

**AN ECOLOGICAL AUDIT OF THE REGULATORY REQUIREMENTS FOR SURFACE
COAL MINE RECLAMATION IN NINE WESTERN NORTH AMERICAN
JURISDICTIONS.**

C.R. Smyth¹ and P. Dearden²

¹ Environmental Insight, P.O. Box 517, Blairmore, Alberta, T0K 0E0.

² Professor, Department of Geography, University of Victoria, P.O. Box 3050, Victoria, British Columbia, Canada, V8W 3P5.

ABSTRACT

The role of regulatory requirements and their impact on the design and implementation of high elevation coal mine reclamation programs was examined in nine mountainous western North American jurisdictions. This 'ecological audit' of regulatory requirements revealed that several jurisdictions are similar programatically in objectives but dissimilar substantively in regulatory provisions such as topographic modifications, revegetation, performance standards and enforcement. Information acquisition and dissemination also varied between jurisdictions. The current command-penalty model of environmental regulation results in adversarial interactions between government and industry in many of the jurisdictions and should be replaced by a formal negotiated system of regulation based on continuing research and adaptive management.

INTRODUCTION

Prior to the environmental awakening of the 1960s, there was little concern for mining disturbances, and reclamation only became an issue when a potentially expensive liability appeared (Ludwig 1982). However, the renewed emphasis on coal mining both in the United States and in Canada during the 1960s and 1970s exposed the latent conflict between industry and the environment with respect to regulation. The environmental dégradation and associated costs related to surface coal mining, e.g., reduction in air and water quality, were considered significant and could not be ignored by government regulatory agencies. Initially, the social and opportunity costs of not reclaiming versus internalizing reclamation costs were examined, and the latter was considered to be more socio-politically acceptable (Randall 1978). Internalization of reclamation costs within surface mining production costs was, therefore, one of the objectives of regulatory policy during this period and continues to be the focus of current policy (Jackson 1991).

Essentially, the objective of regulatory policy in the United States and Canada has not been to reduce surface mining but to minimize or eliminate land degradation. However, finding an optimal solution for the elimination of disturbances generated by surface mining is a particularly complex

problem. In Canada, with the exception of the Yukon and Northwest Territories, mine reclamation is primarily a provincial responsibility (Loree 1989). Individual provinces have promulgated a mosaic of environmental legislation, dating from the 1960s and 1970s (Sage 1976). The acts and regulations enacted by both federal and provincial legislators specify only general criteria for environmental impact assessment and reclamation of mining operations, with considerable ministerial discretion provided in each jurisdiction (Ziemkiewicz et al. 1988).

Province of Alberta

Historically, the province of Alberta was the first jurisdiction in Canada to develop reclamation regulatory policy (Johnson 1987). Land reclamation and certification began in Alberta with the enactment of the 1963 Surface Reclamation Act. The focus of this legislation was to ensure that the surface disturbances created by the oil and gas industry did not affect adversely farming practices. Contouring and leveling of surface disturbances were the major requirements of this legislation.

In 1973, the Land Surface Conservation and Reclamation Act (LSCRA) was passed by the Alberta legislature and formed the regulatory framework for reclamation and land conservation practices for coal, oil sands, pipelines, and sand and gravel industries in the province. The LSCRA required reclamation planning as part of the project development approval process and provided for the establishment of the Development and Reclamation Review Committee (Bratton 1987). The Committee reviews all applications for development and reclamation, and, upon completion of the process, the Minister of the Environment issues an approval document. The Development and Reclamation Review requirements contained within the approval document form the foundation for industry practices and government regulatory activities (inspections and reclamation certification).

In 1976, the Coal Development Policy of Alberta stated for the first time that 'equal capability' would be a requirement of coal mine reclamation (Province of Alberta 1976). The policy stated that the "primary objective in land reclamation is to ensure that the land will be returned to a state which will support plant and animal life or be otherwise productive or useful to man at least to the degree it was before it was disturbed." Conservation and replacement of topsoil and the restoration of drainage systems became requirements in Alberta. The Coal Development Policy created a framework with guidelines which enabled regulatory continuity and provided the basis for operational parameters or performance criteria. Since 1983, 'equivalent capability' has been a requirement of all reclaimed post-mining disturbances. Originally, this concept embraced the criterion of 'equal or greater than' productivity, but the inherent problems in measuring

productivity, e.g., comparison of early successional disturbances with late successional undisturbed habitats, as well as the confounding effects of reclamation management intensity necessitated a change in philosophy (Railton 1987).

In 1992, the Province of Alberta enacted the Environmental Protection and Enhancement Act (EPEA). This new omnibus legislation contains regulatory requirements and provisions for many aspects of environmental management and protection, including the requirements contained previously within the LSCRA (Province of Alberta 1992).

Province of British Columbia

Legislation governing mine reclamation in British Columbia was first introduced in 1969 when the existing mining legislation, Section 8 of the Coal Mines Regulation Act and Section 11 of the Mines Regulation Act, was amended to require reclamation for major coal mines and hardrock mines (McDonald 1978). In 1969, when the legislation was being amended, little was known about surface mine reclamation in British Columbia. Consequently, detailed reclamation regulations were not developed and considerable discretionary power was given to the Minister of Mines (Hogg 1971). The legislation was amended further in 1973 to include coal exploration, mineral exploration, sand and gravel pits and quarries (Errington 1990). In 1984, after consultation with industry and government agencies, the working policy on reclamation pursuant to Sections 7, 8, and 9 of the Mines Act was articulated in the form of guidelines (Rogers 1984). However, mining legislation in British Columbia remained unaltered from 1973 until the promulgation of the Mines Act [S.B.C 1989, c.56] in 1989. The amended Mines Act and its appurtenant regulatory Code now provides the framework for reclamation policy, discretionary power resides with the Chief Inspector rather than with the Minister of Energy, Mines and Petroleum Resources (Employment and Investment).

United States

Regulatory controls in the United States are separated into coal and hardrock mining. Mining of hardrock minerals in the United States is regulated by the General Mining Law of 1872 (Burford 1990), and discussion of this legislation is peripheral to the focus of this paper.

Prior to 1977, coal mines were regulated by a patchwork of state and federal laws (Harris et al. 1988). In 1977, the United States government enacted the Surface Mine Control and Reclamation

Act (SMCRA) Public Law 95-87 through which Congress sought to establish a nationwide program (cooperative federalism) to protect people and the environment from the adverse effect of surface mining operations (McElfish and Beier 1990). The passage of this law allowed for more uniform regulations regarding reclamation and bonding and also provided for greater public involvement in mine permitting and regulation enforcement (Brenner 1985). The SMCRA created two programs: (1) an environmental protection program to establish performance standards and procedures for permitting and inspection of surface coal mines and (2) a reclamation program for rehabilitation of pre-legislation coal mine disturbances (funded by royalties on coal production tonnage).

The SMCRA allowed individual states to submit their own legislative programs thus assuming regulatory authority or 'primacy' thereby avoiding total federal control by the Office of Surface Mine Reclamation and Enforcement (OSMRE) (KaIt 1983). However, in practice, obtaining OSMRE approval of state reclamation was difficult (Carter 1989).

SMCRA performance standards were implemented by a detailed and comprehensive set of regulations which not only defined the environmental objectives but in some cases specified the design criteria to be adopted (Galloway and McAteer 1980). Many of the mining and reclamation techniques required by the SMCRA were unknown to large sections of the mining industry, and operational practices had to undergo significant changes in order to accommodate environmental concerns (Daniels and Zipper 1988). The SMCRA created considerable controversy and was criticized because of onerous and costly provisions and the creation of a large regulatory bureaucracy (Murray 1988). However, the SMCRA stimulated valuable research by state and federal agencies (Brenner 1984).

RESEARCH OBJECTIVES

Although there have been a number of comparative studies of reclamation regulation in the United States (Imes and Wali 1978, Gallaher and Lynn 1989) and Canada (Marshall 1983, Champigny et al. 1991, Champigny and Abbott 1992), most of these did not examine adequately the ecological implications of the legislation or regulations reviewed. International reviews by the above Canadian authors are particularly narrow and present a corporate financial and legalistic review of reclamation and environmental management. This paper compares the regulatory requirements of western North American mountainous jurisdictions to examine their similarities and differences as well as examine the implications of such requirements. Although other forms of government

regulation (air and water pollution laws) affect mining developments, it is beyond the scope of this research to discuss them in detail.

METHODS

Information Analysis

Content analysis, a systematic procedure for extracting information from various forms of communication (Stankey 1972), was chosen as the mechanism of data collection. For the purposes of this study, the text of legislation, regulations (code) and/or guidelines documents was examined for each of the selected jurisdictions. Four broad categories (planning, reclamation requirements, performance criteria and enforcement) were selected on the basis of a review of the literature. These categories represent the complete range of reclamation activities from project commissioning to mine abandonment.

Research Population Identification

'Population' identification (appropriate jurisdictions) and 'item' collection (regulatory documents) required written and verbal communication with government representatives from Alberta, British Columbia and the United States Department of the Interior (Office of Surface Mining Reclamation and Enforcement OSMRE). Communication with the provincial representatives was straightforward, and the appropriate government documents (legislation, code of regulations and guidelines) were provided immediately. However, 'population' identification for the United States was difficult. In the western states, only Alaska, Colorado, Montana, New Mexico, Utah and Wyoming had assumed primacy under the SMCRA. The states of Idaho and Nevada do not have coal mines and the states of Arizona, California, Oregon and Washington have chosen to allow the United States federal government to pre-empt state authority through the SMCRA rather than enact legislation. Following discussions with the OSMRE, each state was contacted, and the appropriate acts and regulations were provided.

Coding

Coding in content analysis is the process by which units of data are assigned to appropriate categories (Berelson 1954). Categories for the present study were developed through a review of the 'items' or regulatory documents and an examination of the publications of Eichbaum and Buente (1980), and Imes and Wali (1978). Thematic coding (Holsti 1969) was chosen since each section of the regulatory document contains context-dependent and exclusive key words and phrases. Therefore, because of the format of the regulatory documents, the information was already pre-coded.

Data Collection

Presence or absence of pre-determined category codes was chosen as the unit of measurement. All documents were read three times after coding and prior to data collection in order to ensure reliability. Data were then collected and tabulated.

Data Tabulation and Summarization

Data analysis involved simple tabulations of the presence/absence data. In one specific case, the data were presented to include qualitative data on information format in addition to the presence/absence data.

RESULTS AND DISCUSSION

Legislation, regulations and enforcement are an important driving force behind the protection of the environment and, therefore, provide the basis for decisions and activities of reclamation practitioners and regulators. Legislation establishes specific reclamation management systems with different levels of control and capital investment. Specific legislation or regulations that address high elevation coal mine reclamation are not part of the regulatory process in any of the jurisdictions reviewed although there are sections within United States federal and state statutes which are applicable. Due to the complexities of the socio-political milieu, legislators and policy makers in the reviewed jurisdictions have developed broad regulations to cover reclamation activities. Therefore, much of the following discussion can be applied generally.

Several areas for discussion were identified by the review of regulations and legislation: (1) regulatory process, (2) performance bonding, (3) planning, (4) regulatory provisions, (5) performance standards, (6) reclamation monitoring and enforcement and (7) regulated professional participation. Only regulatory process and regulated professional participation will be discussed in this paper.

The observed differences in regulatory approaches and requirements between different jurisdictions may be due to historically different land-use practices and political systems. In the United States, the demands on the land-base as well as the environmental damage caused by coal mining in the Appalachians have resulted in rigorously legislated land stewardship and conservation (Baldwin 1994). It is suggested here that the dominant agricultural sector in Alberta has contributed to the pre-eminence of land conservation within industrial development while, historically, land stewardship has not been the focus of the dominant resource extraction industries (i.e., forestry, mining) in British Columbia.

Regulatory Process

The systems for regulating surface coal mines in the jurisdictions reviewed are very complex. Comparatively, the United States system is more reliant on statute and regulation than is either Alberta or British Columbia. Both Alberta and British Columbia make use of less formal guidelines and procedures which are not detailed exhaustively in legislation. However, there is an important difference between the two Canadian jurisdictions reviewed. The Alberta system is based on regulations whereas the British Columbia system is based on code. This may be an important distinction since codes may have less legal force in comparison to regulations (Black et al. 1990). In Alberta, anything that is considered certain in terms of practice or measurement is described in the regulations, and everything else is reviewed by ministerial discretion.

The SMCRA legislation has been criticized because Congress chose to draft regulations into the Act in legislative form rather than follow the usual approach of delegating the rule-making function to the regulatory agency (Rasnic 1983). The result of the legislative approach has been that 'technological forcing' is more pervasive within the SMCRA than within its counterparts: the EPEA (formerly LSCRA) in Alberta and the Mines Act in British Columbia. 'Technological forcing' has often resulted in tension between industry and regulatory agencies (Dickson 1988). Examples of technological forcing are the Approximate Original Contour (AOC) requirement and native plant

species procurement requirements of the SMCRA in the United States and the topsoil requirement of the reclamation guidelines in Alberta.

Legislative and regulatory control of surface mining in Alberta encompasses all forms of surface disturbance (coal mines, quarries and oil and gas) while in British Columbia, oil and gas disturbances are excluded. In contrast, a separate legislative document applies to each type of mineral resource extraction in the United States. Only coal surface mining is regulated federally. In terms of equitable treatment and prevention of landscape degradation, the Alberta regulatory system is superior to all other jurisdictions reviewed. The inequalities of environmental regulation between hardrock and coal mining in the United States (Miller 1991) and between oil and gas and mining in British Columbia do not exist in Alberta with the broad regulatory framework of the former Land Surface Conservation and Reclamation Act (LSCRA) and the current omnibus EPEA.

While there is significant programmatic similarity between the jurisdictions reviewed, there are substantial differences in terms of regulatory process, performance standards and enforcement. At one end of the scale is the legislative, rigorously enforced American system of reclamation regulation and at the other end is the Canadian guidelines approach. The American federal system is very restrictive whereas the Alberta and British Columbia systems are flexible. For example, the AOC regulatory requirement, in particular, may discourage habitat diversity and innovation.

The extensive ecological details of the SMCRA have resulted in an emphasis on ecological concepts (species diversity, successional processes, soil biology and wildlife biology) within operational reclamation practice in the United States (Allen 1992). Ecological concepts are latent within the Alberta regulations and British Columbia code. Whether stated explicitly or implied, inclusion of ecological principles within each jurisdiction is predicated on an assumed knowledge of successional 'assembly rules' (Lawton 1987) and on a preoccupation with static end-products rather than with the process of developing end-products. This ecological audit of jurisdictional regulations demonstrates a lack of ecological perspective: in many reclamation practices, especially in British Columbia.

The guidelines approach in Alberta and British Columbia has established general objectives and performance standards by which reclamation is judged. Guidelines are important since they establish rules for government regulators and direct the attention of reclamation practitioners towards the broad objectives and goals of reclamation (McLellan 1985). However, in the absence of firm regulatory requirements and enforcement, guidelines can result in a form of disjointed incrementalism (*sensu lato* Hollick 1981), a particular problem for an inter-disciplinary field such

as mine reclamation. The Alberta regulatory system does not suffer from the disjointed incrementalism characteristic of the British Columbia system because of their coordinated government research and regulatory program. Essentially, the British Columbia code lacks sufficiently detailed information. A further complication is that the British Columbia system involves a disproportionate amount of industry-based consensus with, in the past, considerable ministerial discretion. However, to minimize regulatory abuse, code statements may be included in the reclamation permit since the requirements in this document may be more legally binding on the mining corporation (Errington 1994).

In addition to the aforementioned jurisdictional differences, three important concerns were identified: (1) industry/government interaction, (2) regulatory flexibility and (3) information acquisition.

Industry/Government Interaction: The interaction between government and industry in all jurisdictions reviewed is best described as adversarial, the cause of which may be due, in part, to mistrust. The legalistic format of the United States results in the most adversarial regulatory process with little flexibility. The statute/guidelines approach taken in Canada is much more flexible and incorporates a greater amount of negotiation between the regulatory agencies and the industry.

Negotiation between government regulators and individual companies is important in the regulatory process of all jurisdictions reviewed although it is transparent in the formal system of rules embedded within the statutes and regulations. Negotiations are often involved in matters that are essentially scientific. However, environmental programs frequently require a standard of proof or evidence that involves policy-based rather than science-based decisions, and this is particularly important where uncertainty is high. Reclamation of high elevation disturbances exemplifies a situation where considerable technical uncertainty exists. For example, very little is known about the effects of management practices on ecosystem responses such as plant population dynamics, species persistence, heterotrophic succession and neo-sol pedogenesis. Judgment under uncertainty is particularly problematic where deep divisions exist between participants in the process (Tversky and Kahneman 1982). Resolution of such conflicts and differences may require adjudication by a panel of experts.

Governments must be prepared to defend such policies and legislation with scientific evidence (Fedkenheuer 1987). In Alberta, reclamation guidelines are continually undergoing revision as new

information becomes available. This is a form of adaptive environmental management (Holling 1978) which will stimulate innovative environmental management, provided there is a continual infusion of scientific information from basic and applied-basic research. Increased ecological and holistic research is necessary, especially in the development of alternative practices that can be defended with empirical data.

Dickson (1988) recommended an approach based on bipartisan discussions as an alternative to the conventional command-penalty model of environmental regulation. In the formal negotiated regulations model proposed herein, regulatory standards would be established in consultation with government, industry and the public. In negotiated regulations, all participants would be required to justify their positions or demonstrate 'due diligence' from a knowledge-base perspective.

Formalized involvement by appointed members of the general (local) public and attentive public would make both industry and government more accountable and could result in greater attention to aesthetics within the process. Short environment and reclamation training courses would empower these advocates for site visits and document reviews.

Although there is less conflict when the regulatory system is negotiated, there are attendant problems related to the difficulty of justifying new standards and the development of 'agency capture' (Fortmann 1990). In order to eliminate the potential for regulatory abuse, a public (individual and/or advocacy group) participation program and a strong research and reporting component must be included as part of any reclamation permit. Since there are significant gaps in the information base, reclamation decisions are based often on value judgments rather than on scientific evidence. Therefore, individuals directly or indirectly affected should have formal input into the development of regulations. Public input would alleviate the 'agency capture' problem and would also result in a greater integration of aesthetic concerns, an aspect of the regulatory process which is acknowledged only tacitly at present. To provide equity in positional justification, research would have to be performed by both government and industry.

In a negotiated system, acceptable management inputs and performance standards would be agreed upon mutually by all affected groups; therefore, the system would provide the trust and cooperation that is necessary while ensuring sufficient flexibility to respond appropriately to difficult situations. Essentially, negotiated policy decisions would provide the direction and rate of technological progress of mine reclamation practice in a more efficacious manner and would reduce the *ad hoc* nature of reclamation practice in British Columbia. Technical and ecological information would be developed through a combination of objective data analyses and subjective judgments of experts on

reclamation as well as through subjective public evaluations. Subjective public intervention is important at both local and regional levels since it is difficult to overcome regulatory inertia without significant electoral influence.

The formal negotiated regulatory model would also be more equitable in dealing with the asymmetry between the societal risks and benefits of the alternative courses of regulatory action. A larger segment of society would be involved in deciding what are acceptable levels of landscape alteration (degradation). Thus, such a process would truly acknowledge that reclamation is a socio-political process.

All jurisdictions have a formalized mine development review process within which proponent proposals are reviewed and accepted or rejected. Following project approval, a formalized industry/regulator reclamation monitoring and certification process is invoked.

Regulatory Flexibility: Flexibility is a necessary part of the regulatory process because of the site-specific nature of reclamation practice. In particular, flexibility in performance standards is necessary to ensure maximum development of the science and art of reclamation through innovation. Implementation of innovative practices is constrained by both a lack of flexibility (United States) and too much flexibility (British Columbia). Although less apparent, excessive flexibility constrains innovation development and adoption through inadequate regulatory incentives.

In addition to the flexibility afforded through the guidelines approach, two other forms of flexibility are provided to accommodate environment and mining practice differences. Variance provisions such as: (1) ". . . considers previous and potential use . . .", (2) ". . . unless these objectives can be otherwise achieved . . .", (3) ". . . can provide evidence which demonstrates to the satisfaction of the chief inspector the impracticality of doing so . . .", and (4) ". . . will not normally be accepted . . ." have been included as phrases in the regulations or guidelines of the jurisdictions reviewed.

Variance provision phrases as a form of regulatory flexibility provide the greatest potential for negotiations between the regulatory agencies and industry as well as the greatest source of discretionary abuse. In areas such as high elevations where technical uncertainty exists, these phrases may be a source of facile justifications.

A final form of flexibility is in the recognition of special forms of mining practices. Variances to the SMCRA AOC requirement are granted under special considerations where (1) volumetric expansion of waste material has occurred, (2) alternative land-uses are proposed, or (3) special

mining methods such as augering, mountaintop removal and steep slope mining are involved. These distinctions or special provisions are the only parts of regulations reviewed which have special reference to high elevation coal mining. In Alberta and British Columbia, special categories of mining are not designated in the legislation or regulations, but the mining practices at many of the mines in the foothills and mountainous regions of Alberta and British Columbia would be so designated.

Although regulatory intransigence (United States) is problematic, 'unrestricted' regulatory flexibility (British Columbia) also has negative side effects, especially when dealing with 'sympathetic administrations.' For example, the code in British Columbia provides for considerable regulatory discretion and potential systemic abuse. 'Agency capture' is a potential problem within this jurisdiction where the engineering profession subordinates ecological considerations.

Furthermore, variances can always be justified by monetary constraints, but this rarely translates to sound environmental practice. Where appropriate, the industry must be forced to demonstrate 'due diligence.' Situations where variances are granted easily inhibit the development of innovative reclamation practices. In the United States, variances are granted only after empirical support while in Alberta and British Columbia, evidentiary support is only implied. However, Alberta with its excellent research program has the mechanism in place to develop consensus scientifically.

Information Acquisition Approaches: Research has an important role in influencing change in practices and in altering the regulatory ethos (Wali 1992). Research is the information generating component of the reclamation process. The recommendations resulting from research are often not very elaborate or expensive and, when applied effectively, can have significant results.

Without considerable regulatory guidance and pressure through legislation or guidelines, reclamation planning information will remain incomplete. Since reclamation research is jurisdictional context-dependent, each government has both cognitive and regulatory functions which must operate through the stimulation of research, provision of funds and facilities and the development of policies and minimum standards.

Within the jurisdictions reviewed, primary modes of information acquisition vary, and three models are suggested: (1) government, (2) industry and (3) combination.

Alberta represents the 'government model' whereby reclamation information is generated through either literature reviews and manuals published by the Land Conservation and Reclamation Council or laboratory and field studies undertaken by the Alberta Research Council. Although cooperative government/industry studies are undertaken, there is no regulated requirement for industry to

undertake research although the mining industry must undertake compliance monitoring in order to satisfy permit obligations.

In Alberta, research is coordinated by the Reclamation Research Technical Advisory Committee (RRTAC) and implemented by the Alberta Research Council, academics and consultants. The Alberta Research Council has conducted surface mine reclamation research in upper montane and subalpine areas near Grande Cache since 1972. This research represents one of only a few long-term field studies in the Canadian Rockies (Macyk et al. 1991). Until 1994, the research program of the Alberta government was one of the most comprehensive and well funded in western North America.

The 'government model' represents a method of information acquisition which is scientifically rigorous and relatively unbiased. However, the model may not accommodate adequately the economic constraints of reclamation nor allow for serendipitous discoveries that might occur if more research were conducted by mining companies.

The 'industry model' is used by British Columbia and is a pragmatic approach to reclamation developed because of environmental variability and differences in mining practices within the province (Thirgood 1978). In this model, the industry must demonstrate competence in generating information for reclamation planning. Although this model was originally considered to be superior to that of specific legislation and regulations (Thirgood and Meagher 1972), this approach has resulted in a short-term and non-holistic approach which is inadequate in developing consensus on reclamation practice and regulatory requirements. The 'industry model' results in a disjointed approach to research and planning. Initially, this approach may have had merit, but considerable regulatory abuse is possible because of the *ad hoc* nature of data collection, lack of empirical documentation of practices and questionable technical competence within industry (Smyth 1995).

Although the British Columbia Ministry of Energy, Mines and Petroleum Resources has long recognized the importance of research, direct funding has been limited since 1977. The Technical Research Committee on Reclamation Assessment (TRCR) coordinates research efforts with industry, government and universities and recommends research priorities based on political sensitivity and perceived needs (Errington 1988). The TRCR in British Columbia produces research priority lists and funds selected projects but has suffered from shortages in manpower and funding, unlike Alberta and the United States. As a result, many components of reclamation theory, practice and regulation in British Columbia have had a conceptual and developmental hiatus during the last decade with much of the research focused narrowly on selected concerns related to

environmental 'protection' (rock drains, spoil dump stability, geohydrology, acid rock drainage, molybdenum toxicity) rather than on ecosystem development.

The 'combination model' is represented by the United States jurisdictions in which there is considerable coordination of academic, governmental and industry research. Although not specifically stated in either the SMCRA or the CFR 30, the performance criteria within the code have dictated not only the direction and magnitude of research but also the complexity. In the United States, reclamation research activities are coordinated through three regional centers associated with universities. A large number of cooperative research projects relevant to the reclamation of high elevation disturbances have been implemented by industry, government and academia, with substantial involvement by the United States Department of Agriculture Forest Service. Considerable reclamation-related research and development is carried out by federal and state agencies, educational institutions and the mining industry in the United States (Baldwin 1994). The SMCRA also contains a provision for research and variance permission within the Experimental Practices in Section 711. United States' coal producers have found that thorough research and persistence are the key components of successful innovation in reclamation practice although it has been difficult to overcome regulatory inertia (Lawson 1988). Innovative proposals and variances from regulatory norms require considerable gestation and knowledge that will develop only with adequate research and integration within a well designed and implemented monitoring process.

Regulated Professional Participation

Consultation and cooperation improves the results of reclamation practice. Implicit within both the formal negotiated regulatory system and the proposed combination performance standard approach is the regulated requirement of certified multidisciplinary teams wherein specific discipline participation is dictated by land-use objectives. Professional certification and codes of conduct are necessary in order to integrate information from a greater number of disciplines and eliminate facile attempts at positional justification. Each discipline has specific contributions to make to the reclamation process. Currently, none of the jurisdictions reviewed have professional requirements as pre-conditions of participation. Although sound ecological management does not necessarily follow from individual accreditation (certification), such a process, if combined with an ecosystem-based practices code, would eliminate many of the current problems in the jurisdictions reviewed.

Currently, many individuals involved in surface mine reclamation are untrained or inexperienced (Burkhart 1988). Within British Columbia, there is a particular need for training and accreditation

of multi-disciplinary professionals to reduce the asymmetric influence of the engineering profession upon the reclamation process. Professional hegemony is divisive and problematic for integrative reclamation practice. In general, engineers do not receive the integrative training necessary for planning landscape/land-use changes.

Therefore, accreditation of reclamation professionals should become a regulatory requirement. The peer-reviewed process would ensure a knowledge-base sufficiency on the part of reclamation practitioners, researchers and consultants, thereby raising and standardizing the quality of reclamation practice. Without such requirements, there is a tendency for 'regulatory functionaries' to dominate the reclamation process. Regulations and/or codes would be amended to require reclamation planning and program implementation involvement by accredited individuals (registered professionals or otherwise) with minimum requirements of experience and formal training in disciplines relevant to the stated post-mining land-use objectives of each project.

Although establishing criteria to accredit practitioners with divergent backgrounds is problematic, a program which assigns a rating to the applicant based on education and professional experience can be implemented (Lemons 1994). Certification is currently a subject for debate within the Society for Ecological Restoration (Rieger 1992).

In addition, members of existing applied science or design professions must also be required to take formal environmental training. Reclamation and more general environmental management training for consulting or industry mining engineers should be required by regulation or code. Finally, a practices code with standardized practices and lexicon is necessary for ensuring environmental due diligence and regulatory compliance. The practices rules would not replace codes of conduct for accredited reclamation professionals who are members of registered professional societies but would simply overlay the existing codes of these professional groups. The development of field guides to accompany the regulations would provide guidance for implementation of regulations and standards. Such guides currently exist within several jurisdictions but these contain dated information and lack an ecosystematic perspective towards reclamation. A formal, yet easily updated system, is necessary.

SUMMARY

Legislation, regulations and enforcement are an important driving force behind the protection of the environment and, therefore, provide the contextual basis for all subsequent reclamation decisions and activities described in the accompanying chapters.

The systems for regulating surface coal mines in the jurisdictions reviewed are very complex. The United States system is more reliant on statute and regulation than either Alberta or British Columbia. While there is significant programmatic similarity between the jurisdictions reviewed, there are substantive differences in terms of regulatory process, performance standards and enforcement. Several areas for discussion were identified by the review of the regulations and legislation: (1) regulatory process, (2) bonding, (3) planning, (4) regulatory provisions, (5) performance standards, (6) reclamation monitoring and enforcement, and (7) regulated occupational participation.

Within the regulatory process, three important concerns were identified: (1) industry/government interaction, (2) regulatory flexibility and (3) information acquisition. Negotiation between government regulators and individual companies is important in the regulatory process of all jurisdictions reviewed although it is transparent in the formal system of rules embedded within the statutes and regulations. In negotiated regulations, formal empirically-based positional justifications are required.

Flexibility is important in the regulatory process, particularly where there is scientific uncertainty. However, regulatory flexibility also has negative side effects, especially when dealing with sympathetic administrations. Appropriate mechanisms to address variance requests are present in most jurisdictions, but where absent, 'agency capture' is possible.

Information acquisition is essential for the development of reclamation theory and practice. Within the jurisdictions reviewed, approaches to information acquisition are determined by regulatory approaches. Three models were identified: (1) government, (2) industry and (3) combination. The government and combination models are superior to the industry-based approach because of the *ad hoc* nature of information collection and questionable technical competence of the industry personnel. Government-industry coordinated research is favored strongly by survey respondents (Smyth 1995).

Finally, none of the jurisdictions reviewed have training and experience requirements as pre-conditions of participation. Although sound ecological management does not necessarily follow from accreditation, regulated participation combined with an ecosystem-based practices code would eliminate many of the current problems.

In general, all jurisdictions need an injection of applied socio-ecological research. Regulations and practices would benefit greatly from an infusion of successional theory, population dynamics, landscape ecology and aesthetics.

REFERENCES

- Allen, E.B. (1992). Evaluating community-level processes to determine reclamation success. *Evaluating Reclamation Success: The Ecological Considerations*. (J.C. Chambers and G.L. Wade, Editors). United States Department of Agriculture, Forest Service, General Technical Report NE-164, Northeastern Forest Experimental Station, Radnor, pp. 47-58.
- Baldwin, A.D. Jr. (1994). Rehabilitation of land stripped for coal in Ohio - reclamation, restoration, or creation? *Beyond Preservation, Restoring and Inventing Landscapes*. (A.D. Baldwin Jr., J. De Luce and C. Pletsch, Editors). University of Minnesota Press, Minneapolis, pp. 181-191.
- Berelson, B. (1954). Content analysis. *Handbook of Social Psychology: Theory and Method*. Volume I. (G. Lindzey, Editor). Addison-Wesley Publishers, Cambridge, pp. 488-522.
- Black, H.C., J.R. Nolan and J.M. Nolan-Haley. (1990). *Black's Law Dictionary*. West Publishing Company, St. Paul Minnesota.
- Bratton, D.L. (1987). Regulatory response to changing reclamation demands. Reclamation Targets for the 1990's. *Proceedings of a Symposium Sponsored by the Alberta Society of Professional Biologists, The Alberta Chapter/Canadian Land Reclamation Association and The Canadian Society of Environmental Biologists - Alberta Chapter*. (C.B. Powter, Editor). Edmonton, pp. 5-12.
- Brenner, F.J. (1984). Restoration of natural ecosystems on surface coal mine lands in the North Eastern United States. *The Biosphere: Problems and Solutions*. Elsevier Scientific Publishers, Amsterdam, pp. 211-225.
- Brenner, F.J. (1985). Land reclamation after strip mining in the United States. *Mining Magazine*, 153,3,211-213,215,217.
- Burford, R.F. (1990). The mining law of 1872. *Geotimes*, 35, 16-18.
- Burkhart, B. (1988). A case for horticulture in the practice of restoration and management. *Restoration and Management Notes*, 6, 2, 68.
- Carter, R.A. (1989). Reclamation plows new ground. *Coal*, 26, 7, 44-48.
- Champigny, N., P.H. Grimley and W.E. Stanley. (1991). International survey of mine reclamation and funding. Part I - Canada. *International Mine Waste Management News*, 1, 2, 5-12.
- Champigny, N. and R.M. Abbott. (1992). Environmental management in the Canadian mining industry. *Mine Reclamation from Exploration to Decommissioning*. Proceedings of the Sixteenth Annual British Columbia Mine Reclamation Symposium. Sponsored by the Technical Research Committee on Reclamation, Mining Association of British Columbia, Ministry of Energy, Mines and Petroleum Resources, Ministry of Environment, Lands and Parks, The Coal Association of Canada and the University of British Columbia. Victoria, pp. 25-33.

- Daniels, W.L. and C.E. Zipper (1988). Improving coal surface mine reclamation in the central Appalachian region. *Rehabilitating Damaged Ecosystems. Volume I.* (J. Cairns Jr., Editor). CRC Press Incorporated, Boca Raton, pp. 139-162.
- Dickson, T.A. (1988). *Reclamation Law in Action*. Report to Energy, Mines and Resources Canada Under Research Agreement 135, 1986. Canadian Institute of Resources Law, University of Calgary, Calgary. 64pp.
- Eichbaum, W.M. and D.T. Buente. (1980). The land restoration provisions for the surface mining control and reclamation act: constitutional considerations. *Harvard Environmental Law Review*, 4, 227-259.
- Errington, J.C. (1988). Mine reclamation research priorities in British Columbia. *Reclamation in Changing Economic Times*. Proceedings of the Twelfth Annual British Columbia Mine Reclamation Symposium. Technical and Research Committee on Reclamation, Ministry of Energy, Mines and Petroleum Resources, Ministry of Environment, Mining Association of British Columbia. Victoria, pp. 17-25.
- Errington, J.C. (1990). British Columbia mine; reclamation legislation and policy. *The Economics of Environmental Control: A Mining Perspective*. Proceedings of the 14th Annual British Columbia Mine Reclamation Symposium, Cranbrook. Mining Association of British Columbia, Technical Committee on Reclamation and the Ministry of Energy, Mines and Petroleum Resources. Victoria, British Columbia, pp. 50-61.
- Errington, J.C. (1994). *Personal Communication*. Ministry of Energy, Mines and Petroleum Resources, Mine Review and Permitting Branch. Victoria.
- Fedkenheuer, A.W. (1987). Reclamation and industry in Alberta - today and tomorrow (1990s). *Proceedings of a Symposium: Reclamation Targets for the 1990s*. The Alberta Society of Professional Biologists, Alberta Chapter, (Canadian Land Reclamation Association and The Canadian Society of Environmental Biologists, Alberta Chapter, Edmonton, pp. 13-23.
- Fortmann, L. (1990). The role of professional norms and beliefs in the agency-client relations of natural resource bureaucracies. *Natural Resources Journal*, 30, 361-380.
- Gallagher, WJ. and S. Lynn. (1989). *A Review of Hardrock Mine Reclamation Practices as Background for Proposed Nevada Legislation*. Public Resource Associates, Washington, DC. 68pp.
- Galloway, L.T. and J.D. McAteer. (1980). Surface mining regulation in the Federal Republic of Germany, Great Britain, Australia and the United States: a comparative study. *Harvard Environmental Law Review*, 4, 261-309.
- Harris, G.R., L.A. King and M.B. Clary. (1988). Growth management for environmental protection in the U.S.A. *Journal of Environmental Management*, 27, 53-68.
- Hogg, J.L.E. (1971). Mined-land reclamation in British Columbia. *The Forestry Chronicle*, 47, 6, 1-4.
- Hollick, M. (1981). The role of quantitative decision-making methods in environmental impact assessment. *Journal of Environmental Management*, 12, 65-78.
- Holling, C.S. (Editor). (1978). *Adaptive Environmental Assessment and Management*. John Wiley and Sons, New York. 377pp.
- Holsti, O.R. (1969). *Content Analysis for the Social Sciences and Humanities*. Addison-Wesley Publishers, Reading, Massachusetts.

- Imes, A.C. and M.K. Wali. (1978). Governmental regulation of reclamation in the western United States: an ecological perspective. *Reclamation Review*, 1, 75-88.
- Jackson, L.J. (1991). *Surface Coal Mines - Restoration and Rehabilitation*. IEACR/32 IEA Research, London. 79pp.
- Johnson, R. (1987). A symposium summary. Reclamation Targets for the 1990's, Proceedings of a Symposium. *Proceedings of a Symposium Sponsored by the Alberta Society of Professional Biologists, The Alberta Chapter/Canadian Land Reclamation Association and The Canadian Society of Environmental Biologists - Alberta Chapter*. C.B. Powter, Editor. Edmonton, pp. 111-114.
- Kalt, J.P. (1983). The cost and benefits of federal regulation of coal strip mining. *Natural Resources Journal*, 23, 893-915.
- Lawson, R.L. (1988). SMCRA: ten years of solid progress. *Forum for Applied Research and Public Policy*, 3, 1, 14-17.
- Lawton, J.H. (1987). Are there assembly rules for successional communities? *Colonization, Succession and Stability*. 26th Symposium of the British Ecological Society and the Linnean Society of London. (A.J. Gray, M.J. Crawley and P.J. Edwards, Editors). Blackwell Scientific Publications, Oxford, pp. 225-244.
- Lemons, J. (1994). Certification of environmental professionals and accreditation standards for university programs. *Bioscience*, 44, 7, 475-478.
- Loree, T. (1989). Mines coming to grips with stringent environmental regulations. *The Northern Miner*, B15-B16.
- Ludwig, J.L. (1982). Management's role in developing reclamation programs. *Proceedings of High Altitude Revegetation Workshop No. 5*. (R.L. Cuany and J. Etra, Editors). Information Series 48, Colorado State University, Fort Collins, pp. 29-35.
- Macyk, T.M., Z.W. Widtman and V. Betts. (1991). Two decades of reclamation research in the subalpine region of Alberta. *Reclamation and Sustainable Development*. Proceedings of the Fifteenth Annual British Columbia Mine Reclamation Symposium and the Sixteenth Annual Canadian Land Reclamation Association Symposium. Technical Research Committee on Reclamation, Ministry of Energy Mines and Petroleum Resources, and The Canadian Land Reclamation Association. Victoria, pp. 249-263.
- Marshall, L.B. (1983). *Mining, Land Use, and the Environment II. A Review of Mine Reclamation Activities in Canada*. EN 73-1/23E Lands Directorate, Environment Canada, Ottawa. 288pp.
- McDonald, J.D. (1978). British Columbia Ministry of Mines and Petroleum Resources Reclamation Policy. *Reclamation of Lands Disturbed by Mining*. Proceedings of the Second Annual British Columbia Mine Reclamation Symposium, Vernon. Technical Research Committee on Reclamation, Ministry of Mines and Petroleum Resources and the Mining Association of British Columbia. Victoria, pp. 67-79.
- McElfish, J.M. and A.E. Beier. (1990). *Environmental Regulation of Coal Mining, SMCRA's Second Decade*. Environmental Law Institute, Washington DC. 282pp.
- McLellan, A.G. (1985). Government regulatory control of surface mining operations - new performance guideline models for progressive rehabilitation. *Landscape Planning*, 12, 15-28.
- Miller, G.C. (1991). Bringing back the land: reclaiming mining disturbances. *International Mine Waste and Management News*, 1, 1, 1-5.

Murray, R.E. (1988). *Surface coal mining in the United States*. Mining Technology International 1988. Sterling Publications Limited. London, pp. 103-108.

Province of Alberta. (1976). *A Coal Development Policy for Alberta*. Queen's Printer, Edmonton.

Province of Alberta. (1992). *Environmental Protection and Enhancement Act*. Chapter E-13.3. Queens Printer, Edmonton. 157pp.

Railton, J.B. (1987). Reclamation experience: an industrial perspective. Planning and Certification of Land Reclamation, April 16-17, 1985 Edmonton Inn, Edmonton / Reclamation in the Eastern Slopes of Alberta, September 25-26, 1986, Overlander Lodge, Hinton, Alberta. *Proceedings 1985 and 1986 Alberta Reclamation Conferences Alberta Chapter of the Canadian Land Reclamation Association*. (C.B. Powter, R.J. Fessenden and D.G. Walker, Compilers). Edmonton, pp. 21-29.

Randall, A. (1978). Reclaiming coal surface mines in central Appalachia: a case study of the benefits and costs. *Land Economics*, 54, 4, 472-489.

Rasnic, C.D. (1983). Federally required restoration of surface-mined property: impasse between the coal industry and the environmentally concerned. *Natural Resources Journal*, 23, 335-349.

Rieger, J. (1992). Certification of restorationists continues to generate controversy. *SER News*, 5, 3, 4.

Rogers, S. (1984). A reclamation policy for the mining industry in British Columbia. *Reclamation of Lands Disturbed by Mining*. Proceedings of the Eighth Annual British Columbia Mine Reclamation Symposium. Technical and Research Committee on Reclamation, Mining Association of British Columbia and the Ministry of Energy, Mines and Petroleum Resources. Victoria, pp. 131-133.

Sage, R. (1976). *Pit Slope Manual*. CANMET. Report 76:22 Mines Branch, Energy, Mines and Resources Canada, Ottawa. 65pp.

Smyth, C.R. (1995). *High Altitude Coal Mine Reclamation: An Ecological Audit of Regulatory Requirements, Planning Information and Participant Attitudes*. Ph.D. Dissertation, Geography Department, University of Victoria. Victoria. 515pp.

Stankey, G.H. (1972). The use of content analysis in resource decision making. *Journal of Forestry*, 70, 3, 148-151.

Thirgood, J.V. (1978). Extent of disturbed land and major reclamation problems in Canada. *Reclamation of Drastically Disturbed Lands*. (F.W. Schaller and P. Sutton, Editors). American Society of Agronomy, Crop Science Society of America and Soil Science Society of America, Madison, Wisconsin, pp. 45-68.

Thirgood, J.V. and M.D. Meagher. (1972). Progress in reclamation research by mining companies in British Columbia during 1971. *The Forestry Chronicle*, 48, 308-311.

Tversky, A. and D. Kahneman. (1982). Judgment under uncertainty: heuristics and biases. *Judgment under Uncertainty*. (D. Kahneman, P. Slovic and A. Tversky, Editors). Cambridge University Press, Cambridge, pp. 3-20.

WalI, M.K. (1992). Ecology of the rehabilitation process. *Ecosystem Rehabilitation Volume I: Policy Issues*. (M.K. WalI, Editor). SPB Academic Publishing BV. The Hague, pp. 3-23.

Ziemkiewicz, P.P., D.B. Stewart and K.G. Crane. (1988). Western Canadian surface coal mining and reclamation technology. *Eighth International Conference on Coal Research*. Volume 2. Japan Coal Mining Research Center, Tokyo, pp. 14-35