Twenty-Plus Years After SMCRA: Reflecting On The Results [1]

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Abstract. In the twenty-plus years since the Surface Mine Control And Reclamation Act (SMCRA) was passed into law, successful reclamation of coal mining disturbances has been accomplished. This has not been accomplished easily or without great cost. Industry, research organizations, environmental groups, and regulatory personnel struggled and partnered to develop balanced federal and state regulatory programs. Detailed environmental baseline studies, complicated mine and reclamation plans, and the need to develop methods to achieve and measure successful reclamation threatened to overwhelm the process. Research aided in developing methods and procedures to achieve reclamation and environmental compliance. Operators, realizing the need to move away from agronomic reclamation approaches and adopt an ecological approach, applied practical research on a large scale, developed new technology, and continued the research relationship. The application of best practices and innovation has become a standard of industry reclamation programs. Research studies, baseline data acquisition, and compliance monitoring continue to evolve through the availability of on-site or regional data. Standards for measuring success are now based on more on-site specific postmine land use goals. By necessity, the regulatory process continues to evolve to provide flexibility and better reflect realistic goal achievement while still meeting the intent of SMCRA. However, excessive oversight and reporting requirements, bureaucratic processes, and required mitigation or monitoring that are without technical merit continue to be problematic and limit resources. Environmental compliance and reclamation success are in the best interest of industry and are further guaranteed by the bonding process and effective SMCRA regulation. The results of a conscientious industry effort speak for themselves in the tens of thousands of acres of stable and productive reclaimed lands with successful post mine land use implementation and environmental protection. Yet there is still a public relations need to dispel a persistent public perception that pre-SMCRA mining impacts are still the case. OSMRE's Awards program and the many state and professional recognition programs, validate reclamation results and successes. Continued application of sound reclamation technology, allowance for innovation, a reasonable level of regulatory oversight balanced with economic considerations, and continued industry responsibility and environmental stewardship will continue the reclamation successes and environmental protection mandated by SMCRA.

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Introduction

The Surface Mine Control and Reclamation Act of 1977 (SMCRA) is one of the most significant, if not the most controversial, environmental statutes ever enacted. It was born out of the concern for the past, present, and future impacts of surface and underground mining. Environmental awareness and activism coincided with an increasing demand for energy, with coal supplying much of that demand. The energy crisis of the 1970's showed how fragile our energy supply and demand balance was. Bountiful deposits of domestic coal and a coal industry poised to produce it were part of the answer to bring the energy situation back into balance. The vast number of surface coal mining operations either operating, coming on line or planned, particularly in the West, raised alarms in the environmental community and the public as a whole. The public required more energy, but demanded it be produced in a more responsible manner. It was not all that difficult to find examples of past surface and underground mining impacts and their problems.

By the early 1970's many states already had laws and regulations in place to require, in some fashion, responsible mining operations and reclamation following these activities. As early as 1918, there was some voluntary reclamation by operators in Indiana, and by 1926 the Indiana Coal Operators Association was planting trees on previously mined areas (NRC, 1981). Some of the earliest reclamation laws were passed in West Virginia in 1939, Indiana in 1941, Illinois in 1943, and Kentucky in 1954 (Bowling, 1978). By 1975, 38 states had some type of reclamation law while the remaining 12 had some sort of local land use control and required reclamation (Imhoff et al., 1976). The states that had regulations established some type of permitting procedures and reclamation requirements, and used education principles to emphasize the need for reclamation. The major western surface coal mining states of Montana, North Dakota, Wyoming, Colorado, and New Mexico already had mining and reclamation laws by 1975. Indian lands in Arizona and other states were under various federal or tribal auspices. The various state regulatory programs prior to SMCRA had been modified and updated in response to increasing environmental awareness and the need to implement improved reclamation practices. Montana had one of the more comprehensive programs prior to SMCRA, requiring topsoil salvage and replacement, specified final graded slopes, burial of toxic materials, and revegetation with diverse, primarily native species. Though not always well defined as to goals or how to

measure achievement, the themes of preventing damage to the people of the state and the environment, restoring desirable postmine land uses or achieving higher or better use, were prevalent in the state programs. However, the particulars of the programs in areas such as grading, topsoiling, revegetation, and environmental protection varied widely for the state programs (Thames, 1977).

National legislation to regulate surface coal mining and reclamation had been proposed by President Lyndon B. Johnson in 1968 as the Surface Mining Reclamation Act of 1968. His comments to Congress reflect the developing national attitude and elements to be included in the future SMCRA legislation. President Johnson stated that " . . . erosion of damaged land pours silt and acid into our streams. Under present practices, only one-third of the land being mined is also being reclaimed. This start has been made by responsible individuals, by mining companies, and by the states that have already enacted laws to regulate surface mining. America needs a nationwide system to assure that all lands disturbed by surface mining in the future will be reclaimed. This can best be achieved through cooperative efforts between the states and the Federal Government" (U.S. Congress, 1968). National legislation proposals to regulate surface coal mining and reclamation failed to pass during presidential terms of Johnson, Nixon, and Ford.

The 95th Congress passed national legislation in 1977 as SMCRA and the legislation was signed into Public Law 95-87 by President Carter. Principally, SMCRA was enacted to protect society and the environment from the adverse effects of surface mining for coal and level the playing field by requiring it on a national scale. SMCRA further required that mining should be prohibited where reclamation was not feasible; ensure contemporaneous reclamation; balance environmental protection and coal production; establish a means to reclaim previously mined areas (Abandoned Mined Lands or AML programs); allow the public to participate in the development of regulations, standards, and programs; and assist the states in program development and enforcement to achieve the purposes of SMCRA. The intent of Congress, similar to that outlined by President Johnson in 1968, was that the states assume the lead in achieving the purposes of the act, except on Indian or certain federal lands where the Office of Surface Mining Reclamation and Enforcement (OSMRE) was given responsibility. While the passage of SMCRA was a milestone, the regulations to implement the permanent regulatory programs under SMCRA were promulgated after a lengthy and difficult process, first at the

federal level and then at the state level where primary responsibility for regulations and enforcement lay.

The permanent regulatory program final rules for implementing the requirements of SMCRA were promulgated in March of 1979 (Federal Register, 1979). This program was developed after a lengthy rule-making process, including public hearings and participation, and public comment periods. The final rules were based on appropriate areas of existing state regulatory programs; recommendations from researchers and technical experts; applicable data and research; input from state agencies or organizations, industry representatives, environmental groups, and other federal agencies. During the process, comments and recommendations were solicited from the general public. As can be imagined, this created a daunting administrative challenge, and many areas of the rules were challenged and altered. Industry was especially involved in the process to ensure that a realistic and flexible program was put into place that balanced economic and operational considerations with environmental protection and proper reclamation. The impacts of the regulations on mining operations were to be significant, challenging, and quick to occur. Industry felt that the regulations were too detailed, too complex, and that they were too inflexible and costly. The states resented, somewhat, the intrusion of the federal government into their regulatory programs (NRC, 1981).

Following promulgation of the final federal rules, the states were required to develop their own regulatory programs to gain primacy for regulating surface coal mining activities. A few states, like Washington, chose to operate under the federal rules. Indian lands also were under a federal initial program, followed later by the permanent programs. Mining companies with current operations were required to submit applications for permits that met the new state or federal regulatory requirements in order to continue operations. New mining operations were required to submit applications that required, among other things, extensive baseline studies and detailed mine, reclamation, and postmine land use plans. At the same time, the outfall of the energy crisis and an increasing demand for energy had significant and far reaching impacts as the rush to permit existing and planned mines occurred and companies began to operate in the new regulatory environment and implement the necessary environmental and reclamation programs.

The state programs, as approved by OSMRE, must be no less stringent than the federal regulatory program. The state programs may be more stringent than the federal program, however. Guidelines that have been developed and enforced in various states can also add to

greater regulatory control, although they do provide a more detailed guidance of the regulatory programs and a means for the operators to facilitate achievement of program requirements. The increased stringency of the state regulatory programs has many times been controversial and good or bad depending on what side of the fence you are on. Regulators argue that the regulations must be as black and white as possible or stringent enough that compliance, or non-compliance, can be more effectively evaluated and the intent of the law achieved. The operators on the other hand, feel that increased flexibility and reasonable regulatory oversight will better achieve the mandated state or federal program requirements. Examples of more stringent state regulatory requirements include specific native species composition of reclaimed areas in Montana, no allowance for technical standards for revegetation success in Wyoming, and specifying sampling techniques and methods in Colorado. There are numerous additional examples in the areas of backfilling and grading, topsoil handling, and hydrology.

The federal and state rules and guidelines have been developed or modified through participation of the public. The mandated process was implemented early on and continues as a means of developing regulatory programs that meet the intent of the law, yet realistically reflect a maturing of expectations based on increased knowledge from research, field experience, monitoring, and a more rational understanding of what success is and how it can be measured. As part of the public process, industry was involved from the beginning in the rule-making process, represented either as individuals, companies, or as groups such as the National Coal Association (NCA), National Mining Association (NMA) and the various state mining associations. The NCA and the state mining associations have further established various technical committees to deal with specific issues such as hydrology or soils and revegetation. Likewise, concerned citizens and environmental groups or organizations have been equally involved in this ongoing process. Federal and state regulatory personnel have initiated rule making and facilitated the public process necessary to develop and promulgate the final rules necessary to implement SMCRA and the related state acts. While this "checks and balances" approach to rule making has not resulted in the optimum regulatory programs either at the federal or state levels, it has resulted in workable programs and has allowed for continuing dialogue and evaluation of these programs as a result of experience, research, and evaluation.

Reviewing the Federal Register for March 13, 1979 (Federal Register, 1979) that promulgated the final rules for the federal permanent regulatory program provides an interesting

insight into the above process. Each rule is discussed in detail, including the rationale, supporting technical references, and discussions of alternative rule language considered. Comments resulting from the public participation process give an idea of the thinking of the time and what the "persuasion" of the commentator might be although no names are given. An example includes comments under rule 816.112 Revegetation: Use of introduced species. A commentator remarked that no introduced species be allowed, but this was contrary to SMCRA. Conversely, a commentator stated that difficulty in obtaining seed and slowness of establishment made the use of native species undesirable. This particular rule was modified based on these and a number of other comments. As a result, there are now many thousands of acres of reclaimed areas with predominantly native species and thousands of additional reclaimed acres containing introduced species that are achieving postmine land use goals. In another example, Rule 816.116 Revegetation: Standards of success, was modified based on numerous comments to allow the necessary flexibility in measuring vegetation success by allowing the use of reference areas or appropriate technical standards.

The approved state regulatory programs in the West have evolved over the years since initial approval. The various regulatory programs, including the rules and guidelines, have changed to meet federal program requirements or to address regulatory and reclamation issues. State mining associations and industry have been intimately involved in the process because of the experience gained in attempting to meet regulatory and guideline requirements. Maintaining flexibility has always been an industry goal in achieving successful reclamation. Flexibility in Montana's program has allowed the creation of sandstone replacement features and more diverse postmining topographic features without imposing an unnecessary regulatory burden. Allowing variable soiling depths and the use of alternative soiling materials in Montana, Colorado, and on Indian lands in the Southwest will encourage plant and community diversity and create more stable landforms. On the other hand, a lack of flexibility or poor applicability of the regulations to a particular location may hinder the process. In Wyoming there is no allowance for technical standards in measuring reclamation success and thus reference areas must be relied on for these measures. The nature of mining operations in Wyoming causes many of these reference areas to be disturbed and then having to be reestablished. Under the federal program rules, reclaimed areas must meet the revegetation success criteria for two consecutive years. In the arid southwest, where annual variation in temperature and precipitation can be extreme, meeting this

criteria can be a challenge, but may have no bearing on the success of vegetation. Twenty years of annual vegetation monitoring of permanent transects at Peabody Western Coal Company's (PWCC) Kayenta and Black Mesa Mines has documented the effects of drought on reclaimed vegetation and the subsequent return of cover and production of the reclaimed area vegetation following more normal climate patterns. This documented resiliency of vegetation may be a far better measure of revegetation success than the meeting of two consecutive years of success.

While the OSMRE, the states, industry, and other groups wrestled with the day-to-day challenges of developing, enforcing, and successfully implementing and meeting regulatory program requirements, research and development was ongoing. In fact, it was either based on or was continuing from research efforts initiated prior to or at the time of SMCRA. As stated by Plass (2000), "National concern regarding the environmental impact of surface mining on natural resources caused a rapid expansion of research in the late 1960's that extended through the 1970's. This was supported by an increase in federal funds to finance research by government agencies and provide grant money for research scientists at colleges and universities." Numerous research studies covering many technical disciplines such as vegetation, soils, hydrology, wildlife, air quality, and mining methods were sponsored by the U.S. Environmental Protection Agency, U.S. Bureau of Mines, USDA Agricultural Research Service, U.S. Forest Service, U.S. Soil Conservation Service, Tennessee Valley Authority, state agencies, OSMRE, and numerous mining companies. "Industry support included financial contributions, but more importantly, access to mine sites, the use of equipment, supplies of seed, fertilizer and other materials, and personnel to establish field studies. Government agencies concerned with mining, natural resource management, environmental protection, and land management became involved. Major contributions in basic and applied research were made by research scientists at colleges and universities."

In the West, early researchers and practitioners such as Aldon (1978) and Wali (1975) outlined philosophies and methods to reclaim surface coal mined lands. Valuable research was undertaken by the USDA-ARS in North Dakota and Wyoming and by the Reclamation Research Unit at Montana State University. Work done at the Colorado School of Mines and Colorado State University further added to the status of the knowledge. This includes only a few that have contributed. Every state with coal mining activity had its premier group of researchers and organizations that concentrated their efforts and expertise in that region (Plass, 2000). Industry

applied this research and knowledge in the field on a large scale to better achieve the desired results for regulatory program requirements and successful revegetation. This also required considerable innovation to apply these findings on a broad scale. Depuit and others (1980) demonstrated through field research that diverse native plant communities could be established on reclaimed areas when applying the proper seeding method, mixture, and rate. Applying this on a large scale required not only adhering to proper seeding time and developing the appropriate mixtures, but also to innovation in seeding equipment and techniques.

Best Practices

The continuous development and application of research derived methodologies, field techniques, and innovative procedures have resulted in a number of best practices applied in day-to-day reclamation operations throughout the country. In the western U.S. they include, but are not limited to, the following.

Regrading and creation of postmine topography.

Dragline stripping operations may be integrated with reclamation operations to assist in developing more diverse topography. Again using the Big Sky Mine in Montana as an example, the use of the dragline for rough backfilling allowed final grading by dozers to create a more natural, diverse landscape that includes second and third order drainage features. The use of truck and shovel operations also allows selective placement of overburden and the development of more diverse postmine topography. An excellent example of this is the McDermit Dump at the La Plata Mine where premine stream channel morphology characteristics have been reestablished in the reclaimed landscape. Sandstone replacement features (sometimes referred to as bluff extensions) have been established in reclaimed areas at the Big Sky and Rosebud mines outside of Colstrip, Montana. These vertical sandstone features reflected and enhanced premine regional topographic features, provided excellent wildlife habitat potential, reduced impacts to existing ponderosa pine and other native plant communities, reduced costs, and allowed greater recovery of the coal resource. Rock linear features and rock piles established on reclaimed slopes and hilltops restore potential habitat for wildlife. This practice is commonly employed at many operations in the West.

Topsoil handling and replacement.

Direct replacement and top lifting of soil is commonly practiced barring operational constraints. It is not only beneficial to rapidly reestablishing a functioning soil ecosystem and providing native plant propagules, it is also the more cost effective soil salvage method. Direct replacement only requires one handling operation, whereas stockpiling requires two and sometimes with long haul distances. In Montana, salvaged soils are further segregated for replacement by A/B and B/C horizons thereby establishing a more ecologically developed postmine soil profile. In keeping with an ecological versus agronomic approach to reclamation, soiling materials once considered non-salvage types are now used to develop specialized seeding and planting sites for improved community diversity and to aid with surface stabilization. In Montana, more rocky and sandy soils associated with ponderosa pine (*Pinus ponderosa*) are salvaged and replaced in reclaimed areas planted with ponderosa pine. At the Kayenta Mine in Arizona, red rock or scoria soils are replaced on hill slopes to develop cultural plant sites, develop pinyon pine (*Pinus edulis*) planting sites, and aid in surface stabilization. At the Big Sky Mine in Montana, topsoil replacement with scrapers is performed on the contour and in a manner to minimize compaction. In the Powder River Basin and other areas where large end-dumps are available, truck haul and dozer spreading of soiling materials reduces compaction of soils. Use of the end-dumps also allows for selective placement of soiling materials that aids in development of unique reclaimed features or plant communities.

At the Kayenta Mine, use of short duration linear stockpiles placed along recently soiled reclaimed parcels allows for efficient, quick respreading of soil by dozers after adjacent regrading has been completed. This allows reclamation to proceed more contemporaneously and can maintain soil microbial activity. Lastly, the use of temporary dozer built soil windrows along short duration facilities (roads, powerlines, etc.), construction projects, final highwalls or boxcut spoil areas reduces costs and better preserves soil quality.

Revegetation.

As mentioned previously, the improved availability of native seed for all life forms has greatly facilitated the establishment of diverse plant communities that are either exclusively native or are dominated by native species. Native seeds from wetlands to desert uplands are

represented in this increased availability. Specific plant community characteristics can be targeted with a greater possibility of successful establishment. The demands of increasing reclamation requirements drove the initial need for greater availability and variety, and that effort continues. The restoration ecology movement has furthered this to an even greater degree. Resources for plant materials and related information are extensive and informative. The reader is directed to the USDA – Natural Resources Conservation Service's National Plant Data Center web page (http://plants.usda.gov) for information regarding the vast number of plant species potentially available for revegetation. Selecting the VegSpec option on this web page will assist the planner in finding, selecting, and setting seeding and planting rates for species necessary to achieve specific revegetation goals. There is an increasing emphasis for developing sources and use of local or specific adapted genotypes for revegetation. Dr. H.C. Stutz has identified specific fourwing saltbush communities in the Four Corners region where seed for that species should be harvested to establish plants in revegetation projects for that region that will reduce the potential for sterile hybrids and provide for regeneration over time (Stutz, 1982). Local seed collection has been used in Montana and Colorado to procure seed for ponderosa pine, tall shrub, and other woody plant nursery seedling production. In Arizona, Peabody Western Coal Company's (PWCC) Kayenta Mine, in partnership with Bitterroot Restoration, Inc., uses locally collected seed to develop seedlings of pinyon pine and a variety of other culturally significant tree, forb, and tree species for planting in specifically prepared sites. Nursery cultural practices and specific seedling quality criteria further insure that well developed and hardy seedlings are available for planting. A number of nurseries have been established that specialize in propagating and growing hardy seedlings of native species, many which have not been used before. Containerized seedling technology has been a major focus in these nursery programs. Hand planting seedlings in prepared sites has been a highly effective reclamation practice for establishing high interest plants or vegetation communities, while improving overall survival rates.

Seeding and planting techniques have developed along with the improved availability of native plant materials. Requirements for simultaneously establishing seasonal variety, species diversity, and woody plant density, has increased seed mix and seeding complexity. Again, applying ecological principles versus agronomic principles has been helpful in overcoming problems and improving success. Seedbed ecology, germination characteristics, site adaptations,

substrate requirements, and many other important relationships are now considered in the development and application of revegetation programs. A number of individuals have developed theories, principles, and approaches to successfully seeding complex mixes and establishing native vegetation (Aldon, 1975b; Depuit and Coenenberg, 1979; Depuit et al., 1980; Frasier and Evans, 1987). It would be remiss not to recognize the many reclamation field personnel who have fine tuned this information as well as developed their own techniques in the field. Successful reestablishment of Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) by Chet Skilbred at the Glenrock Mine in Wyoming has been accomplished through an understanding of the ecology of this species and timing seeding operations that are optimum for establishment. Schuman and others (2000) also reported on similar efforts to successfully establish Wyoming big sagebrush. In addition to developing proper seeding procedures, seeding equipment manufacturers have developed drill and broadcast seeding equipment that are better able to seed complex mixes. The best seeding equipment now has multiple seed boxes that allow splitting of seed mixes into small, fluffy/trashy, and wheatgrass (usually cool season type grasses) components. These seeders can then be adjusted to meter the seed at the proper rates and place the seed at appropriate planting depths. The Truax Company, Inc. is an example of a manufacturer that has seeders that meet these requirements.

Further methods to establish diverse vegetation include seeding seed mix components with separate equipment adapted to a mix component, segregating seeded rows, and timing seeding. The Big Sky Mine in Montana uses a technique that blocks every third row in the cool season box of the drill seeder. Every row receives an entire rate for the warm season grass, forb, and shrub mix. However, by blocking every third row of the cool season grass box, an alternating 14-inch wide row without cool season grasses is available to the less competitive warm season grasses, forbs and shrubs (warm season component). Further, a portion of the warm season component species is broadcast seeded prior to drill seeding to provide additional establishment in the 14-inch wide row and between the normal 7-inch rows. This is somewhat of a "shotgun approach" but has proven effective. Strip seeding has been used in western Colorado to establish shrubs in zones where herbaceous competition is reduced by herbicide or tillage control and the strips seeded exclusively to shrubs or shrubs and forbs only. Split season seeding has also been used with some success in the Northern Great Plains. The warm season component is seeded during the summer and the cool season grass component is interseeded into the establishing stand

either in the fall or the following spring. Timing of seeding to optimum season for target species is a successful and cost effective method and consistent with the best practice of seeding prior to the season of optimum moisture. In the Southwest, seeding the entire mix prior to the onset of monsoon moisture patterns in mid July, and when soil temperatures are higher, has worked well in establishing the warm season grasses, forbs and shrubs while allowing delayed development of cool season grasses for establishment of effective vegetative cover.

Mycorrhizal Fungi.

The vast majority of native plants have established the important symbiotic relationship with ectomycorrhizal and endomycorrhizal (vesicular-arbuscular mycorrhizal or VAM) fungi. Numerous authors have discussed the critical role of these fungi in areas such as enhanced moisture and nutrient uptake for plants and the importance of reestablishing this and other microbial relationships on reclaimed lands (Allen 1984; Aldon 1975a; Coe and Klopatek, 1983; Reeves et al., 1979; and Fresquez et al., 1986). Though the importance has been known for a number of years, use of mycorrhizal fungi has steadily increased in importance in recent years and a number of commercial applications are available for general and specific uses. Mycorrhizal fungi is applied as inoculum to seedlings being developed in nursery programs (Pfannenstiel et al., 1993) or on a larger scale either broadcast and incorporated in soiling materials prior to seeding or applied at the time of drill seeding. Specific native collections of fungi may also been used to develop inoculum. The direct replacement of soiling materials, and in particular, top lifting of these materials where the soil ecosystem is most active is also an important source of mycorrhizal fungi.

Mulching.

Mulching has been a reclamation component for many years and continues to be an important best practice. However, mulching practices and materials have evolved in several ways. While annual grain straw is still used in mulching, the move towards native grass or other perennial grass hay mulch is increasing. Grass hay mulch is superior to annual grain straw in fiber length and strength and in improved and more uniform coverage. At PWCC's Kayenta Mine, an actual applied rate of 1.98 tons/acre of native grass hay mulch using a Haybuster mulcher resulted in an applied mulch cover of 57.2 percent (s.d. = 2.4 percent). This

unpublished data was collected using an optical point bar to record point intercept cover data. The effectiveness of this same cover resulted in little or no erosion on the nearly 400-foot long, 25 percent slope where this hay mulch was applied. Additional benefits of hay mulch over grain straw are a reduction in weeds and a heavy cover of competing annual grains. Care must be taken in obtaining hay from weed free areas and from sources of desirable composition so perennial volunteer species from hay mulch are not a problem. Native grass hay mulch is in use at a number of mines in Arizona and New Mexico. The Rosebud Mine in Montana has used native grass prairie hay cut from surrounding areas to provide increased establishment of native species on reclaimed lands, as well as mulch benefits. Mulching and crimping equipment has been developed to improve coverage and quality. Equipment such as the Haybuster mulcher, processes large round bales by peeling the hay layers off as the bale rotates. This maintains long fiber length and improves distribution. Crimpers are much wider and heavier, have increased down pressure, and have hinged segments to better operate in undulating landscapes. These types of mulching and crimping equipment, used in combination with grass hay mulches, provide very effective and long lasting mulching practices.

Additional practices.

Other best practices relating to revegetation include transplanting live trees and shrubs, either individually or in clumps. Mines in western Colorado have salvaged and selectively placed aspen and tall shrub clumps or pads to establish shrub islands. In Arizona and New Mexico, pinyon pine trees 5 feet or less in height have been salvaged ahead of mining and transplanted into reclaimed areas. These practices also bring in additional native plant propagules and important late successional soil microorganisms for dispersal in reclaimed lands. Eliminating or restricting fertilizer amendments on reclaimed lands, particularly where native or predominantly native species are to be established, is a best technology practice. Western native species have adapted to low fertility environments and adding amendments such as nitrogen increases annual weed competition and can affect perennial plant establishment and potential diversity (McLenden and Redente, 1991 and Redente et al., 1992).

Water is a limiting resource in the West. Any effort to restore, create or enhance existing water sources is a best practice and highly beneficial to achieving wildlife and livestock postmine uses. Recreation use is also possible. Developing ponds on reclaimed landscapes is a

common practice in North Dakota and can be found in all mines from Arizona to Montana. Livestock ponds are created on reclaimed lands in northwestern Colorado that benefit elk and mule deer populations as well. In some cases, these water bodies provide a resource not present before, resulting in an increase and presence of a variety of wildlife species such as migratory birds (LaRue 1994). Sediment ponds have been constructed in most, if not all, the mined lands in the West. These large, well-constructed structures can be retained on the reclaimed landscape and incorporated into postmine land use programs.

The application of these and numerous other best practices have achieved outstanding results throughout the U.S. and particularly in the arid and semi-arid West. At the time of the passage of SMCRA and the energy boom in the coal fields of the West, many speculated that reclamation would not be adequate nor could it be sustained. This has hardly been the case. As a result of efforts by industry, researchers, and regulators reclamation has achieved what SMCRA intended. Reclamationists have developed and perfected much of what is now done on a day-to-day basis and continue to improve and implement best practices. In the West nearly 120,000 acres have been reclaimed since the passage of SMCRA (Table 1), with many additional lands affected prior to SMCRA (pre-law lands) also reclaimed. These reclaimed lands, when taken as a whole, tell the story of remarkable achievement in environmental protection, reclamation, and restoring land use. Land uses are primarily returned as rangeland, wildlife, and livestock grazing, but many additional uses may include cropland, hayland, recreation, cultural plant use, and even industrial. A visit to the awards section of OSMRE's home page (www.osmre.gov) is a testimonial to the achievements that have been accomplished and the innovation that should encourage further efforts and discredit those who were skeptical of the potential results.

Bond release is the final measure of successful reclamation, environmental protection, and achievement of regulatory requirements. Depending on the state, regulatory time frames, or other scenarios, various phases of bond release are required. This process may also be referred to as liability release or termination of (regulatory) jurisdiction (TOJ). Phases of bond release are normally separated into backfilling, grading, and topsoil replacement; establishment of vegetation; and successful achievement of standards and possible demonstration of postmine land use achievement. Final bond, liability release, or termination of jurisdiction acreages in the western U.S. are relatively low compared with the entire U.S. The OSMRE home page lists statistics for the U.S. regulatory and permitting program as of 2000. In reviewing OSMRE

Table 1. Disturbed, Reclaimed, and Phase III Bond Release or TOJ Acreages for Seven Western States and The Navajo Nation as of 2000 (OSMRE, 2002).

State	Acres Disturbed	Acres Reclaimed	Acres of Phase III Bond Release or TOJ[1]	Postmine Land Use Implemented on Reclaimed Areas Prior to Release
Colorado	22,113	14,836	2,427	Yes
Montana	25,700	9,506	0	Yes
New Mexico	22,500	11,583	921	Yes
North Dakota	46,491	26,826	4,365	Yes
Utah	2,689	468	72	Yes
Wyoming	107,207	36,374	251	Yes
Washington[2]	5,216	282	16	Yes
Navajo Nation[3]	30,686	18,333	1,145[4]	Yes
Total	262,602	118,208	9197	

[1]TOJ - Termination of OSMRE jurisdiction for initial program lands.

[2]Federal program lands only in Washington.

[3]Navajo Nation initial and permanent program lands in Arizona and New Mexico.

[4]TOJ pending at Peabody Western Coal Company, Kayenta Mine

program statistics and other state information, the seven western states and Navajo Nation shown in Table 1 account for roughly 10 percent of the reclaimed lands released of bond or liability in the U.S. The majority of released lands are in the eastern U.S., followed by the Midwest. This should not diminish the reclamation and environmental stewardship efforts in the West. As pointed out, nearly 120,000 acres have been reclaimed in the West with postmine land use already implemented on significant portions of these acres. The past OSMRE excellence in surface mining awards have normally been given for efforts and practices achieved prior to bond release (see OSMRE web page). To provide the public with the true picture of industry's environmental stewardship and reclamation efforts, OSMRE program statistics should include a reclaimed acreage category. This lack of information has provided many citizens with only a

partial picture and caused certain groups to widely disseminate misinformation related to the lack of reclamation achieved since implementation of SMCRA (PEER, 1997). Ultimately bond release will settle much of this, but why are western U.S. lands only slowly being released of bond or liability?

This is a complex and varied issue, ranging from no need or incentive for bond release at this time, to complex regulatory requirements that inhibit the successful measure of success or the process as a whole. Some permitted lands have been bonded with one time premiums or very inexpensive premiums, some operations are self-bonded, and some lands may only require a termination of regulatory jurisdiction to release lands. Some companies own the permitted lands, so have very inexpensive surface lease costs. Therefore, at this time, the monetary incentive to pursue bond release on these types of lands may not be great. Permit requirements generated during early regulatory and permitting efforts may have resulted in standards that are unrealistic or difficult to achieve. The cost in terms of sampling and evaluating information, the lengthy and involved preparation of necessary documents, and the potential lengthy process may be daunting or deemed prohibitive in terms of cost and manpower at this time. PWCC's Kayenta Mine is awaiting a termination of jurisdiction by OSMRE for 1,145 acres of reclaimed lands, a process begun in 1994. Recent events regarding this termination of jurisdiction point to the regulatory and bureaucratic confusion that can affect the process. A lack of regulatory guidance for bond release may also contribute to delays in bond release submittals. In Wyoming, the state regulatory program has not yet developed guidelines for the formal bond release process necessary for companies to properly prepare, submit, and process bond release applications. Strict or overly complicated regulations may result in standards that are difficult to achieve. In the interest of timeliness, permit commitments may have been poorly developed or inappropriately stipulated by the regulatory authority. As operations progressed and the status of knowledge increased, permits may or may not have been revised to address needed changes. Regulations can be too complex and needlessly restrictive to allow for an achievable demonstration of successful reclamation. Regulations in some states are now specifying sampling methods, requiring complex parameter demonstrations, or restrict the use of technical standards. The state of New Mexico has encouraged the use of technical standards to provide necessary flexibility in developing realistic standards on a case-by-case basis. New Mexico has

also realized that measuring success of revegetation for two consecutive years in the arid Southwest is not practical and has allowed this measure to be accomplished in 2 out of 4 years.

Attempts to "regulate" dynamic environments such as those that operators experience in the West have dramatic effects on the concept of reclamation success and how it is evaluated. The regulations that require close comparison to native vegetation characteristics is fraught with difficulty as these new reclaimed vegetation types reflect successionally distinct time frames and a poor understanding of successional dynamics and pathways which are highly dependent on the magnitude of disturbance, the reclamation input factors, and environmental controlling factors such as climate. In short, has the process of regulation, compliance, and evaluation become more important than the result as demonstrated by observed on-the-ground success? As an example, Columbian sharp-tail grouse (*Tympanuchus phasianellus columbianus)* have naturally established leks on reclaimed lands at some northwestern Colorado mines including the Seneca Mine. These same reclaimed lands provide habitat diversity and a high degree of utility for large herds of deer and elk. Are these results of lesser importance than meeting a woody density or composition standard or are they a truer measure of success?

Bond or liability release will move forward as these issues are addressed and momentum increases in response to successful efforts. The industry/regulatory relationship has matured and constructive dialogue has aided in addressing difficult issues and developing workable solutions. Availability of on-site or regional data have been helpful in developing successful standards for some site-specific postmine land use goals. Industry and regulatory personnel continue to develop or modify guidelines and implement regulations to provide flexibility and reflect feasible achievement of goals, as outlined above, while still meeting the intent and spirit of SMCRA. Aspects of successful state regulatory programs should become a pattern for those state or federal regulatory programs experiencing similar issues. While bond or liability release presents long-term issues, day-to-day regulatory issues remain.

Industry has a responsibility to practice good environmental stewardship and corporate citizenship. The public expects corporations and their representatives to function in this manner. Environmental compliance and reclamation success are in the best interest of industry both in terms of image and good business practice. This is further guaranteed by the bonding process and SMCRA, which provide very effective and complete regulation of U.S. coal mining operations. The public also demands that companies use cost control and practice fiscal

responsibility in order to provide low cost energy sources. Regulatory agencies and personnel have a similar responsibility to implement regulatory programs in an equitable and practical manner that provides for environmental protection and regulatory compliance but which must also include economic considerations. Decisions made by regulatory agencies or personnel do not affect only the bottom line of companies; they affect the public who ultimately pays these costs. Therefore, if these costs are to be incurred, they should be justifiable and reasonable. In order to address perceived or real regulatory concerns, industry has often been required by stipulated obligations in permits to implement mitigation or monitoring procedures that became unnecessary or had questionable technical merit. Using PWCC's Kayenta Mine and BHP's Navajo Mine as examples, concerns developed for potentially toxic levels of selenium accumulating in plants on reclaimed lands. The mines were required to meet soil suitability standards for both soluble and total selenium that were unrealistically stringent based on the status of selenium knowledge from premine lands in other regions of the western U.S. The requirement resulted in many reclaimed acres being covered in four feet of suitable material and topsoil and millions of dollars in material handling costs unnecessarily incurred. Though PWCC and BHP petitioned for relief from this requirement on a technical basis, the intransigence of several regulatory personnel resulted in continuation of the required mitigation until hundreds of thousands of dollars were spent on additional studies that not only proved that selenium was not an issue, but that livestock were actually marginally deficient in selenium when grazing reclaimed vegetation (PWCC, 1999). A similar situation regarding molybdenum at mining operations in Montana also caused excessive costs to be incurred for mitigation and monitoring in spite of either low or no potential for problems (Neuman and Munshower, 1983). While some regulators require studies and mitigation to keep them in their comfort zone and attempt to reduce the chance of making the wrong decision to near zero, mining companies are forced to absorb excessive costs and time constraints on personnel resources. These costs are eventually passed on to the consumer.

Setting regulatory requirements that are overly difficult to attain or as unrealistic success standards, regardless of discipline, also fall into this category. Over the past 20 years, most mining companies have collected considerable environmental and reclamation data that has been useful to modify many of these overly stringent regulatory requirements that were initially based on best available literature and national agronomic standards. The southwestern coal mines have

been successful using 15 plus years of postmine soil, spoil, and vegetation data to adjust outdated standards with site-specific suitability guidelines for pH, Se, SAR, boron, and sampling methods. These data have also been successfully used in many other regulatory oversight and enforcement issues. The vast amount of information collected at coal mining operations over the last 20 years, either as baseline data or monitoring data, is a resource invaluable well beyond its more common use in addressing regulatory and related issues. For example, the potential for ecological studies regarding successional processes on reclaimed lands or further improving the status of knowledge for reclamation practices and technology is a real possibility. It would appear that graduate study programs could make use of this information either as a springboard for further work or as the basis for study.

When the SMCRA regulations were promulgated in 1977, the government, in an effort to possibly keep enforcement issues simple for themselves, fought for and succeeded in promulgating TSS (total suspended solids) standards which were the same across the country, regardless of the marked differences in geomorphology, soils, cover, storm intensity, and precipitation in the various regions of the U.S. It has taken the western U.S. mining industry, especially the southwestern coal mines, 24 years to make initial inroads in revising this legislation. In this same time period, countless millions were spent on sediment ponds at western coal mines which would serve no other purpose than to act as sediment traps. Unfortunately, the sediment loads in the stream flows, particularly in the southwest, were not improved at all by the construction of these ponds. Why?

PWCC in Arizona conducted a 20-year study of the sediment loads in the principal stream channels above and below the Black Mesa and Kayenta Mines and showed that regardless of watershed size, type of cover or lack of cover, and the presence of ponds, the sediment loads for any given flow range were the same within the limits of sampling error. This data was then compared to suspended sediment in runoff from small watersheds and reclaimed areas using confidence interval tests on the medians and the trend slopes of the data sets. The test results indicated the data sets were all from the same population. The fact that sediment data collected in several watersheds of differing size and other morphological features could plot so closely could only happen if each watershed had an unlimited supply of available sediment in the size ranges (silts and fine sands) which are easily transportable. Because all the watershed soils and channel alluvium are cohesionless, any channelized flow will transport all the sediment the flow

has energy to transport. If sediment is removed from watershed runoff by routing it through a sediment pond, the receiving stream will erode sediment from the channel sides and bottom to satisfy its carrying capacity. A watershed could be completely denuded above a receiving stream on Black Mesa and it would not add additional solids to the stream flows because they are already transporting the maximum sediment loads they can transport. With the recently revised 434 regulations (Federal Register, 2002), the western U.S. mines are not being held to effluent sediment standards for runoff from reclaimed areas and active mining areas where sediment is the only "pollutant" of concern. This more rationale regulatory approach is the outcome of industry led efforts to operate under realistic program requirements that still ensure environmental protection. Years of operational experience and monitoring by industry are instrumental in achieving this and other actions. While not always perfect, industry has attempted to set realistic goals and commitments in permits that allow for flexibility and reflect operational experience.

Regulatory oversight and reporting requirements are placing an increasingly heavy burden on industry, at least on Indian Lands. While staffs are being reduced in industry in an attempt to become more efficient, trim costs, and provide low-cost electrical energy, government inspections and reporting requirements are increasing. Table 2 lists the average number of OSM inspection days per 5-year period from 1985 through 2001 for the Kayenta and Black Mesa Mines. In addition, these mines also receive routine inspections from MSHA, BLM, USEPA, and Navajo Nation EPA on a frequent basis.

As can be seen, there is a near-exponential increasing trend in federal regulatory oversight at these two mines. These field inspections consume large quantities of staff time and additional staff time is taken to address compliance issues, participate in assessment conferences, and partake in appeals for violations that are deemed inappropriate or without merit. At the same time, citations per day of inspection are decreasing as a result of self-auditing programs, compliance awareness initiatives, and efforts to improve relationships and communications among operators and enforcement personnel. The fact that compliance is better than ever begs the question of why there is still a need for this level of inspection effort. Many of the previous enforcement actions were written as 9-inch rill and gully violations pursuant to the Initial Program regulations. The remedial action to abate these violations was to install elaborate and

Table 2. Increasing Trend of Regulatory Oversight (1985-2001) at the Black Mesa and Kayenta Mines, Arizona.

5-Year Period	Average Inspection Days By OSMRE Per Year[1]
1985-1989	37
1990-1994	32
1995-1999	90
2000-2001	122

[1]In addition to OSMRE regulatory personnel, these inspections normally included Navajo Nation, Hopi Tribe, and/or Bureau of Indian Affairs (BIA) inspectors.

costly drainage control using large structures that far exceeded any damage or potential loss of land use caused by rilling or gullying, which in many cases was the precursor to establishing drainage patterns. The inspectors tended to share an unrealistic view that no erosion should occur on reclaimed areas, yet the regulations clearly form the basis for evaluation where established vegetation is required to stabilize "the soil with respect to erosion, not prevention of erosion when it would otherwise be a natural process" (Federal Register, 1979). Numerous violations were also issued for trespass livestock grazing, a situation the operator was attempting to remedy but had little control over due to a lack of BIA or Navajo Nation management and enforcement. Violation issues are not unique to any particular operator. The number and variety of violations and enforcement actions issued to companies throughout the western U.S. would fill many pages and provide an interesting insight to operating in a tightly regulated industry. They would also point to areas in the regulations or methods of enforcement that required reevaluation. Likewise, they point to areas that industry needs to address in day-to-day operations.

Industry has responded to many enforcement action situations that were not justified. The implications of pattern of violations were also relevant. PWCC, for example has successfully challenged a number of rill and gully, trespass grazing, sediment control, and other violations.

This process was lengthy and sometimes painful, but has been instrumental in establishing a dialogue with the regulatory authority, producing guidance for the inspectors and mines, and reducing or preventing unnecessary enforcement actions in the future. Rills or gullies in channels are now viewed more in the context of establishing channelized flow as opposed to a violation for erosion. Inspectors and company representatives are more apt to collaborate on the most appropriate and timely solution to a problem rather than issuance of a violation and hasty abatement procedures. The field revision process has also aided in this process.

Compliance at the Black Mesa and Kayenta Mines has improved substantially since 1985 as noted by the decrease in the citations issued per day of inspection. While issues will most likely always be present, the ability to establish and maintain constructive dialogue and continue to resolve issues between regulatory agencies and mining companies is a measure of the progress made over the last 20 years. Again, this reflects a "checks and balances" approach in an effort to achieve a realistic and responsible regulatory environment. PWCC's experience is likely mirrored in other parts of the country, and particularly in the west.

Monitoring and reporting is an inevitable outcome when operating in a strict regulatory environment. The information and results are beneficial for both the mining companies and the regulatory agencies, demonstrating both achievement and compliance. Monitoring results and annual reports are generated for reclamation progress, annual environmental monitoring efforts, documenting innovative reclamation practices, and any number of other related areas. However, the amount of information collected and reported may be overly involved and can be voluminous. The 2000 Reclamation Status and Monitoring Report for the Black Mesa and Kayenta Mines is contained in five, 3-inch binders. The information is supplied in both electronic and hard copy and in part, contains required data for every aspect of disturbance and reclamation activity as well as status of bond release. Detailed GIS data is also included. The required detail of reclamation status information may be of more benefit to OSMRE than the mining companies as it used for statistical information. The OSMRE is also collecting information regarding polygons and postmining contours that appears duplicative to the mines efforts. This overlap of resources and personnel should be corrected based on simple economic sense and critical evaluation of program needs.

Regardless of the remaining or ongoing issues, in the twenty or more years since SMCRA was passed and regulatory programs implemented, successful reclamation and environmental

protection has been accomplished at levels that should bring satisfaction to the drafters and supporters of this landmark legislation. This has not been accomplished easily or without argument and has sometimes been at significant cost. Industry, research organizations, environmental groups, and regulatory agencies worked towards, and continue to work towards, well-balanced and effective regulatory programs. Industry has implemented increasingly complex reclamation and revegetation programs as a result of research, known BTCA practices, field experience, monitoring results, and yes – regulatory oversight. The result has been the development of a number of best practices that are in use today at mines throughout the country and targeted towards regional and site-specific conditions. In the western U.S., this has resulted in nearly 120,000 acres of reclamation that is fulfilling the postmine land use goals. Bond or liability release is steadily increasing for these lands. Award winning results, as demonstrated by the number of OSMRE reclamation awards given since 1986, can be found throughout the western states. Industry and regulatory agencies have established the means for constructive dialogue and solutions to issues, and have continued to develop this process. Industries responsibility to environmental stewardship needs to be complimented with realistic regulatory agency policy and enforcement. There is a continuing public relations need, both by industry and the regulatory agencies, to dispel the still present public perception that adverse mining impacts are the norm and not the exception. A visit to the internet regarding coal mining will generate a disturbing number of sites with negative information, much of which is misinformation. Mine tours many times yield the surprised observation by the participants that they didn't know reclamation was being practiced at coal mining operations. Environmental compliance and reclamation success is in the best interest of industry and are further guaranteed by the bonding process and SMCRA, which provide very effective and complete regulation of coal mining operations in the U.S. The implementation of SMCRA over the last 20 plus years has evolved into the current regulatory compliance and reclamation programs. The program is not stagnant and continues to evolve based on changing needs and status of knowledge. During this time much has been accomplished through research, application of known technologies, experience, and innovation. The success of these efforts is evident in environmental protection and in the tens of thousands of stable and productive reclaimed acres where postmine land uses are already implemented. In essence, this effort is the conservation of land use for now and future generations. Ideally, maybe not all has been accomplished that SMCRA intended; but on

a practical level success can and has been demonstrated throughout the U.S where the results speak for themselves.

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