typical case would be for a State AML program to market the wetland restoration and reforestation cost for reclamation of a specific AML project to an electric utility that needed wetland mitigation and carbon credits. The State AML program would pay for the reclamation necessary to get the area ready for tree planting and wetland establishment and the utility would pay for tree planting and the creation of the wetland.

Question: **(Who Pays for the Assets)** Where do the actual dollars come from that pay for Eco-Assets?

Answer: In Texas, the Texas Department of Transportation and mine operators purchase the Eco-Assets when they are doing a particular project that requires mitigation.

Answer: From a real estate tax assessment perspective, if you establish a conservation bank that involves wetland, endangered species habitat, or stream restoration, then you

are putting a conservation easement on that acreage. You are then entitled to apply for exemption from real estate taxes based on that conservation easement.

SESSION 2: MARKET-BASED ECONOMIC AND MANAGEMENT CONSIDERATIONS

1. The Elements of a Forest Management and Economic Plan for a Typical Forestry Business Enterprise Dr. Thomas Fox, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

2. The Regulatory Framework for Reclaiming Mine Land: Considerations for Forestry Bradley Lambert and Benny Wampler, Virginia Department of Mines, Minerals, and Energy, Big Stone Gap, Virginia

Question: **(Remining Permit Bond Release Requirements for Forestry)** Concerning the requirement that at least 80 percent of the trees be in place for at least 3 years, does that requirement apply to remining permits and, if so, does that extend the 2 year liability period for these areas?

Answer: That requirement does not apply to remining permits.

Question: **(Types of Trees Planted Relative to Timber Values)** In your talk, you referred to planting both managed and unmanaged forests on reclaimed land. Could you tell us the tree species you would plant on these two different land use types and how would this relate to the types of species that produce the most productive forests?

Answer: It is our goal to establish tree species that are quick to mature like a pine or other softwood. Later, we would try to plant some hardwoods. We are starting to plant more hardwoods in some select areas in response to research findings of the Powell River Project.

3. Economic Analysis for Reforestation on AML and Bond-Released Grassland Conversions John Sprouse, Ohio Department of Natural Resources, Division of Minerals Resources Management, Cambridge, Ohio

4. Reclamation Costs/Benefits for AREA MINING: Overburden Placement, Grading, Site Preparation, Reforestation, and Management Bryce West, Bruce Evans, and Phil Leibering, Black Beauty Coal, Evansville, Indiana

Question: **(Productive Forests versus Getting Bond Release)** Are we just planting trees in order to comply with bond release requirements or are these trees actually being used as a productive forest?

Answer: We believe this is possible but we also believe we are not doing it right. In the mining permit we make the mistake of developing a tree planting mix that tries to duplicated a mature forest rather than establishing. I don't think you can produce a

mixed hardwood forest by planting the seedlings of the species that are found in a mature forest on a reclaimed site. I think that we are missing the early natural successional species that create the habitat necessary to develop the site as a suitable place for the species that dominate a mature forest.

Question: **(Use of Tree Planting Machines in Rock)** Are you able to use a tree planter in rocky soils?

Answer: If the rocks are not thick and too large we can get through them by replacing our coulters every year. We are unable to plant in fields that have solid, large limestone rocks.

Question: **(Vole Control)** How do you treat for Voles?

Answer: The chemical solution we have used in the past is no longer available and I really don't know what we will do if we have problems with voles. We keep the vegetation mowed around our Christmas trees but the voles like to hide in the material you have cut down.

Answer: I have found raptor perches very effective in handling voles. All you need is a steel fence post with a cross piece for a perch. The raptors are a great predator of voles and are very effective at keeping them under control.

Answer: We tried to use raptor perches in our Christmas tree farm but found that we were damaging out chemical sprayer on the steel post perches and had to remove them.

5. Reclamation Costs/Benefits for STEEP SLOPE MINING: Overburden Placement, Grading, Site Preparation, Reforestation, and Management Laurence Emerson, Arch Coal, Inc., Huntington, West Virginia

6. Mined Site Condition, Species Composition, and Stand Development of Economically Viable Hardwood Forest Dr. James Burger, Virginia Polytechnic Institute & State University, Blacksburg, Virginia

7. Cost of Tree Planting, Site Preparation, and Maintenance Dan Williamson, District Forester, Kentucky Division of Forestry, Madisonville, Kentucky

SESSION 2 INTERACTIVE DISCUSSION

Question: **(Landowner Incentives)** Some landowners are not interested in the forestland use. What types of efforts are being done to explain the incentives for reforestation to these landowners?

Answer: In Indiana, reclaimed mine land that is returned to a forest land use after 1968 are eligible to be enrolled in to the classified forest program administered by the Division

of Forestry. This reduces the tax liability to $1/acre/year. If they have 10 percent tax rate, they are paying $0.10/acre/year on their forested land.

Question: **(Regulatory Approval for Planting Trees First)** Has the West Virginia Regulatory Program approved the practice of planting trees the first year after reclamation followed by planting the ground cover the second year in order to give the trees a head start?

Answer: Yes, both the field inspector and the State office have approved this practice at least on a small scale until the practice has proved successful.

SESSION 3: REFORESTATION SUCCESS STORIES

1. Forest Productivity and Values for Pre-SMCRA Mined Land Jason Rodrigue, Bradford Ranger District, Allegheny Forest, USDA Forest Service, Bradford, Pennsylvania

Question: **(Age of Volunteer Species)** How were you able to determine the ages of volunteer species as well as the planted species?

Answer: At each site we interviewed either the landowner or the researcher that was familiar with the site. In Illinois, Dr. Ashby went out in the field with us and told us what he knew about each site. Brent Grey told us all about the history of forests on Peabody Coal lands. This is the way learned about the planting history of each site. We also took tree cores and the determined the ages of the planted and volunteer species.

Comment: **(Carbon Values)** Concerning your carbon value, you used a cost per ton of $3/ton of carbon. The going rate is currently $3/ton for carbon dioxide. This would result in about $1,400/acre for carbon sequestration on forested lands rather than the $388 that you showed.

Question: **(Contour and Area Mines)** Did you look at area mines and contour mines?

Answer: We had area mines in Illinois, Indiana, Ohio, Pennsylvania, and Kentucky. We looked at contour mines in West Virginia and Virginia.

2. Reforestation on AML Reclamation Projects Bill Guyette, Alabama Department of Industrial Relations, Montgomery, Alabama

Question: **(Cost of Reclamation & Reforestation)** You gave a cost of $275/acre for reforestation. Is this cost after all of the other costs for site reclamation such as grading, site preparation, and planting the grasses and legumes?

Answer: This is the cost after the site has been reclaimed and planted to grass. The average cost to reclaim an AML site in Alabama before planting the trees is about $5,000/acre. The $275/acre for reforestation would include the cost of ripping, herbicide

application, and planting and replanting of the trees. It is the policy of the Alabama AML program to plant trees on all of our sites.

Question: **(Landowner Response to Trees)** What has been the response of the landowners to planting these areas into Southern Pine plantations?

Answer: In order to do any AML work we have a realty specialist contact and the landowner and gain a right of entry on the property. This realty specialist goes over every phase of the operation with the landowner from the beginning of reclamation through each phase of revegetation. The realty specialist concludes by encouraging the landowner to have trees planted. It has been our experience that 9 out of 10 landowners are very happy to have the trees planted. The only reason we have had resistance from the landowner was if the landowner had livestock or other plans for the property.

Question: **(Property Liens)** Since AML funds are being used for the tree planting, does this put the landowner into a lien situation because of the increased value of the property?

Answer: There is a provision in SMCRA for filing a lien in the situation when there has been a windfall profit to the property owner. You have to balance this with the overall good to the community such as the elimination of a dangerous highwall. In this situation you could wave the lien. Also with planting trees we consider this a benefit to the community and wave the lien.

3. Total Ecosystem Approach to Terrestrial Carbon Sequestration: Coal Industry Perspectives John Tate, Enviro Power, Bulan, Kentucky

4. A Tennessee Case Study of Reforestation on Active Mine Sites Dave Blankenship, Gatliff Coal Co., Corbin, Kentucky

Question: **(Landowner Response to Roughness)** Did you have any problems with the landowner because of the roughness of the graded spoil?

Answer: Land companies own most of our mine sites. They want to develop the land for commercial timber. So we did not have any problems from landowners. For people who are used to seeing rolling grasslands after mining, the visual appeal of the area is lacking early in the process and I expect that will be a problem when we get around populated areas.

Question: **(Need for Seeding Grass)** Although you hydroseeded the area with grass because the roughness of the site. Could you have just planted trees and wildlife species and eliminated the grass seed?

Answer: We talked about planting the trees first and seeding the ground cover later. However we have some acid-forming black shale material that would oxidize over time and possible create acid mine drainage. For this reason, we needed a quick ground cover to prevent the oxidation of this material.

Question: **(Problems with Harvesting Timber)** Will the roughness of the area present a problem when it comes time to harvest the timber?

Answer: The timber companies have already been harvesting timber in mined areas with only strike off grading and this has not been a problem so we see no problem with harvesting these areas.

Question: **(Rodent Problems)** On a rocky site like you have, do you have problems with rodents eating your seeds?

Answer: We have not had any problems like that and our seeding seems to be working well.

SESSION 3 INTERACTIVE DISCUSSION

MARKET-BASED APPROACHES
TO MINED LAND RECLAMATION & REFORESTATION:
A TECHNICAL INTERACTIVE FORUM
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