

SURFACE MINE TREE PLANTING IN THE MIDWEST PRE- AND POST-PUBLIC LAW 95-87¹

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Abstract. Personnel responsible for reclamation with trees have often expressed frustration and concern that they are not getting the types of results needed under SMCRA. Researchers have documented various problems and looked to a change in regulations as a solution. Industry reclamation personnel question interpretations of present regulations, both visible and invisible, by the regulatory authorities and see ambiguity or misinterpretation as a cause of problems. An example could be use of "native" species in Illinois. The practice of mining itself has changed significantly in the past two decades, while reclamation still has to be carried out in accord with textbook-type theories and practices embodied in SMCRA. Differing viewpoints on what types of reclamation are appropriate for a mining operation continue. With new personnel there appears to be some willingness to take a fresh look at the impact of regulatory activities on the success of reclamation. The ASSMR could render a distinct service by clarifying meanings, suggesting desired changes in interpretation and language, and by carrying out the vital role of securing agreement for those changes. Greater attention to the ultimate requirements for successful tree growth in any area is needed. Several problems, and justification of possible changes in practice based on new interpretations and/or language, will be discussed in the paper.

Additional Key Words: SMCRA, regulations, land uses, tree uses

Introduction

This paper is a response to the ASSMR's Forestry Technical Division's (FTD) call for papers with a focus on 1) the important role trees and shrubs play in successful land reclamation, including the

enhancement of wildlife habitat; 2) advantages and disadvantages of post mining land use regulations under Public Law 95-87 "Surface Mining Control and Reclamation Act of 1977" (SMCRA); 3) ways to encourage more planting of woody-stem species on surface mines; and 4) reforestation in general. The concern of the FTD is especially timely. Tree planting in the midwest under SMCRA has regressed both in quality and in relative quantity compared to pre-law practices 30 or more years ago. Public interest in planting trees, in contrast, is at an all-time high. People have become aware of the value of forests as sinks for CO₂ to offset atmospheric inputs from burning fossil fuels and for various pollutants, for protecting soils from excessive erosion, as sources of high-quality water, and for the

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development of recreation and wildlife areas including refuges for endangered species. Major economic and social benefits are provided by timber production. New national programs using marginal lands to produce inexpensive, woody biomass for chemical feedstocks, cattle feed, and other needs are being developed.

Pre-law Reclamation with Trees

Tree planting in the Eastern Interior Coal Province (Illinois, Indiana, and western Kentucky) did not start with the passage of SMCRA. Long before then establishment of effective and permanent vegetative cover was the rule rather than the exception. Over 15,800,000 trees had been planted in Illinois on approximately 21,000 acres of land prior to its Open Cut Land Reclamation Act in 1961 (Ashby *et al.* 1978). Plant diversity, neither then nor today a high priority goal in reclamation, was considerably less than in pre-mining forests.

The tree-planting programs of coal companies in Illinois, Indiana, and western Kentucky were coordinated or carried out by industry reclamation associations in each state, and staff foresters were employed by several companies. Performance of these pre-law reclamation plantings ranged from failure to highly successful. Many of the acidic areas originally classified as failures have since been taken over by better-adapted species such as river birch, scarcely used before 1962 in Illinois. Diversity of all stands has increased steadily with the invasion of other plants and movement of animals into the newly-created habitats.

Research needs and opportunities in reclamation did not go unnoticed by the academic world and by several government research agencies. Daniel Den Uyl at Purdue University and other workers at the University of Illinois and Southern Illinois University established plantings on mined lands. A 40-year record of species selection for reforestation of mined lands in Indiana was detailed by Medvick (1973). The USDA Forest Service, Central States Forest Experiment Station under Dr. A. G. Chapman carried out an extensive reclamation program. Numerous field plantings were designed and established throughout the midwest from Ohio to Kansas in the 15 years following World War II.

The USDA Northeastern Forest Experiment Station carried out allied studies in Pennsylvania and West Virginia and contributed to the overall growing body of knowledge about reclamation with trees. Conferences were held, and a series of important summaries of studies reporting results for the first 10 or more years of tree growth on midwest plots was published. High quality trees were found on numerous pre-law areas.

A 1960 landmark publication, "Forestation of Strip-Mined Land in the Central States" synthesized and interpreted these findings (Limstrom 1960). After 30 years this publication is still the best reference for reforestation in the midwest. There were a number of principles and practices in Agriculture Handbook No. 166 that should have been incorporated into SMCRA in 1977. A present need is to incorporate in new regulations the experience and knowledge presented in Limstrom's publication together with important new research results.

We knew in 1960 that site conditions, both physical and chemical, affected forestation of strip-mined land. Laws and regulations subsequently passed in Illinois dealt effectively with those chemical problems that adversely affected tree growth. SMCRA extended these provisions more widely, and they have been effective. Many of the presumed chemical problems had already been solved by better handling of overburden materials and better choices of trees for planting. Older barren areas disappeared with ecosystem development. The problems from physical factors affecting plant, especially tree, growth were not addressed.

Limstrom reported that vegetation on mined land at the time of tree planting can be both beneficial and detrimental. Underplanting in black locust or other overhead cover, scarcely used under SMCRA because of the timing of bond release, can reduce climatic stress and lessen erosion. Companion species with nitrogen-fixing bacteria in root nodules can be beneficial for tree growth. Dense ground or overhead cover, however, decreases survival and growth of planted trees, with differences evident among species. Ground cover can greatly increase damage by mice or voles, rabbits, and deer.

Post-SMCRA Reclamation

SMCRA impacts most strongly what seemed or seems reasonable in 1960, 1977, and in 1991 by its emphasis on extensive grading, surface soil replacement, and on establishment of ground cover to control consequent erosion (Vogel and Gray 1987). A seemingly implacable provision of SMCRA is grading to approximate original contour, a provision with enormous consequences for re-establishment of vegetation and for hydrologic relations that in turn also affect revegetation efforts. Water infiltration and percolation rates, and thus replenishment of soil moisture storage, are greatly reduced on the graded lands (Limstrom 1960). Aeration needed for root growth is also reduced. Minesoils differ with respect to the effects of grading on these properties. On excessively loose materials grading has increased soil stability and revegetation success. Elimination of irregular topography greatly changes microclimates; for example, the expanses of graded mined lands are renowned for being windy.

Grading to plane surfaces was supported or demanded by a vast network of people who were committed to growing corn--farmers; federal and state agricultural experiment station research, extension, and administrative personnel; seed, fertilizer, and pesticide dealers and companies; equipment dealers and manufacturers; environmental activists; and local politicians. Although corn has specialized and somewhat unique growth requirements, its production has been worked out in great detail and could be prescribed with a clearly identified end point--number of bushels. Corn production, however, mines soil fertility and may degrade the environment in several ways including excessive erosion and polluted water supplies. Pesticide applications eliminate earthworm and other important soil invertebrates.

A basic article of faith of many people was, and is, "what is good for corn is good for trees". Even if a forestry land use is designated, presumed standards for corn are required. Trees differ in their life requirements, and land capable of supporting tree growth prior to mining has commonly been degraded for many species by unsuitable types of reclamation. Trees may survive on these lands, but national needs for quality hardwoods are not being met. Under

SMCRA the restoration of upper soil horizons of alfisols in the belt from southern Ohio to Missouri is particularly unfortunate. A great deal of the land mined in southern Illinois is abandoned crop land. The upper soil layers of these fields restored during reclamation are acidic, infertile, excessively fine-textured, and readily compacted in handling--just the opposite of conditions needed for good plant growth, especially for trees.

How to implement properly the provisions of SMCRA has given rise to much controversy. Under SMCRA, mined land is to be restored to a condition capable of supporting the uses which it was capable of supporting prior to any mining, or "higher or better uses of which there is reasonable likelihood" (SMCRA, Section 515 b 2). Only a limited number of terms for reclamation including "revegetation", "agricultural", and "long-term intensive agricultural" were used, without definition. To the extent present limitations on growing trees are likely to be remedied, either missed opportunities need to be recognized and accepted, or new interpretations of the law and more appropriate regulations need to be established. Coal companies are often unwilling to propose new and potentially better types of reclamation because of anticipated difficulties in obtaining permission and in fulfilling a work plan under the close scrutiny of skeptical inspectors. Another blockage could be the unwillingness of a state regulatory authority or of the Office of Surface Mining Reclamation and Enforcement (OSMRE) to approve forward-looking reclamation plans. The provisions of SMCRA for experimental practices have scarcely been implemented, not for lack of interest.

A chronic problem has been the unwillingness of environmental activists to accept that certain reclamation practices are provided for in SMCRA. The activists are treated as clients by the regulatory authorities in proposing rules changes, while experienced reclamation personnel are ignored. The activist-regulatory axis gave Illinois "prime farmland fragipan soil" despite opposition by personnel from the USDA Soil Conservation Service, the University of Illinois, Southern Illinois University, and industry. "Prime farmland fragipan soil" is a contradiction in terms and a contravention of SMCRA that cripples efforts for good reclamation.

Regulation in the midwest needs to benefit from experience and viewpoints in other parts of the country. SMCRA sets different standards for reclamation in eastern and western (precipitation 26 in or less, or west of 100° W. longitude) coal regions. OSMRE, in turn, seems to have a different philosophy of regulation in the differing coal regions. Regulation in western states seems to be less rigid and to have "diverse, effective, and permanent vegetative cover" as a goal. The goal in the midwest seems to be to force compliance with a rigid, narrow and, in the opinion of many experienced reclamation workers, incorrect interpretation of the law. Just visiting and talking to people in South Dakota, for example, there seems to be a vitality and sense of freedom compared to the frustration and occasional bitterness of reclamation personnel in the midwest. A hope for the future in midwestern states is that, with time, new regulatory personnel will take a fresh look at the consequences of inappropriate requirements and accept new and better ways to implement SMCRA.

Perceptions of our world have changed greatly from the 1970s when SMCRA was written and passed. The public has developed an awareness that short-term exploitive food production is not necessarily desirable. Excessive erosion, pesticide use, and ground water contamination are examples of problems now recognized. A solution developed to preserve and re-build soils using trees and other non-exploitive vegetation has been a major part of the Conservation Reserve Program, with roughly 22.5 million acres set aside under contract. Our reclaimed lands also need to be restored and used more wisely.

Benefits from Reclamation with Trees

Trees have a major role to play in building better soils. Although these uses of trees have great value, they all too often go unrecognized. Suitable species, even on compacted soils, can develop deep root systems that improve soil porosity for better drainage and aeration (Ashby and McCarthy 1990). The massive additions of organic matter from leaf and branch litter improve soil tilth and nourish soil invertebrates and microorganisms that in turn help build improved soils. These organisms, including earthworms and ants, further develop soil porosity and enhance nutrient cycling. Mycorrhizae on tree

roots contribute to nutrient pumping to enrich surface soils. If the land were later needed for crops, removing young trees could readily be accomplished by shearing at ground level during tree harvest for biomass or other outputs. The fields are then ready for crop production using modern no-till agricultural practices.

Use of trees, especially in a state such as Illinois, had no vocal public interest group even though trees have many values beyond wood products. Trees can contribute significantly to long-term soil improvement and enrichment. Both soils and vegetation develop together if a suitable rooting medium is provided during reclamation. Replacing the highly weathered fragipan soils of the lower midwest thwarts the opportunity for building better soils. The tragic consequences of SMCRA are nowhere more evident than in trying to grow trees on such land. A functional rooting medium is requisite.

Land uses that could be implemented under SMCRA using trees are many and varied. Although most people probably think of forestry or wildlife and recreation, other important functions of trees include soil building and protection, orchards for fruit and nuts, windbreaks, visual and noise barriers, streamside belts for erosion control and filtering of runoff waters from fields, regulated high-quality water supply from forested acres, groundwater recharge and flood protection, agroforestry products, biomass yields for national energy independence, moderation of climatic extremes, and reduction in air pollution and atmospheric CO₂ levels. Many, if not all, of these uses belong under agriculture and should be recognized as very appropriate means to fulfill the letter and the spirit of SMCRA. We know from the pre-law plantings that fresh mineral soils on mined land can produce high-quality hardwoods. Future supplies of high-quality hardwoods in this country have repeatedly been shown to be very limited. It is a tragedy that SMCRA so far has thwarted the higher and better use of mined lands in the midwest for this national need.

Limits to Tree Growth under SMCRA

The present system of mandating a standard textbook type of soil reconstruction for varied land uses inevitably has led to problems. A

"diverse, effective, and permanent vegetative cover" implies, and realistically requires, flexibility in site preparation to achieve that goal. Two well-documented causes of failure of trees under SMCRA are soil compaction after grading and detrimental effects of ground cover, with some variability among tree species in their responses. Both have been shown to have direct and indirect effects on tree performance.

Soils compacted in grading have low macroporosity and high soil strength that greatly limit plant growth. How little the effects of compaction were earlier understood or recognized is illustrated by the provision in SMCRA for, "...compacting, grading and appropriate revegetation...." (SMCRA, Section 508 a 5). The writing and implementation of SMCRA have been defective because, with few exceptions, the types of soils needed for superior tree growth have been relatively poorly studied and poorly understood. Findings from reclamation studies that have substantially enriched that fund of knowledge need to be implemented. Root-system development in compacted soils is greatly limited by a combination of mechanical resistance and low oxygen tension resulting from poor ventilation. Poor infiltration and percolation result in excessive runoff and in root death from seasonally-perched water tables. Drought-period stress is greatly accentuated by decreased moisture recharge and limited root penetration.

A significant feature of desirable soils for trees is an admixture of coarse fragments (Ashby et al. 1984). Environmental and growth benefits of coarse fragments in soils are better water entry and movement, lessened erosion, increased aeration, long-term release of nutrients, and much more extensive development of root systems. Interfaces of coarse fragments and soil fines foster root growth and water movement. Cosmetic replacement of degraded soils cannot bring the benefits of soil enrichment over time that natural soil building can bring through breakdown in minesoils of valuable mineral resources from the overburden.

Compared to compaction, the deleterious effects of ground cover as a major factor limiting tree survival and growth have not been as well defined or recognized (Vogel 1973). Based on conventional forestry studies, one can conjecture that competition for moisture and nutrients,

shading, and allelochemic inhibition of tree seedlings by other plants all play a role. The relative importance of these factors no doubt varies with kind of tree and stage of development from seedling to maturity. Ground cover is associated with increased populations of voles (mice), rabbits, and deer that damage or destroy young trees. Entire tree plantings may be eliminated during high points of population cycles.

How to satisfy requirements for percent ground cover and obtain successful tree growth is still being studied. Aggressive, easily-established and fast-growing herbaceous species were naturally first used in the early years of SMCRA to meet requirements for bond release. Tree growth has rarely, if ever, been successful in stands of tall fescue (*Festuca arundinacea*) or alfalfa (*Medicago sativa*). Some improvements in use of ground cover have taken place, most notably elimination of tall fescue from planting mixes because of an endophyte that limited agricultural uses. Strips sprayed out for tree planting after ground cover is established are commonly too narrow. The strips may be taken over by weeds, and newly-planted trees must compete with the wide-ranging roots of established vegetation. New candidate species such as creeping red fescue (*Festuca rubra*) have been suggested, and to a limited extent, verified as less competitive with trees. Possible use of warm-season versus cool-season grasses has been considered. This would chiefly affect the degree of competition during the growing season between trees and grasses. Trees make most of their growth well before the period of activity of warm-season grasses.

A major problem in growing trees, beyond that of competing ground cover, is weed control. Replaced topsoil sometimes has great quantities of weed seed of many kinds, enhancing control problems. Although weeds can benefit survival, growth almost invariably suffers. Control using cultivation is expensive, dependent on the weather, commonly short-lived, and may further compact the soil and/or damage tree root systems. Herbicides are also expensive and weather dependent, may damage trees, last a few months or years at best, and are becoming less available because of organized opposition by environmental activists and lack of financial incentives for required re-registration for use.

A natural means of weed and ground-cover control is planting trees densely. Under favorable conditions trees of many species can establish canopy closure in 2 years and eliminate herbaceous competition. This technique obviates a short-term need for further management. Thinning or harvest with possible product recovery will be needed for maximizing long-term economic returns. Coal companies have been reluctant to assume long-term management responsibilities.

SMCRA states in Section 515 b 19, "...introduced species may be used in the revegetation process where desirable and necessary to achieve the approved postmining land use plan;...." Illinois modifies reclamation plans for permits to allow only what some regulator considers "native" species for shrub and tree planting, in great contrast to pasture and row-crop practices. The species allowed and not allowed under this approach are hard to understand in terms of what actually is or is not native, and of the reclamation needs. Such unwarranted regulations complicate permit approval and drive coal companies to propose a restricted number of reclamation options in the hope of continued permit approval.

Recommendations

Several innovations in the philosophy and implementation of regulating reclamation that result in better reclamation with trees may already have been implemented locally on a limited scale. Recommended changes include:

1. Set up varied categories of land use, and have alternative standards for the rooting medium depending on land use. Germany has successfully been doing this for years.

2. Designate primary areas for trees as a higher and better use and restore the type of rooting medium needed for good tree growth. Emphasize production of high-quality timber.

3. Incorporate in the rooting medium on ramps and end cuts and other primary areas for trees those materials (e.g., coarse fragments) from the overburden that will give the best tree growth.

4. Do not require replacement in the lower midwest of sub-surface materials including fragipans.

5. Use only minimal grading, and leave the surface rough for maximum water infiltration and minimum erosion. The coarse fragments will further minimize erosion and weather rapidly to release nutrients.

6. Keep herbaceous cover within primary tree areas to a minimum. Sediment ponds are now required on each site for unusually heavy rainfall events. Use terraces on steep or long slopes with potential off-site sediment production.

7. Plant trees in bare strips along the contour in areas where they are an alternative land use. These strips should be 2 m or more in width and alternate with strips of minimally competitive, non-palatable ground cover.

8. Make the site as unsuitable as possible for rodents and deer, and install 20-foot raptor perches every 4 or 5 acres.

9. Unless a woody plant has been designated a noxious weed, allow unrestricted use of diverse tree and shrub species adapted to a site to meet specified objectives.

10. Build minesoils that will maximize the use of reclaimed lands for high-quality hardwoods and other national needs for which mined areas can be uniquely suited.

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