TU SYSTEM ENVIRONMENTAL RESEARCH PROGRAM[1]

by

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Abstract. Texas Utilities Company's Environmental Research Program, begun in 1971, is unlike any other--financed by a private company and directed by an independent advisory committee with the research conducted by the most qualified graduate students to be found. The company has no review, editing or publishing rights to the program's findings and all of the work is published by the research fellows in open literature. The original Environmental Research Steering Committee included five members from various universities, and these five remain active on the committee today. The number of professors on the committee has been increased to thirteen over the years in order to address new environmental issues such as wetlands. Over the past twenty-five years, the committee has designated over $3 million to fund graduate students in research--unguided by the Company--on the environmental effects of surface mining and power generation. To date, eighty-one theses or dissertations have been completed on geology, hydrology, soils, forage/crop plants, forestry, wildlife, aquatic ecosystems, and wetlands. The results of the work have been utilized by the Company, the regulatory agencies, and other industries in protection of the environment in the development/ utilization of Texas lignite. A significant benefit of the process is the worldwide placement of the graduates in key positions--federal/state regulatory agencies, the academic world, industry--wherein they can continue application of the knowledge and training achieved through this program.

Additional Key Words: Environmental impacts, lignite, mining, reclamation.

Introduction

Texas Utilities pioneered the use of lignite for generating electricity at the turn of the century. When Big Brown Steam Electric Station in Freestone County went on line in 1971, it ushered in the modern lignite era as it was the first large-scale lignite mine-mouth generating station in Texas.

TU was a pioneer in another way. It made a commitment to be a good environmental steward in the process of using the lignite resource. At that time, there were no state or federal laws requiring the reclamation of strip-mined land in Texas, and few regulations addressed the burning of lignite in power plants.

To accomplish its objective of environmental responsibility, the company had a three-pronged approach namely, research, planning and implementation.

However, little or no research existed on the environmental effects of a Texas lignite mine-mouth generating facility. Thus, with a research void, and almost no guidelines to follow, TU encountered many questions in developing its strategy. Major unknowns included the impact of surface mining on water resources and whether mined lands could be returned to productive use for crops, livestock, timber and wildlife.

The company didn't have any preconceived ideas. It just wanted its impact on the environment to be as negligible as possible, and if there was an impact, the company wanted to minimize or remedy the impact. In brief, TU was looking for unbiased, sound environmental science on which to base its programs, and then monitor the program's results.

So, having committed itself to reclaim the land as soon as mining began, the company pledged that all of its environmental programs would be research-based. It was a commitment that went beyond reclamation. It embraced soil, air, water, and wildlife protection. To ensure objectivity in the research and independence in reporting findings, a steering committee of scientists and educators from five of the state's universities were asked

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[1]Paper presented at the 1997 National meeting of the America Society for Surface Mining and Reclamation, Austin, Texas,, May 12-16, 1997.

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Proceedings America Society of Mining and Reclamation, 1997 pp 680-684
DOI: 10.21000/JASMR97010680

to guide TU's new Environmental Research Program. The committee has been expanded over the years to include more disciplines, and now it has 13 members.

If this was a bold step on TU's part, it was equally so for those who agreed to be part of the initial steering group for they were agreeing to be a partner with industry and "navigate unchartered waters." The Environmental Research Program is unlike any other in the world. While funded by TU, the philosophy of the program is to promote quality graduate student education and research on environmental issues related to protection of land, air and water resources. The steering committee, which receives no compensation from Texas Utilities, selects graduate students based on their academic achievements, experiences and proposed study. While the company does not dictate the research to be done, the study must relate to environmental effects of mine-mouth generation activities and be of interest to science and society in general. This determination is made by the steering committee.

The students, who are directed by their own supervisory professors at their respective universities, receive fellowships which provide funds for a monthly stipend, tuition, equipment, travel and overhead to the university. Additionally, an environmental research center with laboratory and living facilities is available at the Big Brown site for the research fellows to use, free-of-charge.

The students proceed with their research regardless of the impacts of their findings on operations. Gathering of unbiased, sound research on the wise use of resources is the hallmark of the program. The student's research work serves to fulfill the requirement of his or her dissertation or thesis, and is not subject to direction, review, editing or publication by Texas Utilities. The research findings may be published by the student in scientific literature after peer review.

More than 80 theses and dissertations on geology, hydrology, soils, forage and crop plants, forestry, wildlife and the ecology of power-plant cooling reservoirs have been completed.

A book of abstracts of the completed studies is available upon request from Texas Utilities. The study results are impressive, and the knowledge gained from the research has spread far beyond TU operations. The program has helped to establish procedures that best illustrate co-existence between industry and nature. The studies have not only advanced environmental science, but helped TU and other companies develop cost-effective, ecologically sound techniques for land rec- lamation, water treatment, air pollution control, land use, and wetlands development.

It might be noted that Texas passed a law regulating strip-mined land in 1975, and much of the Texas Railroad Commission requirements were based on TU's research and experience. Congress passed a similar law in 1977 incorporating many of TU's findings.

Graduates of the Environmental Research Program are actively involved in environmental activities throughout the world. Former students now hold positions at universities in 13 states, are on the staff of state fish and wildlife, water and air agencies from Oregon to New York. They work in government agencies such the Bureau of Land Management, Department of the Interior (including the Office of Surface Mining), the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Forest Service, U.S. Geological Service, and the Railroad Commission of Texas Surface Mining and Reclamation Division. A number of graduates hold important positions at universities, utilities, mining, chemical, oil, timber and engineering businesses. Some are members of the American Society for Surface Mining and Reclamation (ASSMR).

While the Environmental Research Program encompasses both power plant and mining studies, almost half of all the research has involved mining and reclamation activities because these activities have the greatest impact on the environment. Therefore, the remainder of this presentation will concentrate on the mining/reclamation environmental studies.

Research On Topsoil Substitution

An important part of the program is to conduct baseline studies prior to mining operations to provide a comparative point for future comparisons. Over the past 25 years, many diverse ecological and environmental problems have been investigated. These include chemical and physical characteristics of mined soils, reforestation, grass and forage production on reclaimed land, wildlife habitat development and protection, mammal succession on reclaimed mined lands, agricultural productivity on reclaimed lands and the quality of surface and ground waters in postmined areas.

Since the reclamation studies are the focus of this presentation, a few will be highlighted, especially those that have had a continuing influence on TU 's reclamation process.

The three lignite operation sites which include three generating stations and adjacent surface mining areas are all available to the research students. The three mine areas, Big Brown in Freestone County, Monticello in Titus, Franklin and Hopkins Counties and Martin Lake in Panola and Rusk Counties, include 104,200 acres permitted for mining of which about 38 percent has been mined and reclaimed. Research is conducted at all stages of the mining and reclamation process. This wide-open laboratory allows interaction between the research students and plant and mine workers. The students' one-on-one relationships with engineers, dragline operators and survey teams of those mines have developed benefits no one could have imagined when planning the Environmental Research Program. Plant and mine staffs have learned how their activities affect the environment and the time, study and cost that goes into reclamation. The students see the day-to-day operations of a lignite mine and its adjacent generating facility, and their studies reflect the insight of experiencing real-world challenges.

One of the first graduate studies at the research center had a great influence on TU's method of handling overburden during the mining process, and the successes of its forage and tree-planting programs. Prior to Patrick Angel's study (Angel 1973), the accepted method in handling spoil material was to segregate and replace native soil horizons on the reclaimed areas. This was a costly and time-consuming process. Angel's research revealed that a better growth medium was provided when the overburden, the soils' "parent material," was mixed and used as topsoil substitutes.

East Texas minesoils, like native soils were invariably deficient in nitrogen, but the Big Brown minesoils investigated by Angel were found to be better than the native soils, partly due to the increase in total cations that resulted from mixing the top soil with deep soil layers. It was shown that mixing the overburden enhanced the water-holding capacity, thus the mixed soils have a greater ability than the native soils to hold available moisture during dry periods. Now, where appropriate, selected overburden materials are mixed and the horizons no longer need to be separated and stored as they are removed to expose the seams of lignite.

Research on Reforestation

Trees in eastern Texas serve as wildlife habitat and as commercial timber, and there have been a significant number of studies on various species through the Environmental Research Program. Studies on pine tree growth on reclaimed soils have included: differences in loblolly pine growth in native soil and mine soil and the effects on various cultural practices on tree survival and growth in mine soils. Planting techniques, i.e., direct seeding versus seedlings, containerized versus bare root, as well as fertilizer and herbicide treatments, have all been thoroughly investigated.

Gerald Wood's (Wood 1985) research on loblolly pine seed source selection provided not only valuable information to the reclamation program but valuable experience for him in his current role as forester on the Texas Utilities staff. Martin Shupe (Shupe 1986) studied the effects of nitrogen and phosphorus fertilizers on a loblolly pine plantation on a lignite mine spoil. Although these treatments resulted in an increase in the diameter and height of the two-year-old pines, Shupe concluded that fertilizer applications, other than those normally applied for initial cover crop establishment were probably not necessary for tree establishment and early growth.

Because of this research, reforestation has become an important component of TU's reclamation efforts with significant acreage planted in commercial pine forests. More than one million seedlings were planted in 1996. Since 1982 reforestation of TU's post-mined land has taken a giant leap forward. Currently, there are more than 10 million pine and hardwood trees planted on reclaimed land at the three mine sites. While pastureland still makes up the majority of reclaimed land, forestland dominates our current land use efforts.

Research on Forage Production and Row Crops

Livestock grazing is an important land use around the mining areas of Texas. Studies conducted by Frank Hons (Hons 1980) investigated forage plant growth and production. His studies showed good yields of both grasses and legumes at the Big Brown mine when minesoils were fertilized with adequate amounts of nitrogen, especially nitrate, and phosphorus. Studies subsequent to Hon's work indicated that reclaimed land required lower fertilization than unmined land. Most of TU's reclaimed pastureland is established in coastal bermuda and clover.

Jeff Skousen's study (Skousen 1986) showed that coastal bermudagrass could have increased value as forage when diverse broadleaf forages and grasses are seeded into established stands of coastal bermudagrass on minesoil. Establishment of a variety of legumes and non-legumes within bermudagrass stands provides a more diverse plant community for wildlife and recreational opportunities and produces forage that is often more nutritious and resilient to weather than bermudagrass alone.

Row crop production historically has not been widespread in the lignite regions of Texas, mainly because of drought, infertile and otherwise unsuitable soils. Paul Askenasy (Askenasy 1977) studied the possibility that crop production could be feasible on reclaimed soils at the Big Brown mine. Experiments in growing corn, sorghum and soybeans indicated that all would grow successfully under proper fertilization and cultivation practices. The most promising crop was grain sorghum. As in previous studies, Askenasy's work showed that nutrient storage and water-holding capacity of the soil apparently improved following mining.

Although mining operations may impact the geology, hydrology and soils and plant and animal communities, the studies conducted at the Environmental Research Center suggest that these changes are not detrimental to the continuation of land use as it was before mining. Indeed, many of the changes appear to be conducive to higher levels of productivity than before, and new uses for the land might be possible. For TU, mining has caused net improvements in the soil's ability to support livestock forage, row crops and many species of trees. The improvements resulted largely from beneficial changes in soil texture and removal of native soil clay pans which restrict movement of air, water, and roots. Studies at the Martin Lake mine showed that mining generally enhanced the productivity of the surface soil. In one case, the study showed that productivity on all minesoils could potentially be increased by selecting plants best adapted to the physical characteristics of the minesoils, rather than using only the plants that performed best on unmined soils.

Research on Wetlands

Wetlands research, including species selection, design, planting procedures, as well as waterfowl and wildlife response, have been a part of the program's efforts. Studies by Reynolds (1989), McKnight (1991), DeRoia (1993), Renfro (1993), King (1994), and Thomas (1994) were pioneers in the wetlands area on reclaimed land. Their contributions have been of significant assistance to Texas Utilities in its extensive and nationally recognized wetlands programs.

Time does not permit elaboration of all of the studies. Suffice to say, that the work has been, and continues to be, diverse and plentiful. This is best illustrated in the abstracts referred to earlier.

Summary and Conclusions

The Environmental Research Program with its open laboratories at the Texas Utilities mine and plant sites, provides useful and relevant studies that benefit all aspects of the mining industry and has provided for new commercial opportunities in the area through the introduction of new species and hardier plants and renewed farming opportunities.

Twenty-five years ago Texas Utilities publicly dedicated itself to a specific environmental philosophy--the mining industry's equivalent of do no harm. The Environmental Research Program has played a vital role in fulfilling that commitment. Benefits of the Environmental Research Program have consisted of:

- expanded knowledge base on the effects of mine/mouth power generation,
- funding and research sites for graduate students and stimulation of the academic community,
- dissemination of information on which to base sound, cost-effective regulations,
- enabling TU to operate in a manner that protects and enhances the environment while reducing costs, thereby providing customers with lower rates,
- talented alumni from the program serve in responsible positions in wide-ranging academic, regulatory, and business sectors.

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