[redacted]

Copy 2

Open file - HRB-Singer

HRB-SINGER, INC.
SCIENCE PARK, BOX 60 • STATE COLLEGE, PA. 16801
A SUBSIDIARY OF THE SINGER COMPANY

DEVELOPMENT OF NEW BOND RELEASE CRITERIA FOR SURFACE COAL MINES IN THE EASTERN AND INTERIOR COAL PROVINCES OF THE UNITED STATES

FINAL TECHNICAL REPORT

Prepared For: *United States Department of the Interior*
Bureau of Mines

Prepared By: *HRB-Singer, Inc.*
Science Park
P. O. Box 60
State College, Pa. 16801

Contract No. J0177024

18 SEPTEMBER 1978

SINGER
AEROSPACE & MARINE SYSTEMS

DISCLAIMER NOTICE

LP

REPORT DOCUMENTATION PAGE

1. Report No.

2.

3. Recipient's Accession No.

4. Title and Subtitle
Development of new bond release criteria for surface coal mines in the eastern and interior coal provinces.

5. Report Date
September 1978

6.

7. Author(s)
William M. Knuth, Eric L. Fritz, James A. Schad, William F. Nagle

8. Performing Organization Report No.
5145-F

9. Performing Organization Name and Address
Energy and Natural Resources Department
HRB-Singer, Inc.
P. O. Box 60
State College, PA 16801

10. Project/Task/Work Unit No.

11. Contract or Grant No.
J0177024

12. Sponsoring Organization Name and Address
Office of the Assistant Director-Mining
Bureau of Mines
Department of the Interior
Washington, D.C. 20241

13. Type of Report
Final

14.

15. Supplementary Notes

16. Abstract

This study involved a review of bonding and bond release practices in the states of the Eastern and Midwestern Coal Provinces. Data was collected from regulatory authorities and site visits to document the bonding and release procedures in the states related to achieving successful reclamation. The regulations related to PL95-87 were reviewed. The analysis included suggested modified or new bond release criteria, a review of applicable bond release inspection techniques was prepared, a conceptual graduated bonding system and incentive procedures for reclamation of surface mine sites to alternative or higher land uses. A number of conclusions and recommendations for further research were included. A detailed bibliography and a glossary are included in the report.

17. Originator's Key Words
Surface coal mining
Bonding
Bond Release
Inspection Techniques
Graduated Bonding
State Regulations
Federal Regulations

18. Availability Statement

19. U.S. Security Classif. of the Report
Unclassified

20. U.S. Security Classif. of This Page
Unclassified

21. No. of Pages

22. Price

FOREWORD

This report was prepared by the Energy and Natural Resources Department of HRB-Singer, Inc., State College, Pennsylvania under USBM Contract Number J0177024. The contract was initiated under the Coal Mine Health and Safety Program. It was administered under the technical direction of PM&SRC with Mr. Jerry Coalgate acting as the Technical Project Officer. Mr. Frank Naughton was the contract administrator for the Bureau of Mines.

This report is a summary of the work recently completed as part of this contract during the period July 18, 1977 to July 18, 1978. This report was submitted by the authors on September 18, 1978.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

TABLE OF CONTENTS (CONT'D)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Cont'd)

LIST OF ILLUSTRATIONS (Cont'd)

I. EXECUTIVE SUMMARY

This study was initiated to determine the status of state surface coal mine bonding and release practices in the eastern and midwestern coal provinces. The study was divided into two phases. The objectives of Phase I, Review and Analysis, were:

- Collect available field and published data in order to perform the required analysis.
- Evaluate the effectiveness of reclamation related to physical factors, in meeting minimum standards for environmentally sound reclamation, and adherence to state bond release criteria.
- Evaluate bond release inspection techniques utilized by the states.
- Review the various time intervals within the various states' regulations related to bonding and release.
- Analyze the economic effect of bonding practices in the states on productivity. This included any special reclamation fees.
- Discuss the policy implications of bonding practices.
- Review the status of bond forfeitures in the states.
- Determine areas for further study during Phase II.

These objectives were completed during Phase I activity.

The objectives of Phase II of this study were:

- Determine and recommend modified or new bond release criteria which allow for efficient, economical resource recovery and adequate environmental protection.
- Develop a series of general inspections techniques which can be applied to regulatory inspections for bond release.
- Develop a basic framework for a graduated bonding system that sets the amount of bond based on economic, physical and mining factors.
- Discuss methods of speeding up the release of the bond obligation of the operator especially related to alternative land uses.
- Recommend areas which require further research and discuss research methodologies.

The timeliness and importance of this study has been amplified by the federal rules on surface coal mining resulting from PL 95-87. Although many of the areas discussed in this report are not specifically covered by the federal rules, areas such as bond release criteria are applicable. The study has considered the requirements of the federal rules especially in conjunction with Phase II activities. Many of the analyses and results of this study can be used by both federal and state regulatory authorities as an aid in implementation of the federal requirements. A number of conclusions resulted from this study:

- It was found that physical factors which effect the ease of reclamation occur on a regional basis with northern and central Appalachia having the least favorable conditions.
- There was variability among the states in the timing and amount of bond returned during the bond release cycle.
- There was a general lack of standardized bond release inspection techniques between states and individual inspectors.
- There was evidence that the small operator is at an economic disadvantage related to the bonding procedures in the states.
- The economic effects of bonding and reclamation requirements on production is not as evident as other factors such as the 1973 oil embargo.
- Special fees for reclamation of abandoned lands are present in three states. The programs have not generally been implemented for a long enough period to definitely determine their success.
- Bond forfeitures in the states were found to be a minor part of the enforcement activity up to the present time.
- Data relating to effluent quality and quantity from regrading to final release is lacking and is required to set effluent guidelines.
- Standardized inspection techniques related to various bond release criteria have not been developed for surface coal mine situations.
- Incentives for good reclamation are generally lacking such as graduated bonding techniques.

- There is a general lack of statistically valid cost data relating to the cost of reclamation and regulatory inspection costs.
- The incentives for returning the reclaimed land to alternative or higher land uses have generally not been strong enough to encourage this activity.

The major recommendations resulting from this study are:

- A standardized set of factors for reclamation costs should be developed so that studies that include these costs would be comparable.
- A research study should be undertaken to develop a water quality and quantity data base from regrading to final release in order to establish effluent guidelines.
- Further research should be initiated to develop detailed bond release inspection technique methodologies and to produce a series of inspection manuals.
- A field verification of the impact of the final federal rules should be conducted one year after implementation.

II. BACKGROUND AND OBJECTIVES

A. BACKGROUND

Since 1968 legislative activity has produced, in the eastern and midwestern mining states, fifteen different sets of surface coal mining laws and regulations - one for each coal producing state. The one condition that all of the legislative efforts have in common is a requirement for the surface coal mining operator to post a performance bond to assure fulfillment of the reclamation requirements. In addition, a requirement that the bonds are returned to the operator following successful reclamation is common to all those states' regulations.

Because of the independent development of surface coal mining laws and regulations, some potential problems and inequities have emerged. The bond represents an early initial capital outlay for the operator. The lack of uniformity of dollar amounts per acre, time interval of bond retention, special reclamation fees, bond release requirements, and inspection techniques may put operators in some states and of a certain production size at an economic disadvantage.

In addition, the range of bond release criteria and inspection techniques that are utilized by the fifteen states may indicate that the bonding criteria and inspection techniques may not be adequate in some states to insure successful and environmentally sound reclamation whereas others might be too stringent and taxing on the resources of the mine operator and regulatory personnel.

Given the wide geographic distribution of surface mining sites in the various states, along with the variability of climate, soils, overburden geology, topography and hydrology, it is possible that one set of bonding and bond release criteria may not be adequate for all fifteen states.

This study, therefore, reviews and evaluates the economic and environmental impacts of the current bonding, bond release, and inspection techniques. These results were used to recommend new bonding criteria, bond release criteria, and inspection techniques that are based on regional physical variables (if practical), the economic needs of the operator, and the environmental concerns for ecologically sound reclamation.

B. OBJECTIVES

The general objectives of this study, the results of which are included in this report, are:

- To evaluate the reclamation effectiveness which has been achieved while current bonding practices have been in effect. This includes the effectiveness of reclamation efforts based on state requirements for achieving environmentally sound reclamation.
- To review the current bonding and release practices, and to assess the economic effects of these practices on large, medium and small operators. This includes an analysis of the competitiveness and productivity of an operator in one state who works under bonding requirements different from another state.
- To recommend modified or new bond release procedures based on the results obtained in the review portions of this study.
- To determine and discuss standardized bond release inspection techniques that can be applied to bond release criteria.
- Develop a conceptual, graduated bonding system based on financial stability, operator performance and mining conditions.
- Evaluate and recommend the various time intervals for release of the bond, especially related to alternative land uses.
- Recommend further research required in the area of bond release, inspection techniques and bonding.

III. OVERVIEW OF THE TECHNICAL APPROACH

To satisfy the objectives of this study, a two-phase approach is being followed. The flow of the project and the relationship of the two phases and their respective tasks are shown in Figure 1. The procedures and results from Phase I of the study are included in this report.

Phase I, Review and Analysis of Current Bonding and Release Procedures, involved the collection and subsequent analysis of a variety of data related to current bonding and release practices in the fifteen eastern and midwestern states included in this study. The specific objectives of Phase I were: 1) to determine the status of current state bonding and release procedures; and 2) to evaluate on a state-by-state basis the bonding and release procedures related to inspection techniques, environmental effectiveness, economic impact on operations, and the effect on production and competitiveness between operators in the states.

Phase II, New Criteria Development, involved an analysis of the data derived from the initial Phase I. The specific objectives of Phase II were: 1) to recommend modified or new bond release criteria, 2) to develop potential bond release inspection techniques, 3) to develop a conceptual graduated bonding system, and 4) to recommend various time intervals for bond release.

The program was divided into a series of twelve tasks. Each task is briefly described below. The tasks relate to those shown in Figure 1.

PHASE I

Task 1 - Data Collection

This task involved collecting data pertaining to bonding and bond release practices for each of the fifteen eastern and midwestern states. The data that were collected came from four major sources; 1) existing published information, 2) data resulting from discussions with surface mining community personnel including state and federal regulatory personnel and mining operators, 3) field observations of sites released from bond, and 4) information from other sources such as mining associations, public interest groups, bonding companies and universities. All of the subsequent analysis tasks utilized the data that were collected during this task.

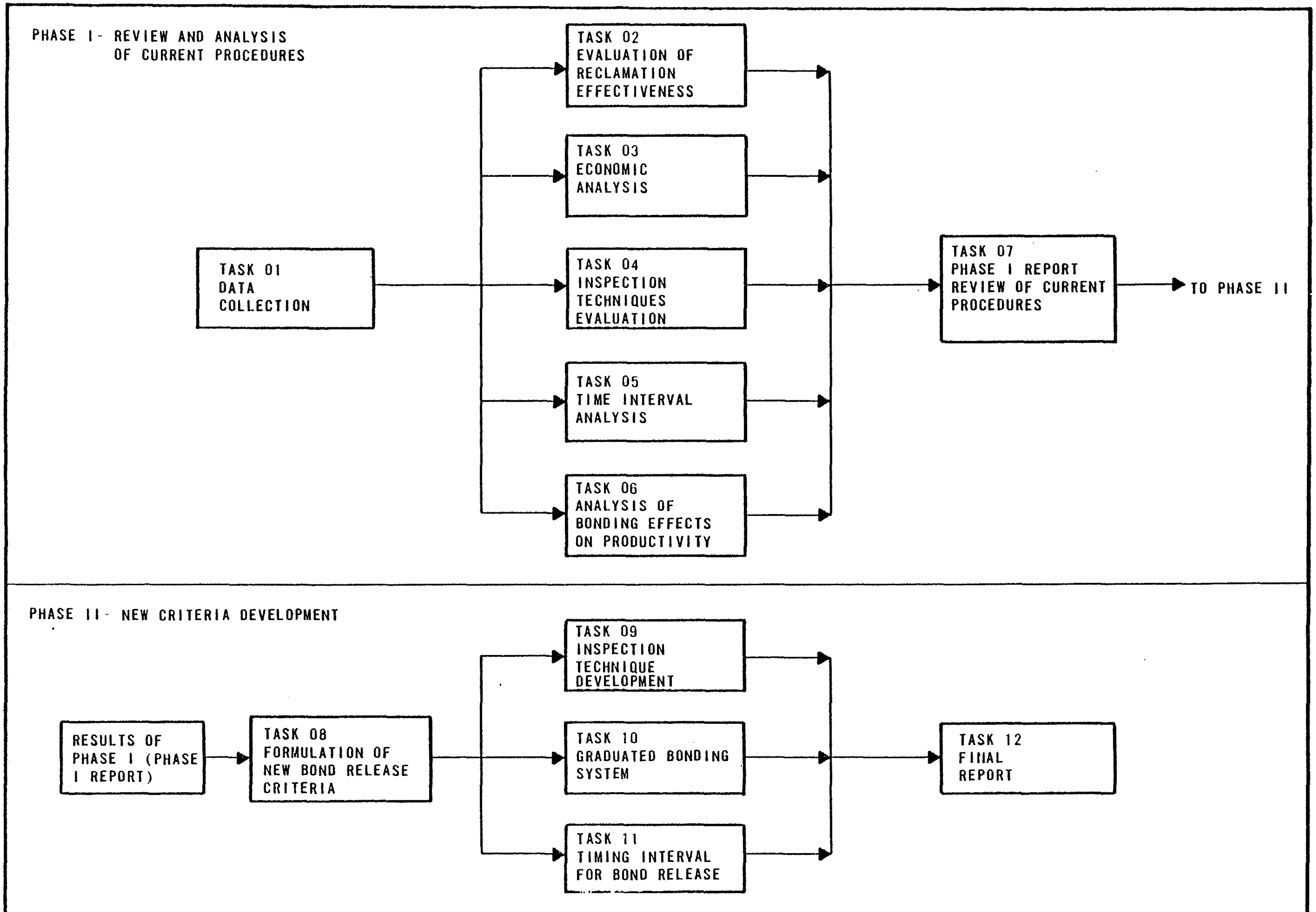


FIG. 1 PROGRAM APPROACH

78-5

Task 2 - Evaluation of Reclamation Effectiveness

This task included four elements: 1) an evaluation of the major physical factors which impact upon the ability of an operator to perform successful reclamation; 2) an analysis on a state-by-state basis of the data resulting from field observations of reclaimed sites released from bond to determine the ability of various operators to meet minimum environmental reclamation standards; 3) an evaluation using field observations and data from discussions with the mining community to determine the success of the operators in meeting the specific state reclamation requirements; and 4) an analysis, in those appropriate states, of the effectiveness of special reclamation fees or taxes in the reclamation of abandoned mine lands.

Task 3 - Economic Analysis

This task entailed an economic analysis of bonding and release practices. The economic role of bonding and the regulatory strategies in bonding were analyzed. A matrix was developed to show the pertinent factors associated with bonding by state. The effects on different size operators and between states were evaluated as they relate to bonding and reclamation. An estimated average bonding cost was derived for each state according to factors such as time frame for bond submittal and release, the amount of the bonds, and minimum bonds.

An economic view of the coal industry of each state was undertaken and presented in a static and dynamic form. The static form utilized 1975 U.S. Bureau of Mines production information, size and number of mines data, and U.S. Bureau of Mines strippable reserve data. Data based on the regions developed in Task 2 (Evaluation of Reclamation Effectiveness) was also evaluated and visible trends noted.

Task 4 - Inspection Techniques Evaluation

An analysis was undertaken during this task to review inspection techniques currently stipulated by states' legislation and/or regulations for use in determining the success of reclamation. This analysis included a comparison of the types of inspection techniques actually used by the states. In addition, comments by the operators and regulatory personnel, related to inspection techniques, were included.

Task 5 - Time Interval Analysis

This task involved a detailed analysis of the time intervals required by states' legislation or regulations for reclamation and bond release. This analysis included a review of each state's legislation or regulations and inputs from regulatory personnel and surface mine operators. All data was integrated so that each state requirement was compared to the various time frames involved in the bonding cycle.

Task 6 - Analysis of Bonding Effects on Productivity

This task involved an analysis of the effect of bonding practices on an operator's productivity. The bonding process impacts the operator through a variety of factors. These factors were illustrated through hypothetical mining operations and scenarios. The scenarios were developed to show the comparative advantages created by state laws regarding small and large operators and operators in different states.

The behavior of bonding companies and how it affects the ability of operators to create new productive capacity was included in this analysis.

Task 7 - Phase I - Report

This report presented the results of the review and analyses conducted in the various tasks of Phase I. It served as a summary document of the Phase I activities. It was published during February of 1978.

PHASE II

Task 8 - Formulation of Bond Release Criteria

This task involved an analysis of results of the tasks performed during Phase I to determine those bond release criteria which might be modified and the development of new bond release criteria not currently covered. The modified or new criteria were divided into four major areas; backfilling and regrading, water, revegetation and other permanent earthen structures.

Task 9 - Inspection Technique Development

An evaluation and discussion of potential bond release inspection techniques was the major emphasis of this task. This included impacts of the implementation of the techniques on both the operator and the regulatory authority.

Task 10 - Graduated Bonding System

This task involved the conceptual development of a graduated bonding system which would reward good reclamation practices. Elements of the system included the financial stability of the operator, the past reclamation practices of the operator, and the physical conditions affecting mining on a site specific basis.

Task 11 - Timing Interval for Bond Release

An analysis of the timing interval for bond release for various land uses was conducted. Recommended timing of bond release for various land uses along with special requirements were included.

Task 12 - Final Technical Report

This task represented the final task in the program. This report is the result of the work completed during the study.

IV - PHASE I - REVIEW AND ANALYSIS

A. DATA COLLECTION

1. Objectives

The objectives of this task were to identify, review and analyze literature and other available information related to bonding and bond release practices. In addition, on-site visits to various surface mine operators and regulatory personnel in each of the fifteen states were to be undertaken. Site evaluations of reclaimed sites released from bond were to be completed. All of the resulting data was to be reviewed and filed for use on the subsequent analysis tasks.

2. Approach

In order to minimize the time involved in data collection, a number of activities were conducted simultaneously. These activities are listed and discussed below.

a. Collection of Existing Data

A number of data sources were utilized to collect research studies and other published data related to bonding and bond release in the eastern and midwestern states. Major data sources included:

- U.S. Bureau of Mines Research Reports and Information Circulars (IC).
- U.S. Geological Survey Professional Papers and Bulletins
- National Technical Information Service (NTIS)
- Argonne National Laboratories, Energy and Environmental Systems
- U.S. Environmental Protection Agency
- The Federal Register
- The Appalachian Regional Commission
- Current Surface-Mined Reclamation Literature Alerting Service (Seamalert)
- State Surface Mine Regulation Agencies
- State Mining Associations
- Various University Research Libraries

- Environment Reporter
- Energy Users Report
- Coal Week and Coal Daily

The data available was reviewed for its relevancy to this study and incorporated into our existing Energy and Natural Resources Library.

b. Discussions with the Mining Community

In order to determine the opinions of the surface mine operators and regulatory authorities, we proposed to hold discussions with a total of 61 operators in the fifteen states. Various size operators were to be visited. The size of the operator was based on the most recent annual production figures (1976). The sizes of operators based on annual production were: 1) Small Operator - less than 100,000 tons/year; 2) Medium Operator - between 100,000 and 500,000 tons/year; and 3) Large Operator - over 500,000 tons/year. A list of discussion items was developed for the operators in each state. The maximum number of operators visited in any one state was six. A sample of the discussion items for surface mine operators in Ohio is shown in Figure 2. It should be noted that the discussion sheets were used by HRB-Singer personnel as a guide and all discussions were unstructured and informal. The operators, with whom discussions were held, were selected on the basis of location in a county where significant surface production was occurring. Actual operators were selected by contacting companies in a particular county as listed in the Keystone Coal Manual. This procedure was used so that the selection of an operator within the county and size category was not biased. The only requirement for site selection was that the operator had a site that had gone through the complete bonding cycle.

All operator discussions were completed during the month of September, 1977. Generally, discussions were held with the owners of small and medium sized companies. Discussions with large mining companies were held with the personnel responsible for reclamation and/or bonding.

In addition to the operators, discussions were held with regulatory authorities in each of the fifteen states. Again, a discussion sheet was developed for state regulatory discussions. A sample discussion sheet is shown in Figure 3. The discussions with the regulatory personnel were held during September, 1977.

DISCUSSION ITEMS: OHIO COAL OPERATORS

OPINIONS RELATING TO STRENGTHS AND WEAKNESSES OF CURRENT BONDING PRACTICES AND CHANGES. IF ANY, NEEDED TO IMPROVE THE BONDING PROCEDURES ARE THE MAIN POINTS OF CONCERN.

1. TIME FRAME FOR BONDING AND RELEASE IN OHIO.
2. EFFECTS OF BONDING ON OPERATING COSTS

   COMPARISON WITH SIMILAR SIZE OPERATIONS WITHIN OHIO.

   COMPARISON WITH SIMILAR SIZE OPERATIONS IN SURROUNDING STATES.
3. INSPECTION PROCEDURES AND STANDARDS FOR BOND RELEASE, STRENGTHS AND WEAKNESSES AS CURRENTLY PRACTICED IN OHIO.
4. EFFECTIVENESS OF CURRENT BONDING PRACTICES WITH RESPECT TO ACHIEVING RECLAMATION OBJECTIVES AS REQUIRED IN OHIO.
5. IMPACT OF THE SPECIAL RECLAMATION TAX IN ACHIEVING RECLAMATION OF ABANDONED MINE LANDS IN OHIO.
6. IMPACT OF LICENSING REQUIREMENTS ON OHIO OPERATORS.
7. DATA RELATING TO RECLAMATION COSTS IN OHIO, e.g.,

   DESIGN ENGINEERING AND OVERHEAD

   BOND AND PERMIT FEES

   BACKFILLING AND GRADING

   REVEGETATION
8. BASIC INFORMATION ABOUT THE OPERATOR -- THE MINING COMPANY, NOT THE SPECIFIC MINE SITE OPERATION, e.g.,

   SIZE

   YEARS IN OPERATION

FIG. 2 SAMPLE OF OPERATOR DISCUSSION ITEMS

78-5

DISCUSSION ITEMS: OHIO DEPARTMENT OF NATURAL RESOURCES

OPINIONS RELATING TO STRENGTHS AND WEAKNESSES OF CURRENT BONDING PRACTICES AND CHANGES, IF ANY, NEEDED TO IMPROVE THE BONDING PROCEDURES ARE THE MAIN ITEMS OF CONCERN.

1. TIME FRAME FOR BONDING AND RELEASE IN OHIO.
2. NUMBER AND AMOUNT OF BOND FORFEITURES IN OHIO IN 1976.
3. ESTIMATES OF COSTS OF RECLAMATION THAT OHIO USES, e.g.

   DESIGN ENGINEERING AND OVERHEAD

   BOND AND PERMIT FEES

   BACKFILLING AND GRADING

   REVEGETATION
4. EFFECTIVENESS OF CURRENT BONDING PRACTICES WITH RESPECT TO ACHIEVING RECLAMATION OBJECTIVES FROM OHIO'S VIEW POINT.
5. STRENGTHS AND WEAKNESSES OF INSPECTION PROCEDURES AND STANDARDS FOR BOND RELEASE AS CURRENTLY DONE IN OHIO.
6. ECONOMIC IMPACT OF BONDING PROCEDURES IN THE STATES; IMPACT OF PROCEDURES ON VARIOUS SIZE OPERATORS; IMPACT ON OPERATIONAL COMPETITIVENESS WITH SURROUNDING STATES.
7. CHANGES THAT SHOULD BE MADE IN OHIO, IF ANY.
8. ADEQUACY OF LICENSING REQUIREMENTS IN OHIO.

FIG. 3 SAMPLE OF REGULATORY DISCUSSION ITEMS

78-5

c. Field Observations and Reclamation Evaluation

In addition to the operator and regulatory discussions, sites which had gone through the bonding cycle and had been released from bond after 1975 were visited by HRB-Singer personnel. A Reclamation Evaluation Checklist was developed by which a variety of physical conditions at each site was evaluated. This checklist was developed by combining a series of physical site descriptions. Specific sampling tests were held to a minimum, however, data on water quality, soil pH and slopes were collected. The reclamation evaluation checklist is shown in Figure 4. A series of ground photographs were taken at each site to correspond to items on the checklist. The evaluations were conducted in conjunction with discussions with the operators. A total of 50 reclaimed sites were evaluated. The checklist was later used to compare effectiveness of reclamation in the various states.

d. Other Data Sources

A number of other data sources were utilized during the data collection task. These included inputs from public interest groups such as the Environmental Policy Institute in Washington, D.C. In addition, a number of bonding companies were contacted in order to get a better feeling of how bonding companies rate surface mine operators who request bonding. These comments and information were included in our data base for use in the analysis tasks.

3. Results

The data collection task produced a large amount of data which was organized into a project data base. The results of each data collection effort is discussed below.

a. Existing Data

A large number of pertinent reports and data were gathered during this effort. A bibliography of the more important items is included in Appendix A to this report. All items were cataloged and filed in the project library and made available for use in the analysis tasks.

RECLAMATION EVALUATION CHECKLIST

PHOTO STATE ______ COUNTY ______ NEAREST TOWN ______

SIZE OF AREA (ACRES) ______ SIZE OF OPERATION S (<100K) M (100-500K) L (>500K)

RECLAMATION COMPLETION DATE ______ BOND RELEASE DATE ______ TODAY'S DATE ______

Take photographs of the items indicated with a dot (•).

General Description

• 1. What is the land use (or cover) of the reclaimed area? (Refer to list) ______

• 2. Describe the adjacent land use. (Consider total perimeter of reclaimed area.) ______

3. What is the distance in miles from the nearest urban area (pop. 5000>) ______ miles

4. What is the distance of the site from the nearest public road? ______

5. What is the distance from the site to bodies of water (streams, ponds, lakes, rivers)? ______

• 6. How would you judge the quality of reclamation at the present time? 5 (superior) 4 (good) 3 (adequate) 2 (poor) 1 (very poor)

• 7. How well does the reclaimed area presently blend with adjacent undisturbed areas? 5 (very well) 4 (well) 3 (moderately well) 2 (somewhat poorly) 1 (poorly)

• 8. Describe briefly any major aesthetic or environmental degradation that could be attributed to the mining activity: ______

Highwall

		YES	NO	N/A
9. Is a highwall present?	9.	___	___	

• 10. If a highwall is present, describe its geological composition, condition; estimate height. ______

		YES	NO	N/A
• 11. If a highwall is present, is material backfilled against the coal?	11.	___	___	___
• 12. Is water seeping from the cover?	12.	___	___	___
• 13. Is the highwall reduced?	13.	___	___	___
• 14. If the highwall is not reduced, is it composed of solid rock? (See item #10 above	14.	___	___	___

SAMPLE

Soils and Erosion

		YES	NO	% of Total Area Affected
• 15. Is rill erosion present?	15.	___	___	______
• 16. Is gully erosion present?	16.	___	___	______
• 17. Are gullies and rills stabilized by vegetation?	17.	___	___	N/A
• 18. Is there a direct link between sediment from rills and gullies and water bodies? (Exclude sediment reduction impoundments.)	18.	___	___	

• 19. If there is a direct link, describe. ______

• 20. Erosion protection and sediment structures: Check which, if any are present.

		Still effective?	YES	NO	Still necessary?	YES	NO
Diversion ditches	___	Still effective?	___	___	Still necessary?	___	___
Vegetative buffers	___	" "	___	___	" "	___	___
Sediment traps	___	" "	___	___	" "	___	___
Sediment basins	___	" "	___	___	" "	___	___
Other (describe) ______		" "	___	___	" "	___	___

		YES	NO
• 21. Are there thin spots in the topsoil where spoil is visible?	21.	___	___
• 22. Are all rocks larger than six inches in diameter buried?	22.	___	___

23. Soil pH for selected samples: 23. pH ___ ___

FIGURE 4 - RECLAMATION EVALUATION CHECKLIST

RECLAMATION EVALUATION CHECKLIST - PAGE 2

NEAREST TOWN TO SITE ____________________

Grading

			YES	NO
•	24. Are spoil piles graded and shaped to conform to adjacent undisturbed areas?	24.	___	___
	25. Is the table portion of the terrace sloped toward the highwall?	25.	___	___
	26. Is the slope less than or equal to 10°?	26.	___	___

27. List the percent of slope and length of the three steepest slopes on the site.

Percent of Slope	Length
________	____
________	____
________	____

Water

			YES	NO	N/A
	28. Are chemical precipitates ("yellow boy") present in water on or running off the site?	28.	___	___	___
	29. Is there evidence of high sediment loads in streams draining the reclaimed area?	29.	___	___	___
•	30. Are natural drainageways free of overburden?	30.	___	___	___

31. What is the pH of water standing or running off the site? Describe whether running (drainage, stream, creek) or standing (puddles, ponds, lakes)

31. Type of Water	31. pH
________	____
________	____
________	____
________	____
________	____

SAMPLE

Vegetation

• 32. Check the type of vegetative cover that is present

Trees	____	Wildlife plantings	____
Grasses	____	Other (specify)	____
Trees and grasses	____		________
Trees, grasses, and legumes	____		________

• 33. If trees are present, what is the estimated planting density and survival rate?

Density		Survival Rate	
____________	trees per acre	________	(Percent of trees per acre)
____________		________	
____________		________	
____________		________	

• 34. What is the estimated percentage of cover of herbaceous species? Greater than 70% ___ Less than 70% ___

• 35. Check the type(s) of vegetation present in the adjacent undisturbed areas.

Trees	____
Grasses	____
Trees and grasses	____
Trees, grasses, and legumes	____

• 36. Rate the quality of the vegetative cover on the reclaimed area with respect to the surrounding undisturbed area.

Higher than surrounding area	______
About the same as	______
Somewhat below	______
Much below	______

Haul Roads

			YES	NO
•	37. Are abandoned haul roads reclaimed?	37.	___	___
•	38. Are water bars part of the reclamation effort?	38.	___	___

NAME OF PERSON(S) COMPLETING THIS CHECKLIST ____________________

FIGURE 4 - RECLAMATION EVALUATION CHECKLIST (CONT'D)

b. Discussions with the Mining Community

We had planned to visit a total of 61 surface mine operators to conduct discussions. Figure 5 shows the distribution of the planned number of discussions compared to the actual discussions. Of the 61 operators planned to be visited, a total of 57 discussions were held. This represented a success rate of 94% which is considered very high. During the course of the discussions it was found that the small operator; 1) if successful, was moving into the medium sized production range during 1977, and 2) in some cases, was in the process of being purchased by a larger operator. Therefore, 50% of the small operators planned to be visited (based on 1976 production) estimated their 1977 production at over 100,000 tons, or were bought by a larger company.

Figure 6 shows the locations of the surface mine operators with whom discussions were held. The distribution generally coincides with the major surface coal mine production areas.

As these discussions were planned, we emphasized to the operator that his comments would be held in strictest confidence. Most of the operators were very candid in the discussions. We coded each discussion identifying the operator only by an alpha-numeric designator to ensure confidentiality of the data. The discussion item responses were put on index cards and filed for future use in the analysis tasks.

Discussions were held with regulatory personnel in each of the fifteen states. We treated the responses to each discussion item in a similar manner as the operator responses. All responses were indexed and filed for future use.

It should be noted that all operators and regulatory personnel were most cooperative and the results of this study could not have been as complete without this cooperation.

c. Field Observations and Reclamation Evaluation

A total of 51 sites which had been released from bond were visited and the reclamation evaluation checklist completed. This was less than the 57 operators visited because 6 sites were found to be not released from bond at the time of the visit. Therefore, data was collected on these 6 sites but not used in the reclamation evaluation. The 51 reclaimed sites were visited by the field

	PLANNED 1			COMPLETED 2			RECLAMATION CHECKLIST COMPLETED
	LARGE >500,000 TPY	MEDIUM	SMALL <100,000 TPY	LARGE >500,000 TPY	MEDIUM	SMALL <100,000 TPY	
ALABAMA	1	2	2	2	2	1	3
ARKANSAS	0	1	1	0	0	2	2
ILLINOIS	3	1	1	3	1	1	5
INDIANA	2	1	2	3	2	0	4
IOWA	0	0	2	0	0	2	2
KANSAS	0	1	1	1	1	0	2
KENTUCKY	3	2	3	3	3	1	6
MARYLAND	0	1	2	0	1	1	2
MISSOURI	2	0	0	2	0	0	2
OHIO	2	2	2	3	2	1	6
OKLAHOMA	1	1	0	2	0	0	2
PENNSYLVANIA	2	2	2	2	2	2	5
TENNESSEE	0	2	2	0	2	1	3
VIRGINIA	0	2	2	1	2	0	2
WEST VIRGINIA	1	2	2	2	3	0	5
SUBTOTAL	17	20	24	24	21	12	51
	TOTAL PLANNED		61	57	TOTAL COMPLETED		

1. SIZE BASED ON 1976 ACTUAL PRODUCTION FIGURE

2. SIZE BASED ON 1977 ESTIMATED PRODUCTION FIGURE

FIG. 5 COMPARISON OF PLANNED VERSUS COMPLETED DISCUSSIONS WITH SURFACE COAL MINE OPERATORS

78-5

78-5

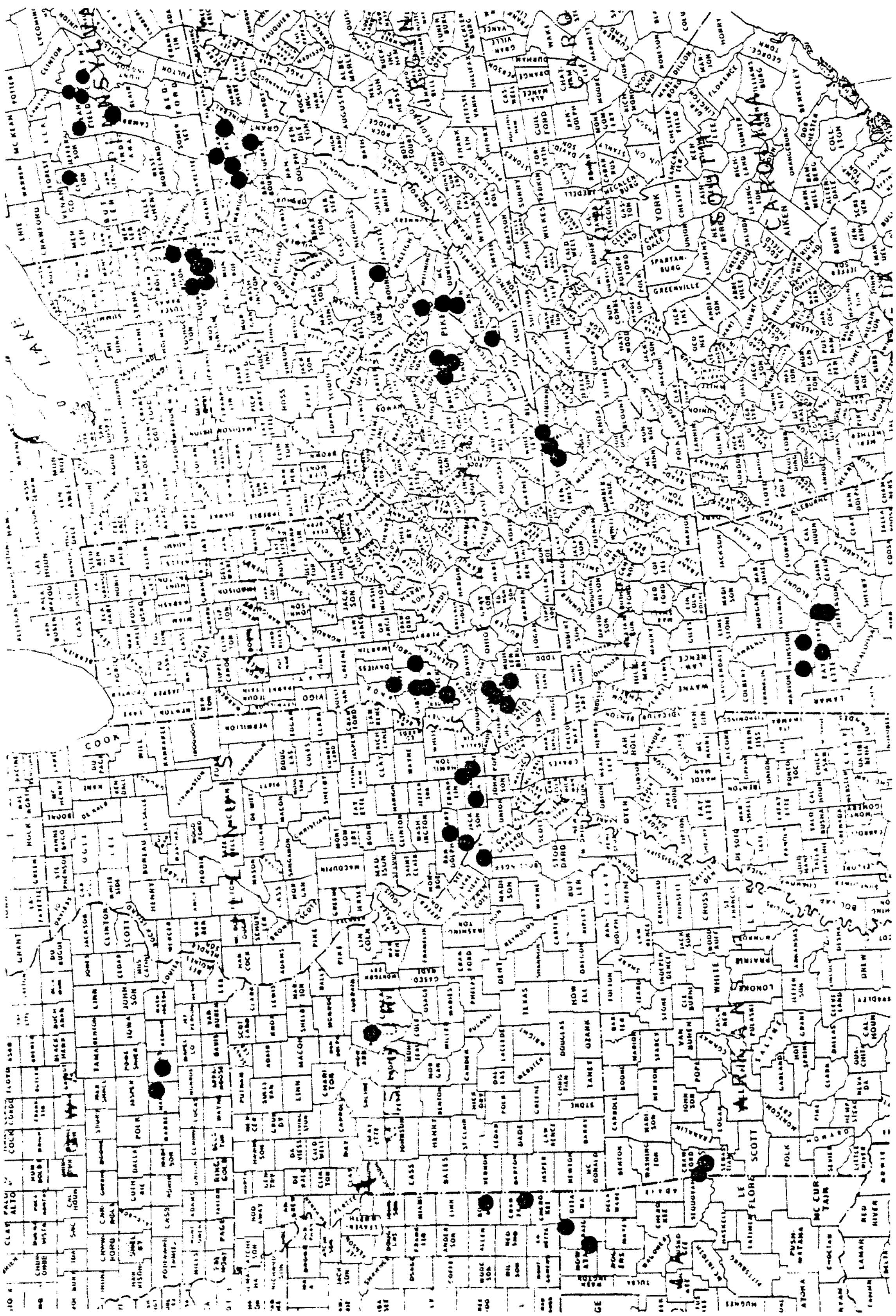


FIG. 6 LOCATION OF SURFACE MINING OPERATORS VISITED

teams during September, 1977 in conjunction with the operator discussions. The completed checklists from the reclamation sites were coded and filed for future use. In addition, ground photography of the sites was cataloged and filed. All completed checklists were very detailed and the related photography was used to further document site conditions.

d. Other Data Sources

In addition to the mining community discussions, a number of informal discussions were held with personnel who are familiar with or are involved in the bonding and release cycle. These contacts and discussions were made to clear up points that arose during the analysis tasks. Close contact was maintained and discussions were held with Mr. Walter Heine, Director of the Office of Surface Mining Reclamation and Enforcement. Other contacts included the Environmental Policy Institute in Washington, D.C.; Battelle Columbus Labs which is conducting a Technology Assessment of Energy in Appalachia; a number of bonding companies who are actively involved in bonding surface coal mine operators; and state surface mining associations. Special note should be made that the director of bonding and permits for one of the largest U.S. Coal Companies visited our facility as a result of our visit to his company and many valuable inputs were received.

The collected data were all entered into the project data base and was used extensively in performing the analysis tasks.

B. EVALUATION OF RECLAMATION EFFECTIVENESS

1. Objectives

The objectives of this task were to 1) determine on a regional basis those areas which showed commonality in the physical factors which affect the ease of reclamation, 2) evaluate, based on the reclamation effectiveness checklist, those states in which environmentally effective reclamation is taking place, and 3) determine the degree to which the operators in various states are meeting the minimum standards required by the states legislation.

2. Regional Analysis of Physical Factors Affecting Reclamation

a. Delineation of the Study Area

This analysis consisted of several steps. The initial step was to delineate the study area. This analysis was limited to the eastern and midwestern coal states. Initially, a base map was selected which was a 1:7,500,000 scale map of the eastern and midwestern United States showing state and county boundaries. Then, those counties underlain by coal-bearing formations were determined. The distribution of the coal formations is shown in Figure 7. Next, using data available from U.S. Bureau of Mines Reserve Data of 1971 and 1974, and the Keystone Coal Manual of 1977, those counties with active surface coal mining in 1976 and/or known recoverable strippable reserves were delineated. These counties are shown on Figure 8. Those counties shown served as the study area for the analyses in this report. As can be seen by comparing Figures 7 and 8, there are fewer counties contained in the study than those that are underlain by coal-bearing formations; this is because in some areas the coals are 1) too deeply buried to be surface mined, such as in northwest West Virginia, 2) too thin to be listed as a recoverable reserve and, 3) in the Western Interior Basin, the lack of data on reserves limits accurate delineation. A total of 309 counties are included in the study area; 173 in the Appalachian coal fields, 71 in the Eastern Interior coal fields, and 65 in the Western Interior coal fields.

b. Determination of Physical Factors Affecting Reclamation

In order to evaluate the reclamation success of operators in the study area and to compare reclamation activities between states, it was determined

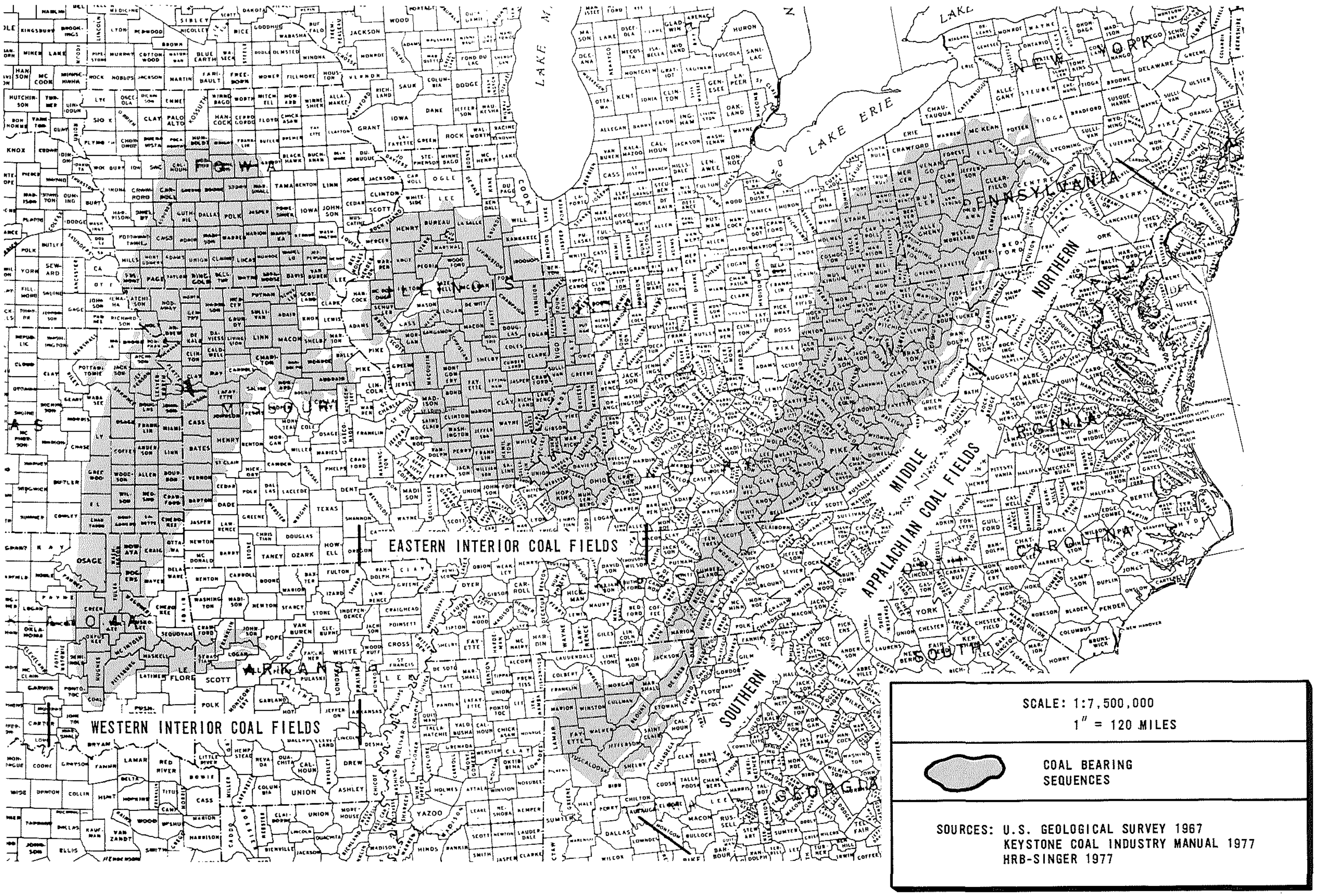


FIG. 7 AREAS UNDERLAIN BY COAL BEARING FORMATIONS

78-5

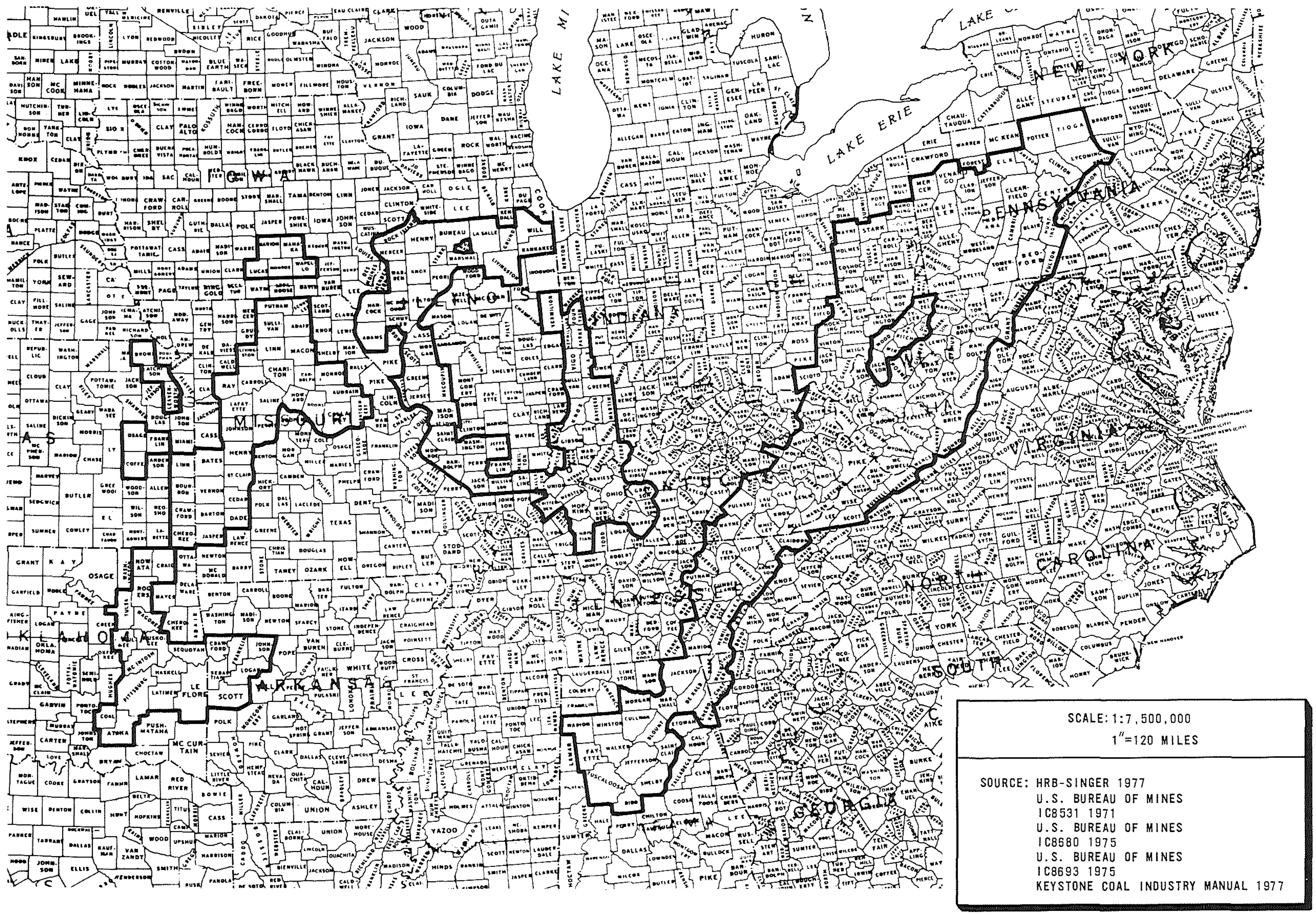


FIG. 8 COUNTIES WITH ACTIVE SURFACE COAL MINING (1976) AND/OR KNOWN RECOVERABLE STRIPPABLE RESERVES

78-5

that an analysis of the ease of reclamation in the study area, based on key physical factors, was required. This analysis was performed to show regional differences, if any, in the ease of reclamation based on physical factors present.

The initial step in the analysis was to determine those physical factors which affect the ease of reclamation. Since over 95% of reclamation efforts in the study area are geared toward revegetation (cropland, grasses, and/or trees) of the reclaimed sites, the analysis concentrates on successful revegetation as the final stage of reclamation. We were aware, however, that other higher land uses (residential, industry, etc.) might be encountered on a site specific basis. Although a detailed analysis was not conducted on this type of end land use, analysis methodologies were evaluated (See Page 213).

A series of physical factors which affect successful revegetation reclamation were determined by utilizing past research, discussions with the mining community, and using the professional expertise of the project team. Six key physical factors affecting successful reclamation were derived. The six physical factors were: soil type, slope, pH conditions in the overburden, geology of the overburden, average annual runoff, and mean annual precipitation. These six major physical factors were then evaluated to determine the relative importance of each in effective successful reclamation.

Since this analysis has not been attempted in past studies, several steps were taken to insure the reliability of the weightings assigned to each factor. Initially, each member of the project team assigned weighted values for each factor, based on a total of 10 as to the factor's impact in achieving successful reclamation in the study area. The results of these weightings were then tabulated. A session was held wherein the project members discussed the results and refined the weightings given to the factors. These ratings were then discussed with operators and regulatory personnel in various coal mining regions within the study area. These comments were then utilized to further refine the weightings of each factor. The results of the weighting analysis are discussed in the following sections. It should be noted that this analysis is a general regionalization. Localized conditions were not included because of lack of specific data and program constraints. Site specific conditions should be determined from available data supplemented by field verification.

(1) Soil Type

This is considered to be one of two most important physical factors affecting the ease of reclamation. The presence or absence of adequate soils is an important factor for attaining adequate vegetative growth on reclaimed sites. This factor was given a weighted value of 2.5 (or 25 percent), based on 10 for all factors.

(2) Slope

Slope was considered along with soil type as the most important factor in affecting the ease of reclamation. Although in some situations the existing slope condition may be modified by mountaintop mining, it was still considered as a key factor in achieving successful reclamation. Slope was given a weighted value of 2.5 (or 25 percent), based on 10 for all factors.

(3) pH Conditions in the Overburden

This factor is concerned with the geochemistry of the overburden, which in turn dictates the pH of the strata above the coal. This factor, along with the other factor related to overburden (the geology of the overburden), was considered to be slightly less important than soil type and slope. However, the weighting for this factor indicates that it is important in the ease of reclamation. pH conditions in the overburden were given a weighted value of 2.0 (or 20 percent).

(4) Geology of the Overburden

This factor involves the physical presence of limestone in the overburden and/or glaciated material in the overburden. This factor was judged equally with pH conditions in the overburden and together they account for 40% of the factors related to ease of reclamation. It was given a weighted value of 2.0 (or 20 percent).

(5) Mean Annual Precipitation

This factor was considered less important in that within the study area all annual rainfall is greater than 32 inches, which indicates adequacy for plant growth. It was given a weighted value of .5 (or 5 percent) on a scale of 10 for all factors. It should be noted that if the total U.S.

was being included in an analysis such as this, rainfall or the lack of it would make this factor more important because of western reclamation conditions. The study area is not susceptible to major periods of drought, however, some localized seasonal deficiencies could occur at any time.

(6) Average Annual Runoff

This factor was judged less important because of its direct dependency on the other physical factors included; that is, soil type, slope and annual precipitation. It was given a rated value of .5 (or 5 percent).

From the weightings given and the interrelationship of the physical factors as shown in Figure 9, it can be seen that four physical factors account for 90 percent of the impact on successful reclamation. The remaining two factors account for only 10 percent of the impact.

C. Rating of the Physical Factors

The next step in the analysis task involved an analysis of each of the physical factors and rating the different characteristics of each physical factor on a scale of 0-10 with 0 being a very adverse condition and 10 being a very favorable condition. It was decided that no condition is so adverse that it cannot be overcome, therefore no condition was rated 0 and conversely, no condition was perfect and none were rated 10. The characteristics of each physical factor and its rating are discussed in the following sections.

(1) Soil Type

There are four principal soil types within the study area. Each soil type was evaluated as to its ability to support vegetation related to reclamation. In past studies, general characteristics of the soil types have been included in discussions of reclamation, but no specific descriptions had been developed for the soil capabilities in supporting revegetation. Each soil type is described below with its rating.

(a) Mollisols

These dark, thick soils generally form under grasslands on nearly level to gently rolling terrain. They are capable of supporting corn,

PHYSICAL FACTOR	WEIGHTED NUMBER (BASED ON 10)	% OF TOTAL
1. SOIL TYPE	2.5	25
2. SLOPES	2.5	25
3. pH* CONDITIONS IN THE OVERBURDEN	2.0	20
4. GEOLOGY OF THE OVERBURDEN	2.0	20
5. MEAN ANNUAL PRECIPITATION	.5	5
6. AVERAGE ANNUAL RUNOFF	.5	5
TOTAL	10	100

* ACID PRODUCING POTENTIAL

FIG. 9 WEIGHTED IMPACT OF THE PHYSICAL FACTORS AFFECTING SUCCESSFUL RECLAMATION 78-5

soybeans and feed grains without much fertilization. These soils are high in organic material and also contain colloidal material which makes them susceptible to erosion if they occur on steep slopes, however they rarely occur on steep slopes. They are thick and fertile and are excellent for reclamation.

This soil type, based on its characteristics, was rated the highest of the soil types. It was given a rating of 8.

(b) Alfisols

These soils develop on gentle to moderate slopes. Much of these soils are used for farming; they support corn, winter wheat, soybeans, tobacco, sugar beets and other canning crops with less fertilization than Inceptisols and Ultisols. These soils are generally much thicker than Inceptisols and Ultisols. Because of their thickness and plant support characteristics, they are good reclamation soils.

Alfisols, because of their characteristics, were rated a 7. It was rated slightly lower than Mollisols because more fertilization is generally required.

(c) Ultisols

These soils form on moderate slopes and normally support forests. They have very little organic matter, and generally are thin although they are usually thicker than Inceptisols. They can support corn, soybeans, hay, cotton and tobacco however fertilization is necessary. As a plant support medium for reclamation purposes, they are slightly better than Inceptisols however they are still relatively poor reclamation soils.

These soils are significantly poorer than either Alfisols or Mollisols because of lack of organic matter, thinner profile and fertilization requirements. It was given a rating of 4.

(d) Inceptisols

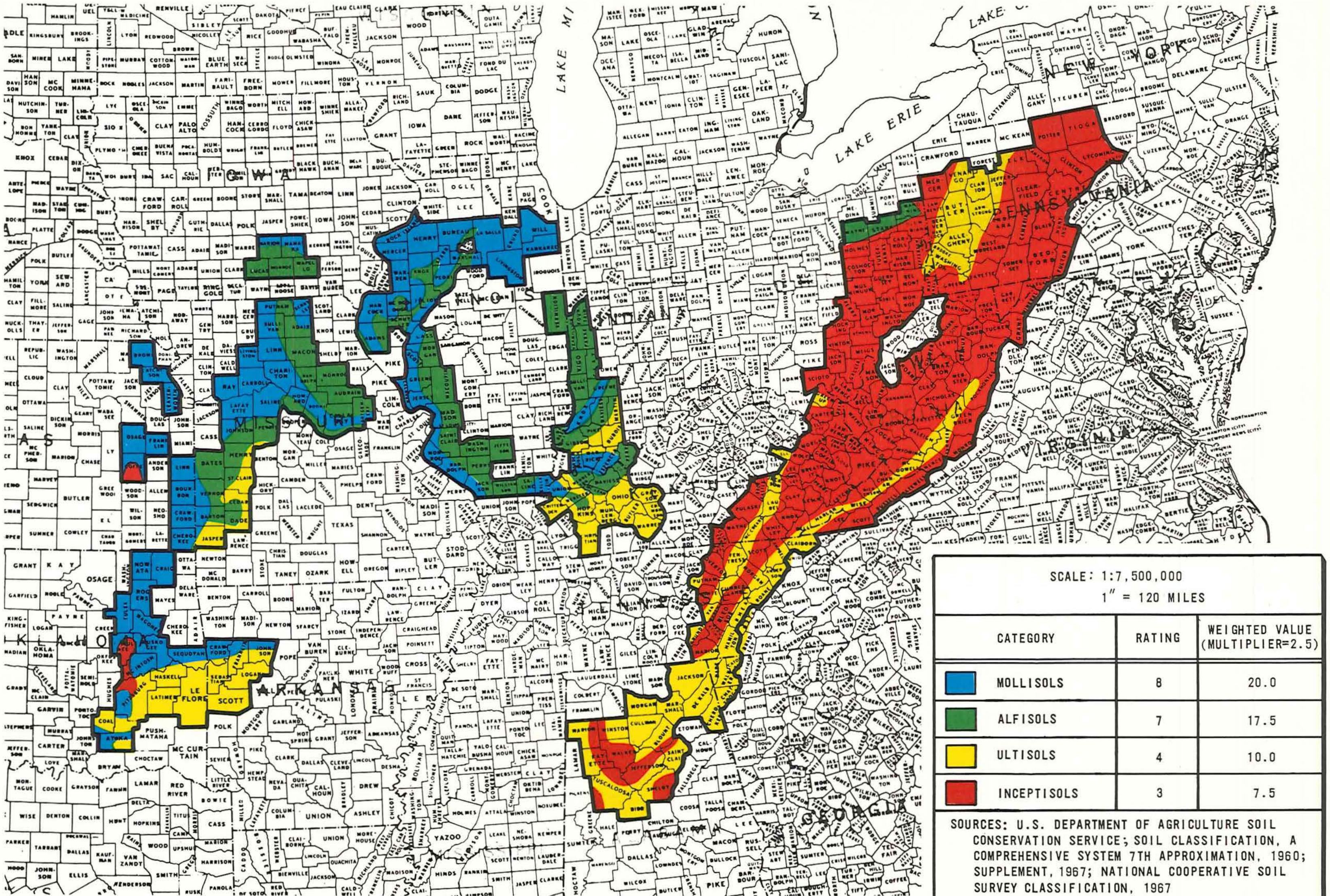
Inceptisols are a common soils group stretching from Pennsylvania to Alabama. These soils normally support hardwood forests and pasture land. They are usually thin soils that require some fertilization to support crops. They form on moderate to steep slopes and are generally not good reclamation soils because of low fertility and thin horizons.

Inceptisols were judged to have the poorest characteristics for support of reclamation revegetation. They were rated slightly below Ultisols and were given a rating of 3.

The distribution of the principal soil types in the study area is shown in Figure 10. The better soils (Mollisols and Alfisols are found in the central and northern parts of the Eastern and Western Interior coal fields. Some poorer Ultisols are found in the southern portions of the Eastern and Western Interior fields, mainly western Kentucky, Arkansas and Oklahoma. The Appalachian coal field contains almost exclusively the poorer Ultisols and Inceptisols. A small portion of northern Ohio contains Alfisols of higher quality. The Ultisols and Inceptisols are generally ubiquitous in the northern and southern parts of the Appalachian coal field whereas Inceptisols dominate the soil type in central Appalachia. The weighted value of each soil type based on the previous analysis is shown in Figure 10. The use of these weighted values is discussed in the section on Regionalization of the Factors.

(2) Slope

Slope was divided into four major categories, each category being related to percent of an area containing gentle slopes, that is, less than 8°.



SCALE: 1:7,500,000
1" = 120 MILES

CATEGORY	RATING	WEIGHTED VALUE (MULTIPLIER=2.5)
MOLLISOLS	8	20.0
ALFISOLS	7	17.5
ULTISOLS	4	10.0
INCEPTISOLS	3	7.5

SOURCES: U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE; SOIL CLASSIFICATION, A COMPREHENSIVE SYSTEM 7TH APPROXIMATION, 1960; SUPPLEMENT, 1967; NATIONAL COOPERATIVE SOIL SURVEY CLASSIFICATION, 1967

FIG. 10 DISTRIBUTION OF THE PRINCIPAL SOIL TYPES

78-5

(a) More than 80% of Area Gently Sloping

This category is best described by having at least 80% of the area in gentle slopes or less (<8°). This is generaly flatland, predominantly farmland and row crops. This category is generally subject to a minimum amount of erosion. This category was rated the highest with a rating of 9.

(b) 50-80% of Area Gently Sloping

This category contains some 50-80% of its area in gently sloping land (<8°). It is characterized by flatland and rolling hills. Lands in this category are subject to more erosion than the first category. It was given a rating of 7.

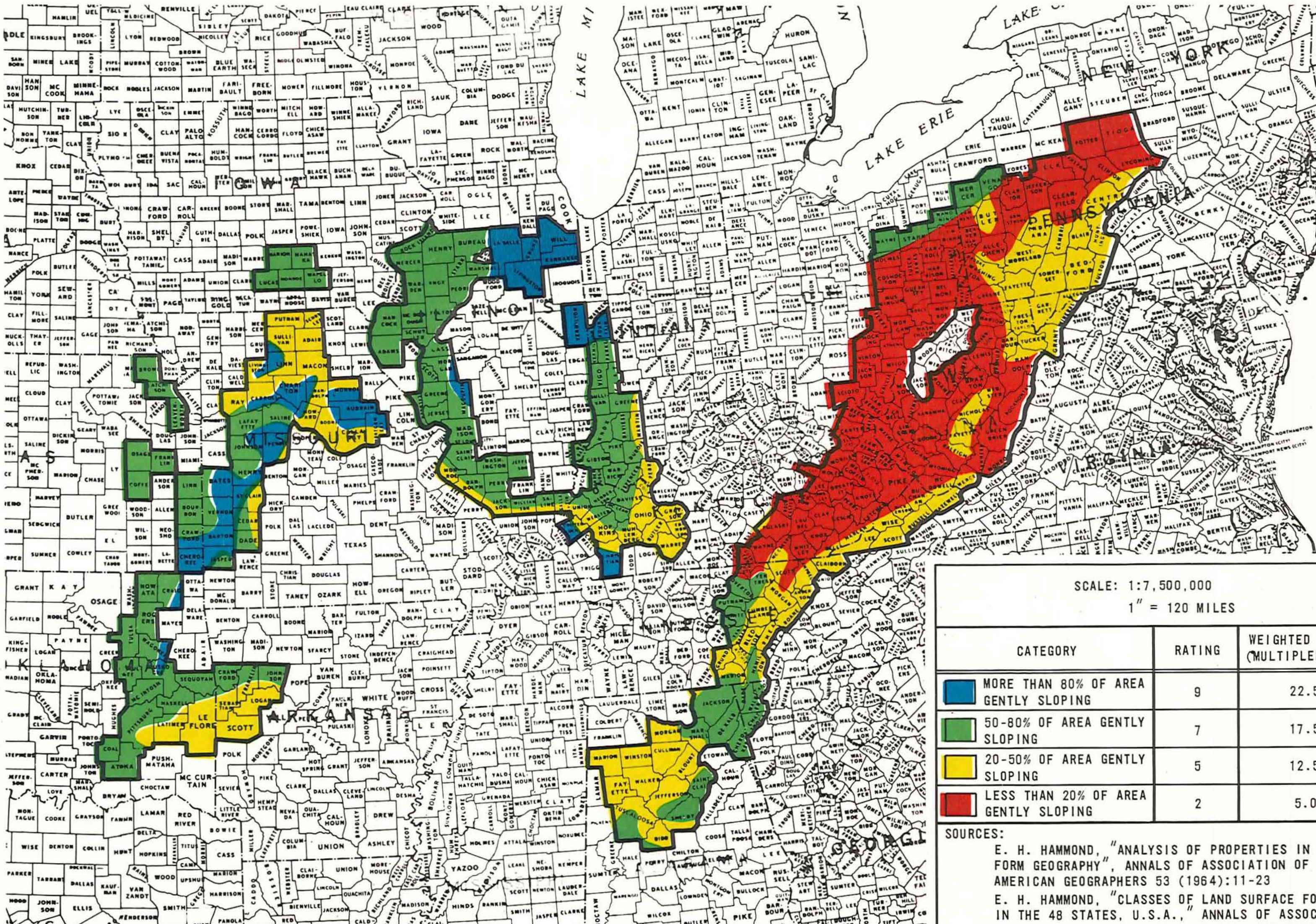
(c) 20-50% of Area Gently Sloping

This category is characterized by more than 50% of the area being in slopes in excess of 8°. Some amount of the area is in flatland. Erosion on the land in this category is a common problem and control measures are usually required. Row crops are usually limited to the more gently sloping areas. This category was given a rating of 5.

(d) Less than 20% of Area Gently Sloping

This area is dominated by slopes greater than 8°. Row crop agriculture is difficult and general farming and agriculture dominates the cleared land. Much of the land is in forests. Erosion is a severe problem on cleared or bare land and erosion control methods are required to avoid erosion on the bare slopes. It was given a rating of 2.

The distribution of various slope categories is shown in Figure 11. The gentler slopes and flatland are present in the northern and central portions of the Eastern Interior coal fields in Indiana and Illinois, and in the central portions of the Western Interior coal fields. The areas with steeper slopes are generally found in the southern portions of the Eastern Interior field and the northern and southern portions of the Western Interior fields.



SCALE: 1:7,500,000
1" = 120 MILES

CATEGORY	RATING	WEIGHTED VALUE (MULTIPLER 2.5)
MORE THAN 80% OF AREA GENTLY SLOPING (blue)	9	22.5
50-80% OF AREA GENTLY SLOPING (green)	7	17.5
20-50% OF AREA GENTLY SLOPING (yellow)	5	12.5
LESS THAN 20% OF AREA GENTLY SLOPING (red)	2	5.0

SOURCES:
E. H. HAMMOND, "ANALYSIS OF PROPERTIES IN LAND FORM GEOGRAPHY", ANNALS OF ASSOCIATION OF AMERICAN GEOGRAPHERS 53 (1964):11-23
E. H. HAMMOND, "CLASSES OF LAND SURFACE FORM IN THE 48 STATES, U.S.A.," ANNALS OF ASSOCIATION OF AMERICAN GEOGRAPHERS 54 (1964) MAP SUPP NO. 4

FIG. 11 SLOPE DISTRIBUTIONS

78-5

The Appalachian coal fields are characterized by the steeper slopes with northern and central Appalachia containing the steepest slopes.

The weighted value of each slope category is included in Figure 11. These are used in the regional analysis discussed in a later section.

(3) pH Conditions in the Overburden

Dividing this physical factor into workable units was most difficult. Data relating to this factor was difficult to obtain. The major portion of the data was obtained from sources in the U.S. Environmental Protection Agency and from some state regulatory authorities. A total of five categories were developed.

(a) pH of the Overburden Between 4.5 - 9.0

This category contains those areas in which the overburden pH is most condusive to vegetation growth. Indications are that most reclamation vegetation grows easily under those pH conditions. Overburden in this category was given a rating of 9.

(b) pH of the Overburden no less than 4.5 but with Rock Layers Greater than 9.0

This category is similar to the first in that pH is greater than 4.5. However, certain distinct rock layers, regardless of thickness,may be present in which the pH exceeds 9.0. This alkaline condition may cause some problems in that plant growth may be inhibited. Therefore, this category was given a rating of 7.

(c) Overburden Contains Rock Layers with a pH Range of 3.4-9.0

This category contains distinct rock layers, regardless of thickness, which are fairly acid. These must be treated, if present, in order to neutralize the acidity to insure good plant growth. Acidity in the overburden is a more serious problem to overcome than alkalinity. Thus, this category was given a rating of 4.

(d) Overburden Contains Rock Layers with pH Greater than 9.0 and Rock Layers with pH as low as 3.4

This category contains distinct rock layers, regardless of thickness, with both high alkalinity and acidity. This condition compounds the problems encountered in category (3).

because of the alkalinity problem. This category was therefore rated lower than the previous category and assigned a rating of 3.

(e) Overburden Contains Rock Layers with pH less than 3.4

The condition of high acidity in the overburden makes this category most difficult to treat in attaining successful revegetation. Even if the area is covered with topsoil, the roots can penetrate the topsoil and die when they come in contact with the spoil material from this layer. It should be noted that this category presents a potential problem only if the spoil from these layers is placed on or near the surface after backfilling and regrading. In many cases the best treatment is careful planning to ensure this layer is buried deeply in the pit during backfilling. Because of the potential acidity problems and careful planning requirements for this category it was assigned a rating of 2.

The distribution of the pH conditions in the overburden is shown on Figure 12. The best pH conditions in the overburden are found in the northern and central portions of the Eastern Interior field and in the southern portion of the Western Interior field. The worst pH conditions (highly acid) are found in the central and northern Appalachian field and in southern Indiana and western Kentucky in the Eastern Interior field.

(4) Geology of the Overburden

This category includes two major parameters related to the overburden; 1) the presence or absence of limestone, and 2) the area has or has not been subjected to glaciation. A total of four categories were developed for this factor.

(a) Glaciated with Limestone in the Overburden

This is considered the optimum condition in that glaciated areas have thick, unconsolidated cover and the limestone layers tend to neutralize potential acid conditions. Equally important is the fact that limestone cobbles and other calcareous rocks are associated with glacial till and offer further capacity to neutralize potential acid conditions. This category was given a rating of 9.

(b) Glaciated without Limestone in the Overburden

This category was rated less than the first category in that the absence of limestone makes any acid problem more difficult to neutralize. This category was rated 7.

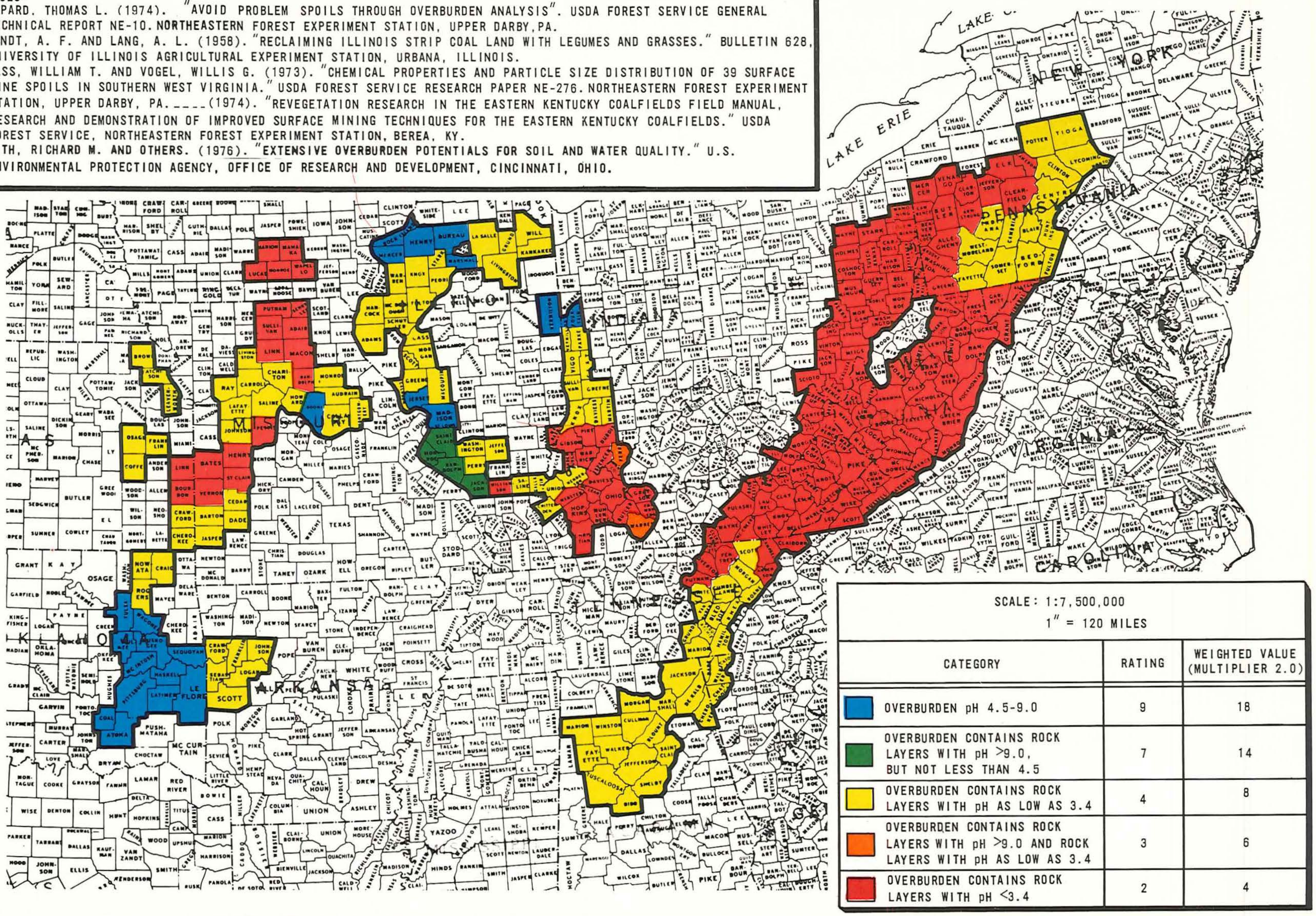
SOURCES:

DESPARD, THOMAS L. (1974). "AVOID PROBLEM SPOILS THROUGH OVERBURDEN ANALYSIS". USDA FOREST SERVICE GENERAL TECHNICAL REPORT NE-10. NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.

GRANDT, A. F. AND LANG, A. L. (1958). "RECLAIMING ILLINOIS STRIP COAL LAND WITH LEGUMES AND GRASSES." BULLETIN 628, UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION, URBANA, ILLINOIS.

PLASS, WILLIAM T. AND VOGEL, WILLIS G. (1973). "CHEMICAL PROPERTIES AND PARTICLE SIZE DISTRIBUTION OF 39 SURFACE MINE SPOILS IN SOUTHERN WEST VIRGINIA." USDA FOREST SERVICE RESEARCH PAPER NE-276. NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA. ____(1974). "REVEGETATION RESEARCH IN THE EASTERN KENTUCKY COALFIELDS FIELD MANUAL, RESEARCH AND DEMONSTRATION OF IMPROVED SURFACE MINING TECHNIQUES FOR THE EASTERN KENTUCKY COALFIELDS." USDA FOREST SERVICE, NORTHEASTERN FOREST EXPERIMENT STATION, BEREA, KY.

SMITH, RICHARD M. AND OTHERS. (1976). "EXTENSIVE OVERBURDEN POTENTIALS FOR SOIL AND WATER QUALITY." U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF RESEARCH AND DEVELOPMENT, CINCINNATI, OHIO.



SCALE: 1:7,500,000

1" = 120 MILES

CATEGORY	RATING	WEIGHTED VALUE (MULTIPLIER 2.0)
OVERBURDEN pH 4.5-9.0	9	18
OVERBURDEN CONTAINS ROCK LAYERS WITH pH >9.0, BUT NOT LESS THAN 4.5	7	14
OVERBURDEN CONTAINS ROCK LAYERS WITH pH AS LOW AS 3.4	4	8
OVERBURDEN CONTAINS ROCK LAYERS WITH pH >9.0 AND ROCK LAYERS WITH pH AS LOW AS 3.4	3	6
OVERBURDEN CONTAINS ROCK LAYERS WITH pH <3.4	2	4

FIG. 12 pH CONDITIONS IN THE OVERBURDEN

78-5

(c) Not Glaciated with Limestone in the Overburden

The absence of glaciation makes the regrading portion of reclamation generally more difficult in that more rock is encountered. The presence of limestone aids in neutralizing the acidity problem. This category was rated 5.

(d) Not Glaciated without Limestone in the Overburden

This category was rated the lowest in that it lacks limestone in the overburden and has not been subjected to glaciation. This category was given a rating of 3.

Figure 13 shows the distribution of parameters related to the geology of the overburden. The highest rated categories are located in the northern part of the Western Interior field and in the northern and central portions of the Eastern Interior fields. These areas have been subjected to glaciation. The lower rated categories are located in the southern portions of the Western and Eastern Interior fields, and in the Appalachian coal field.

5. Mean Annual Precipitation

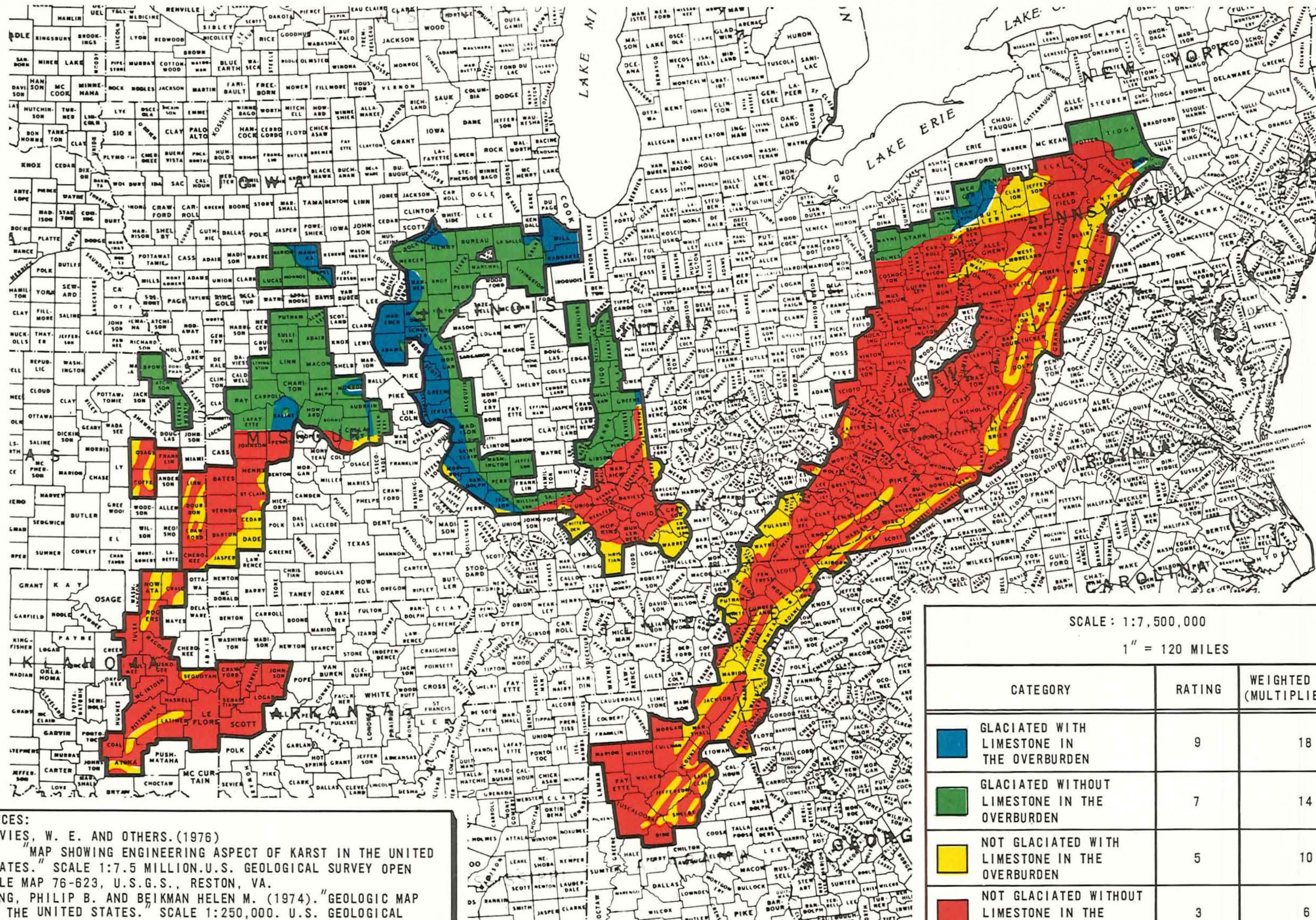
Mean annual precipitation was not weighted as high as the previous factors because of adequate precipitation throughout the study region. Two categories were used for this factor.

(a) Annual Precipitation over 48 Inches

This includes all areas where the total annual precipitation exceeds 48 inches. The maximum rainfall in the study area was about 60 inches in two small areas of Appalachia; Webster County, W. Va. and Marion and Hamilton Counties, Tennessee. The category was rated an 8.

(b) Annual Precipitation 32-48 Inches

This category represents the lower amount of rainfall received in the study region. The minimum rainfall received is 32 inches, more than adequate for reclamation revegetation. This category was rated 7.



SOURCES:
DAVIES, W. E. AND OTHERS. (1976) "MAP SHOWING ENGINEERING ASPECT OF KARST IN THE UNITED STATES." SCALE 1:7.5 MILLION. U.S. GEOLOGICAL SURVEY OPEN FILE MAP 76-623, U.S.G.S., RESTON, VA.
KING, PHILIP B. AND BEIKMAN HELEN M. (1974). "GEOLOGIC MAP OF THE UNITED STATES." SCALE 1:250,000. U.S. GEOLOGICAL SURVEY, RESTON, VA.

SCALE: 1:7,500,000

1" = 120 MILES

CATEGORY	RATING	WEIGHTED VALUE (MULTIPLIER 2.0)
GLACIATED WITH LIMESTONE IN THE OVERBURDEN	9	18
GLACIATED WITHOUT LIMESTONE IN THE OVERBURDEN	7	14
NOT GLACIATED WITH LIMESTONE IN THE OVERBURDEN	5	10
NOT GLACIATED WITHOUT LIMESTONE IN THE OVERBURDEN	3	6

FIG. 13 GEOLOGY OF THE OVERBURDEN

78-5

The distribution of mean annual precipitation is shown on Figure 14. The amount of rainfall is directly related to the nearness of a moisture source (the Gulf of Mexico) and the topography of the region. The southern portions of the study region receive more rainfall along with the Appalachian Mountains.

(6) Average Annual Runoff in Inches

This physical factor was not weighted as high as most of the other factors because it is related to slope, soil type and annual precipitation. A total of three categories were developed for this factor.

(a) Annual Runoff less than 10 Inches

Runoff less than ten inches causes only minor erosion problems. Heavy downpours may cause localized erosion. This category was rated 9.

(b) Annual Runoff 10-20 Inches

This category represents areas in which runoff is not an uncommon problem. Again, heavy downpours may cause local severe erosion. This category was rated as 6.

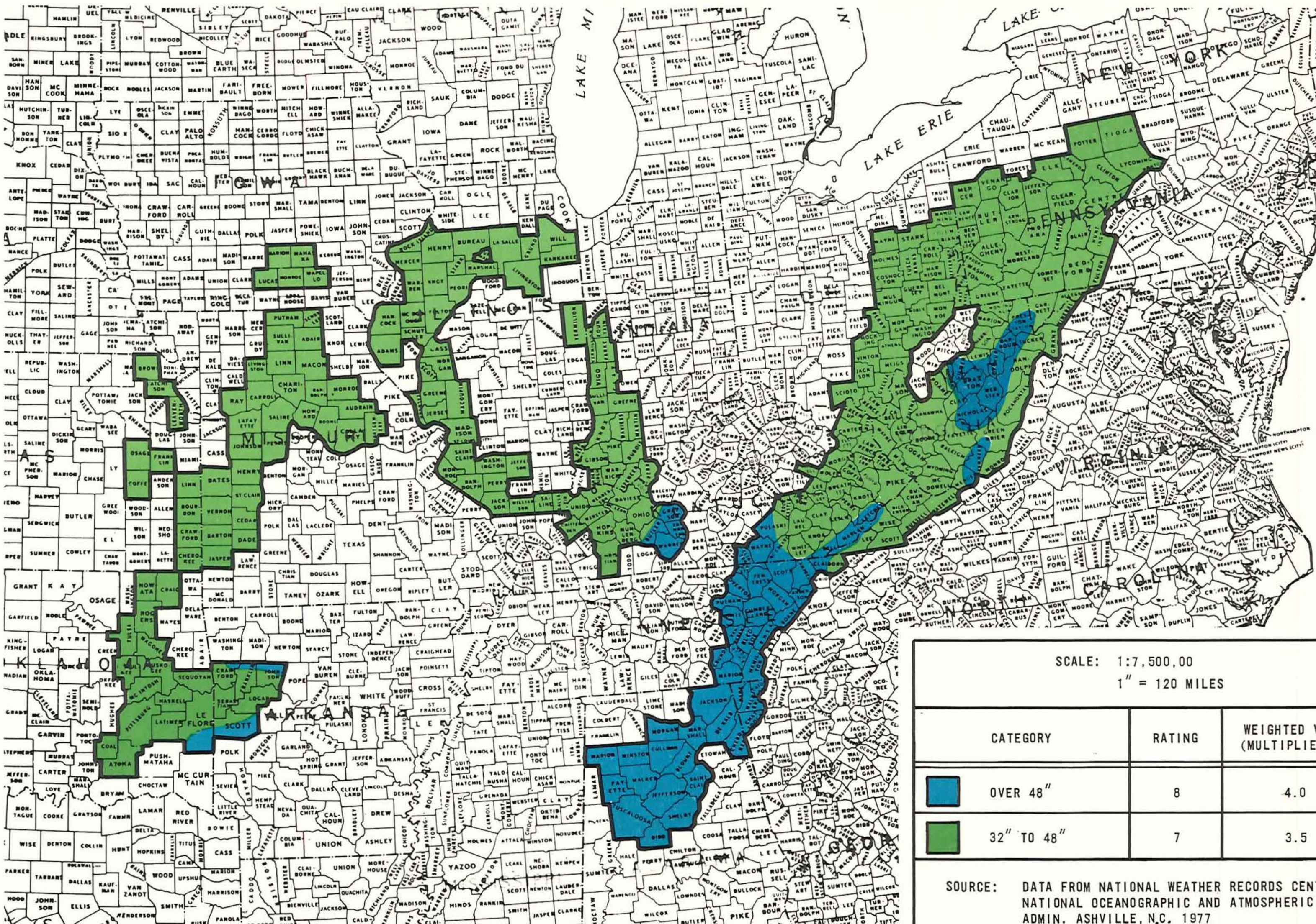
(c) Annual Runoff over 20 Inches

This category represents areas where erosion occurs on unprotected slopes. Severe erosion and flash flooding occurs during heavy precipitation events. This category was rated as 3.

The distribution of runoff generally corresponds to the distribution of soil types, slope and rainfall. Central and southern Appalachia contain the areas of most severe runoff. Figure 15 shows the distribution of the average annual runoff.

d. Regionalization of the Ease of Reclamation

In order to develop a regionalization of the ease of reclamation, several related analysis steps were taken. Each step is discussed in the sections below.



SCALE: 1:7,500,00
1" = 120 MILES

CATEGORY	RATING	WEIGHTED VALUE (MULTIPLIER .5)
(blue) OVER 48"	8	4.0
(green) 32" TO 48"	7	3.5

SOURCE: DATA FROM NATIONAL WEATHER RECORDS CENTER NATIONAL OCEANOGRAPHIC AND ATMOSPHERIC ADMIN. ASHVILLE, N.C. 1977

FIG. 14 MEAN ANNUAL PRECIPITATION IN INCHES

78-5

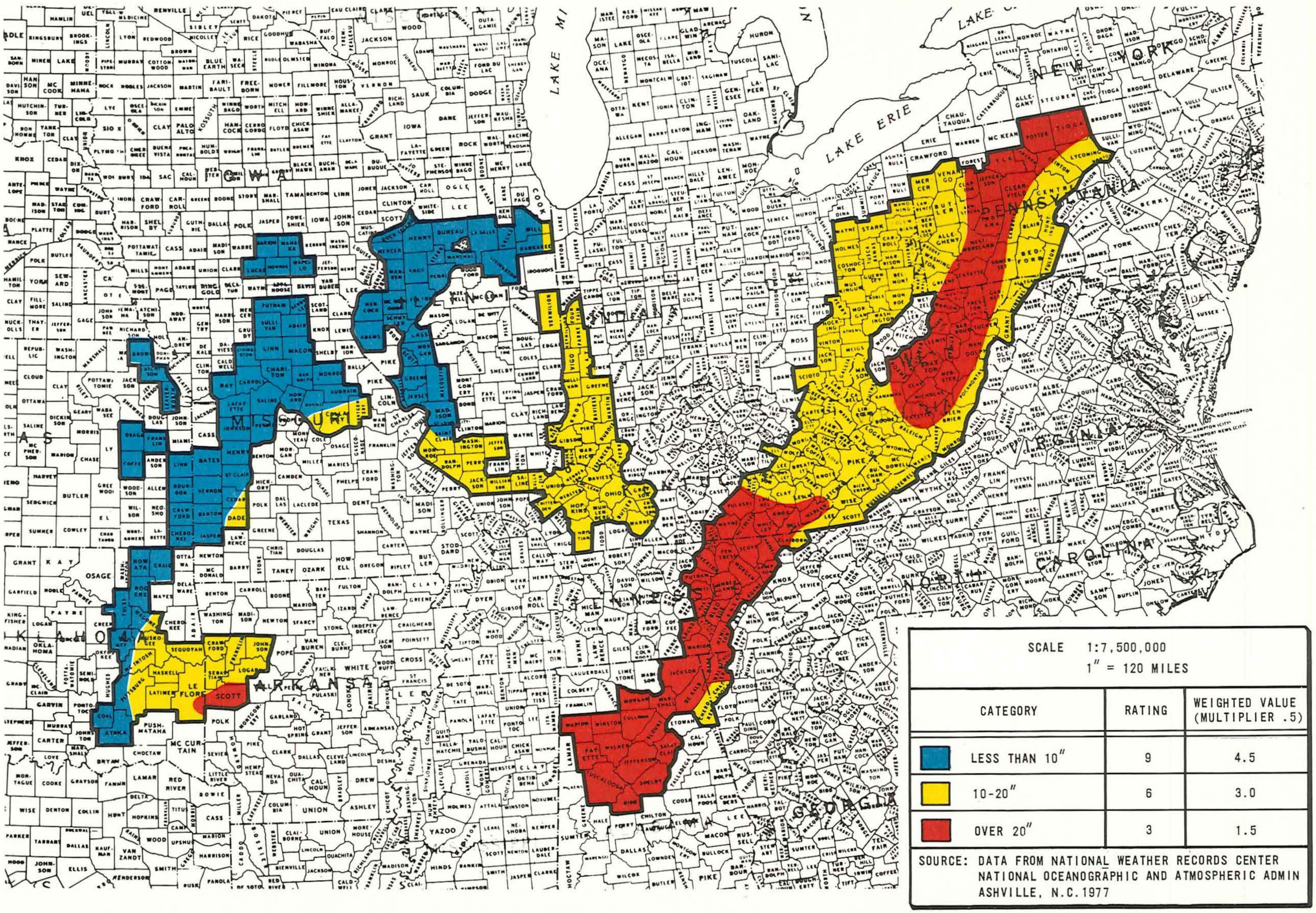


FIG. 15 AVERAGE ANNUAL RUNOFF IN INCHES

78-5

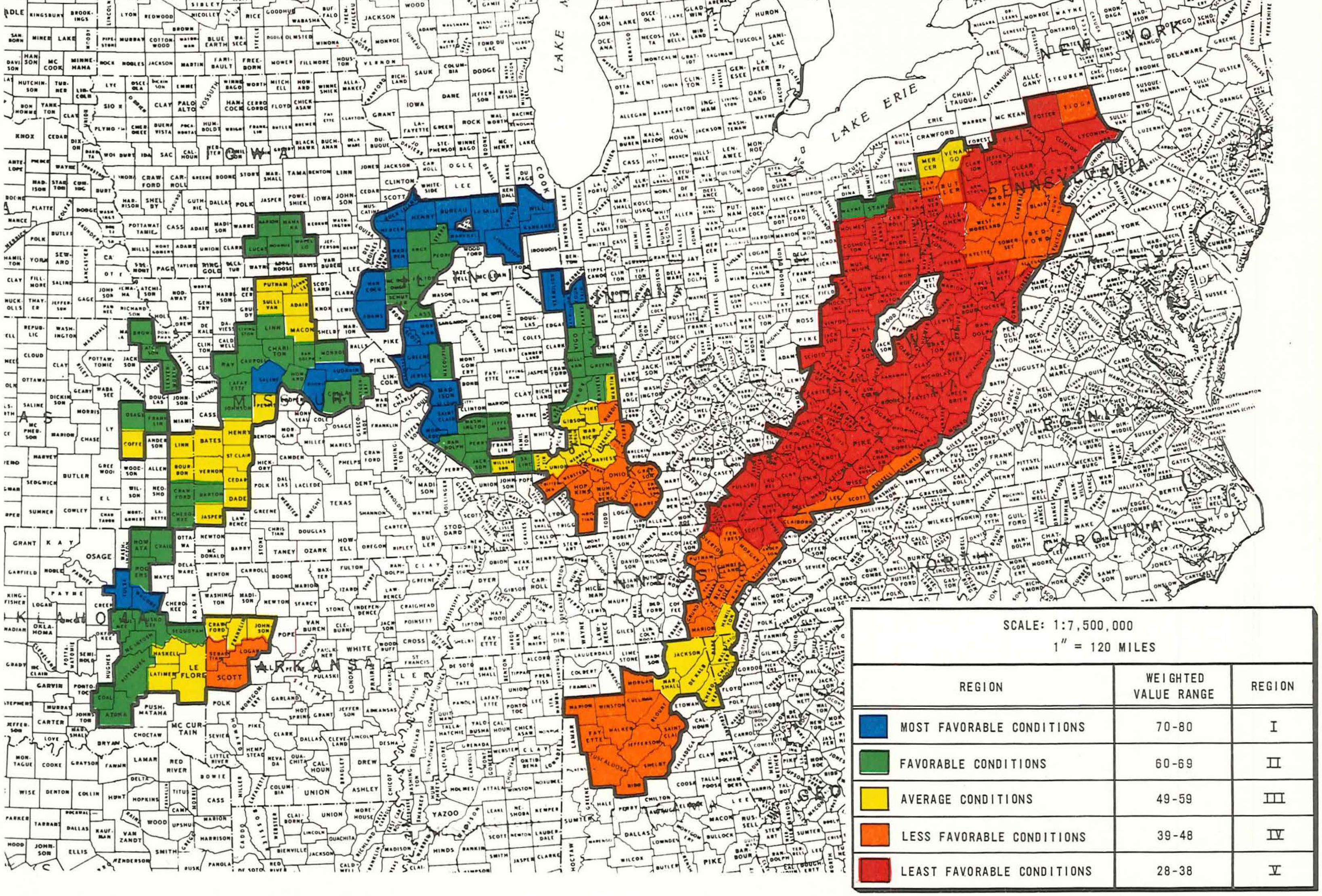


FIG. 18 REGIONALIZATION OF RECLAMATION CONDITIONS

78-5

(1) Determination of Weighted Values

Each of the categories related to specific physical factors were multiplied by the weighted number to arrive at a weighted value for each category. Figure 16 shows the results of these calculations. The figures show that the highest total weighted value that could be obtained is 87.0 which relates to the optimal physical conditions for successful reclamation. The lowest possible weighted value was 27.0 which relates to the worst physical conditions for successful reclamation.

(2) Calculations of Weighted Values

Using the weighted values for each category of physical factor, numerical values for each county in the study area were calculated by summing the weighted values for each physical factor in a county (derived from the maps, Figures 10-15). For example; Jersey County, Illinois, had the highest (80.25) of the cumulative weighted values of the six physical factors. On the other hand, the lowest (27.50) cumulative weighted value was found in eight counties in Appalachia. These counties were Knox and Whitley Counties in eastern Kentucky; Calhoun, Harrison, Marion, Monongalia and Taylor Counties in West Virginia; and Cameron County in Pennsylvania.

The cumulative weighted values for each county was determined and the distributions plotted as shown in Figure 17. From the distribution, five distinct groupings were evident. These groups were assigned as Regions I through V in descending order of weighted values. Region I contained the highest weighted values, and therefore the most favorable conditions for reclamation. Figure 17 also shows the average weighted value for each state and coal field along with the ranges of weighted values in each state. As can be seen, the states within coal regions tend to cluster together. The states in the Eastern and Western Interior coal fields generally have better conditions for reclamation and generally lie in the average to most favorable regions. Illinois had the most favorable conditions of all the states, and Oklahoma and Iowa had the highest values for the Western Interior fields. The Appalachian states, conversely, range from average to least favorable conditions for reclamation. Eastern Kentucky and West Virginia had the least favorable conditions.

PHYSICAL FACTORS/CATEGORIES	RATING WITHIN FACTORS 0-10	% OF TOTAL	MULTIPLIER BASED ON (10)	WEIGHTED VALUE
A. SOIL TYPES	---	25	---	---
1. MOLLISOLS	8	---	2.5	20.0
2. ALFISOLS	7	---	2.5	17.5
3. ULTISOLS	4	---	2.5	10.0
4. INCEPTISOLS	3	---	2.5	7.5
B. SLOPES	---	25	---	---
1. MORE THAN 80% OF AREA GENTLY SLOPING (<8°)	9	---	2.5	22.5
2. 50-80% OF AREA GENTLY SLOPING (<8°)	7	---	2.5	17.5
3. 20-50% OF AREA GENTLY SLOPING (<8°)	5	---	2.5	12.5
4. LESS THAN 20% OF AREA GENTLY SLOPING (<8°)	2	---	2.5	5.0
C. pH CONDITIONS IN OVERBURDEN	---	20	---	---
1. OVERBURDEN pH 4.5 - 9.0	9	---	2.0	18.0
2. OVERBURDEN CONTAINS ROCK LAYERS WITH pH>9.0, BUT NOT LESS THAN 4.5	7	---	2.0	14.0
3. OVERBURDEN CONTAINS ROCK LAYERS WITH pH AS LOW AS 3.4	4	---	2.0	8.0
4. OVERBURDEN CONTAINS ROCK LAYERS WITH pH>9.0 AND ROCK LAYERS WITH pH AS LOW AS 3.4	3	---	2.0	6.0
5. OVERBURDEN CONTAINS ROCK LAYERS WITH pH <3.4	2	---	2.0	4.0
D. GEOLOGY OF THE OVERBURDEN	---	20	---	---
1. GLACIATED WITH LIMESTONE IN THE OVERBURDEN	9	---	2.0	18.0
2. GLACIATED WITHOUT LIMESTONE IN THE OVERBURDEN	7	---	2.0	14.0
3. NOT GLACIATED WITH LIMESTONE IN THE OVERBURDEN	5	---	2.0	10.0
4. NOT GLACIATED WITHOUT LIMESTONE IN THE OVERBURDEN	3	---	2.0	6.0
E. MEAN ANNUAL PRECIPITATION	---	5	---	---
1. OVER 48"	8	---	.5	4.0
2. 32" TO 48"	7	---	.5	3.5
F. AVERAGE ANNUAL RUNOFF	---	5	---	---
1. LESS THAN 10"	9	---	.5	4.5
2. 10-20"	6	---	.5	3.0
3. OVER 20"	3	---	.5	1.5
TOTAL WEIGHTED NUMBER		100		
			HIGHEST TOTAL WEIGHTED VALUE (OPTIMAL)	87.0
			LOWEST TOTAL WEIGHTED VALUE (WORST)	27.0

FIG. 16 INDIVIDUAL RATINGS AND WEIGHTED VALUES OF FACTORS AFFECTING SUCCESSFUL RECLAMATION (PRELIMINARY DATA)

73-5

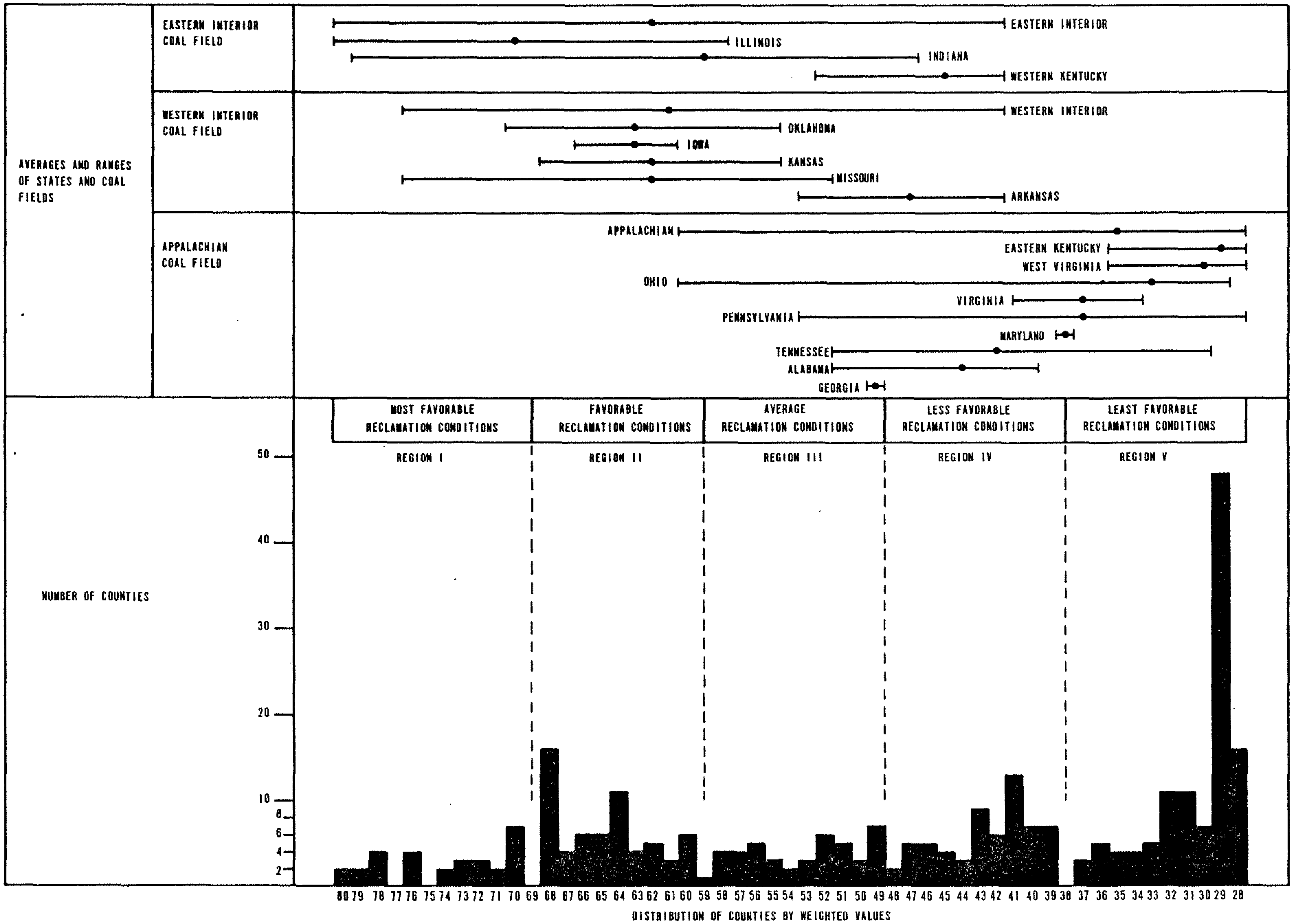


FIG. 17 RESULTS OF SUMMATIONS OF WEIGHTED VALUES TO DETERMINE EASE OF RECLAMATION

78-5

(3) Mapping and Describing the Regions

Each of the counties in the study area was mapped according to the region that its cumulative weighted value fell in. The counties contained in each of the five regions are shown in Figure 18. Counties in Region I, those with most favorable reclamation conditions, were found mainly in northern and central Illinois with some counties in Indiana. Some counties in Missouri and Oklahoma were also included in Region I. Counties in Region V, the least favorable reclamation conditions, were limited to central and northern Appalachia. The entire coal regions of eastern Kentucky and West Virginia were included in Region V. In addition, major portions of Ohio and Pennsylvania were in Region V. This regionalization was used to develop some comparative economic and productivity analyses of the regions in section IV of this report.

In order to better understand the regionalization, a description of each of the regions is included. One can note that the descriptions are based on a region-by-region analysis of the physical factors used for the regionalization. Figure 19 shows a comparison of the regions with the dominant and subdominant physical characteristics of each region and percentages. As the figure shows, the presence of favorable physical factors decrease as the regions become less favorable for reclamation. Each region is discussed in the following sections.

REGION I - Most Favorable Reclamation Conditions - This region contains those counties which have the most favorable conditions for successful reclamation based on the weightings of the six physical factors. A number of counties in central and northern Illinois are included. In addition, two counties in northern Indiana, three counties in central Missouri and two counties in Oklahoma are included. No counties in the Appalachian coal field are included.

The soils of the region are dominated by Mollisols in 62% of the counties and by Alfisols in the remaining 38% of the counties. All of the region contains over 50% of the land in gentle slope (<8°). Seventy-one percent of the counties in the region contain 50-80% of the land in gentle slopes. Twenty-nine percent of the counties contain area in which over 80% of the land was in gentle slope. The characteristics of the overburden indicated that almost all the region had overburden with pH greater than 3.4. Forty-six percent of the counties had overburden with pH as low as 3.4 but not more than 9.0,

	PHYSICAL FEATURES: SOIL TYPE				SLOPE				pH OF OVERBURDEN				GEOLOGY OF OVERBURDEN				PRECIPITATION		RUNOFF		
	MOLLISOLS	ALFISOLS	ULTISOLS	INCEPTISOLS	>80% OF AREA GENTLY SLOPING	50-80% OF AREA GENTLY SLOPING	20-50% OF AREA GENTLY SLOPING	<20% OF AREA GENTLY SLOPING	pH 4.5-9.0	pH 4.5-9.0 SOME >9.0	pH-SOME AS LOW AS 3.4	pH-SOME <3.4	GLACIATED WITH LIMESTONE	GLACIATED WITHOUT LIMESTONE	NOT GLACIATED WITH LIMESTONE	NOT GLACIATED WITHOUT LIMESTONE	32″-48″	>48″	0″-10″	10″-20″	>20″
REGION I MOST FAVORABLE RECLAMATION CONDITIONS	A 62%	B 38%	-	-	B 29%	A 71%	-	-	A 42%	-	A 46%	-	A 47%	A 46%	-	-	A 100%	-	A 100%	-	-
REGION II MORE FAVORABLE RECLAMATION CONDITIONS	A 48%	A 43%	-	-	-	A 86%	B 10%	-	-	-	A 68%	B 18%	B 18%	A 68%	-	-	A 78%	B 22%	A 66%	B 34%	-
REGION III AVERAGE RECLAMATION CONDITIONS	-	B 22%	A 55%	-	-	A 58%	B 23%	-	-	-	A 48%	A 47%	-	-	A 41%	A 43%	A 71%	B 29%	-	A 52%	B 32%
REGION IV LESS FAVORABLE RECLAMATION CONDITIONS	-	-	A 38%	B 31%	-	B 15%	A 76%	-	-	-	A 61%	B 36%	-	-	B 30%	A 67%	B 47%	A 53%	-	A 48%	A 52%
REGION V LEAST FAVORABLE RECLAMATION CONDITIONS	-	-	B 15%	A 85%	-	-	B 8%	A 92%	-	-	B 4%	A 96%	-	-	B 13%	A 87%	A 89%	B 11%	-	A 70%	B 30%

A-DOMINANT TYPE - HIGHEST PERCENTAGE OF COUNTIES IN THIS CATEGORY - IF ONLY A, 95% OR GREATER IN THAT CATEGORY.

B-SUBDOMINANT TYPE - SECOND HIGHEST PERCENTAGE OF COUNTIES IN THIS CATEGORY.

A-A-TWO DOMINANT TYPES - TWO HIGHEST PERCENTAGES OF COUNTIES WITHIN 5% OF EACH OTHER.

FIG. 19 SUMMARY OF PHYSICAL CHARACTERISTICS OF THE REGIONS

78-5

while 42% of the counties had overburden pH's in the 4.5-9.0 range. Ninety-three percent of the counties were in glaciated areas equally divided between the absence or presence of limestone in the overburden. All of the counties received between 32" and 48" of annual precipitation. Ninety-seven percent of the counties experienced less than 10" of runoff per year.

REGION II - Favorable Reclamation Conditions - This region contains those counties with favorable reclamation conditions based on the weighting of the six physical factors. A number of counties in Illinois and Indiana are included in this region. In addition, counties in Iowa, Missouri, Kansas and Oklahoma are in Region II. Three counties in northeastern Ohio are in this region because of their similarity of soil types and slopes to northern and central Indiana.

The soils of the region are comprised mainly of Mollisols and Alfisols. Forty-eight percent of the counties contained Mollisols and 43% contained Alfisols. Eighty-six percent of the counties were comprised of land in which 50-80% was in gentle slopes. The pH of the overburden varies in that 68% of the counties contained overburden with pH in the 3.4-9.0 range. Eighteen percent of the counties had overburden with some material less than 3.4. Glaciated areas were contained in 72% of the counties. Sixty-four percent of the counties contained glaciated areas without limestone beds in the overburden. Seventy-eight percent of the counties received between 32 and 48 inches of annual precipitation. Annual runoff in 66% of the counties was less than 10 inches. The remainder of the counties have annual runoff between 10 and 20 inches per year.

REGION III - Average Reclamation Conditions - This region contains those counties which have average conditions for successful reclamation based on the weightings of the six physical factors. All of the coal fields in the study area are well represented in this region and this region is a transition zone between favorable and unfavorable reclamation conditions. The region includes counties in the southcentral part of the Eastern Interior field and counties distributed in all portions of the Western Interior fields. In addition, counties in southern and northern Appalachia are included. Those counties in the Eastern and Western Interior fields in the region represent areas which have less attractive factors related to those particular fields, whereas the Appalachian counties in Region III represent some of the better reclamation conditions in Appalachia. Thirty percent of the counties in Region III contain Ultisols, which is the largest single soil category. Thirty-five percent of the counties contain a combination of Mollisols, Alfisols and Ultisols. Twenty-one percent of the counties contain a combination of Mollisols and Alfisols. Areas in which 50-80% of the land is gently sloping are contained in 58% of the counties. The remaining slope conditions are fairly equally-divided among over 80% of the land in gentle slope, 20-50% of the land in gentle slope or combinations thereof. The p^H conditions in the overburden are in two categories. Forty-eight percent of the counties contain overburden in the 3.4-9.0 range. Forty-seven percent of the counties contain overburden with some layers of less than p^H 3.4 and up to 9.0. Eighty-four percent of the counties are in non-glaciated areas with 43% of the counties having overburden without limestone beds and 41% with limestone beds. Seventy-one percent of the counties receive 32-48 inches of annual precipitation. Fifty-two percent of the counties have an annual runoff of 10-20 inches. Thirty-two percent of the counties have annual runoff of less than 10 inches.

REGION IV - Less Favorable Reclamation Conditions - Most of the counties included in this region are located in western Kentucky and in the Appalachian coal fields. This region represents the worst reclamation conditions found in the Eastern Interior coal field. In Appalachia, Region IV contains counties in northern and southern Appalachia.

The soils of Region IV are a combination of the poorer reclamation soils. Thirty-eight percent of the counties contain Ultisols while 31% contain Inceptisols. Twenty-four percent of the counties contain some combination of the two. Seventy-six percent of the counties contain land that is 20-50% gentle slope. The overburden is characterized by 61% of the counties containing overburden pH ranging from 3.4-9.0. Thirty-six percent of the counties contain overburden with some layers with pH less than 3.4 up to a pH of 9.0. Ninety-seven percent of the counties are in non-glaciated areas and 67% of the counties contain overburden without limestone. Annual precipitation in 53% of the counties is over 48 inches and in the remaining counties it ranges from

32 inches to 48 inches. Annual runoff in 52% of the counties is greater than 20 inches while in 48% of the counties the runoff is between 10 and 20 inches.

REGION V - Least Favorable Reclamation Conditions - This region contains those counties in which the least favorable reclamation conditions exist based on the weightings of the six physical factors. This region is limited to Appalachia with the bulk of the counties located in central and northern Appalachia.

Eighty-five percent of the counties in this region contain Inceptisols. This is the poorest reclamation soil type. Ninety-two percent of the counties have land of which 20% or less is in gentle slopes. Ninety-six percent of the counties contain overburden in which some layers have pH of less than 3.4 up to 9.0. Overburden that is non-glaciated and without limestone beds is located in 87% of the counties. Annual precipitation of 32 to 48 inches is found in 89% of the counties. Seventy percent of the counties have an annual runoff between 10 and 20 inches. The remainder of the counties have runoff in excess of 20 inches annually.

From the regional analysis it can be seen that counties in the Appalachian coal field are at a distinct disadvantage in the ability to achieve successful reclamation, based on purely physical factors. This is the first time, to our knowledge, that such a detailed regional analysis of the ease of reclamation has been attempted. This analysis serves as a base for our regional analysis, and the data relating to each state is used for comparative analysis in proceeding tasks.

(3) Comparison of Reclamation Activities in the States and Minimum Standards for Environmentally Sound Reclamation

a. Evaluation of Meeting Minimum Environmental Standards

Field data results from the reclamation checklist were compared to a series of key reclamation factors to determine if recent reclamation within the fifteen states is environmentally sound. A total of eight key reclamation factors were selected on the basis of those commonly mentioned in the states' reclamation legislation and regulations. The eight factors used were slope, backfill, surface material pH, revegetation, topsoil, water pH, erosion, and erosion protection features. These reclamation factors were included on the reclamation checklist which was utilized to collect field data. For each of the factors, categories with quantitative or qualitative limits were established based on averages of specific state guidelines. For example, four categories for the surface material pH factor were developed; the first category is pH >6.5 which is an excellent environmental condition. The second category is pH 5.6-6.4 which is an environmentally acceptable condition, but not a good as the first. The third category is pH 4.5-5.5 which involves moderate environmental problems. The fourth category is pH <4.5 which indicates a significant problem.

Water sampling at the reclaimed sites was done with a Leeds & Northrup Portable pH Meter. Soil samples were analyzed using a LaMotte-Morgan Soil Test Kit, Model St-1001-MR.

Not all of the factors were assigned four categories. For instance, the topsoil factor has only two categories; if topsoil was not restored it represents an environmental degradation (there are some areas where soil and subsoil are a better plant medium than the existing topsoil, but this is a limited situation and in this analysis we have dealt with general situations).

To evaluate the recent reclamation in the states (areas released from bond) a matrix type of analysis was performed as shown in Figure 20. The eight key reclamation factors and the categories within these factors are shown. To provide a rating system of the reclaimed sites among the sixteen states (eastern and western Kentucky are considered separately), each category has been assigned a numerical rating based on 0-10 range. An excellent environmental condition was rated 8, an acceptable environmental condition is rated 6, moderate environmental degradation was rated 4, and a significant environmental degradation was rated 2. By summing all ratings associated with the 51 reclaimed sites visited, a relative index of reclamation achievement related to minimum environmental standards is arrived at for each state. The highest rating that could be achieved by a state was 64 and the lowest rating was 18. The results of the sum of the ratings is shown at the bottom of Figure 20.

An analysis of all the sites indicates that most of the sites generally meet minimum environmental standards when taking the average ratings of all eight reclamation factors. Minimum environmental standards are those minimum requirements which will not be deleterious to the environment such as adequate

RECLAMATION FACTORS	RATING	ALA			ARK		ILLINOIS					INDIANA				IOWA		KAN		KENTUCKY						MD		MO		OHIO						OKLA		PENN					TENN			VA		W.VA					TOTAL SITES	PERCENTAGE	
SITE NUMBER		1	2	3	1	2	1	2	3	4	5	1	2	3	4	1	2	1	2	E 1	E 2	W 1	W 2	W 3	W 4	1	2	1	2	1	2	3	4	5	6	1	2	1	2	3	4	5	1	2	3	1	2	1	2	3	4	5			
STEEPEST SLOPE																																																					51	100	
0-10°	8	X	X		X		X	X	X	X			X		X	X	X	X	X										X	X				X		X	X					X											19	37	
11-20°	6			X							X	X								X	X	X	X	X	X	X	X	X			X	X	X		X			X	X	X	X							X	X				22	43	← MINIMUM STANDARD
21-30°	4																																										X	X	X	X	X			X	X	X	8	16	
>30°	2					X								X																																							2	4	
pH OF SURFACE MATERIAL																																																					51	100	
≧6.5	8	X					X	X	X		X			X	X	X	X		X		X			X				X	X	X	X	X	X	X	X	X	X						X	X	X			X	X	X			28	55	
5.6-6.4	6		X			X				X		X	X					X		X			X		X																X					X	X				X	X	14	27	← MINIMUM STANDARD
4.5-5.5	4				X																	X				X	X											X	X	X		X											8	16	
<4.5	2			X																																																	1	2	
REVEGETATION																																																					51	100	
>70%	8							X	X		X	X	X		X		X		X	X	X						X		X		X	X	X	X	X		X	X					X	X	X			X	X	X	X	X	27	53	
ROW CROP	8						X			X				X																																							3	6	← MINIMUM STANDARD
<70%	2	X	X	X	X	X										X		X				X	X	X	X	X		X		X						X			X	X	X	X				X	X						21	41	
TOPSOIL																																																					51	100	
RESTORED	8						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	43	84	← MINIMUM STANDARD
NOT RESTORED	2	X	X	X	X	X																						X								X	X																8	16	
WATER pH		●					●	●	●	●			●				●		●							●				●			●		●	●						●		●				●	●				34	100	
6.0-8.0	8		X	X								X		X	X	X				X			X	X			X	X	X		X	X					X	X							X								17	50	← MINIMUM STANDARD
5.0-5.9	4					X					X										X				X									X					X				X			X	X			X	X	X	12	35	
<5.0	2				X													X				X																		X	X												5	15	
EROSION																																																					51	100	
NO EROSION	8									X	X						X		X							X										X	X					X		X									9	18	
RILL & GULLY (STABILIZED)	6						X	X					X	X	X	X		X		X		X					X		X	X		X		X	X			X					X		X	X		X	X	X	X	X	24	47	← MINIMUM STANDARD
RILL & GULLY (UNSTABILIZED)	2	X	X	X	X	X			X			X									X		X	X	X			X			X		X						X	X	X						X						18	35	
DRAINAGE CONTROL																																																					51	100	
PRESENT	8																									X					X		X	X	X			X		X	X	X	X	X		X			X			X	14	28	
ABSENT <10° SLOPE	6	X	X		X		X	X	X	X	X		X		X	X	X	X	X										X	X						X	X																18	35	← MINIMUM STANDARD
ABSENT >10° SLOPE	2			X		X						X		X						X	X	X	X	X	X		X	X				X							X						X		X	X		X	X		19	37	
BACKFILL																																																					51	100	
COMPLETE	8	X	X				X	X	X	X	X	X	X		X	X	X		X			X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X		36	71	← MINIMUM STANDARD
HIGHWALL REMAINING	4			X	X	X								X				X		X	X							X	X														X	X	X	X	X					X	15	29	
AVERAGE RATING		36.0			27.0		55.2					53.0				58		49		45		40				51		45		55.6						53		45.2					50.6			37		49.6							

● WATER NOT PRESENT AT SITE

FIG. 20 COMPARISON OF RECLAIMED SITES IN ACHIEVING ENVIRONMENTALLY SOUND RECLAMATION

78-5

vegetative cover, soil conditions amenable to plant growth, slope configurations that generally blend with surroundings and are stable, water quality that is not biologically degrading or poses a sedimentation problem, and generally, a reclaimed site that is aesthetically pleasing to the eye. Minimum environmental conditions mentioned herein were defined by the study team and documented in reclamation and environmental literature. A summary of the analysis of each factor is provided below.

(1) Slope

Eighty percent of the reclaimed sites had remaining slopes of less than 20°. These steeper slopes were encountered in central Appalachia - eastern Kentucky, West Virginia, Tennessee and Virginia.

(2) pH of Surface Material

Surface material pH in excess of 5.6 was found on 82% of the sites. The remaining 18% of the sites had surface material with pH less than 5.6 Low pH conditions were generally confined to the Appalachian states.

(3) Revegetation

Some 58% of the sites had adequate row crops or over 70% vegetative cover on the reclaimed sites. A high percentage (42%) of the sites had less than 70% vegetative cover. This problem was found in each of the coal fields. This indicated that it is probably a common problem not necessarily associated with regional physical factors but more of a technical reclamation and/or inspection problem.

(4) Topsoil

Eighty-six percent of the sites had the topsoil restored in place. The sites that had not restored the topsoil were not in any specific coal field or reclamation region. This is probably either an enforcement problem or no topsoil was available for restoration.

(5) Water pH

Some of the reclaimed sites studied did not have water present. Thirty-four sites did have water present. At least one site in each of the states had water. Fifty percent of the sites with water met minimum environmental standards in that the water pH was between 6.0 and 8.0. The remaining 50% of the sites had water with pH lower than 6.0 and 15% of those sites had water pH of less than

5.0. Again, those sites in which the water pH was below minimum standards were in states within all coal fileds. The pH distribution across the study area indicates that sampling and inspection procedures should be reviewed for water pH.

(6) Erosion

Sixty-seven percent of the sites had no erosion or the rill and gully erosion was stabilized. Thirty-three percent of the sites had rill and gully erosion which was not stabilized. This condition was somewhat related to the slope condition remaining on the sites. The majority of these sites were in the Appalachian coal fields. It is interesting to note that reclaimed sites, for which the services of the county agent or the Soil Conservation Service had been utilized, were much less susceptible to erosion problems.

(7) Drainage Control

It is interesting to note that 26% of the sites had some type of drainage control present. This ranged from diversion ditches on long slopes to controlled runoff structures including water bars and overflow ponds. Thirty-five percent of the sites had no drainage control but the slopes were less than 10° and control was generally not needed. Some 39% of the sites confined to the Appalachian coal field had no drainage control although slopes in excess of 10° were common.

(8) Backfill

Seventy-one percent of the sites had complete backfill with no highwall remaining. Some 29% of the sites had the highwall remaining. In five states all sites had highwalls remaining. This condition can be attributed to the regulations and procedures of these states in which an operator left portions of a highwall remaining if it was related to recreation or wildlife use.

b. A Comparison of the Ease of Reclamation and Achieving Environmentally Sound Reclamation

The average ratings of the eight reclamation factors were calculated for each of the states in the study area by taking the averages of the sites in each state. The results of this calculation are shown at the bottom of Figure 20. The ratings for all states ranged from 27 to 58. By using the definition of the ratings as discussed in Section IV B3,a relative range related to environmentally sound reclamation was developed. States with a rating in the 18-32 range were below average in meeting environmentally sound reclamation. Those states in the 32-48 range were average in meeting environmentally sound reclamation. The states in 48-64 range were above average in achieving environmentally sound reclamation.

The results of the rating of the states are shown in Figure 21. The results show that Iowa received the highest rating, 58.0, while Arkansas was the lowest, 27.0. Based on the ranges discussed in the previous paragraph, all of the states except Arkansas were average or above average in achieving environmentally sound reclamation. It is interesting to note that the average rating of the states in the Eastern Interior coal field is 49.4 or above average. The states in the Western Interior and Appalachian coal fields average in the upper part of the average range with 46.4 and 46.2, respectively. Several Appalachian states are in the above average range with Ohio ranked second overall at 55.6.

In order to arrive at a true picture of these ratings, they were compared to the ease of reclamation weightings derived in a previous section. This comparison looks at the ability to achieve environmentally sound reclamation in relation to the ease of reclamation in the states based on physical factors. The results of this analysis are shown in Figure 22.

The analysis shows an expected comparison for the Eastern and Western Interior coal fields. The states in those fields have more favorable reclamation conditions than Appalachia and are above average in meeting minimum environmental standards. The averages for the Eastern Interior field indicates that favorable reclamation conditions exist and the states are above average in achieving sound reclamation. For the Western Interior field the averages indicate that they have favorable reclamation conditions and are average in achieving sound reclamation. The Western Interior field average is lower because of the less favorable reclamation conditions in Arkansas and the sites in that state were below average in achieving sound reclamation.

The analysis indicates an interesting trend in the Appalachian coal field. All of the Appalachian states have less favorable or the least favorable reclamation conditions but are average or above average in achieving environmentally sound reclamation. Three states in particular should be mentioned.

RATING		STATES	COAL FIELDS
ABOVE AVERAGE	60		
		IOWA 58.0	
	55	OHIO 55.6	
		ILLINOIS 55.2	
		INDIANA 53.0	
		OKLAHOMA 53.0	
		MARYLAND 51.0	
		TENNESSEE 50.6	
	50	WEST VIRGINIA 49.0	EASTERN INTERIOR 49.4
		KANSAS 49.0	
AVERAGE			WESTERN INTERIOR 46.4
			APPALACHIAN 46.2
	45	PENNSYLVANIA 45.2	
		EASTERN KENTUCKY 45.0	
		MISSOURI 45.0	
	40	WESTERN KENTUCKY 40.0	
		VIRGINIA 37.0	
		ALABAMA 36.0	
	35		
BELOW AVERAGE	30		
		ARKANSAS 27.0	
	25		

FIG. 21 RATINGS IN ACHIEVING ENVIRONMENTALLY SOUND RECLAMATION

78-5

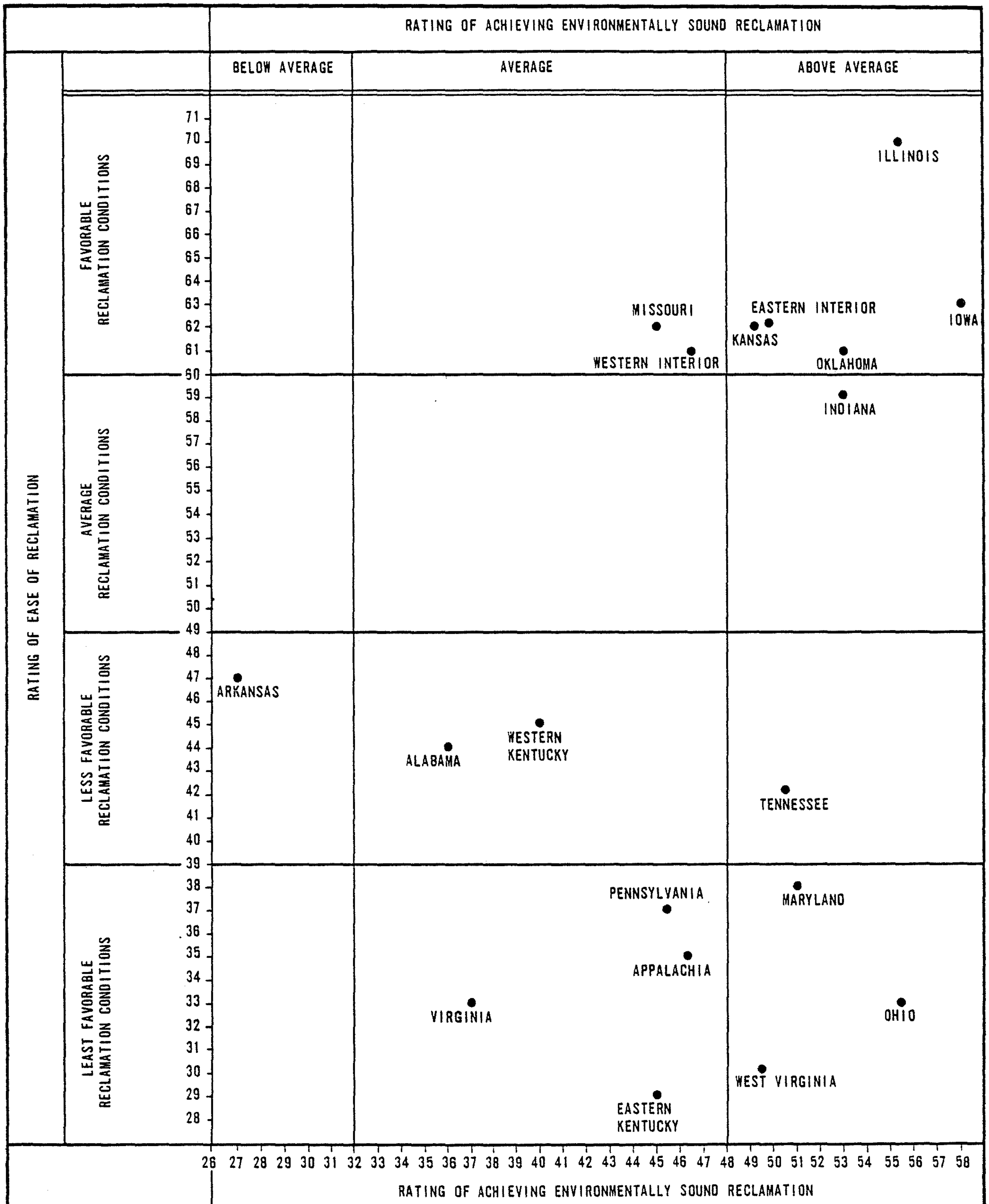


FIG. 22 COMPARISON AMONG STATES OF EASE OF RECLAMATION TO ACHIEVING ENVIRONMENTALLY SOUND RECLAMATION

78-5

West Virginia had the least favorable conditions of any state in the study except eastern Kentucky but was above average in achieving environmentally sound reclamation. Ohio was rated as having some of the least favorable reclamation conditions but was rated as second to Iowa in achieving environmentally sound reclamation. Maryland also was in the least favorable range for reclamation but was achieving above average environmentally sound reclamation. In reviewing the results of the discussions with mining operators and regulatory personnel and the regulations of Maryland, Ohio and West Virginia, it was felt that the major reasons for the success in those states were: 1) Adequate regulation and enforcement, 2) Close cooperation between operators and regulators, and 3) Use of advisory services provided by state and federal agencies related to reclamation.

In summary, the results of this analysis indicate that nine states have above average success in achieving environmentally sound reclamation. The fact that these states have a wide range of physical conditions for reclamation will affect the adequacy of regulations. Also, the operational structure of the state regulatory agencies and their relationship with the operators are additional factors in achieving environmentally sound reclamation.

3. Reclamation Compliance Related to State Bond Release Criteria

a. Bond Release Criteria in State Regulations

State requirements for bond release generally fall into seven categories; regrading, backfilling, revegetation, topsoil, water, erosion, and appearance.

Regrading - Most states' legislation address regrading requirements. Maximum allowable slopes are presented in most laws. In a contour mining situation outslopes, terraces, and highwall slopes may have different maximum allowable slopes. In an area mining situation the highwall and lowwall (spoil side of the pit) may have different maximum allowable slopes from the remainder of the mined area.

Backfilling - Most backfilling requirements consist of covering toxic materials or exposed coal seams with some minimum depth of non-toxic spoil or topsoil. In many states, permanent water impoundments may be substituted for non-toxic spoil. Some states require complete backfilling of the highwall.

Topsoil - Topsoil replacement is a requirement in most states. Minimum depths are listed in many regulations.

Revegetation - Most states have specific percent cover requirements for release of reclaimed sites planted with grasses and legumes. In addition most states have planting density and tree survival requirements per acre for tree plantings. Some states also require specific percent cover of grasses and legumes in tree plantings.

Water - Some states require that surface water quality meet certain standards. These standards may pertain to p^H, acidity, alkalinity, iron and sedimentation.

Erosion - Some states' legislation require erosion protection by construction of diversion ditches, vegetation barriers, etc.

Appearance - Most states' legislation mention subjective requirements regarding how well reclaimed areas blend with adjacent undisturbed lands, but no criteria related to appearance is specified.

The following paragraphs summarize on a state-by-state basis the bond release compliance requirements for the seven major categories mentioned previously. Included in these summaries is a discussion of the bond release requirements for these categories as contained in the Federal Register, December 13, 1977, Pages 62,639 through 62,716, Final Federal Regulations For Surface Coal Mining.

b. Specific State Bond Release Criteria

(1) Alabama

Regrading - "Contouring" means the surface configuration achieved by grading or regrading spoil piles to a rolling topography so that the regraded spoil piles are blended into the surrounding terrain in such a manner that the regraded area complements the drainage pattern of, and is similar to, the surrounding terrain.

Backfill - The operator shall backfill the final pit by sloping the last spoil pile toward the highwall to a depth of ten (10) feet above the bottom coal seam. The operator may elect to impound water to provide lakes or ponds for wildlife, recreational or water supply purposes. Such impoundment may be formed if its formation will not result in a harmful level of acid water accumulation.

Revegetation - Permanent vegetation shall be deemed as adequate vegetative cover if the vegetation has survived two growing seasons. Perennial grasses and legumes must cover at least 80% of the surface area. Tree or shrub species shall be at such a density to provide a minimum of 435 established seedlings per acre.

Topsoil - If any of the affected lands are toxic; deficient in plant nutrients; composed of sand, gravel, shale or stone to such extent as to prevent revegetation; the operator is required to cover such lands with topsoil, other overburden material, or fertilizers to insure revegetation.

Water - No specific criteria. Refers to Alabama Water Pollution Control Act of 1971.

Erosion - No specific criteria.

Appearance - No specific criteria. Site blends into surrounding terrain so that it is similar to surrounding terrain.

(2) Arkansas

Regrading - All ridges and peaks of land affected by open-cut mining shall be graded to a rolling or terraced topography. No final slope shall be greater than one vertical to three horizontal.

Backfill - Whenever the exposed face of mined seams that contain acid forming material are not covered by water, the operator shall cover the exposed face of such seams with earth of spoil material to a depth of not less than three feet.

Topsoil - Topsoil shall be applied if soil tests indicate a necessity.

Revegetation - Soil tests shall be made.

Water - A pH of 6.0 to 8.0 must be maintained on water bodies.

Erosion - No specific criteria. Graded to rolling or terraced topography with adequate drainage.

Appearance - No specific criteria. Return to productive use which is left to the expertise and imagination of the operator within the requirements of the law.

(3) Illinois

Regrading - All land affected by surface mining shall be graded to a rolling topography traversable by machines necessary for maintenance in accordance with planned use. Such slopes shall have no more than a 15% grade, or 30% grade for forest and wildlife plantings. However, the slope of affected lands need not be reduced to less than the original grade. All highwalls shall be reduced to a maximum slope of 50%.

Backfill - Acid forming materials present in the exposed face of the mined mineral seam shall be covered with not less than four feet of water or other materials.

Topsoil - Soil shall be returned (at least 18 inches).

Revegetation - Four hundred and fifty living trees/acre. Sixty-five percent cover of legumes and/or perennial grass shall be required in August through October of the seeding year or an 85% stand shall similarly be required the year following seeding.

Water - Shall be able to support acceptable aquatic life.

Erosion - No specific criteria. Appropriate water disposal practices such as diversions and terraces shall be supplied.

Appearance - No specific criteria. The affected lands need not be reduced to less than original grade of the overburden prior to mining. Long-range multiple land-use is recommended.

(4) Indiana

Regrading - Grading shall be carried out on the affected area by the operator so as to reduce peaks and ridges and diminish depressions between such peaks to a rolling topography consistent with the land use objectives of the reclamation plan. Final cut 33 1/3% maximum.

Backfill - The operator shall construct earth dams in final cuts of all operations unless acid forming materials are present in the exposed face of a mineral seam; in this case, the operator shall cover the acid forming material with a minimum of two feet of nontoxic overburden.

Topsoil - No specific criteria. Generally 18 inches of topsoil for row crops and 6 inches for pasture and hay.

Revegetation - Satisfactory vegetative cover is cover which would be acceptable in commercial agricultural and forestry operations in Indiana and approved by the Department of Natural Resources.

Water - Shall not be acidic.

Erosion - No specific criteria. Must establish cover crop vegetation immediately after grading to prevent erosion and sedimentation. Must break up long uninterrupted slopes. No requirement for any drainage control except immediately after grading.

Appearance - No specific criteria. Must conform to land use objectives in plan of reclamation.

(5) Iowa

Regrading - Spoil banks should have a maximum of one foot of vertical rise for each four feet of horizontal distance (14°) except where original contour was steeper.

Backfilling - Cover with at least two feet of earth or spoil material, acid forming materials present in a mineral seam exposed by mining operations if the exposed acid forming materials are not covered by impounded water.

Revegetation - Revegetate to a condition similar to the premine state. A diverse, effective and permanent vegetative cover capable of self-regeneration and plant succession equal in extent of cover to the natural vegetation shall be established on all affected land.

Topsoil - Topsoil consisting of the A, B and C horizons shall be removed separately and replaced on graded spoil. A minimum of five feet of glacial till must be placed over top of the spoil before topsoiling.

Water - No specific criteria. Leachate will not pollute surface or ground water.

Erosion - No specific criteria. Cover with quick growing plant species.

Appearance - No specific criteria. Must comply with rehabilitation proposed in application. Be compatable with surrounding areas.

(6) Kansas

Regrading - Land to be restored to rolling type terrain shall have a gently sloping surface with drainage provided to suitable outlets for all portions of the permit area. Maximum slope is 25%.

Backfilling - Cover the face of the coal or other minerals with compacted nonacid-bearing and nontoxic materials to a distance of at least two (2) feet above the seam being mined or by a permanent water impoundment.

Revegetation - All disturbed areas shall be seeded with grasses and legumes. Subjective evaluations are made after one growing season. The vegetation should minimize soil erosion, conceal the effects of stripping operations and put the land into an approved beneficial use.

Topsoil - Reclamation shall be conducted in such a manner that upon completion of grading and shaping of the overburden, the surface of mined lands shall be covered with an adequate depth of soil materials capable of sustaining vegetation of at least the quality and variety of that sustained prior to mining operations.

Water - No specific criteria. All waters in existence on mined land after reclamation shall become public waters. Must conform to regulations of Division of Water Resources. Impound, drain or control the flow of all runoff water so as to reduce soil erosion.

Appearance - No specific criteria. Should be returned to productive use.

(7) Kentucky

Regrading - The steepest slope of the reduced or backfilled highwall and of the outer slope of the fill bench shall be no greater than 45 degrees. With area mining complete, backfilling is required with grading to approximate original contour. However, where a flat surface or a surface with less slope than the original ground surface is desired, such surface shall be deemed to comply with approximate original contour.

Backfilling - In the area mining situation, backfilling must be complete. The restored contour mining bench must have a minimum of four feet of fill over the floor of the pit from which the coal has been removed.

Revegetation - At least 70% cover for permanent vegetation on all surface mined areas; or 80% cover on areas approved for grasses and legumes only.

Topsoil - None required. Soil must meet pH level required by department regulations.

Water - pH must be between 6.0 and 9.0. Iron must be <7mg/l. Settleable matter must be <150 Jackson Turbidity Units except during precipitation.

Erosion - No specific criteria. Erosion control plan required. May require operator to remove backfill and regrade water control structure after approval of vegetative cover.

Appearance - No specific criteria. Reclaim area as per plan.

(8) Maryland

Regrading - All areas where the slope of the original ground can be defined as having an angle of inclination of less than 12° from horizontal shall be restored in accordance with the definition of approximate original contour.

Areas where the slope of the original ground is >12°, the outer-slope and the highwall slope shall not exceed 35°. The table portion of the terrace shall not exceed 5° slope.

Backfilling - A minimum of four feet of fill shall be placed over the bottom of the pit.

Revegetation - Eighty percent cover for permanent grass cover. Sixty percent cover for grasses where trees are major cover.

Topsoil - Unless an exception is granted by the committee, topsoiling material shall be saved and stockpiled during the mining cycle and shall be distributed on the surface of the backfilled land for the purpose of establishing vegetative cover.

Water - pH range 6.0-8.5. Comply with Maryland law and FWPCA.

Erosion - No specific criteria. Discharges should be channeled to prevent erosion. Must protect adjacent property. Approved by SCS.

Appearance - No specific criteria mentioned.

(9) Missouri

Regrading - All ridges and peaks of overburden created by strip mining shall be graded to a rolling topography traversable by farm machinery, but such slopes need not be reduced to less than the original grade. The slope of the ridge of overburden resulting from a box cut need not be reduced to less than 25°.

Backfilling - The operator shall cover the exposed face of a mineral seam, where acid forming materials are present, to a depth of not less than two feet with earth that will support plant life or with a permanent water impoundment.

Revegetation - No specific criteria. Planting should be appropriate to type of reclamation.

Topsoil - No specific criteria mentioned.

Water - No specific criteria mentioned.

Erosion - No specific criteria. The commission may require terraces or other measures as are necessary to control erosion on reclaimed land.

Appearance - No specific criteria mentioned.

(10) Ohio

Regrading - To original contour unless the reclamation plan includes terracing.

Backfilling - Backfilling must be complete.

Revegetation - Eighty-five percent cover with grasses and legumes. Eighty percent grass cover with 900 hundred trees per acre.

Topsoil - Topsoil shall be saved and evenly distributed over the graded area to a minimum depth of twelve inches.

Water - No specific criteria. Must conform to standard methods for examination of water.

Erosion - No specific criteria. Mulch should be used when grade or length of slope may cause substantial erosion.

Appearance - No specific criteria mentioned.

(11) Oklahoma

Regrading - All ridges and peaks of overburden created by surface mining shall be graded to a rolling topography traversable by machines or equipment customarily used in connection with the use to be made of the land after reclamation; such slopes need not be reduced to less than original grade.

Backfilling - The operator shall cover the exposed face of a mineral seam, where significant concentrations of acid forming materials are present, to a depth of not < three feet with earth that will support plant life or with a permanent water impoundment.

Revegetation - No specific criteria. Appropriate revegetation as determined by the operator. The department may prescribe density of plantings.

Topsoil - No specific criteria mentioned.

Water - No specific criteria mentioned.

Erosion - No specific criteria mentioned.

(12) Pennsylvania

Regrading - Must begin at or beyond the top of the highwall and sloped to the toe of the spoil bank at a maximum angle not to exceed the approximate original contour of the land with no depressions to accumulate water and with adequate provisions for drainage.

Backfilling - Acid-forming material shall be buried in the surface mining pit. The top layer of this material shall be covered with clean fill with a minimum thickness of ten feet.

Revegetation - On soils with pH's greater than 4.5, six feet by eight feet spacing of trees at 900 per acre is required. No specific grass cover mentioned but 70% is commonly used.

Topsoil - All topsoil and sufficient subsoil shall be removed to insure ample material for a cover of at least twelve inches after backfilling has been completed. No specified provision for soil sampling.

Water - No discharge to the waters of the Commonwealth unless pH value is between 6.0 and 9.0. Drainage courses shall not be disrupted by surface mining.

Erosion - No specific criteria mentioned.

Appearance - No specific criteria mentioned.

(13) Tennessee

Regrading - The entire area shall be regraded to a stable configuration that blends as naturally as possible with the surrounding area and presents no hazards to public health, safety or property. No slope except stable rock highwall shall exceed 35°.

When the slope of the original ground covering the coal seam is 15° or less, the following regulations apply. Complete backfilling to approximately the original contour or rolling topography shall be required.

Backfilling - At least four feet of compacted spoil shall be placed over the floor of the pit at all points.

Revegetation - Standards for legumes and perennial grasses shall require at least an 80% ground cover.

Topsoil - Topsoil or other soil suitable for supporting vegetation shall be separated and removed to an approved storage area for stockpiling during the mining operation. This soil shall be replaced after regrading.

Water - No specific criteria mentioned. Must meet requirements of Tennessee Water Quality Control Act of 1970.

Erosion - No specific criteria mentioned. Revegetation should minimize erosion. Water flow shall be controlled to minimize erosion.

Appearance - No specific criteria mentioned.

(14) Virginia

Regrading - Soil and spoil impinging onto disturbed lands will be graded so as to blend into the adjoining undisturbed land. The table portion of the restored area shall be a bench with a slope toward the highwall.

Backfilling - Spoils shall be retained on the bench insofar as feasible, and such spoils are to be subsequently used for backfilling to reduce the highwall. A minimum of four feet of material suitable for vegetation growth will be placed over the pit area and over any toxic or acid-producing material previously placed in the pit.

Revegetation - Survival for a period of two growing seasons.

Topsoil - No specific criteria mentioned.

Water - No specific criteria mentioned.

Erosion - No specific criteria. Must have erosion control plan in permit application. Mulch can be applied to control erosion.

Appearance - No specific criteria mentioned.

(15) West Virginia

Regrading - The table or bench shall be sloped towards the highwall. The outer slope shall be regraded to blend with undisturbed areas.

Backfilling - With area mining, backfilling shall be complete. A minimum of four feet of material suitable for vegetative growth shall be placed over the pit area and over any toxic or acid-producing material.

Revegetation - In no instance shall the official vegetative cover check be carried out until the plantings have survived two growing seasons. Standards for perennial grasses and legumes shall require at least 80% ground cover.

Standards for woody plants shall require the survival of a minimum of six hundred trees. For combination of grasses and woody plants, 60% ground cover and 60% survival rate.

Topsoil - In all acid-producing materials and acid-producing overburden, topsoil or upper horizon removal shall be required. All materials removed shall be stockpiled and returned to the surface of the regraded area.

Water - pH between 5.5 and 9.0.

Erosion - No specific criteria. Seeding of annuals is recommended where excessive runoff is likely to occur.

Appearance - No specific criteria mentioned.

c. Federal Surface Mining Reclamation and Enforcement Provisions

Regrading - The final graded slopes shall not exceed the approximate pre-mining slope or any lesser slope specified by the regulatory authority. On approval of regulatory authority, cut-and-fill terraces may be allowed.

When rills or gullies deeper than nine inches form in areas that have been regraded and topsoil replaced, but vegetation has not yet been established, the area shall be regraded. Shallower rills may be required to be stabilized by the regulatory authority.

Backfilling - All exposed coal seams remaining after mining and any acid-forming, toxic-forming, combustible materials, or any other waste materials identified by the regulatory authority that are exposed, used or produced during mining shall be covered with a minimum of four feet of nontoxic and noncombustible material.

Revegetation - The operator will establish on all land that has been disturbed, a diverse, effective and permanent vegetative cover of species native to the area of the disturbed land, or species that will support the planned post-mining land use. Success of revegetation shall be measured on the basis of reference areas approved by the regulatory authority. The ground cover on the revegetated area shall be equal to the ground cover of living plants of the reference area for a minimum of two growing seasons. The ground cover shall not be considered less than 90% of the ground cover of the reference area for any significant portion of the mined area.

Topsoil - After final grading and before the topsoil is replaced, regraded land shall be scarified and otherwise treated to eliminate slippage surfaces and to promote root penetration. The topsoil shall be redistributed in a manner that achieves an approximate uniform thickness, prevents excessive compaction of the spoil and topsoil, and protects the topsoil from wind and water erosion before it is seeded and planted.

Water - The pH of water effluent must be in the 6.0-9.0 range. All surface drainage from the disturbed area including disturbed areas that have been graded, seeded or planted shall be passed through a sedimentation pond(s) before leaving the area.

Erosion - No specific criteria, but references are made to minimizing erosion in sections on regrading, revegetation, topsoil and water.

Appearance - No specific criteria but area must be generally compatible with premining land use.

d. Analysis of Reclaimed Field Sites in Meeting State Bond Release Requirements

Reclamation compliance with state bond release criteria was determined by comparing the field data of the reclaimed sites with state legislation and rules and regulations.

The following paragraphs summarize, on an individual state compliance basis, the results of this analysis.

(1) Alabama

Regrading - Regrading on all three sites comply with the state law. The steepest slope is 11°.

Backfilling - Backfilling was complete on one site. The other two sites were partially backfilled but within compliance of the law. One site had very low pH readings indicating the acid-forming material may be near the surface.

Revegetation - Vegetative cover was much less than 70% on all three sites. This does not comply with the law which requires 80%. Trees were also planted and survival densities were 400 trees per acre or less on the three sites which is not in compliance with the standard of $\geq$ 435 trees per acre in the law. Trees were planted in areas separate from grasses; there was no combination planting.

Topsoil - Topsoil was not replaced on all portions of the sites. This is a possible violation of the law which states the operator must replace topsoil or other overburden material capable of supporting vegetation on the surface.

Water - Water quality was good on the two sites that had surface water. The low pH was 6.2 and the high was 7.5.

Erosion - Gullies and rills were present on all three sites and they have not been stabilized by vegetative cover. No erosion protection was present.

Appearance - Mined sites blended poorly with adjacent areas.

(2) Arkansas

Regrading - Regrading on the sites that were visited complies with the law. The steepest slope other than the low wall and highwall was 8°. The slope of one low wall was 43°. This was in compliance with state regulations.

Backfilling - Backfilling was accomplished leaving a pond in the old pit. The pH of the lake in one pit was 3.6, the other was 7.2. Surface material on one site had pH readings ranging from 5.4 to 6.6, the range at the other site was 4.6 to 5.4. These ranges indicate some acid-bearing material may be near the surface.

Revegetation - Percent cover on both sites was deficient; less than 50% in both cases.

Topsoil - Very little topsoil was replaced at either site. The surface material was composed of spoil in most areas.

Water - The pond in one final cut had a pH of 7.2. The pond on the other site had a pH of 3.6. One area of standing water was located and the pH was 5.7. The law states that water pH should be between 6.0 and 8.0.

Erosion - Gully and rill erosion was present on both sites and was not stabilized by vegetation. No diversion ditches were present.

Appearance - The sites blend moderately well with the adjacent areas.

(3) Illinois

Regrading - Regrading complied with the requirements of the law. The steepest slope was 11°.

Backfilling - Backfilling was complete on all five sites. The pH of surface material was favorable on all sites. The pH readings generally clustered around 7.1, the lowest reading was 5.0 and the highest was 8.0. The pH readings indicate that there is very little acid-forming material near the surface.

Revegetation - The % cover was greater than 70% on three sites. The other two sites were being used for row crop agriculture. The vegetative cover did comply with the law.

Topsoil - Some thin spots were noticed on three of the five sites, however they were few in number and the pH was favorable for plant growth.

Water - No surface water was found on the sites, except for an area of standing water which had a pH of 5.3.

Erosion - No rill or gully erosion was found on two of the five sites. Rill erosion only was found on two sites and the rills were stabilized by vegetation. Rill and gully erosion was present on one site; these erosion features were not stabilized by vegetation. No erosion protection features were present at that site.

Appearance - Sites blend well to very well with adjacent areas.

(4) Indiana

Regrading - Regrading generally conformed to the law, however the slope of the final cut was greater than the legal limit on one site.

Backfilling - Backfilling was complete and complied with the law. The pH readings from surface material generally clustered around 7.2, however two small bare areas on separate sites had pH readings <3.8 which indicates some acid bearing material near the surface.

Revegetation - The % cover was >70% on three of the four sites. The site which had less than 70% cover was planted with row crops which explains the lower % cover. Revegetation complied with the law.

Topsoil - Thin spots where spoil is visible were found on three sites, however except for two "hot spots" the pH was clustered near 7.2.

Water - The pH of standing water and ponds on the three sites that had surface water ranged between 6.0 and 8.0.

Erosion - Rill and gully erosion was present on the sites but affected 1% of the area. On the row crop site, erosion was typical of that found in an agricultural situation. On two of the other three sites the rills and gullies were stabilized by vegetation and were no longer a problem. No diversion ditches were present nor required.

Appearance - The sites blend well with adjacent areas.

(5) Iowa

Regrading - Field observations indicate that operators satisfy regrading requirements of the law. No slopes greater than 4° were observed on the sites that were visited. The slopes were traversable by farm machinery.

Backfilling - Backfilling was complete on the visited sites. Soil pH was not lower than 6.8 and no spoil material was visible which indicated that replacement of glacial till and topsoil on top of the spoil material was adequate and within the confines of the law.

Revegetation - Vegetation species were legumes and grasses. The % cover was less than 70% on one site and not totally effective for preventing erosion. On the other site, vegetative cover was greater than 70% and no gully or rill erosion was noticed.

Topsoil - Topsoil was replaced on both sites and the pH was favorable for plant growth.

Water - Water was located on one site and the pH was 6.8.

Erosion - Gully and rill erosion was present on less than 1% of the area on one site. No diversion ditches were present.

Appearance - The reclaimed sites blended very well with the surrounding area.

(6) Kansas

Regrading - Except for remaining highwalls along the final cut, no slopes were greater than 2°. The land was traversable by farm machinery.

Backfilling - Backfilling was accomplished within the law. On one site the pit was made into a permanent impoundment as a substitute for backfilling. The other site was backfilled with non-toxic spoil material (pH 6.3).

Revegetation - Revegetation species were grasses and legumes. On one site the percent cover was less than 70%. The vegetation on the other site was near 100%.

Topsoil - Topsoil was replaced on both sites, however some "hot spots" were found with spoil material present. Soil pH in these "hot" areas was $\leq$3.8, however these areas were few in number and generally less than 10 feet in diameter. Soil pH outside the hot spots was generally within the range of 6.3 to 6.8.

Water - Water used as a substitute for backfilling in one pit had a pH of 4.0 which is limiting to many aquatic organisms. However, this is apparently within the law because no mention is made concerning water quality of impoundments in the law. No diversion ditches were present.

Erosion - Rill and gully erosion was present on one site however, it was stabilized by bales of straw.

Appearance - Except for the remaining highwalls the areas blend very well with surrounding terrain.

(7) Kentucky

Regrading - Field observations indicate that operators satisfy regrading requirements of the law. Aside from reduced highwalls, the steepest slope measured was 16.5°. Highwalls were either reduced or completely backfilled.

Backfilling - Backfilling was complete on four of six sites that were visited. On two contour mining sites the highwall was not completely backfilled. On three of the six sites surface material pH measurements of 4.0 and lower were recorded which indicates that some toxic spoil is being placed near the surface.

Revegetation - The vegetative cover on two of the six sites satisfied the percent cover requirements of the law. On the other four sites, percent cover was less than 70%.

Topsoil - Thin spots in the topsoil where spoil is visible were present on all six sites.

Water - Water bodies of some type were present on all six sites. On one site the only water body present was standing water with a pH of 6.2. Ponds were present on the other five sites. Two ponds had a pH of 6.0, and the other three were 5.5, 5.6 and 4.0. The last three ponds are in violation of Kentucky law which states that water pH must be between 6.0 and 9.0 No erosion ditches were present.

Erosion - Rill or gully erosion is present on all sites, sometimes covering 25% or more of the site.

Appearance - Most sites did not blend with the surrounding terrain.

(8) Maryland

Regrading - Spoil regrading complies with the law on the two sites that were visited. The steepest slope found was 18°, and most slopes were <10°.

Backfilling - Highwalls were completely backfilled. The pH readings of surface material were generally within the range 3.8-5.3. This indicates that some acid-forming material is near the surface.

Revegetation - On one site the vegetative cover was greater than 70% and near compliance with the law, while the other site was less than 70% cover and not in compliance with the law.

Topsoil - Thin spots exist where spoil material is visible.

Water - Water present on one site had a pH of 6.5.

Erosion - Rill erosion was present on the site having less than 70% vegetative cover. No rill or gully erosion was found on the site with more than 70% cover. Diversion ditches were present on one site.

Appearance - The sites blended moderately well with the surrounding areas.

(9) Missouri

Regrading - Regrading of spoil was in compliance with the law on the two sites that were investigated.

Backfilling - Backfilling requirements were satisfied by forming a lake in the final cut.

Revegetation - One site has vegetation that had greater than 70% cover and one site was less than 70% cover. No specific criteria are discussed in the law.

Topsoil - Thin spots in the topsoil where spoil material is visible were present on both sites. On one site these thin spots corresponded with "hot spots" where no vegetation was growing (the pH was 3.8). However, these areas were few in number and less than eight feet in diameter.

Water - A stream traversed one site and had a pH of 6.4. The water impoundment on the old highwall at the second site had a pH of 6.2. The law does not provide specific water quality criteria.

Erosion - Gully and rill erosion was present on both sites, however on the site with vegetative cover >70%, the rills and gullies have been stabilized by vegetation and are not a serious problem. Erosion is a serious problem on the second site where vegetative cover is <70%. Rill and gully erosion affect about 50% of the site. No erosion protection features were present.

Appearance - Both sites blend with surrounding areas.

(10) Ohio

Regrading - Regrading complied with the law on the six sites that were visited. The steepest slope was 20°.

Backfilling - Backfilling was complete on all six sites. The pH readings for surface material clustered around 6.7; the low reading was 5.8 and the high reading was 7.6. The good pH readings indicate that no acid-bearing materials are present near the surface.

Revegetation - The percent cover was greater than 70% on five of the six sites and was in close compliance of the law on those five sites.

Topsoil - Some thin spots were present on some of the sites, however, they were not numerous and pH was favorable in all areas.

Water - Water pH readings were above 7.0 except for one site where readings averaged 5.0.

Erosion - Gully and/or rill erosion was present on all sites, however, diversion ditches were also present on four sites and were partially effective for protecting steep slopes until vegetation could stabilize the gullies and rills. Two sites had rills and gullies not stabilized by vegetation.

Appearance - Reclaimed areas blend very well with surrounding areas.

(11) Oklahoma

Regrading - Regrading conformed with the requirement of the law. The steepest slope found was 7°.

Backfilling - Backfilling was complete on both sites. Surface material pH was between 6.8 and 8.5, which indicates that no acid-bearing material is near the surface.

Revegetation - Percent cover was greater than 70% on one site and slightly less than 70% on the other.

Topsoil - No topsoil was replaced.

Water - Only one water body was found; the pH was 7.5.

Erosion - No rill or gully erosion was found on either site.

Appearance - The sites blend well with surrounding areas.

(12) Pennsylvania

Regrading - All five sites met the state criteria. The steepest slope was less than 20°.

Backfilling - The pH of the surface material ranged from 4.5-6.2. This may indicate some near-surface toxic material. The sites met the state criteria.

Revegetation - Considering the 70% minimum cover required for grasses and legumes, only one site met the requirement. The four other sites were below 70%. This criteria was only partially met.

Topsoil - All sites meet the state criteria. Topsoil had been regraded and fertilized.

Water - The criteria of pH between 6.0-9.0 was partially met. Of the four sites with water, two had water with pH <5.0 and one site had a pH > 6.0.

Erosion - Although erosion was a problem at all the sites, the state had no specific criteria for erosion.

Appearance - Three of the sites did not blend well with the surrounding area. The state had no specific criteria for appearance.

(13) Tennessee

Regrading - Regrading conformed with the requirements of the law. The steepest slope found on the site was 29°.

Backfilling - Backfilling was not complete on any site. The pH of the surface material was 6.4 or greater which indicates that acid-bearing material is not near the surface.

Revegetation - The percent cover was greater than 70% on all three sites and therefore complied with the law.

Topsoil - Thin spots in the topsoil were noticed but their pH was favorable and they supported vegetation.

Water - All water pH readings were 6.2 or greater except for one area of standing water which had a pH of 4.7.

Erosion - Rill and gully erosion was present on two of the three sites. The erosion features affected very limited portions of each site and usually were stabilized by vegetation. Diversion ditches were located on two of the three sites.

Appearance - The sites blend well with adjacent areas.

(14) Virginia

Regrading - Spoil has been regraded to comply with the law. Highwalls have been reduced.

Backfilling - Highwalls are present on both sites and they have been reduced. Some pH readings of 3.8 were obtained from the material on the bench, which indicates that some acid-forming material has been placed near the surface.

Revegetation - Percent cover of vegetation was less than 70% at both sites, however, the vegetation had survived two growing seasons and met the requirements of the law.

Topsoil - Thin spots in the topsoil where spoil material is visible were present on both sites. Soil pH at the thin spots was 3.8 while pH readings in other areas clustered around 6.8.

Water - There were six water bodies on the two sites, including two areas of standing water. Except for one area of standing water with a pH of 3.5, all other pH readings were within the range of 5.6 to 6.9. This included streams and drainage ditches traversing the sites.

Erosion - Rill and gully erosion was present on the outslope of the reclaimed mines and it affected 5-10% of the area. A diversion ditch was present on one site.

Appearance - The reclaimed areas blend well with adjacent undisturbed areas.

(15) West Virginia

Regrading - Regrading on the five sites complied with the law.

Backfilling - Backfilling was complete on all sites that were visited. The pH of the surface material on the five sites was ≥ 6.0 except for one sample which was 5.4. This indicated that the backfilled surface material was not acid-producing.

Revegetation - The percent cover was greater than 70% on all five sites, indicating close compliance with the law.

Topsoil - Two of the five sites had thin spots where spoil material was visible. This problem was not extensive and no acidity problems were apparent.

Water - Water bodies were present on three of the five sites. Standing water on one site had an extremely low pH of 2.6, and on a second site had a pH of 5.3. The remaining three water bodies had pH readings of 5.6, 5.8, and 5.9, all of which comply with the law which stated that pH must be between 5.5 and 9.0.

Erosion - Rill and gully erosion was present on all sites and did not affect more than 20% of the area on any one site. Diversion ditches were on three of five sites.

Appearance - Reclaimed areas generally did not blend well with adjacent areas.

Figure 23 presents the results of the comparison of the reclaimed field sites and the specific state bond release criteria. As shown in Figure 23, although there was a wide diversity between the states in specific bond release criteria, most of the reclaimed field sites partially or totally met their respective state's bond release criteria.

Sites in only one state, Alabama, did not meet the state's criteria. The sites did not meet the state criteria regarding revegetation and topsoil. All sites met the state's regrading requirements. In four states; Arkansas, Maryland, Tennessee, and Virginia, backfilling criteria were only partially met, especially related to the burial of toxic material. The bond release criteria for revegetation were not met on the sites in Alabama and only partially met in five other states; Iowa, Kansas, Kentucky, Maryland, and Pennsylvania. The criteria for topsoil replacement was met in all states with the exception of those sites in Alabama. Bond release criteria related to water pH were met in all states except Arkansas, Kentucky, and Pennsylvania, wherein low pH was obtained in some of the individual samples at the field sites. No specific criteria were spelled out in the states for erosion and appearance; therefore all sites met the criteria.

In summary, this comparison indicates that state bond release criteria were met on the reclaimed field sites related to regrading, topsoil handling, erosion, and appearance. The reclaimed sites were less successful in meeting the bond release criteria for backfilling, revegetation, and water.

It should be emphasized that this analysis was based on conditions at the five reclaimed sites that were visited and the bond release criteria of each specific state regulation. It should be noted that each state differed in its bond release requirements and explicitness and, therefore, interstate comparisons are not valid for meeting regulatory requirements.

STATES	CRITERIA							TOTAL		
	REGRADING	BACKFILLING	REVEGETATION	TOPSOIL	WATER	EROSION	APPEARANCE	YES	PARTIAL	NO
ALABAMA	YES	YES	NO	NO	YES	YES	YES	5	0	2
ARKANSAS	YES	PARTIAL	YES	YES	PARTIAL	YES	YES	5	2	0
ILLINOIS	YES	YES	YES	YES	YES	YES	YES	7	0	0
INDIANA	YES	YES	YES	YES	YES	YES	YES	7	0	0
IOWA	YES	YES	PARTIAL	YES	YES	YES	YES	6	1	0
KANSAS	YES	YES	PARTIAL	YES	YES	YES	YES	6	1	0
KENTUCKY	YES	YES	PARTIAL	YES	PARTIAL	YES	YES	5	2	0
MARYLAND	YES	PARTIAL	PARTIAL	YES	YES	YES	YES	5	2	0
MISSOURI	YES	YES	YES	YES	YES	YES	YES	7	0	0
OHIO	YES	YES	YES	YES	YES	YES	YES	7	0	0
OKLAHOMA	YES	YES	YES	YES	YES	YES	YES	7	0	0
PENNSYLVANIA	YES	YES	PARTIAL	YES	PARTIAL	YES	YES	5	2	0
TENNESSEE	YES	PARTIAL	YES	YES	YES	YES	YES	6	1	0
VIRGINIA	YES	PARTIAL	YES	YES	YES	YES	YES	6	1	0
WEST VIRGINIA	YES	YES	YES	YES	YES	YES	YES	7	0	0
							TOTAL	91	12	2

YES - RECLAIMED FIELD SITES HAVE MET CRITERIA OR THERE IS NO SPECIFIC CRITERIA

PARTIAL - SOME SITES HAVE MET CRITERIA BUT SOME HAD NOT TOTALLY MET SPECIFIC CRITERIA.

NO - NONE OF THE SITES MET THE CRITERIA.

FIG. 23 COMPARISON OF FIELD SITES RELEASED FROM BOND TO STATE BOND RELEASE CRITERIA

78-5

C. EVALUATION OF BOND RELEASE INSPECTION TECHNIQUES

1. Objectives

The objectives of this task were to determine what bond release standards are required by state regulations and what inspection techniques are currently being used to evaluate these standards. Another objective was to determine the general opinions of the state regulatory personnel and operators related to improving bond release inspection techniques.

2. Inspection Techniques Utilized For Bond Release

Bond Release Inspection Techniques can be generally divided into two categories: 1) Inspection Techniques related to release of the regrading bond, and 2) Inspection Techniques related to release of the revegetation bond.

Although all of the states in the study area have some type of specific standards for release of the regrading and/or revegetation bond, only in Illinois does the law specifically state an inspection technique to be used. The Illinois regulations stipulate that a random line transect technique be used to determine percent vegetation cover for release of the bond after revegetation.

This fact indicates that although the states have stipulated specific standards that must be met for bond release, the methods to be utilized to inspect sites for compliance with the standards are left up to the regulatory authority and/or inspectors.

Currently, the most commonly used technique for bond release inspections is the ocular technique. This technique essentially is one in which the inspector visually inspects the site and, based on this, determines whether the site should be approved for release. This method is highly dependent upon the training, experience and objectivity of the inspector. In some instances, the regulatory authorities recognize that the ocular technique is not necessarily the best technique. Some state regulatory authorities are providing the inspectors with range-finders and/or inclinometers for regrading inspections and are looking into some type of random transect sampling technique for use in determination of revegetation success.

The discussions with the regulatory authorities related to bond release inspection techniques were reviewed and general agreement among the state regulators was noted in two areas. First, the regulatory authorities recognize that quantitative techniques should be used in the inspections and that the inspections should be more standardized. Many of the regulatory authorities would like to see a checklist for inspectors to use for bond release. The checklist would serve to reduce some of the subjectivity, but should remain flexible enough to allow for site-specific conditions. The other most mentioned comment pertaining to inspection techniques was the lack of sufficient inspectors in the states and the high turnover of inspectors which, in turn, affects the ability to perform inspections. These problems are manifested in the large work load of the inspectors and the lack of trained inspectors.

In all of the states, the operator discussions brought up one point related to bond release inspection techniques. The operators felt that there was considerable variability among inspectors in performing bond release inspections. The operators would prefer to see a set procedure for bond release inspections, possibly using a checklist. A majority of operators felt that even if the bond release inspection techniques and requirements were stricter but more standardized, they would know more precisely what is required of them when performing regrading and revegetation and consequently would avoid having to reclaim again an area that the operator felt complied with the law. At the same time, some operators emphasized that the techniques and requirements must be flexible enough to meet site-specific conditions.

In summary, the bond release inspection techniques is an area of agreement between the regulators and operators. Both feel that definite bond release inspection techniques would be most useful. Standard, but flexible, requirements and inspections are things that both the regulator and operator feel would improve the reclamation and release cycle.

It should be noted that a review of the Final Interim Rules on Surface Mining Reclamation and Enforcement by the Office of Surface Mining Reclamation and Enforcement, Department of Interior, dated 13 December, 1977 shows that a number of bond release standards are included. Among these are: final slope, water quality, topsoil, rills and gullies, and revegetation cover. The final rules include provisions for measurement of final slopes to adequately represent the premining slope conditions, and measuring success of revegetation based on reference areas. However, no specific inspection techniques are suggested by which to measure these and other criteria and provisions.

D. TIME INTERVAL ANALYSIS

1. Objectives

The objectives of this task were to determine the various time frames by state involved in the surface mining cycle from permitting to release of the reclamation/ revegetation bond. In addition, comments from regulatory personnel and surface mine operators resulting from discussions were reviewed and pertinent comments included. This type of analysis served to compare the differences in the time frames for the bonding and release cycle within the various states in the study area. It should be noted that time frames for bonding and release from an economic viewpoint are discussed in Section IV E - Economic Analysis.

2. Results of the Time Interval Analysis

This analysis involved a detailed evaluation of the time interval required by state legislation or regulations for permits and licenses, backfilling, revegetation and bond release. The analysis utilizes the state laws and regulations, operator comments, and regulator comments. Time intervals for various phases of permitting and reclamation are presented in Figure 24. A discussion of each element of the time interval is discussed below.

a. Term of Permit

This element refers to the length of time in which an approved permit is in effect. Nine states in the study area have the term of permit for 12 months. These states feel that an annual renewal makes the operators more conscious of keeping up with and performing good reclamation in that permit renewal may depend upon past performance. The remaining states varied in their requirements for term of permit. These varied from 3 years, 10 years, to duration of the operation, and unlimited permit. The results of the analysis of this element indicates that most states prefer the annual renewal in order to control the performance of the operators. The arguments for longer permit terms included less paper work and less burden on the inspector's work load.

STATE	TIME INTERVAL FOR BOND RELEASE	OTHER RELATED REQUIREMENTS	REGULATORY COMMENTS	OPERATOR COMMENTS
ALABAMA	60% RELEASED UPON COMPLETION OF REGRADING. 40% UPON MEETING COVER REQUIREMENTS AFTER 2 GROWING SEASONS.	THE COMMISSION MUST MAKE AN INSPECTION WITHIN 30 DAYS OF A REQUEST AND SUBSEQUENT EVALUATION: MUST BE MADE WITHIN 15 DAYS OF INSPECTION.	ONE YEAR PERMIT IS ADEQUATE.	SATISFACTORY FOR THE MOST PART. DOES NOT ALLOW FOR REMINING. TWO YEAR PERMIT WOULD BE BETTER.
ARKANSAS	UPON APPROVAL OF COMMISSION, BUT NOT TO EXCEED 10 YRS.	----	FELT TIME FRAME WAS ADEQUATE IN THAT REGULATOR CAN REQUEST OPERATOR MAINTAIN VEGETATION THAT HAS DECLINED AFTER BOND RELEASE.	SATISFACTORY
ILLINOIS	BOND LESS $100 ACRE RELEASED UPON REGRADING AND TOPSOILING. REVEGETATION BOND RELEASED UPON APPROVAL OF DEPT. NO SPECIFIC TIME FRAME.	MUST BE REVEGETATED WITHIN 2 YEARS OF GRADING.	REGULATORS ACTUALLY PRACTICE PARTIAL RELEASE IN THAT OPERATOR CAN ASK FOR RELEASE AFTER GRADING. USUALLY ONLY LARGE OPERATOR ASKS.	CONFLICTING VIEWS ON THREE-YEAR CYCLE.
INDIANA	PARTIAL RELEASE UPON APPROVED REGRADING. REVEGETATION BOND WILL CONTINUE TO BE POSTED UNTIL APPROVED. NOT TO EXCEED 15 YEARS.	THE OPERATOR MUST NOTIFY THE DEPARTMENT WITHIN 60 DAYS OF COMPLETION OF REGRADING.	AVERAGE TIME FOR RELEASE RUNS BETWEEN 3-5 YEARS. SINCE 1972 THERE HAS BEEN NO PARTIAL RELEASE AFTER REGRADING.	SATISFACTORY FOR MOST PART. WOULD LIKE QUICKER TURN-AROUND ON PERMIT APPROVAL AND REGRADING INSPECTION (ALLOWS FOR EROSION TO DEVELOP)
IOWA	ALL RECLAMATION MUST BE COMPLETED WITHIN 12 MONTHS AFTER MINING.	THE TIME FRAME FOR RECLAMATION MAY BE EXTENDED, IF NECESSARY	OPERATOR IS ALLOWED TO START MINING BEFORE PERMIT COMPLETE. BOND IS NOT RELEASED UNTIL RECLAMATION IS COMPLETE.	GENERALLY SATISFACTORY.
KANSAS	BOND RELEASED AFTER REGULATORY DETERMINATION REVEGETATION WILL BE INSPECTED AFTER ONE GROWING SEASON.	INSPECTION WILL BE MADE AS SOON AS POSSIBLE AFTER REQUEST.	GENERALLY 3 MONTHS IS MAXIMUM TIME FOR OBTAINING PERMIT. FEELS SITE SPECIFIC CONDITIONS CAUSE TIME DIFFERENCES IN RECLAMATION. NO TIME LIMIT FOR RECLAMATION-OPERATOR REQUESTS.	WOULD LIKE TO SEE PARTIAL RELEASE OF BOND UPON APPROVAL OF REGRADING.
KENTUCKY	FULL AMOUNT LESS $300 ACRE RELEASED UPON APPROVAL OF REGRADING. REMAINDER RELEASED NO SOONER THAN ONE GROWING SEASON.	USUALLY 2 TO 3 GROWING SEASONS FOR ESTABLISHING REVEGETATION	OPERATORS SHOULD BE ABLE TO COMPLETE RECLAMATION WITHIN TIME LIMIT. SOME ARE NOT.	TIME FRAME SATISFACTORY. WOULD LIKE TO SEE BOND DATED UPON APPROVAL RATHER THAN SUBMISSION DATE.
MARYLAND	VEGETATION CANNOT BE INSPECTED UNTIL AFTER 2 GROWING SEASONS.	----	CAN HOLD REVEGETATION BOND UP TO 5 YEARS MAXIMUM. BOND COULD BE RETURNED IN LESS THAN 2 YEARS FOR HIGHER LAND USE.	WOULD LIKE TO SEE PARTIAL RELEASE. TWO GROWING SEASONS MAY BE TOO LONG.
MISSOURI	CAN RELEASE 2/3 BOND ON REGRADING. VEGETATION MUST SURVIVE TWO GROWING SEASONS.	INVESTIGATION FOR BOND RELEASE MUST BE MADE WITHIN 30 DAYS OF A REQUEST BY THE OPERATOR.	IF GULLIES DEVELOP AFTER REGRADING AND PARTIAL RELEASE, REGULATOR RELUCTANT TO MAKE COMPANY CORRECT.	2 YEARS NOT ADEQUATE TO ESTABLISH GOOD VEGETATIVE COVER IN ACIDIC AREAS. MIGHT LIKE INCREASING PERMIT TO 3-4 YEARS.
OHIO	50% OF BOND RELEASED UPON SATISFACTORILY COMPLETING REGRADING. REMAINING BOND RELEASED UPON APPROVAL OF REVEGETATION BUT NO SOONER THAN 1 GROWING SEASON.	USUALLY 2 GROWING SEASONS REQUIRED	PERMITS ISSUED FOR 3 YEARS. MOST OPERATORS NOT UTILIZING FULL 3 YEARS.	GENERALLY SATISFACTORY.
OKLAHOMA	UP TO 90% OF BOND RELEASED UPON APPROVAL OF GRADING.	APPLICATIONS FOR PERMITS MAY BE FILED ONLY BETWEEN JUNE 1 AND JUNE 30	NO SPECIFIC COMMENTS.	WOULD LIKE TO SEE 80% OF BOND RELEASED UPON REGRADING.
PENNSYLVANIA	AS OUTLINED IN APPROVED MINING PLAN AND ONLY AFTER INSPECTION. 5% OF BOND MAY BE HELD FOR 5 YEARS FOR REMEDIAL WORK.	80% OF BOND CAN BE RELEASED AFTER REGRADING. 5% OF BOND MAY BE HELD FOR 5 YEARS USUALLY 2 GROWING SEASONS.	TIME FRAME IS ADEQUATE. LICENSE REVOCATION IS A POWERFUL TOOL.	GENERALLY SATISFACTORY.
TENNESSEE	PROVISIONS MADE FOR PARTIAL RELEASE UPON SATISFACTORILY BACKFILLING & REGRADING. COMPLETE RELEASE UPON APPROVAL-NO SPECIFIC TIME FRAME.	USUALLY 2 GROWING SEASONS.	SATISFIED WITH TIME FRAME. 75% OF OPERATORS GET BOND RELEASED IN 2ND YEAR.	WOULD LIKE TO SEE QUICKER TURN-AROUND ON PERMITS AND AUTOMATIC RELEASE OF REGRADING BOND.
VIRGINIA	VEGETATION MUST SURVIVE 2 GROWING SEASONS (18 MONTHS) BEFORE INSPECTION CAN BE MADE.	----	BIGGEST PROBLEMS ARE SURFACE MINING WITH UNDERGROUND PERMIT AND LACK OF CLEAR AUTHORITY TO GET VIOLATIONS CORRECTED.	SPEED UP INSPECTION AND RELEASE OF BOND.
WEST VIRGINIA	CANNOT BE INSPECTED UNTIL PLANTINGS HAVE SURVIVED 2 GROWING SEASONS. 3/4 OF BOND RETURNED AFTER BACKFILLING	A REVEGETATION PLAN IS TO BE PREPARED AND SUBMITTED FOR APPROVAL WITHIN 60 DAYS OF COMPLETION OF BACKFILLING.	SATISFACTORY	SATISFACTORY FOR MOST PART. 2 GROWING SEASONS SEEMS RATHER LONG.
FEDERAL	60% OF BOND UPON COMPLETION OF BACKFILLING, REGRADING AND DRAINAGE CONTROL. SOME TO BE DETERMINED TO BE RELEASED AFTER SUCCESSFUL REVEGETATION. RESPONSIBLE FOR SUCCESSFUL REVEGETATION FOR FIVE FULL YEARS AFTER LAST YEAR OF AUGMENTED SEEDING.	---	---	---

FIG. 24 TIME INTERVAL ANALYSIS COMPARISON (CONT'D)

78-59

b. Term of License

Licensing of surface mine operators was practiced in 5 states. The term of the license ranged from 12 months in Maryland, Ohio and Pennsylvania to continuous in Alabama and unlimited in Iowa (annual renewal). No license was required in 10 states. In 3 states; Iowa, Pennsylvania and Maryland, the regulatory personnel felt that licensing was a powerful tool in controlling adequate reclamation in that licensing kept less reliable operators out of the business. This was concurred with by the operators in those states. In the remaining states that had licensing, the regulatory personnel felt that permits were all that were necessary in that the permit was really a license. It is interesting to note that a large number of operators in various states felt that licensing may be a good way to insure that only qualified operators would be mining for longer periods of time. Indications are that licensing and permitting are taken to mean the same thing by the mining community. They can be different; for example, Pennsylvania issues permits on site-specific mining operations while the license is for the operator himself no matter how many permitted sites he has. License revocation can result in all of his permitted sites being shut down. It should be noted that in all the states any company or corporation must be licensed to do business, but this is separate from specific licensing for strip operators.

c. Review Time for Site Registration

This element deals with the time allotted to the regulatory authority to review permit applications and render a judgement. Many surface mine operators felt that this review cycle was too long and/or unpredictable. Even though maximum periods for review are set, often the decision extends beyond that period. This impacts on the yearly plans and economic base of the operators. The regulatory personnel indicated that lack of manpower was the major problem in turning permit applications around in less time.

Thirteen states specified the maximum time for permit application review. These ranged from 15 days to 120 days. In Tennessee, a range is given in that the application should be processed in no less than 20 days or not more than 30 days. In 2 states the length of time was not specified; these were Oklahoma and Pennsylvania. In Pennsylvania, which had a large number of permit applications pending, the reviewers are hampered by lack of personnel and the operators would like to see the process speeded up. In summary, the wide range in permit review times might indicate advantages for operators in certain states.

d. Timing of Backfilling and Regrading

The timing requirements for backfilling and regrading vary among the states included in the study. The review of the regulations found that timing for backfilling and regrading was described in three ways; 1) a maximum linear distance from the pit in which backfilling and regrading was to have commenced, 2) a minimum time to commence backfilling and regrading after coal removal or commencement of mining, and 3) maximum time to complete backfilling and regrading.

(1) Maximum Linear Distance From Pit in Which Backfilling and Regrading Must be Current

A total of eight of the states have this requirement in their regulations. Of these, seven are Appalachian states. Only Tennessee and Alabama in Appalachia do not stipulate some minimum linear distance from the point of mineral extraction in their legislation. The maximum distance required ranges from 3000 feet in West Virginia for contour mining to 300 feet in Virginia for mountaintop mining. Two states in which area mining is present stipulate the maximum distance in terms of two spoil ridges instead of or as an alternative to footage. This regulation is a method of keeping backfilling and regrading concurrent with active coal removal activity.

(2) Minimum Time to Commence Backfilling and Regrading

In four states, all in Appalachia, regulations stipulated a minimum time period in which commencement of backfilling and regrading must begin. The time ranged from 15 days in Kentucky and Tennessee to 6 months in Alabama. Virginia's regulations stipulated 60 days. It is interesting to note that all Appalachian states have some requirement for concurrent backfilling and regrading, be it by maximum linear distance from pit and/or minimum time to commence backfilling and regrading. Only Indiana and western Kentucky outside of Appalachia have such a requirement. This is attributed to the fact that area mining generally done in the eastern and western interior fields is, by nature, a mining technique in which concurrent backfilling and regrading is an accepted part of the technique.

(3) Maximum Time to Complete Backfilling and Regrading

Ten of the fifteen states in the study area have regulations which stipulate a maximum time to complete backfilling and regrading. As can be seen in Figure 24, there is a wide variety of maximum times stipulated by the states. They range from 12 months in Illinois and Oklahoma to 2 months in West Virginia. It is interesting to note that in only one state, Arkansas, is there no specified timing requirement for backfilling and regrading. However, plans and a schedule for backfilling and regrading are a requirement in an operator's permit application in Arkansas.

e. Timing of Revegetation

The timing of revegetation can be divided into two specific time units; time interval for beginning revegetation and minimum time for completion of successful vegetation. These are noted in Figure 24.

Almost all of the states require that the revegetation be started as soon as appropriate after regrading or within a specified time frame. This requirement insures that there will be no major gap between completion of regrading and revegetation of the prepared area.

The time frame for completion of successful vegetative cover varies among the state requirements. Seven states require that the minimum time frame for determination of successful vegetation is after or toward the end of the second growing season. Three states require one growing season before determination of successful vegetation. The remaining four states have no time frame specified, however, the regulations do allow for the regulatory personnel to determine an appropriate time. In general, the determination of vegetation success after the second growing season is the most commonly used criteria by the states in the study area.

f. Total Time Interval for Bond Release

This includes the total time required for holding of the bond and the partial bond increments and timing of the release. These intervals are noted in Figure 24. Eleven states have provisions for partial release after regrading. The partial release is stated in terms of a percentage of the total bond or a dollar amount withheld. The partial release percentages range from 50% in Ohio to 80% in Pennsylvania and Oklahoma. For those states that have partial releases stated in dollar amounts withheld, Illinois releases all but $100/acre of bond after regrading and topsoiling while Kentucky releases all but $300/acre upon approval of regrading.

In addition to the timing of successful vegetation and partial release of the bonds, several states stipulate when reclamation must be completed and/or how long the revegetation bond can be held (5 years in Pennsylvania).

g. Regulatory and Operator Comments

Included in Figure 24 are comments received from regulators and operators in the respective states that were directly related to the time interval of bonding and release. A general opinion of the operators visited is included. In addition, specific relative comments were noted.

In summary, the time interval analysis showed that the states differ widely in the time elements required for bonding and release. The states do attempt however, to insure concurrent backfilling and regrading. There were wide ranges of timing for revegetation initiation and minimum times for determination of successful revegetation.

E. ECONOMIC ANALYSIS OF BONDING PRACTICES

Introduction

The economic analysis is divided into two parts. The first part is a descriptive analysis of bonding practices that are currently being used. Each state's reclamation legislation, regulatory agency's rules and regulations, and personal interviews with regulatory personnel were reviewed. The results of the discussions with operators are also presented.

The second portion of the section is an analysis of the impacts of current bonding practices on operators. The impacts were measured in terms of total bond assessed, premium rates and payments,and the true cost of bonding. The true cost of bonding is determined by using the net present value of the discounted cash flows from the bonding cycle. The impacts of these costs on the competitiveness and productivity of operators is examined. Special reclamation fees are briefly analyzed as to their costs.

1. Descriptive Analysis of State Bonding Practices

a. Review of Bonding Practices

(1) Objective

The objective of the review of state bonding practices is to establish the status of performance bonding in coal mine reclamation. The philosophy of bonding and its legal definition are discussed. Common strategies used by state regulators, operators and bonding companies are examined. Each state in the study area is examined separately and its bonding variables noted. A final matrix is provided to summarize the state data for ease of comparison.

(2) Methodology

The state bonding practices were examined first by scrutinizing the state reclamation laws and regulations for pertinent information. HRB-Singer also personally held discussions with representatives of each reclamation authority. These discussions were supplemented with telephone communications as further questions arose. A small sample of large, medium, and small sized operators was visited as explained in Section IV, Data Collection. These discussions provided insight into the actual machinations of and the impact of the bonding practices of each state. Finally, a few bonding companies were contacted to determine their views of bonding.

(3) Results

(a) Basic Philosophy and Strategies of Bonding

A performance bond is a written obligation to perform a task specified in the document. The bond specifies a penalty to be paid in lieu of performance of the desired act. In Blackstone's terminology* the "obligor" promises to perform the desired act for the "beneficiary" or pay a penalty. In the case of coal mine reclamation bonding the "obligor" is the surface coal mine operator and the beneficiary is the state regulatory agency. The penalty of the bond is usually stated in terms of dollars per acre disturbed for each permitted area.

(b) Types of Bonds

Many types of bonds are used depending upon who guarantees the performance of the reclamation. First, in the absence of a third party guarantee, the operator must post collateral of the sum of the total bond. This collateral can be cash; certificates of deposit; or federal, state, local, or other bonds accepted by the reclamation authority. Certificates of deposit seem to be the most common form of collateral. In this way, the operator earns a savings passbook rate of interest on the collateral over the term of the bond. Common securities accepted as collateral are U.S. treasury bonds; state and local bond issues; highway bonds; or, in some cases, other negotiable bonds. In most cases, the market value of any securities must be determined before they are accepted, as the face value may be less than their market value.

Secondly, corporate financial institutions licensed to do business in a state can be a third party guarantee of an operator's reclamation work. In return, the operator pays a fee or premium usually expressed in dollars per $1000 bond. Premiums are due in advance of a period and are usually collected annually over the life of the bond. One bonding company in Pennsylvania that was contacted demanded $50 per $1000 bond for a five-year bond obligation.

---

* Blackstone's Legal Dictionary

A corporate surety allows an operator to forgo laying out thousands of dollars of collateral over the life of the bond. Should the operator default, the surety is obligated to pay the penalty.

A third type of bond called a certified letter of credit is accepted in some states. A certified letter of credit is similar to a corporate surety, except that a bank or savings and loan guarantees the bond. The bank in turn charges the operator a premium and may require him to post collateral. Operators in Kansas and Arkansas use this method and post their equipment as collateral, thereby avoiding tying up usable capital as collateral. The certified letter of credit probably offers the least cost to the operator but also the highest risk assumed by the guarantor.

Setting the amount of the bond at a workable level is important. The punitive amount of the bond should be high enough to assure that the reclamation work is completed by the operator or at least high enough for a third party to complete the work. This figure would vary from site to site depending upon the slope, amount of overburden moved, and other physical factors; and from operator to operator depending upon his management efficiency, equipment mix and experience. Ideally, the amount of any bond should vary to take these factors into consideration.

At a minimum, bonding provides an insurance policy to guarantee that reclamation will be done, either by the operator or a third party. At most, bonding is an enforcement mechanism to provide for concurrent reclamation. Bonding cannot affect the quality of reclamation, since the quality of reclamation is mandated by legislated requirements and agency rule making. The speed of reclamation can be enhanced through economic incentives created by the bonding cycle. Each day the bond is maintained on an acreage, a cost is incurred. It is an economic incentive for firms to reduce their bonding costs by reducing the number of acres affected and time over which a permitted acreage is bonded. This inventory control of bonded acres is not a costless activity. If an operator perceives the gain due to expeditious bond release to be less than the costs of gaining speedy releases, he will not be as concerned with speedy release and control of bonded acreages. Pennsylvania and Alabama claimed to forgo partial releases after regrading because the cost of reporting was too high.

In summary, a performance bond is a legal, written obligation to perform a desired act or pay a specified penalty. State strategies are to set the punitive amount of the bond at least high enough to be able to cover the cost of a third party to complete the job. Ideally, the amount of the bond should reflect the physical characteristics of each site and characteristics of the operator. Operators' strategies are to reduce the number of acres affected and to reduce the time interval of the bond by speedy reclamation. Costs of reporting and lack of regulatory authority responsiveness to requests for release of bond may outweigh the economic gain of getting partial bond releases after grading. This phenomena has been reported in several states.

(c) State by State Description of Bonding Practices

The size of the bond penalty and the time frame over which it is held affect the economics of performance bonding. The size of the penalty is set by the reclamation authority within the guidelines mandated in their empowering law. Such guidelines can set a range for per-acre bond penalties and minimum bond penalties per permit area. Some state laws are less specific and leave the bonding up to the regulatory authority usually stipulating that the bond should reflect the cost of reclamation.

Three states have adopted a formula to determine the amount of bond. Kentucky and Pennsylvania relate the bond to physical factors. Indiana has the most advanced bond scheduling scheme that relates operator characteristics and physical characteristics of the site explicitly. Indiana specifically penalizes an operator who has consistently performed poor reclamation by increasing his bond rate. Other states have flexible bond rate scheduling but criteria is not explicitly stated. A sample of Indiana's checklist is shown on the following page.

In many cases, the empowering law has mandated that the state regulatory authority post bonds according to the cost of reclamation and yet the regulatory authority has found it impractical to do so. Such a scheduling program is not costless. Regulatory authorities that are under-staffed and under-funded cannot manage such a program. In these cases, flat rates are charged, such as Virginia's $800/acre bond rate out of a $200 - $1000/acre range. Also, the range of bond rates specified in the law may be too low to reflect the true cost of reclamation. This has caused states such as Virginia (since 1977) and West Virginia to charge the maximum bond rate of $1000/acre as a flat rate.

R-501-D

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF RECLAMATION

BONDING EVALUATION FACTOR SHEET

IC 13-4-6 As Amended
Per Acre Basis

Operator:______________________________ Date:______________________________

Mine and/or Pit#:______________________ Permit#:___________________________

$2,000 ( )	(1)	Previous Compliance: i.e., if the operator has violated any of the provisions of IC 13-4-6.
$750 ( )	(2)	Business Structure: i.e., if the operator is conducting business as a corporation with less than three (3) years under the same charter.
$1,000 ( )	(3)	Previous Surface Mining Experience: i.e., if the operator has less than three (3) years surface mining experience under IC 13-4-6 as amended.
$1,000 ( )	(4A)	Surface Mining Method: i.e., if the operator uses exclusively dozers and/or frontend loaders for overburden removal.
$250 ( )	(4B)	Depth of Overburden: i.e., if the average depth of the overburden is greater than thirty (30) feet. *(Only if 4-A applies).*
$250 ( )	(4C)	If the operator removes a coal seam that is twenty-four (24) inches or less. *(Only if 4-A applies).*
$500 ( )	(5)	Size of Proposed Operation: i.e., if the operator submits an application for twenty-five (25) acres or less.
$250 ( )	(6)	Geological Formation: i.e., if the overburden is composed of more than thirty (30) percent consolidated materials such as: limestone, sandstone and shales or a combination thereof.
$1,000 ( )	(7)	Attachable Real Property and Other Assets: i.e., if the operator does not have attachable real property or other assets within the State of Indiana.
$250 ( )	(8)	If the operator does not plan to separate unconsolidated materials and replace those materials on the surface of the graded affected areas.

****

Factor Summary

1.__________
2.__________
3.__________
4A.__________
4B.__________
4C.__________
5.__________
6.__________
7.__________
8.__________

EVAULATION TOTAL AMOUNT:______________________

BONDING AMOUNT RECOMMENDED:______________________

BONDING AMOUNT APPROVED:______________ DATE:______________

DATE BOND SUBMITTED BY OPERATOR:______________

DATE PERMIT ISSUED:______________

NAME:______________________ TITLE:______________________

The size of the bond penalty is also influenced over the term of the bond by such practices as grading releases and partial acreage releases. These reduce the size of the bond when certain elements of the reclamation effort are completed.

The time frame of bonding is determined by when the bond is submitted and when it is released. Some states require the operator to submit his bond at the time he makes application for his permit. This will cause the operator to bear the cost of the bond over the unproductive time of permit application review. All other factors held constant, such states would have higher bonding costs. The time of the bond submission in the permit cycle is noted for each state as well as the average time to get a permit processed.

A bond can be released in three ways; as a partial release after grading or planting, as a partial acreage release after portions of a bonded area are brought to a sufficiently reclaimed state, or at final release. Where it could be determined, the average per-acre bond was determined and the average number of growing seasons till bond is released were noted.

Interpreting these variables into costs is done in a part of this section. Below is a description of each state's bonding practices. The accompanying matrix has been made to facilitate comparison (Figure 25).

Alabama: Alabama's first comprehensive strip mining law was passed in 1969. Under this law each acre on a permit was bonded for $150. The Alabama Reclamation Act of 1975 amended this to $1200/acre. In Alabama, the total bond for a permit is subject to a minimum of $10,000. Sixty percent of the bond can be returned after regrading, also any portion of a bonded acreage can be released upon completion. The initial bond is submitted after the permit application has been approved, but before the permit is issued. The operators interviewed thought the average length of time a bond was held, after seeding and fertilizing was finished, was two growing seasons. The operators also thought that small or new operators had a difficult time getting corporate sureties.

Arkansas: Arkansas passed its comprehensive strip mine law in 1971. The bond was set at $500/acre but a subsequent law in 1977, Law 336, has placed the bond penalty in a range of $700 - $850. The criterion used to set the bond is the depth of overburden and the type of equipment the operator is using.

STATE	NAME OF STATE AGENCY	NAME OF LAWS AND DATES PASSED	AVERAGE 1975 STRIP PRODUCTION PER MINE (THOUSANDS)	% OF TOTAL STATE PRODUCTION FROM STRIP MINES	RANGE OF BOND PER ACRE	AVERAGE SIZE BOND PER ACRE
ALABAMA	SURFACE MINING REGULATION COMMISSION OF DEPARTMENT OF INDUSTRIAL RELATIONS	SURFACE MINE RECLAMATION ACT OF 1975	70 TPY	66%	$1200/ACRE	$1200/ACRE
ARKANSAS	DEPARTMENT OF POLLUTION CONTROL AND ECOLOGY	OPEN CUT LAND RECLAMATION ACT OF 1971	61 TPY	100%	NEW ACT-336 $700-$850/ ACRE	$800/ACRE
ILLINOIS	DIVISION OF LAND RECLAMATION OF THE DEPARTMENT OF MINES AND MINERALS	SURFACE MINED LAND CONSERVATION AND RECLAMATION ACT, 1975	748 TPY	46%	$600-$5000/ ACRE	$3100/ACRE
INDIANA	DIVISION OF RECLAMATION OF THE DEPARTMENT OF NATURAL RESOURCES	CHAPTER 344-ACTS OF 1967 INDIANA STATUTES	416 TPY	99%	$1000-5000/ACRE BASED ON OPERATOR AND MINING FACTORS	$1000/ACRE
IOWA	DIVISION OF MINES AND MINERALS OF THE DEPARTMENT OF SOIL CONSERVATION	AN ACT RELATING TO SURFACE MINING 1975	32 TPY	42%	ESTIMATED COST OF RECLAMATION BASED ON DEPTH OF OVERBURDEN, SLOPE, EQUIPMENT.	$250/ACRE
KANSAS	MINED LAND CONSERVATION AND RECLAMATION BOARD OF THE STATE CORPORATION COMMISSION	MINED LAND CONSERVATION AND RECLAMATION ACT 1972	120 TPY	100%	$300-$1000/ ACRE	$750/ACRE
KENTUCKY	DIVISION OF RECLAMATION OF THE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION	CHAPTER 350 REVISED STATUTES 1974	EAST 80 TPY WEST 212 TPY	EAST 53% WEST 56%	POINT SYSTEM $500-3000/ACRE PHYSICAL FACTOR IS BASIS.	$1500/ACRE
MARYLAND	STATE BUREAU OF MINES MARYLAND ENERGY AND COASTAL ZONE ADMINISTRATION	MARYLAND STRIP MINING LAW OF 1974	40 TPY	98%	NEW REGULATION $1600/ACRE 1977	$1600/ACRE
MISSOURI	OFFICE OF LAND RECLAMATION DEPARTMENT OF NATURAL RESOURCES	RECLAMATION OF MINING LANDS ACT OF 1972	470 TPY	100%	$300-700/ACRE	$700/ACRE
OHIO	DIVISION OF RECLAMATION DEPARTMENT OF NATURAL RESOURCES	STRIP MINING AND RECLAMATION OF MINED LAND, 1974	93 TPY	67%	ESTIMATED COST OF RECLAMATION (~$30-40 FT. OVB)	$2700/ACRE
OKLAHOMA	DEPARTMENT OF MINES	MINING LANDS RECLAMATION ACT OF 1971	93 TPY	100%	$350-650/ACRE	$650 ACRE
PENNSYLVANIA	BUREAU OF SURFACE MINE RECLAMATION, OF THE DEPARTMENT OF ENVIRONMENTAL RESOURCES	SURFACE MINING CONSERVATION AND RECLAMATION ACT OF 1971	59 TPY	47%	ESTIMATED COST OF RECLAMATION GRADUATED TO HIGHWALL.	$1000/ACRE
TENNESSEE	DIVISION OF SURFACE MINING AND LAND RECLAMATION OF THE DEPARTMENT OF CONSERVATION	TENNESSEE SURFACE MINING ACT OF 1972	45 TPY	54%	$1000/ACRE REGS-1975	$1000/ACRE
VIRGINIA	DIVISION OF MINED LAND RECLAMATION DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT.	VIRGINIA CODE 45.1-198.- CHAPTER 17, 1974	30 TPY	35%	$200-1000/ ACRE	NEW REGS. $1000/ACRE 1977
WEST VIRGINIA	DIVISION OF RECLAMATION DEPARTMENT OF NATURAL RESOURCES	ARTICLE 6, CHAPTER 20, CODE OF WEST VIRGINIA, 1971	52 TPY	19%	$600-1000/ ACRE	$1000/ACRE

FIG. 25 MATRIX OF STATE BONDING PRACTICES

78-59

STATE	MINIMUM BOND	GRADING RELEASE	PARTIAL ACREAGE RELEASE	APPROXIMATE TIME TO ESTABLISH VEGETATION COVER	LENGTH OF TIME FOR PERMIT APPLICATION	LENGTH OF PERMIT	SPECIAL RECLAMATION FEE	WHEN BOND IS SUBMITTED
ALABAMA	$10000	60%	ANY PORTION	2 GROWING SEASONS	60 DAYS	12 MONTHS	NO	AFTER PERMIT APPROVAL
ARKANSAS	NOT SPECIFIED	ALL BUT $100/ACRE	NOT SPECIFIED	(WITHIN 10 YRS) 2 GROWING SEASONS	90 DAYS	UP TO 10 YEARS	NO	WITH PERMIT APPLICATION
ILLINOIS	NOT SPECIFIED	ALL BUT $100/ACRE	NOT SPECIFIED	2 GROWING SEASONS	120 DAYS	1 TO 2 YEARS	NO	WITH PERMIT APPLICATION
INDIANA	NOT SPECIFIED	70%	NOT SPECIFIED	1-3 GROWING SEASONS	60 DAYS	12 MONTHS	NO	WITH PERMIT APPLICATION
IOWA	NOT SPECIFIED	NO	NOT SPECIFIED	12 MOS AFTER MINING COMPLETED	15 DAYS	12 MONTHS AUTOMATIC RENEWAL	NO	WITH PERMIT APPLICATION
KANSAS	$3000	NO	NOT SPECIFIED	1 GROWING SEASON	20 DAYS	12 MONTHS	NO	AFTER PERMIT APPROVAL
KENTUCKY	$5000	ALL BUT $300/ACRE, NOT LESS THAN $2000	NO	2-3 GROWING SEASONS	30 DAYS	12 MONTHS	NO	WITH PERMIT APPLICATION
MARYLAND	$10000	ALL BUT $600/ACRE	NOT SPECIFIED	2 GROWING SEASONS	MINUMUM OF 15 DAYS	LIFE OF MINING PROJECT	$40/ACRE	AFTER PERMIT APPROVAL
MISSOURI	$2000	67%	ANY PORTION	2-3 GROWING SEASONS	30 DAYS	12 MONTHS	NO	AFTER PERMIT APPROVAL
OHIO	$5000	50%	NO	2 GROWING SEASONS	60 DAYS	3 YEARS	2 CENTS/TON	WITH PERMIT APPLICATION
OKLAHOMA	NOT SPECIFIED	80%	NOT SPECIFIED	NOT SPECIFIED	NOT SPECIFIED	1 TO 2 YEARS	NO	WITH PERMIT APPLICATION
PENNSYLVANIA	NOT SPECIFIED	80%	NO	2 GROWING SEASONS	NOT SPECIFIED	DURATION OF OPERATION NEW PLAN YEARLY	NO	AFTER PERMIT APPROVAL
TENNESSEE	NOT SPECIFIED	80%	NOT SPECIFIED	2 GROWING SEASONS	30 DAYS	12 MONTHS	NO	WITH PERMIT APPLICATION
VIRGINIA	$2500	NEW REGS. 50% 1977	YES UNTIL NEW REGULATION 1977	2 GROWING SEASONS	30 DAYS	12 MONTHS	NO	WITH PERMIT APPLICATION
WEST VIRGINIA	$10000	75%	NO	2-3 GROWING SEASONS	30 DAYS	12 MONTHS	$60/ACRE	WITH PERMIT APPLICATION

FIG. 25 MATRIX OF STATE BONDING PRACTICES (CONT'D)

78-59

The Arkansas regulatory authority and some Arkansas operators thought that small, independent coal operators had a difficult time getting corporate sureties.

Illinois: In Illinois, the bond is submitted with the permit application. Bonds range from $600 to $5000/acre with an average around $3100/acre. Illinois releases all but $100/acre after grading, although many operators do not apply for this release. The average bond is held for two growing seasons.

Indiana: Indiana has the most sophisticated system to relate the bond penalty to the physical factors of mining and the history of the operator. The bond can be set from $1000 - $5000/acre. The Indiana Division of Reclamation felt that most reputable operators could get a bond close to $1000 - $2000/acre, but that small or new operators probably get bonds around $3500 -$4000/acre. Operators with reputations for poor reclamation automatically receive the maximum $5000/acre. If an operator brings his reclaimed land into row crops, he could conceivably get it released from bond within a year of planting; but commonly, two growing seasons are needed.

Iowa: Iowa is a state with mostly small coal operations. The Iowa Department of Mines and Minerals reported that a common bond was $10,000 for forty acres. The amount of bond is not expressed as a $/acre but rather the total permitted area is looked at as a whole and factors such as the thickness of overburden, slope, and presence of acid forming material are considered. Iowa has no partial release of bond after regrading or planting.

Kansas: Kansas sets its bond rate between $300 and $1000/acre and reported an average around $750/acre. Kansas also has a $3,000 minimum bond per permit. Kansas has no partial release of bond after regrading or planting.

Kentucky: Kentucky is second only to West Virginia in history of regulation. Kentucky passed its first reclamation law in 1954 but passed its first comprehensive law in 1961 and has improved it a number of times since. D. B. Brooks[1] has contributed much to the literature of the economic effects of reclamation laws in discussing Kentucky's reclamation experiences.

---

[1] Brooks, D. B. "The Impact of Surface Mine Regulation on the Coal Industry! The Case of Kentucky." Council of Economics of the American Institute of Mining, Metallurgical and Petroleum Engineers Proceedings 1969, pp 65-92, among others.

Kentucky requires the bond be turned in with the permit application; and bond is set from $500 to $3,000/acre. Kentucky has a point system that relates physical factors of the mine site to the bond amount. The average size bond is around $1500/acre. After planting and fertilizing, all but $300/acre of the bond can be released to the operator subject to a minimum of $2000 per permit.

Maryland: Maryland has mining activity in only two counties and has mostly small to medium sized operators. The Maryland law was passed in 1974 and was amended in 1976. Bond is set at $400/acre for grading and $50 or more/acre for revegetation. This scheme has recently been revised to $1000/acre for grading and $600/acre for revegetation.

Missouri: Missouri requires the bond be submitted before the permit is issued but after the application for permit is made. Bonds range from $200 - $700/acre and up to 67% of the bond can be released after grading. Missouri also has a $2000 minimum bond requirement.

Ohio: Ohio requires the bond be submitted with the application for permit. The bond is supposed to be set at the estimated cost of reclamation. The average bond was reported to be around $2700/acre. Fifty percent of the bond can be released after grading. Ohio has a $5000 minimum bond.

Oklahoma: Oklahoma requires the bond be submitted with the application for permit. The bond is set by the regulatory authority and ranges from $350 to $650 per acre. Up to 80% of the bond can be released after grading. Minimum bond is $5000.

Pennsylvania: Pennsylvania has had the "hallmark" law for surface mine reclamation. The Pennsylvania Surface Mine Conservation and Reclamation Act of 1971 has been a model law for some years and has greatly influenced the federal legislation. The bond is submitted after the permit approval but before the permit is issued. The bond rate varies according to a formula graduated by the height of the highwall. The average bond was reported to be about $1000/acre.

Tennessee: Tennessee requires the bond be submitted with the application for permit. Bond is set at $1000/acre, of which $800 can be released after grading.

Virginia: Virginia has only six producing counties in the southwest corner of the state. The bond rate in Virginia was set between

$200 - $1000/acre with the stipulation that it be set at the cost of reclamation. During the early stages of reclamation regulation in Virginia, the minimum bond of $200/acre was assessed. After conducting some reclamation of orphaned lands it was found that it cost the state about $800 per acre and the bond rate was changed to reflect this. Recently, the bond has been increased to the maximum of $1000/acre. Prior to the new bonding procedures no partial release was granted for grading, but any portion of a permitted area could be released as reclamation was completed. The new regulations establish a 50% release after planting but forbid releasing portions of a permit area. Virginia also has a $2500 minimum bond.

West Virginia: West Virginia has the longest history of surface mine reclamation legislation. Their first law was passed in 1939 but a comprehensive reclamation law was not forthcoming until the early 1960's. West Virginia requires the bond be submitted with the permit application. The law allows bond to range from $600 - $1000/acre, however the maximum of $1000/acre is assessed. A minimum of $10,000 bond is also required.

b. Findings from Discussions Held with Coal Operators

(1) Objective

The information obtained from the discussions with the operators offer insight into the problems operators have in dealing with bonding and with the regulatory system as a whole. The objective was to determine the opinions of operators on the present bonding procedure and to note any specific problems of concern.

(2) Methodology

The responses to the discussion items with coal operators were grouped according to similarities in opinions expressed by the respondents. The opinions gathered were in very general terms. However, there are some general common sentiments in their responses. Each of the discussion items is presented and analyzed in the following subsection.

(3) Results

(a) Time Frame for Bonding and Release

More than half of the respondents under each size group of operators feel that the bonding cycle in their respective state is satisfactory. This is the consensus of opinions from the majority of respondents in Alabama, Illinois, eastern and western Kentucky, Virginia, West Virginia, Pennsylvania and Ohio. However, six large operators, one each from Alabama, Illinois, Indiana, eastern Kentucky, Missouri and Pennsylvania and a small operator from Maryland and western Kentucky expressed the opinion that the bonding cycle is not satisfactory. The following reasons are given by respondents who felt that the bonding cycle is not satisfactory.

- In Alabama, the respondent feels that the permit period should be longer to allow more time for later mining.
- In Illinois, the respondent feels that the three year permit is a problem, although such period enables them to do long range planning. The respondent feels that a yearly cycle would probably be better because if a permit is amended it has to go through the same procedure as with a new permit.
- In Indiana, however, the respondent from a large coal company felt that one year permit cycle is a problem primarily due to paper work to accomplish the requirements.
- In Maryland, the respondent felt that two growing seasons are too long for the revegetation bond release and thought the bond should be released incrementally. This is the opposite view of the respondent from Missouri.
- The respondent from eastern Kentucky would like to get a partial acreage release on a portion of a site upon completion of the reclamation on the site as an incentive to encourage compliance and better reclamation.

Six large and five medium operators have other comments about the bonding cycle. In Indiana, two respondents from a large company expressed their concern about the 30 to 90 days delay in processing the permit. This is the same sentiment expressed by a large and medium size operator from eastern Kentucky. They felt the waiting period on the permit application took too long and hence, delays the start of the mining process. One respondent each from a large coal firm in Oklahoma and from a medium size coal firm in Tennessee feel that partial release is good incentive for firms to stay current with their reclamation and would like partial release to be automatic.

(b) Effects of Bonding on Operating Costs

About fifty percent of the total respondents (23 out of 57) think that bonding has minimal or negligible effect on their operating costs. This is the consensus of opinion among large, medium and small operators who paid surety bond premiums to bonding/insurance companies who put up the bond for them.

Also, about half of the large and small operators who responded felt that neither they nor their counterparts (similar size operators) from other states have the competitive advantage with respect to the impact of bonding on the costs of operation. Only five out of twenty-one medium size operators feel the same way.

Fifty percent of both the large and medium size operators think that the small sized operators in their respective state are disadvantaged, however, only two of the small operators thought they were at a disadvantage. The reasons they gave are listed below.

- Large operators usually have more resources (e.g., man-power, capital equipment for planning and reclamation activities) than small operators.
- Large operators can set up dummy operations to take advantage of the reclamation tax per ton charged for the reclamation of abandoned spoil banks.
- Bonding may put the small operators out of business if they cannot obtain surety bonds and have to put up 100 percent collateral.

- Bonding increases costs significantly to small operators who need initial capital. The costs of preparation of required plans to obtain the permit and/or licenses hurt the small operators. The large company can usually absorb a lot of these costs which the small operators are unable to handle.

Of the respondents who expressed opinions on the effect of bonding when compared to similar size operators in other states, their opinions differed. Two large operators from Illinois, and one each from Pennsylvania and eastern Kentucky felt that they are not disadvantaged by similar size operators in other states. However, two large and one small operator in Pennsylvania felt that they have the disadvantage because they have to work under more stringent requirements compared to the other states. This opinion was shared by three medium sized operators coming individually from Kansas, Maryland and Ohio.

(c) Effectiveness of Current Bonding Practices with Respect to Achieving Reclamation Objectives

Seventy-two percent (41 out of 57) of all operators, with whom discussions were held, felt that current bonding practices are sufficient and effective. Of these; 46 percent were large operators, 34 percent were medium size, and about 20 percent were small operators. Other important comments under this discussion item are as follows:

- A respondent representing a large operator in Alabama felt that the bond is essential but it is not the key factor to good reclamation.
- A large operator in Missouri and in Oklahoma and a small operator in Iowa indicated that the loss of the license, and not the bond, is the real threat to an operator.

- A respondent from a large operator in eastern Kentucky felt that their current point system does not give points for good practices in the past. He feels credit should be given for good past performance.
- A respondent from a medium size operator in western Kentucky indicated that the state cannot reclaim for the amount of the bond per acre ($1,500). His estimate is $12,000/acre or above.
- Two large operators in Pennsylvania indicated that a sliding scale should be desirable to establish the amount of bond based on the magnitude of the land disturbed and the reclamation success of an operator.
- One respondent from a large firm in Ohio indicated that the bonding practices provide no incentive to excel.

(d) <u>Impact of Special Reclamation Fees</u>

Only three states in the study area have requirements for special reclamation fees for the reclamation of abandoned mined lands. These states are Maryland, West Virginia and Ohio. An economic analysis of these fees can be found on page 135. The special reclamation fee started in Ohio only in 1976.

In Maryland, a medium and a small operator did not indicate any impact of such a fee on their operations. However, they said that the special reclamation fees in that state are not being used for reclamation. They reiterated that the money goes to some general fund retained by the state.

In West Virginia, two large and three medium sized operators felt that the special reclamation fees in that state are being used appropriately but they have not been in effect long enough to make a definite statement.

In Ohio, the respondents indicated that it is too early to comment on it. However, at present they think that the money is currently used for research activities on surface mining at the Ohio universities.

(e) Impact of Licensing Requirements

No respondent really made direct comments on whether the impact of licensing requirements on their operation is significant or not. However, time delay for license approval is a common complaint of all who responded to this discussion item. Some of the responses to this discussion item are listed below.

- In Alabama, a response from a large firm is quoted here as "license goes on indefinitely; permitting procedures are always a pain in the neck."
- Three responses from Pennsylvania and two from Ohio indicated that licensing and permit requirements are greater inducements to sound reclamation than the bonding requirements. They believe that the bond imposes no hardships on the operators, but the loss of a license or permit to mine puts them out of business.
- In Maryland, one response indicated that the present organizational structure for licensing is too complex. The Bureau of Mines in the state should do the licensing instead of the whole Land Reclamation Commission or Department of Natural Resources.

2. Analysis of Effects of Bonding on Productivity

a. Introduction

It is very difficult to isolate the impact of bonding on productivity from the other factors that are operating simultaneously with it in the whole reclamation process. The difficulty is compounded by the fact that management, accounting procedures, mining practices, and some physical factors and other forces (like enforcement) vary from one mine to another. Furthermore, the information and data needed to do empirical analysis are very limited and often inaccessible.

Published data shows estimated costs of bonding alone by mining method for selected regions in the East, Midwest[a)] and in the West[b)] ranged from $23 to $90 per acre. The estimated bond cost per ton ranged from less than a cent to one cent in the West and from less than a cent to three cents in the East. The estimated regional costs of bonding alone seem to be insignificant, but the figures corresponding to the total reclamation cost appear significant.

Bonding is tied up with other major pre-mining planning activities that affect the cost of operation. In this context pre-mining planning, bonding, and the whole reclamation operation can have short-term and long-term effects on cost and production. The short run impacts could be reflected in some adjustments such as an increase in operational costs to meet the pre-mining planning, bonding requirements, and disruption of some productive operations if not a decrease in total production. In the long run, mine operators can respond to these institutional changes by reorganizing production activities or introducing technology to offset cost increases.

---

a) Evans, R. J. and J. R. Bitler, Coal Surface Mining Reclamation Costs in the Appalachian and Midwestern Coal Supply Districts. U.S. BOM IC 8695/1975.

b) Persse, F. H., D. W. Lockard, and A. E. Lindquest. Coal Surface Mining Reclamation Costs in the Western United States. U.S. BOM IC 8737/1977.

b. Objective

The objective of this task is to analyze the effects of bonding on productivity and competitiveness of an operator in one state who has to compete with operators in another state who work under more or less stringent bonding requirements.

c. Methodology

The economic analysis of the impact of current bonding practices on large and small operators at the state and regional levels performed in this task is strictly descriptive. The use of this method is dictated by the inaccessibility of historical and/or cross-sectional data needed to apply a quantitative technique. The data collected from the discussions with the small sample of coal operators on the effects of bonding on their operations are mostly opinions and feelings with very limited facts and figures.

One method that could have measured the direct effect(s) of bonding on productivity is the quantitative analysis of the relationships between the costs of pre-mining activity related to bonding and output by size of operations. This technique calls for time series data on cost of operation and production by size of operation before and after the enactment of surface mining regulations in each state. However, unavailability of the data precludes this analysis.

The cost of mining operations, before and after the enactment of the state surface mine reclamation regulations, are unknown in most instances as most firms do not identify costs to the unit operations of mining. Even when such data is identified by coal producers, it is not public record. The U.S. Bureau of Mines and various other authors have made cost studies using model mines, case studies and statistical models; but the great divergence among these estimates shows the variability of data.[1] The uncertainty of mining parameters, both site specific differences and intermanagerial differences, make cost estimation tenuous at best.

[1] Callagan, Dennis J. and John A. Boyseasmith. "Operations Study of Selected Surface Coal Mining Systems in the United States." 1975; Cook, Frank & William Kelley. "Evaluation of Current Surface Coal Mining Overburden Handling Techniques and Reclamation Practices" 1976; Evans, Robert J. and John R. Bilter. "Coal Surface Mining Reclamation Costs - Appalachian and Midwestern Coal Supply District U.S. BOM IC 8695; Nephew, E. A. and R. L. Spose. "Costs of Coal Surface Mining and Reclamation in Appalachia. Oak Ridge Natl. Lab., 1976, among others.

Price figures for coal are quoted in industry statistics as an average for all coal products. The heterogeneous nature of coal makes such statistics unsatisfactory for economic interpretation. Coal varies in use as well as in chemical quality and heating characteristics. It was hoped that price differences for coal between states and regions could be used to illustrate cost differences from mining and reclamation, but price fluctuation from differences in coal quality would obscure this relationship. Existing price data is not sufficient to segregate these effects.

Deprived of good economic data on extractive costs, reclamation costs and coal prices, quantitative modeling is of little use and any results would be questionable. The following analysis is therefore strictly a descriptive analyses of the coal industry.

To accomplish the purpose of this task, hypothetical mining situations were employed. Rough indirect indicators of the impact of bonding on productivity and competitive position of coal operators are measured from the data generated on three elements of bonding. Comparison of the magnitude of these indirect indicators of impact based on three bonding elements is made among the states under each reclamation region established in Section V. The concepts and assumptions underlying the estimation of the true costs for state reclamation bond and the steps followed in the calculation are in the subsections presented below.

The problems of deriving the actual cost of bonding are discussed. The economic significance of the total bond amount, partial bond release, and the actual cost of bonding is examined. The actual cost of bonding is derived using the net present value of the cash flows from bonding. The relative costs of bonding are presented for each for a variety of scenarios using different size acreages and premium rates.

d. Cost Estimation for State Reclamation Bonds

(1) <u>Objectives</u>

The operators with whom discussions were held considered the cost of bonding to be an insignificant part of the total mining cost. Most operators, however, did not have an understanding of the true costs of bonding. Most considered the per acre assessed bond penalty or the premium rate they paid to be synonymous to the bond cost. These economic figures are important to the operator but do not express the true cost of bonding since they fail to take into account the time frame of cash flows in the bonding cycle. The true cost of bonding under certain simplifying assumptions are presented below.

(2) Methodology

The total bond amount for four different sized parcels of acreage, (8, 50, 100 and 400 acres) is presented. The bond premium in dollars per year for each of the four model acreage sizes is presented assuming a 0.5%, 1.5% and 2.5% premium rate per year. The economic significance of the total bond amount and the premium paid and premium rate is discussed.

The actual cost of bonding must take into account the timed cash flows during the bonding cycle. Costs of collateral bonds and surety bonds are examined. To estimate some measure of bond cost, simplifying assumptions were made. In the calculation of costs it is assumed that the bond is submitted at time zero (t_o) and mining and regrading take place in one year. Partial release is granted in that time if allowed by that state's mining law. Final release in all cases is assumed to be two years after regrading. The total bond cycle from submittal to final release is assumed to be 3 years.

Surety bonds are assumed to pay the stated premium in advance of each period. Costs are calculated for permit areas of 8, 50, 100 and 400 acres respectively. Premium rates of 0.5%, 1.5% and 2.5% are used. The cash flows involved in a surety bond are as follows. The operator pays the premium on the total bond at time t_o. If no partial release is granted, he will pay similar premiums at t_1 (period 1 or year 1) and t_2 (period 2 or year 2). If partial release is granted, the premiums at t_1 and t_2 will be reduced according to that state's allowed grading release.

Start of mining		Partial release				Final release
t_o	______	t_1	______	t_2	______	t_3

Time Frame

At first glance the cost of the bond might appear to be the simple sum of the three premium payments at t_o, t_1 and t_2. This notion is incorrect as it ignores the timed cost of money. It is common to assume that one would prefer a dollar today to a dollar next year. The dollar in the future is naturally discounted since its use is denied for one year. The measure of this preference for present dollars is called the discount rate. It reflects the lost opportunity of using the money over time. It is obvious that the premium at t_o is of a higher cost than the premium at t_2. The operator has two years of use of the money used to pay the premium at t_2. To compare the two time periods, we must bring the premium paid in t_2 to present dollars. This is done by the following formula:

$$\frac{Pf}{(1 + dr)^n}$$

where Pf is the premium paid in the future, dr is the discount rate and n is the number of periods (years) in the future.

The discount rate is difficult to discern. In this analysis an 8% discount rate was assumed since it is a reasonable rate of return to be expected for coal mining investments. It is assumed that had the bond premiums been invested in the company itself or some other venture, it would have yielded 8% on the invested capital.

Returning to the time line the first premium payment at t_o is multiplied by $\frac{Po}{(1 + .08)^o} = P_o$. This is obvious as a dollar today is worth a dollar. The second premium at t_1 is equal to $\frac{P_1}{(1 + .08)^1} = .9259\ P_1$ in present dollars. The third premium at t_2 is equal to $\frac{P_2}{(1 + .08)^2} = .8573\ P_2$ in present dollars. The costs of bonding were calculated using the present value of the cash flows for surety bonding for each state for four permit sizes using three premium rates. The average size bond was taken from the matrix shown in Figure 25 and multiplied by the number of acres for the four permit sizes. Costs reflect the average bond rate for each state and an assumed discount rate of 8%. Costs also reflect partial releases after grading or planting.

The costs of collateral bonds are derived in a similar manner. The cash flows are discounted to present dollars. The cash flows for collateral bonds are assumed to be as follows:

(-) Post Collateral	(+) Grading Release		(+) Final Release
t_o ————	t_1 ————	t_2 ————	t_3

The posting of the initial collateral is the only negative cash flow. The grading release and final release are positive cash flows as they are funds being released from legal obligation. If we did not discount for the timed nature of the cash flows, the apparent cost of bonding would be zero. For example; \$10,000 is posted as collateral at t_o, \$8,000 returned at t_1 and \$2,000 returned at t_3, (-\$10000)+ \$8000 + \$2000 = 0. This is not correct intuitively since the operator is denied the use of \$2,000 for three years and \$8,000 for one year. We must discount the cash flows to determine the cost.

The discount rate here is more difficult to determine. We will assume as before, that the rate of return for the best alternative to posting collateral is 8%, that is our opportunity cost and therefore our discount rate. We will also assume, however, that the operator is posting a certificate of deposit that is earning 6%, therefore the net rate of discount is 2%, 8% opportunity cost minus 6% earnings.

The initial posting of collateral is then discounted at $\frac{P_o}{(1+.02)^o}$ $= P_o$. The grading release at t_1, if applicable, is discounted by $\frac{P_1}{(1+.02)^1}$ $= .9804P_1$. The final release at t_3 is discounted by $\frac{P_3}{(1+.02)^3} = .9423P_3$. Since we know P_o is negative and P_1 and P_3 are positive and that $P_o = P_1 + P_3$ then $P_o + .9804P_1 + .9423P_3$ is negative. This is to be expected as it represents the cost of collateral bonding.

e. Results - Bonding Elements that Affect Productivity

The specific elements in the state-by-state bonding regulations that can affect productivity and competitive position of coal operators are:

(1) Total amount or rate of the performance bond.

(2) Time interval for bond submittal, release, and provision for partial release.

(3) Opportunity cost of the amount of collateral for the bond or the cost of premiums for surety bond.

The magnitude of the indirect impact of these three bonding elements on productivity are discussed below.

(1) Total Amount of Performance Bond

The rate or amount/acre of the performance bond varies from state to state. The usual practice is for the statute to set up a range for the bonds or a minimum total requirement or both. In spite of the fact that the bond is required as a tool to ensure reclamation, the rate of the performance bond in each state is much lower than the estimated cost of reclamation.

In this analysis, the most current data on the average rate of performance bond for each state was used. Several size acreages to be disturbed or to be bonded are assumed. Total costs of bonding for the assumed acreages are estimated by states. It is assumed that all operators in the same state will be required to post the same amount for the same acreage to be disturbed.

The total amount of the bond is economically significant because it directly or indirectly limits the capital available to the operator to invest in production of coal. Operators using collateral bonds are most significantly affected. The capital they post as collateral cannot be used to purchase equipment, pay wages, or be used as collateral for loans because it is legally encumbered. The operator using collateral bond is then denied the use of his own capital and hindered from attracting outside capital.

Operators using surety bonds are impacted indirectly from the total bond amount in that having outstanding obligations in bond reduces his ability to attract outside capital. However, little of his internal capital is tied up. By virtue of the fact that the operator is privy to surety bonds is a measure of financial health as bonding companies are selective as to who they will bond. Most bonding companies use financial measures such as net worth in determining an operator's fitness for surety bonds. Operators that are higher risk, either through poor financial health or poor reclamation record, will either be denied surety bonds or pay higher premiums.

The average rate of performance bond to be posted per acre by state is given in Figure 26. It is highest in Illinois ($3,100/acre), followed by Ohio ($2,700/acre). The average rate of $1,000/acre applies to Pennsylvania, Tennessee, West Virginia, and Indiana. Maryland, eastern and western Kentucky have comparable average rates of $1,000 and $1,500, respectively. The lowest average rate was observed in Iowa.

A comparative analysis of bonding in the states that fall in categories according to ease of reclamation and achieving environmentally sound reclamation is discussed in this section (see Figure 22). This comparative analysis is based on the assumption that in a given category, the significant interstate differences in the amount of the bond to be posted for similar acreage can impose significant and different production constraints on similar size operators. For purposes of analysis, the states and the corresponding categories are listed below.

Category A - Average and favorable reclamation conditions with average and above average rating of achieving environmentally sound reclamation. In this category the states included are Illinois, Iowa, Kansas, Oklahoma, Indiana and Missouri.

Category B - The states included which had least favorable reclamation conditions but with above average environmentally sound reclamation are West Virginia, Ohio and Maryland.

Category C - The states with least favorable reclamation conditions but with average environmentally sound reclamation are Pennsylvania, Virginia and eastern Kentucky.

Category D - The states with less favorable reclamation conditions but with average and above average environmentally sound reclamation are Alabama, western Kentucky and Tennessee.

Category E - This region is described with less favorable reclamation conditions and below average rating for reclamation. Arkansas is the only state in this category.

STATE	AVERAGE BOND SIZE (DOLLARS) PER ACRE	PERCENTAGE GRADING RELEASE	PERMIT SIZE							
			8 ACRES		50 ACRES		100 ACRES		400 ACRES	
			DOLLARS		DOLLARS		DOLLARS		DOLLARS	
			TOTAL BOND	BOND AFTER PARTIAL RELEASE	TOTAL BOND	BOND AFTER PARTIAL RELEASE	TOTAL BOND	BOND AFTER PARTIAL RELEASE	TOTAL BOND	BOND AFTER PARTIAL RELEASE
ALABAMA	1200	60%	10000	4000	60000	24000	120000	48000	480000	192000
ARKANSAS	800	80%	6400	1280	40000	8000	80000	16000	320000	64000
ILLINOIS	3100	(ALL BUT $100/ACRE)	24800	800	155000	5000	310000	10000	1240000	40000
INDIANA	1000	70%	8000	2400	50000	15000	100000	30000	400000	120000
IOWA	250	NO	2000	2000	12500	12500	25000	25000	100000	100000
KANSAS	750	NO	6000	6000	37500	37500	75000	75000	300000	300000
KENTUCKY	1500	80%	12000	2400	75000	15000	150000	30000	600000	120000
MARYLAND	1600	(ALL BUT $600/ACRE)	12800	4800	80000	30000	160000	60000	640000	240000
MISSOURI	700	67%	5600	1867	35000	11667	70000	23333	380000	93332
OHIO	2700	50%	21600	10800	135000	67500	270000	135000	1080000	540000
OKLAHOMA	650	80%	5200	1050	32500	6500	65000	13000	260000	52000
PENNSYLVANIA	1000	80%	8000	1600	50000	10000	100000	20000	400000	80000
TENNESSEE	1000	80%	8000	1600	50000	10000	100000	20000	400000	80000
VIRGINIA	1000	50%	8000	4000	50000	25000	100000	50000	400000	200000
WEST VIRGINIA	1000	75%	10000	10000	50000	12500	100000	25000	400000	100000

FIG. 26 TOTAL AMOUNT OF BONDS REQUIRED PER STATE FOR 8,50,100 AND 400 ACRE PERMIT AREAS

78-5

It can be observed that there is a significant disparity in the average amount of bond per acre among the states in a given category. Assuming similar-size operators exist among the states in Category A, a mine operator in Illinois would post a much higher amount than his counterparts in the other states. The differences in the amount of the performance bond to be posted for the acres specified are shown in Figure 26. To disturb the same acreage, the operator in Illinois would post 12.4 times as much as his counterpart in Iowa, 4.7 times as much as his Oklahoma counterpart, 4.4, 4.1 and 3.1 times as much as his counterparts in Missouri, Kansas and Indiana, respectively.

In Category B, Ohio has the highest average rate per acre, followed by Maryland and West Virginia. For the same number of acres disturbed, the coal operator in Ohio would post more than his counterpart in Maryland (1.69) and in West Virginia (2.16).

In Category C, eastern Kentucky has the highest average bond of $1,500. For disturbing the same acres, an operator in eastern Kentucky has to post a bond 1.5 times as much as his counterpart in Pennsylvania and 1.58 times as much as his counterpart in Virginia. Tennessee has the same average rate as in Pennsylvania.

Western Kentucky and Alabama have comparable average rates for the performance bond, especially for 8 acres. It is $10,000 for the former and $12,000 for the latter. Beyond 8 acres, a coal mine operator in western Kentucky has to post 1.25 times as much as his counterpart in Alabama for disturbing the same size area.

(2) Time Interval for Bond Submittal and Release

Assuming that partial release can be obtained a year after the total amount of the bond is posted, it can be observed that the total amount of the bond held decreased significantly in states with a high percentage of partial release. The percentages of partial release by state and the amount of the bond held after partial release are also shown in Figure 26.

To illustrate the impact of the partial release on total amount of the bond, states in Category A are used as an example. To reiterate, this category is composed of Illinois, Iowa, Kansas, Indiana, Oklahoma, and Missouri for this analysis. The operators in Illinois have to post the highest per acre bond.

However, they can take advantage of the partial release requirement so they can recover the whole amount except for $100/acre. This is equivalent to about 97 percent partial release. On the other hand, the counterpart operators in Kansas do not have that option. Consequently, the operators in Kansas have the highest amount of the bond held after the end of the first time period or one year.

In Category B, West Virginia operators have the option of obtaining 75 percent partial release in comparison to their Maryland and Ohio counterparts who can obtain only 63 and 50 percent partial release, respectively.

For each category the interstate differences in the amount of the total bond to be posted by similar-size operators for disturbing the same acreage have obvious implications on their production and competitive position. The magnitude of the bond posted for a certain period is an indicator of liability to the operator. In general, the higher the liability, the more restrictions and constraints are imposed on the ability of the coal operators to acquire additional input resources in terms of capital, labor, equipment, and other supplies for expansion of production. In addition to capital constraints, operators also have to make production adjustments to accommodate increases in costs resulting from bonding.

Other costs not considered in this analysis are the time and effort that coal management must spend to secure bonds, process releases, and handle collateral accounts. In turn, constraints to production of individual operators have further repercussions to the coal industry of each state and finally to the industry as a whole. In some degree these constraints can contribute to the inability of coal operators to respond to increases in the market demand for coal, especially in the short run.

(3) Premium Rates and Costs of Bonding

As was stated above, bonding companies scrutinize prospective operators before bonding them. High risk operators will be denied bonds or pay higher premiums. In some cases, new operators must post 100% collateral plus pay high premiums until they establish a reputation with the bonding company. The premium rates reported through our interviews are shown in Figure 27. The total amount of the bond and the amount of the bond held after partial release also determines the cost of premium payments the coal operators have to bear.

STATE	SIZE OPERATOR	PREMIUM RATE
ALABAMA	LARGE	$12.50/$1000
ALABAMA	LARGE	$14.00/$1000
ALABAMA	(REGULATORY AUTHORITY)	$12.50/$1000
ILLINOIS	LARGE	$5.00/$1000 DOWN FROM $10.00/$1000
IOWA	(REGULATORY AUTHORITY)	$12-$15/$1000
KANSAS	LARGE	$5/$1000
KANSAS	MEDIUM	$10/$1000
EASTERN KENTUCKY	MEDIUM	$12.50/$1000
OKLAHOMA	LARGE	$5/$1000
TENNESSEE	MEDIUM	$15-$25/$1000
TENNESSEE	MEDIUM	$25/$1000

FIG. 27 BOND PREMIUM RATES REPORTED DURING DISCUSSIONS

78-5

The premium rate shows a definite trend of being low for large firms and high for small firms. The premium rate will determine the magnitude of each premium payment. Although the premium payments are low compared to the overall cost of mining, they do contribute to the restrictions on the level of working capital the operator needs to run a mine. The premium payments for each discount rate and size of permitted area are shown in Figure 28.

The actual cost of bonding was calculated using the net present value of the discounted cash flows over the bonding cycle. The costs calculated represent the true costs of bonding within the assumptions of the analysis. The assumptions are 1) that the discount rate is 8%, 2) that the bond is paid each year in advance of the period, and 3) that each surety bond operator posts no collateral. The last assumption is necessary or the posting of collateral would be a cash flow.

The actual costs are presented in two ways. First, the total cost for each permit acreage size and premium rate is given in Figures 29 and 31. Secondly, the costs are expressed in per ton figures (Figures 30 and 31.)

The costing assumptions tend to ignore the fact that some states require bonds to be submitted with the permit application. When this is done, the operator must carry the liability (and cost) of the bond over the permit application review time. Arkansas, Illinois, Indiana, Iowa, Ohio, Oklahoma, Tennessee, Virginia and West Virginia all require bonds be submitted with permit applications.

The total costs per permit area of using surety bonds is presented in Figure 29 . Costs can be determined for differing assumptions; for example, one may wish to determine the cost of a small operator in Indiana as opposed to a large operator for a 50-acre permit. The cost for the large operator can be read directly from the appropriate column and if we assume the small operator has a bond rate twice as high as the large operator, one need only double the cost. To vary the premium rate differences of the two operators, one would cost the large operator at 1.5% and the small operator at 2.5%. Looking at Figure 29 we would get $1151.23 (Indiana, 50 acres, 1.5%) for the large operator and $3837.40 (2 x Indiana, 50 acres, 2.5%). The process used to calculate the costs is commutative, therefore one need only use proportions to vary cost assumptions. Note that the $3837.40 is also Indiana for 100 acres and 2.5% premium rate.

STATE	PERMIT SIZE											
	8 ACRES			50 ACRES			100 ACRES			400 ACRES		
	PREMIUM RATE			PREMIUM RATE			PREMIUM RATE			PREMIUM RATE		
	0.5%	1.5%	2.5%	0.5%	1.5%	2.5%	0.5%	1.5%	2.5%	0.5%	1.5%	2.5%
ALABAMA	50	150	250	300	900	1500	600	1800	3000	2400	7200	120000
ARKANSAS	32	96	160	200	600	1000	400	1200	2000	1600	4800	80000
ILLINOIS	124	372	620	775	2325	3875	1550	4650	7750	6200	18600	310000
INDIANA	40	120	200	250	750	1250	500	1500	2500	2000	6000	10000
IOWA	10	30	50	62.50	187.50	312.50	125	325	625	500	1500	2500
KANSAS	30	90	150	187.50	562.50	937.50	375	1125	1875	1500	4500	7500
KENTUCKY	60	180	300	375	1125	1875	750	2250	3750	3000	9000	15000
MARYLAND	64	192	320	400	1200	2000	800	2400	4000	3200	9600	16000
MISSOURI	28	84	140	175	525	875	350	1050	1750	1400	4200	7000
OHIO	108	324	540	675	2025	3375	1350	4050	6750	5400	16200	27000
OKLAHOMA	26	78	130	10.5	487.50	812.50	325	975	1025	1300	3900	6500
PENNSYLVANIA	40	120	200	250	750	1250	500	1500	2500	2000	6000	10000
TENNESSEE	40	120	200	250	750	1250	500	1500	2500	2000	6000	10000
VIRGINIA	40	120	200	250	750	1250	500	1500	2500	2000	6000	10000
WEST VIRGINIA	50	150	250	250	750	1250	500	1500	2500	2000	6000	10000

FIG. 28 PERIOD PREMIUM PAYMENTS (DOLLARS) FOR SURETY BONDS (CALCULATED FOR TOTAL BOND BEFORE PARTIAL RELEASE ONLY)

78-5

STATE	8 ACRES			50 ACRES			100 ACRES			400 ACRES		
	PREMIUM RATE			PREMIUM RATE			PREMIUM RATE			PREMIUM RATE		
	0.5%	1.5%	2.5%	0.5%	1.5%	2.5%	0.5%	1.5%	2.5%	0.5%	1.5%	2.5%
ALABAMA	85.67	257.01	428.35	513.99	1541.98	2569.95	1027.98	3083.95	5139.90	4111.92	12335.80	20559.60
ARKANSAS	43.41	130.23	217.05	217.33	651.99	1086.65	542.66	1627.98	2713.30	2170.64	6511.92	10853.20
ILLINOIS	131.13	393.40	655.65	819.58	2458.74	4097.90	1639.16	4917.49	8195.80	6656.64	19669.96	32783.20
INDIANA	61.40	184.20	307.00	383.74	1151.23	1918.70	767.48	2302.47	3837.40	3069.92	9209.88	15349.60
IOWA	27.33	83.50	139.15	173.95	521.86	869.75	347.90	1043.72	1739.50	1391.60	4174.90	6958.00
KANSAS	83.63	250.49	418.15	521.86	1565.59	2609.30	1043.72	3131.11	5218.60	4174.88	12524.69	20874.40
KENTUCKY	81.40	244.20	407.00	508.74	1526.23	2543.70	1017.48	3052.47	5087.40	4069.92	12209.88	20349.60
MARYLAND	106.80	320.40	534.00	667.49	2002.47	3337.45	1334.98	4004.94	6674.90	5339.92	16019.76	26699.60
MISSOURI	44.64	133.92	223.20	279.02	837.06	1395.10	558.05	1674.15	2790.25	2232.20	6696.60	11161.00
OHIO	204.30	612.89	1021.56	1076.85	3230.56	5384.25	2153.70	7661.11	10768.50	8614.80	30644.44	43074.00
OKLAHOMA	35.27	105.82	176.35	220.46	661.38	1102.28	440.91	1322.73	2204.56	1763.65	5290.95	8818.24
PENNSYLVANIA	54.27	162.80	271.35	339.16	1017.49	1695.80	678.32	2034.98	3391.60	2713.28	8139.92	13566.40
TENNESSEE	54.27	162.80	271.35	339.16	1017.49	1695.80	678.32	2034.98	3391.60	2713.28	8139.92	13566.40
VIRGINIA	75.67	227.01	378.35	472.91	1418.73	2364.55	945.82	2837.46	4729.10	3783.26	11349.78	18916.30
WEST VIRGINIA	72.29	216.87	361.45	361.45	1084.36	1807.25	722.90	2168.72	3614.50	2891.60	8674.90	14458.00

FIG. 29 ACTUAL COST (DOLLARS) OF BONDING PER PERMIT AREA USING SURETY BONDS

78-5

The calculation of per ton costs assume a three-foot seam and are presented three ways by varying the assumptions concerning the percentage of the permit area mined and the percent recovery. In the first three columns, 100% of the area is mined out and 100% recovery is assumed. The next assumption is 80% recovery and 80% of the permit area is mined out. This is indicative of mid-western strip mining on relatively flat land by area methods. The third set of figures assumes 80% recovery and 30% of the permit area is mined out. These assumptions are indicative of the mountainous contour mining in Appalachia.

The costs per ton presented in Figure 30 are not given for each permit area size as they are all the same due to the assumptions by which we calculated them. Since we used average bond sizes and all the calculations were multiplicative, the per ton figures are all the same since multiplication is commutative.

The collateral costs were only calculated for 8-acre and 50-acre permit areas. Acreages larger than that would be uneconomic to post collateral. Collateral costs are presented per permit size in Figure 31.

The bonding costs estimated per ton of coal using surety bond or collateral bond under the assumptions of the analysis can be used to indicate the increased or additional production costs/ton that the operator has to pay. It can also indicate the cost/ton that the coal producer can pass on to his consumer as a consequence of bonding. The estimated costs on per ton basis reflected the same interstate differences noted in the discussion on the total amount of the bond. To illustrate the differences, Category A can be used as an example. This region falls under the assumption of 80% permit area mined out and 80% recovery. Using a 1.5% premium rate, a coal operator in Illinois who chose to use surety bond pays close to two cents per ton compared to a cent and/or less than a cent his counterparts would pay in the other states.

It is also interesting to see in this region and in the other regions that the costs per ton using surety bond at a 1.5% premium rate is comparatively the same as the costs per ton using collateral bond. Beyond a 1.5% premium rate, the cost per ton using surety bond is higher than the cost per ton using collateral bond.

	100% OF PERMIT AREA IS MINED, 100% RECOVERY			80% OF PERMIT AREA IS MINED, 80% RECOVERY			30% OF PERMIT AREA IS MINED, 80% RECOVERY		
	0.5%	1.5%	2.5%	0.5%	1.5%	2.5%	0.5%	1.5%	2.5%
ALABAMA	0.2	0.7	1.1	0.3	1.1	1.8	0.9	2.8	4.7
ARKANSAS	0.1	0.4	0.6	0.2	0.6	0.9	0.5	1.5	2.5
ILLINOIS	0.4	1.1	1.8	0.6	1.7	2.8	1.5	4.5	7.4
INDIANA	0.2	0.5	0.8	0.3	0.8	1.3	0.7	2.1	3.5
IOWA	0.1	0.2	0.4	0.1	0.4	0.6	0.3	1.0	1.6
KANSAS	0.2	0.7	1.1	0.4	1.1	1.8	1.0	2.8	4.7
KENTUCKY	0.2	0.7	1.1	0.3	1.0	1.7	0.9	2.8	4.6
MARYLAND	0.3	0.9	1.5	0.5	1.4	2.3	1.2	3.6	6.1
MISSOURI	0.1	0.4	0.6	0.2	0.6	1.0	0.5	1.5	2.5
OHIO	0.6	1.7	2.8	0.9	2.6	4.3	2.3	6.9	11.6
OKLAHOMA	0.1	0.3	0.5	0.2	0.5	0.8	0.4	1.2	2.0
PENNSYLVANIA	0.2	0.4	0.7	0.2	0.7	1.2	0.6	1.8	3.1
TENNESSEE	0.2	0.4	0.7	0.2	0.7	1.2	0.6	1.8	3.1
VIRGINIA	0.2	0.6	1.0	0.3	1.0	1.6	0.9	2.6	4.3
WEST VIRGINIA	0.2	0.5	0.7	0.3	0.7	1.2	0.7	2.0	3.3

FIG. 30 COST PER TON FOR BONDING USING SURETY BONDS (CENTS/TON)

78-5

	TOTAL COST PER PERMIT AREA (NET PRESENT VALUE OF CASH FLOWS)		COSTS PER TON		
	8 ACRES	50 ACRES	100% OF PERMIT AREA IS MINED, 100% RECOVERY	80% OF PERMIT AREA IS MINED, 80% RECOVERY	30% OF PERMIT AREA IS MINED, 30% RECOVERY
	(DOLLARS)	(DOLLARS)	(CENTS)	(CENTS)	(CENTS)
ALABAMA	348.36	2390.15	1.0	1.5	2.0
ARKANSAS	174.22	1088.87	0.4	0.8	2.0
ILLINOIS	516.73	3229.57	1.4	2.2	5.9
INDIANA	248.23	1551.44	0.7	1.1	2.8
IOWA	115.36	720.97	0.3	0.5	1.3
KANSAS	345.07	2162.91	0.9	1.5	4.0
KENTUCKY	326.67	2041.64	0.9	1.4	3.7
MARYLAND	433.71	2710.72	1.2	1.9	4.9
MISSOURI	180.88	1130.11	0.5	0.8	2.2
OHIO	834.68	5216.77	2.3	3.6	9.5
OKLAHOMA	141.55	884.71	0.4	0.6	1.6
PENNSYLVANIA	217.77	1361.09	0.6	0.9	2.5
TENNESSEE	217.77	1361.09	0.6	0.9	2.5
VIRGINIA	309.14	1932.14	0.8	1.3	3.5
WEST VIRGINIA	233.01	1456.26	0.6	1.0	2.6

FIG. 31 TOTAL COSTS AND COSTS PER TON FOR COLLATERAL BONDS

78-5

3. Summary

This analysis gave some indicators of the magnitude of the effect(s) of bonding on productivity and competitiveness of coal operators. It was shown how the total amount of the bond varied between states in a unique region on account of the disparity of the average rate required by each state. It was also shown how the total cost of the bond changed by virtue of the partial release options. These partial release options in percentages also differed from one state to another. The analysis also showed the actual costs of bonding on a per ton basis using surety bond with alternative premium rates. The actual cost of bonding per ton was also calculated using collateral bond.

The interstate disparity in the average rate and total amount of performance bond indirectly measured the differences in magnitude of the liability that each operator has to bear for the life of the bond. In turn, this liability imposes some capital constraints on the ability of the operators to expand production. Although all size operators are affected as shown by the magnitude of the bond they have to post for specified acres, the effects especially of capital constraints will most likely be stronger on small operators than on large operators. This is supported by a majority of opinions obtained from large and medium size operators in the discussions held with them.

To some extent these capital and production constraints can contribute toward restraining entry into the coal industry. In addition, such capital and production restrictions imposed on small operators can lead to an increase in firm concentration in the coal industry.

The actual cost of bonding estimated in cents per ton using surety bond and collateral bond also differed from one state to another under one unique region. These differences in the costs reflect the differences in the increase of mining costs, in the short run, that similar size operators have to pay as a consequence of bonding. The operators interviewed felt that bonding cost has an insignificant or negligible effect on their operation. In all likelihood, they are probably just thinking of the one year cost they have to pay as premiums for specified acres. However, their operation is geared towards a long run basis and the short run cost increases, resulting from bonding, can add up to a significant figure in the long run. The motivation of the operator is, of course, to maintain a profit level. As long as this profit level is not affected significantly by the increase in cost resulting from bonding, the impact to them would be insignificant as they claim at present.

The analysis thus far has demonstrated that small operators are in many cases disadvantaged. They have difficulty obtaining surety bonds and when they do, they must pay higher premiums. If relegated to collateral bonding, the small operator suffers severe capital constraints. Management of small operators tends to have less expertise in modern reclamation techniques and is less likely to understand the legalities of reclamation regulation. Small operators are also less likely to be able to afford the services of mining engineers, soil scientists, hydrologists and lawyers.

4. Special Reclamation Fees

Special reclamation fees are found in only three states; Maryland, Ohio and West Virginia. Maryland and West Virginia have had special reclamation fees for quite some time but Ohio is a newcomer. Special reclamation fees as defined here are fees per acre or per ton that are non-refundable to the operator and are used solely to reclaim orphaned land.

Maryland has had a special reclamation fee since its reclamation law of 1971. The operator posted a fee of $30 per acre to a special fund committed to reclaiming orphaned land. The Maryland law is unique in that the state matches the funds from the general funds of the state. In this way the general public and the mining industry share the cost of cleaning up yesterday's scars. Recently, Maryland has increased their special reclamation fee to $40 per acre which the state will also match at $40/acre.

The Ohio special reclamation fee was instituted by earmarking 2 cents of a four-cent per ton severance tax for reclamation of abandoned stripped lands. The fee adds no additional burden to the operator as the 4 cents per ton fee has existed for some time but has just been reallocated. The operator pays the fee at the end of the year according to his tonnage produced.

The West Virginia special reclamation fee is $60/acre. The operator, as in Maryland, pays the fee at the time he applies for his permit with his permit fees.

The costs of these programs are not easily comparable as the Maryland fees come from two sources and the Ohio fee is stated in cents per ton. The following table compares these costs using the same assumptions used to calculate bond cost per ton.

	100% Recovery 100% of Area Mined	80% Recovery 80% of Area Mined	80% Recovery 30% of Area Mined	By Law
Cost to Maryland operator	0.9¢/ton	1.4¢/ton	3.6¢/ton	$ 40/acre
Total fees derived-MD	1.8¢/ton	2.7¢/ton	7.2¢/ton	$ 80/acre
Ohio	$91.98/acre	$58.87/acre	$22.08/acre	2.0¢/ton
West Virginia	1.3¢/ton	2.0¢/ton	5.4¢/ton	$ 60/acre

In interpreting this table we find that the cost of special reclamation fees increases for Maryland and West Virginia as factors of recovery and percentage of permit area mined are considered but that the cost of the fees diminishes in Ohio as the number of tons decreases per permit area because of the assumptions. The cost of the special reclamation fees are comparable to the costs of bonding.

F. POLICY IMPLICATIONS

1. Introduction

The regional economic analysis presented here is a brief review of selected economic variables of the coal industry in the study area, and are related according to the regions presented in Section IVB determined by the physical factors of reclamation. This analysis will look at size of mine, production (1975), reserves (1974) and a general view of quality differences of the coal across the regions. This discussion is important as it will relate to the policy alternatives generated in Phase II of the study. The likely impact of differing policy alternatives on each region can be inferred by referring to these economic variables.

Figures on labor productivity were collected but definable trends specifically associated to reclamation regulation or bonding activities could not. Generally the labor productivity was higher for those areas that had a higher proportion of surface mining and whose operations were larger. Historical trends for labor productivity declined gently after the 1969 Federal Mine Health and Safety Act and more drastically after the 1973 oil embargo. As no definable trends could be associated to reclamation activities labor productivity is not discussed further.

2. Analysis of Production and Strippable Reserves

Regional production and reserves data were broken down on a county by county basis. The regionalization was based upon counties rather than states and the regions cross state boundaries and many states have counties in 3 or more regions. Counties that were not used in the regionalization were excluded. The study area included 72% of the United States' strip production, 100% of the auger and strip auger production (here included with strip) and 92% of deep production.

Figure 32 presents regional data on production for the year 1975 and measured and indicated reserves estimated in January 1974. The tonnage of strip mined coal increases with increasing severity of reclamation conditions, yet the percentage of strip mining to total production for each region declines with increasing severity of reclamation conditions. This can be explained by the historical prominence of the Appalachian coal fields. Coal mining has long been the prominent industry throughout most of Appalachia. The high local relief found in this area

REGIONS	1975 STRIP PRODUCTION (1000 TONS)[1]	% OF TOTAL AS STRIP (%)	1975 DEEP PRODUCTION (1000 TONS)[1]	NUMBER OF STRIP MINES 1	AVERAGE PRODUCTION PER STRIP MINE (1000 TONS)[1]	STRIPPABLE RESERVES (MILLION TONS)[2]	% OF TOTAL AS STRIP (%)	DEEP RESERVES (MILLION TONS)[2]	YEARS OF PRODUCTION STRIP	YEARS OF PRODUCTION DEEP
REGION V LEAST FAVORABLE RECLAMATION CONDITIONS	119725	43	159260	1213	68	12686	16	65774	106	413
REGION IV LESS FAVORABLE RECLAMATION CONDITIONS	81485	50	81679	1134	69	4770	14	29822	58	365
REGION III AVERAGE RECLAMATION CONDITIONS	28449	65	15360	143	199	5198	28	13609	183	886
REGION II FAVORABLE RECLAMATION CONDITIONS	34318	76	10778	83	407	9988	39	15693	291	1456
REGION I MOST FAVORABLE RECLAMATION CONDITIONS	2753	61	1734	6	459	3591	34	6965	1305	4017
	PRODUCTION					RESERVES				

[1]US BUREAU IF MINES MINERALS YEARBOOK 1975. INCLUDES STRIP, AUGER & STRIP-AUGER AS STRIP.

[2]US BUREAU OF MINES INFORMATION CIRCULARS (VARIOUS)

FIG. 32 REGIONAL PRODUCTION FACTORS

78-5

brought coal close to the surface or into outcrop, which made small contour mining operations feasible. This mining technique has continued even though reclamation conditions are generally least favorable in Appalachia. In the regions with more favorable reclamation conditions, the percentage of strip production to total production is higher. The total number of operators and the average size strip operation for each region in 1975 are presented. The trend shows that the number of surface mine operators increases with increasing severity of reclamation conditions and operator size decreases with increasing severity of reclamation conditions. The returns to scale in mining and reclamation in the regions of less severe conditions are usually high. The increased severity of reclamation with steep slope conditions reduces the minimum efficient scale of operation.

The amount of strippable and deep reserves also increase with increasing severity of reclamation conditions, although the percentage of strippable to total reserves for each region decreases with severity of reclamation conditions. The reserve figures were also divided by the 1975 production figures to yield a general picture of the number of years of available production. These figures assume static demand production and technology, and are only meant as an empirical example. In both strippable and deep reserves, the time horizon of production decreases with increasing severity of reclamation conditions.

This would indicate that on a pure production basis, future production could shift more to the less severe regions. The trend toward the regions of less severe reclamation conditions would be tempered by the sulfur emission standards until technology is available for sulfur reduction. Figure 33 graphically shows how the strippable reserves are broken down by sulfur content among the regions. The percentage of reserves of specified sulfur content in each region is presented.

The data shows that the majority of the low sulfur reserves in the study region are in Region V - least favorable reclamation conditions. This region is in the Appalachian coal fields. The regions with more favorable reclamation conditions contain a significant amount of strippable reserves. However, much of these reserves has high sulfur content.

Historical trends of the size of mines for the entire study area and for small mines for each region are presented in Figure 34 and 35, respectively. This

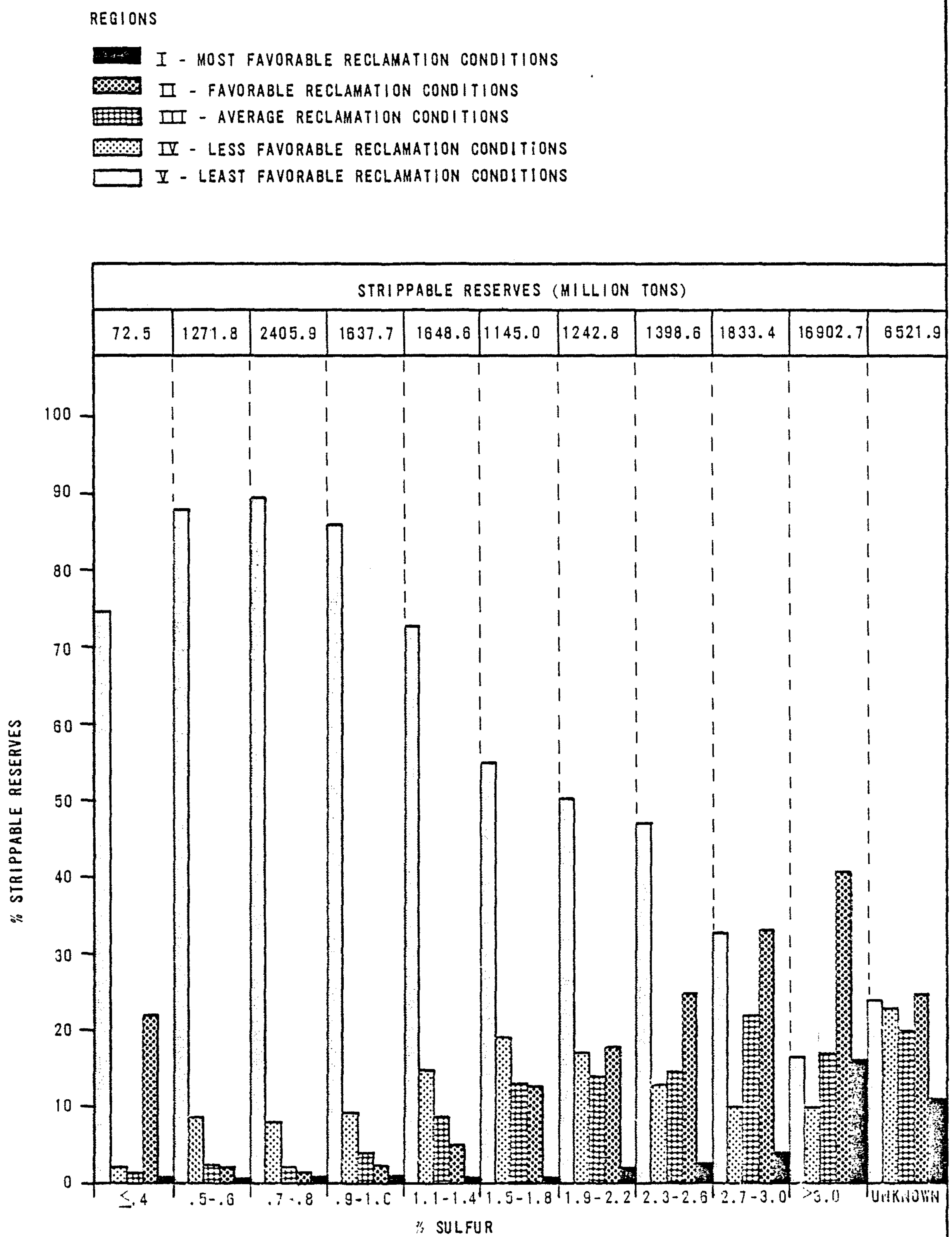


FIG. 33 PERCENT RESERVES BY REGION BY PERCENT SULFUR

78-5

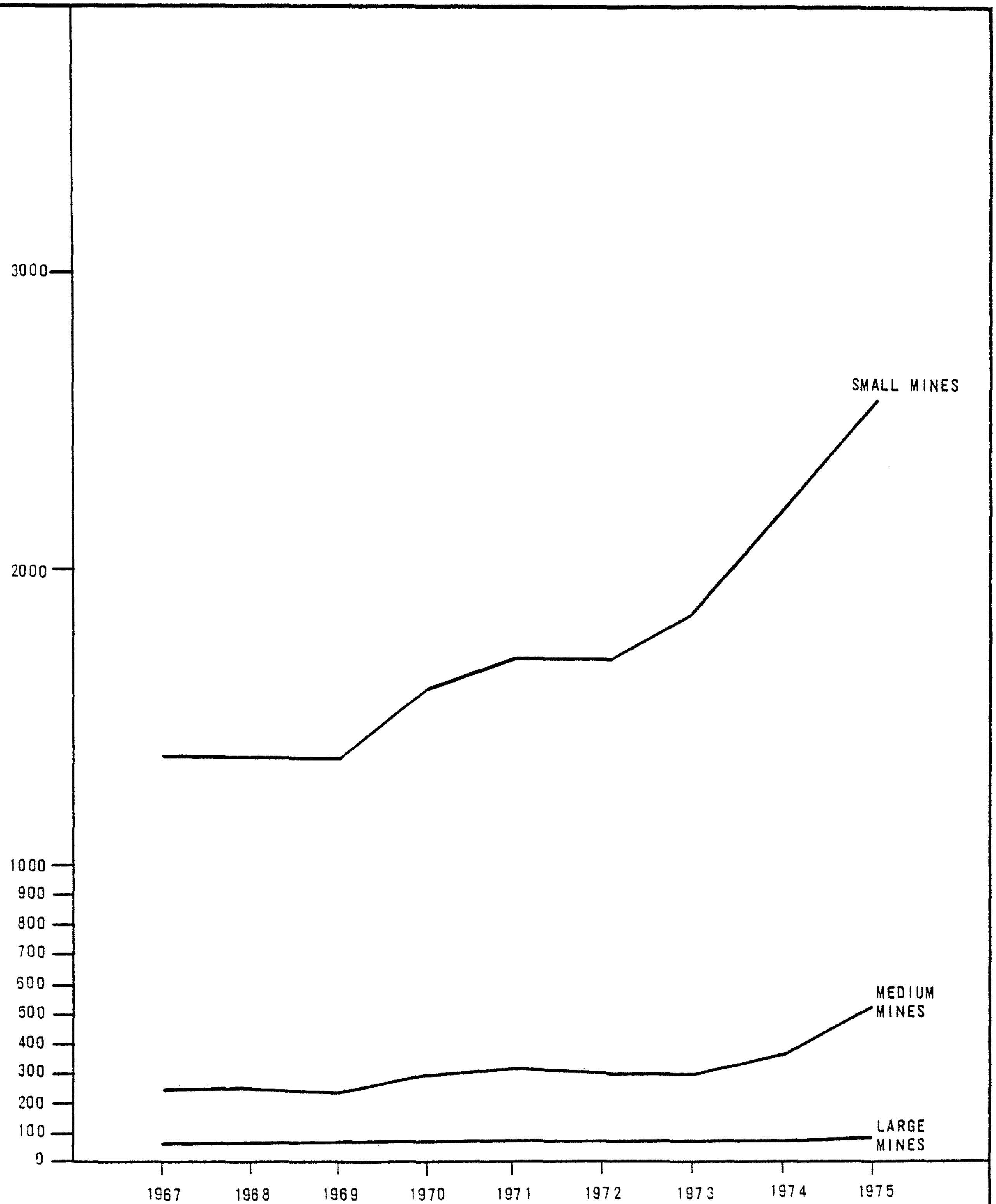


FIG. 34 TREND IN SIZE OF MINES IN STUDY REGION

78-5

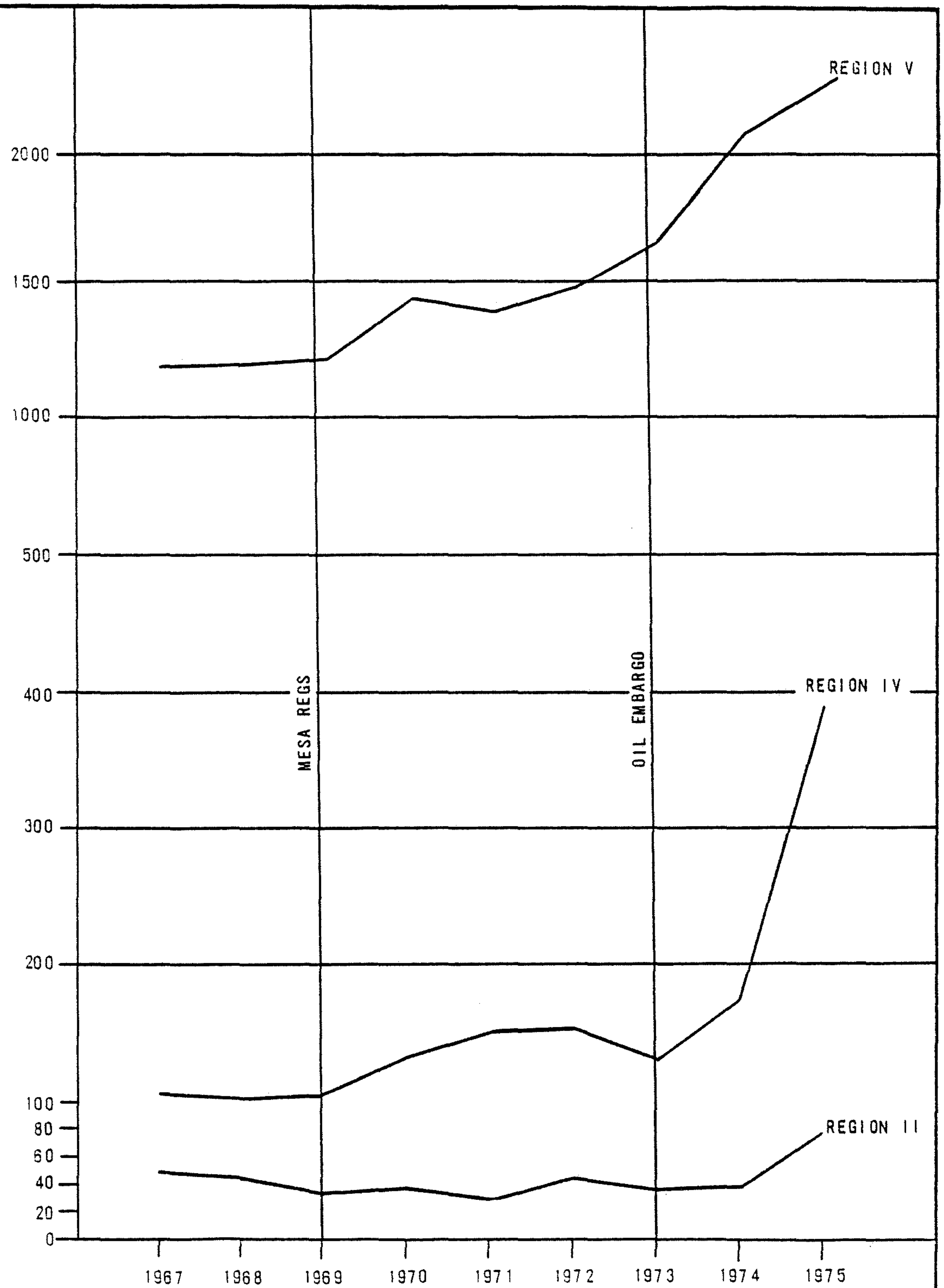


FIG. 35 TREND IN NUMBER OF SMALL MINES BY REGION

78-5

data comes from USBM Minerals Yearbook data presented by state and therefore the regions presented do not exactly coincide with the regions presented in Chapter V, as each state was assigned to the reclamation region that most closely represents the state as a whole. Because of this methodology, region III had no representatives and is therefore not depicted in Figure 35.

Figure 34, Size of Mines for the Study Area, shows the number of mines in each of the three size classes used in the study. The data shows that the smaller mines and medium sized mines increased at a more rapid rate (steeper slope of curve) than large mines which increased in number almost imperceptibly. Also, the growth spurts of the number of small and medium sized mines is closely related to the 1969 passage of the Federal Coal Mine Health and Safety Act and the 1973 oil embargo. The ability to respond to short term market fluctuations shown by the small and medium sized firms is a function of their lower capital requirements and shorter lead time. In the absence of boom conditions these mines also tend to be the first to exit the market.

Figure 35, Number of Small Mines by Region, shows the historical trend and relative number of small operators in each of the regions. It is clearly seen that the number of small operators decreases with increasing ease of reclamation. The fact that the number of small operators is significant in regions of less favorable reclamation conditions indicates that the small operator and associated problems must be considered in any analysis.

3. Policy Perspectives

The economic variables presented in this chapter are useful in examining possible impacts of different policy alternatives. The Federal Office of Surface Mining Regulation of the Department of Interior and the state reclamation authorities are charged with the responsibilities of assuring adequate protection of the environment from surface mining activities. Policy emphasis has promoted an increased share of energy consumption to coal. These and other federal, regional and state goals hinge upon the physical, economic and legal environment that the coal industry faces. Policy prescriptions to achieve any one of the goals may have detrimental impacts on other goals.

In this case, it has been shown that larger companies can obtain preferential surety rates and have more access to capital resources. Bonding practices and surface mine regulation in general will favor larger firms. This fact may be beneficial to strict environmental interests as small operators tend to be less flexible to environmental concerns and have a higher incidence of non-reclamation compliance. However, throughout the coal industry it has been shown that small mines tend to respond faster to short run market changes. Antitrust laws and policy also favor the retention of numerous small firms. State and local governments concerned with the problem of absentee ownership of coal production might favor a more equitable climate for smaller operators as they tend to be locally owned.

Prohibitions of steep slope mining might reduce erosion but also legally limit the reserves of low sulfur-high Btu coal in Region V. Policies tending to inhibit small operators may be more of a problem in Regions IV and V and may run counter to Appalachian redevelopment goals for these regions.

G. STATUS OF BOND FORFEITURES IN THE STATES

Information on bond forfeitures was spotty in most states. Many states reported no bond forfeitures, and specifics such as yearly number of permits, number of acres and total bond forfeited were not readily available. The information collected and discussions with regulatory personnel indicated that bond forfeitures were not a significant amount or a problem. It was the small and/or new operator who was most likely to encounter difficulties in completing reclamation.

1. General Patterns of Bond Forfeitures

Three patterns related to bond forfeitures were noted. The first and most prevalent pattern was no forfeitures at all. This pattern doesn't reflect necessarily the lack of enforcement since most state regulatory authorities try to work with the operator to get the reclamation work completed. In addition, some state regulators and surface mining associations encourage operators in difficulty to sell out to an operator who completes the work so that bonds are not forfeited. Mining personnel in Kansas and Maryland specifically mentioned this type of effort.

Secondly, forfeitures appear to cluster around the passage and implementation of a new surface mining law or regulatory change. This is to be expected since new demands are made upon operators and those that have been marginally operating or those unable to technically adjust to the regulatory changes go out of business. This pattern again was associated with the small operator. This pattern was specifically noted in Kentucky, Pennsylvania and Virginia.

A third pattern noted was that some states report a slow but constant trickle of forfeitures, usually averaging less than one per year. Indiana and Illinois reported this pattern.

2. Status of State Bond Forfeitures

Those states reporting no recent forfeitures (1976-77) were Alabama, Arkansas, Iowa, Kansas, Missouri, Oklahoma and Tennessee. Of these, however, Alabama and Tennessee reported that forfeiture actions were pending in some cases.

The November 21, 1977 issue of Coal Week reported that Tennessee regulatory authorities had closed 17 mines and had given notice to 11 more. In all, $289,000 of bond is up for forfeiture and the 11 operators could face forfeitures of $211,000. Even so, this amounts to less than 10% of all permits in effect. In addition, it was noted that 5 operators in eastern Kentucky were shut down for failing to haul back spoil material, a function that indirectly affects reclamation within an integrated mining technique.

Illinois has the most detailed information on bond forfeitures which are published in their annual report. The information listed gives a running total since January 1, 1962 to January 1, 1977. There was $71,392.50 listed as being forfeited with $52,400 still in action. Also shown are the acres still left unreclaimed by the operator. There are 166.55 acres of permitted areas and 116.00 acres of unpermitted land.

The publication also lists the names of the companies involved. Of the 23 companies involved, only three were listed in the Keystone Coal Manuals (1968-77). This would be because either they were too small or they went out of business prior to 1965.

The three companies listed were one each; small, medium and large. One company listed two brothers as president and vice-president and an unlisted coal company located in the same county bears their last name. An Illinois coal co-op was the sales agent for both the large and medium operators and continued to list the large operator as one of its clients 2 years after its name was dropped from the Keystone Coal Manual. The name of the cooperative disappeared from the manual by 1975.

The small firm was listed in the 1976 small operators listing of the Keystone Coal Manual but did not make the 1977 listing.

It is evident that most of the forfeitures in Illinois have been with small companies. The regulatory authority claimed the most common reason was bankruptcy.

Indiana has had 5 operators forfeit bonds in the last 15 years. This affected only 160 acres out of 200,000 acres permitted. All forfeiting companies were new or small operators.

Kentucky had no readily available data but did report a history of bond forfeitures. Thirty-eight percent of all noncompliances were reported to result in forfeiture actions being taken but not necessarily resulting in actual forfeitures. Regulatory authorities would rather compel the operator to perform the required work rather than have to seek satisfaction through forfeitures. The threat of forfeiture acts as a tool toward that end.

Maryland reports 2 forfeitures since 1971 but none in the last four years. Both were small operators. Ohio has had no forfeitures since it passed the 1972 law but some are delinquent. Pennsylvania reported 10 since 1971 and all were small or new operators.

Virginia reported 59 forfeitures totaling $596,000 on 3241.11 acres. West Virginia has had 561 forfeitures from 1961 to 1977 totaling $1,773,336.30 or an average of a little over $100,000 per year.

The problems of bond forfeitures in the states were minor; with Indiana, Illinois, Kentucky, Maryland, Ohio, Pennsylvania, Virginia and West Virginia reporting some forfeitures in the past several years. Indications are that bond forfeitures are a last resort and both regulatory authorities and operators make efforts to insure bonds are not forfeited. Those operators that do forfeit are almost always small and/or new operators.

H. PHASE I CONCLUSIONS

As a result of the Phase I analyses, a number of conclusions were developed. The major conclusions are summarized below.

(1) The regional analysis of physical factors effecting reclamation indicates that the ease of reclamation is regional in nature. The regions with the least favorable physical factors generally included those areas comprising central and northern Appalachia. The more favorable regions included the northern portions of the Eastern Interior coal field and parts of the Western Interior field.

(2) There was a definite relationship between the number and size of surface mine operators in the reclamation regions. In the regions of less favorable reclamation conditions, there are a large number of operators with low annual production. In the region of favorable reclamation conditions, there are fewer operators but annual production is higher.

(3) Based on strippable reserve estimates in the reclamation regions, future production trends may indicate a shift toward increased production in more favorable reclamation regions. This trend may be tempered by the presence of higher sulfur content reserves in the more favorable reclamation regions.

(4) A comparison of the field evaluations of sites released from bond and state regulatory standards indicated that the released sites were generally in compliance with their respective state's requirements for bond release. The released sites in some states were not as successful in meeting a set of average minimum environmental standards.

(5) There was considerable variability between states in the timing of the initial bonding and release of the bond. The partial release after regrading and revegetation varied greatly in time cycle and amounts released.

(6) The absence of standardized inspection techniques for bond release was noted in all of the states. The inspection techniques utilized were generally left to the discretion of the inspector. This lead to some variability in determining the success of reclamation for bond release.

(7) Many operators and regulators felt that there was no incentive for an operator to perform good reclamation. Interest was indicated in some type of graduated bonding system that recognized the operator performing consistently good reclamation.

(8) The economic analyses of bonding and release indicated that the small operator is at an economic disadvantage related to bonding in the states. This is also the case for new operators in the states.

(9) Surface mine operators in some states are at an economic disadvantage with similar size operators in other states because of differences in initial bonding practices and timing of partial and final release in the states.

(10) A quantitative figure on costs of reclamation in the states could not be determined for a number of reasons including: the variability of costs especially in backfilling and regrading from site to site; the question of when actual mining ends and reclamation begins; and the wide variability in the amount, quality and type of bookkeeping practices related to reclamation costs.

(11) The general decrease in productivity of surface coal mines in the states in this study over the past several years correlates more with economic factors such as the oil embargo rather than with the implementation of comprehensive state surface mining regulations. It was felt, however, that various factors such as market conditions, labor problems, and economic conditions contributed to the decrease in productivity.

(12) The small operators were affected more by the advent of any constraint on production (regulatory and/or economic) than were the larger, more established operators.

(13) Special reclamation fees or taxes utilized by several states for reclamation of abandoned lands have not been in effect for a period of time sufficient to determine the success of such fees or taxes.

(14) Bond forfeitures in the states were minimal and a majority of the states reported no forfeitures. A number of states reported that a number of bond forfeitures were in process and indications are that forfeiture actions during 1978 will increase significantly.

D. TIME INTERVAL ANALYSIS

1. Objectives

The objectives of this task were to determine the various time frames by state involved in the surface mining cycle from permitting to release of the reclamation/revegetation bond. In addition, comments from regulatory personnel and surface mine operators resulting from discussions were reviewed and pertinent comments included. This type of analysis served to compare the differences in the time frames for the bonding and release cycle within the various states in the study area. It should be noted that time frames for bonding and release from an economic viewpoint are discussed in Section IV E - Economic Analysis.

2. Results of the Time Interval Analysis

This analysis involved a detailed evaluation of the time interval required by state legislation or regulations for permits and licenses, backfilling, revegetation and bond release. The analysis utilizes the state laws and regulations, operator comments, and regulator comments. Time intervals for various phases of permitting and reclamation are presented in Figure 24. A discussion of each element of the time interval is discussed below.

a. Term of Permit

This element refers to the length of time in which an approved permit is in effect. Nine states in the study area have the term of permit for 12 months. These states feel that an annual renewal makes the operators more conscious of keeping up with and performing good reclamation in that permit renewal may depend upon past performance. The remaining states varied in their requirements for term of permit. These varied from 3 years, 10 years, to duration of the operation, and unlimited permit. The results of the analysis of this element indicates that most states prefer the annual renewal in order to control the performance of the operators. The arguments for longer permit terms included less paper work and less burden on the inspector's work load.

STATE	TERM OF PERMIT	TERM OF LICENSE	REVIEW TIME FOR PERMIT APPLICATION	TIME INTERVAL FOR BACKFILLING AND REGRADING	TIME INTERVAL FOR REVEGETATION
ALABAMA	12 MONTHS	CONTINUOUS	60 DAYS	RECONTOURING MUST PROCEED AS OUTLINED IN PERMIT. REGRADING MUST COMMENCE 6 MONTHS AFTER BEGINNING OF MINING AND BE COMPLETED 6 MONTHS AFTER COMPLETION OF MINING.	REVEGETATION TO OCCUR AS SOON AS APPROPRIATE IN FIRST GROWING SEASON AFTER CONTOURING.
ARKANSAS	UP TO 10 YEARS	NOT REQUIRED	90 DAYS	AS OUTLINED IN RECLAMATION PLAN. NONE SPECIFIED.	AS OUTLINED IN RECLAMATION PLAN. NONE SPECIFIED.
ILLINOIS	FROM DATE OF ISSUANCE UNTIL 3RD SUCCEEDING JUNE 30	NOT REQUIRED	120 DAYS	GRADING TO BE COMPLETED PRIOR TO 11 MONTHS AFTER JUNE 30 OF THE FISCAL YEAR IN WHICH MINING OCCURRED.	REVEGETATION SHALL BE COMPLETED PRIOR TO 3 YEARS AFTER JUNE 30 OF THE FISCAL YEAR IN WHICH MINING OCCURRED.
INDIANA	12 MONTHS	NOT REQUIRED	60 DAYS	BACKFILLING MUST BE WITHIN 2 SPOIL RIDGES AND BE COMPLETED WITHIN 12 MONTHS OF DEPOSITION OF MATERIAL.	TO BEGIN AS SOON AS POSSIBLE AFTER APPROVAL OF REGRADING AND REVEGETATION PLAN. CAN BE RELEASED AFTER THE FALL OF THE SECOND GROWING SEASON.
IOWA	UNLIMITED	UNLIMITED	15 DAYS	NO TIME SPECIFICATIONS FOR BACKFILLING AND REGRADING.	NO TIME SPECIFIED FOR REVEGETATION. ALL RECLAMATION MUST BE COMPLETED WITHIN 12 MONTHS AFTER MINING COMPLETED.
KANSAS	12 MONTHS	NOT REQUIRED	20 DAYS	REGRADING WILL BE COMPLETED NOT MORE THAN 180 DAYS AFTER PLACEMENT OF SPOIL RIDGE.	REVEGETATION MUST BE COMPLETED WITHIN 12 MONTHS AFTER PERMIT HAS EXPIRED.
KENTUCKY	12 MONTHS	NOT REQUIRED	30 DAYS	REGRADING TO BEGIN WITHIN 15 DAYS OF COAL REMOVAL. BACKFILLING AND REGRADING MUST BE WITHIN 1000 FEET OF PIT AND BE COMPLETED WITHIN 90 DAYS OF COMPLETION OF MINING.	RECLAMATION MUST BE COMPLETED WITHIN 12 MONTHS AFTER PERMIT HAS EXPIRED.
MARYLAND	DURATION OF THE OPERATION	12 MONTHS	15 DAYS	GRADING SHALL NOT BE MORE THAN TWO SPOIL RIDGES BEHIND MINING OR MORE THAN 1500 FEET FROM MINING.	REVEGETATION REQUIRED THE FIRST GROWING SEASON AFTER APPROVAL OF BACKFILLING.
MISSOURI	12 MONTHS	NOT REQUIRED	30 DAYS	REGRADING SHALL BE COMPLETED NOT MORE THAN 180 DAYS AFTER FINAL PLACEMENT OF SPOIL RIDGES.	SEEDING AND PLANTING SHALL BE COMPLETED WITHIN 24 MONTHS AFTER EXPIRATION OF THE PERMIT.
OHIO	36 MONTHS	12 MONTHS	60 DAYS	RECLAMATION MUST PROCEED WITHIN 2 SPOIL RIDGES OR NOT MORE THAN 500 FT. FROM ACTIVE MINING. LENGTH OF PIT MAY NOT EXCEED 3000 FEET.	TEMPORARY COVER IMMEDIATELY FOLLOWING FINAL GRADING. PERMANENT COVER AS SOON AS POSSIBLE FOLLOWING THE PRESCRIBED TIME TABLE IN THE RULES.
OKLAHOMA	JUNE 30 TO FOLLOWING JUNE 30	NOT REQUIRED	NOT SPECIFIED	REGRADING MUST BE COMPLETED WITHIN 1 YEAR AFTER MINING COMPLETED.	SEEDING TO BE COMPLETED AT FIRST APPROPRIATE TIME AFTER GRADING.
PENNSYLVANIA	DURATION OF OPERATION	12 MONTHS	NOT SPECIFIED	AS PER MINING PLAN. REGRADING MUST BE LESS THAN 1500 FEET FROM PIT.	AS OUTLINED IN APPROVED RECLAMATION PLAN. NO SPECIFIC TIME MENTIONED.
TENNESSEE	12 MONTHS	NOT REQUIRED	NO LESS THAN 20 DAYS OR NOT MORE THAN 30 DAYS	BACKFILLING AND REGRADING SHALL COMMENCE WITHIN 15 DAYS OF COAL REMOVAL AND MUST BE WITHIN 1500 FEET OF PIT. ALL BACKFILLING AND REGRADING MUST BE COMPLETED WITHIN 180 DAYS AFTER INITIATION OF DISTURBANCE.	REVEGETATION SHALL IMMEDIATELY FOLLOW GRADING WITH APPROPRIATE SEASONAL PLANT SELECTION.
VIRGINIA	12 MONTHS	NOT REQUIRED	30 DAYS	GRADING AND BACKFILLING SHALL BE STARTED WITHIN 60 DAYS FROM COAL REMOVAL OR LESS THAN 700 FEET FROM POINT OF MINERAL REMOVAL.	APPROPRIATE VEGETATION SHALL BE PLANTED OR SEEDED ACCORDING TO PLAN FOLLOWING REGRADING.
WEST VIRGINIA	12 MONTHS	NOT REQUIRED	30 DAYS	GRADING & BACKFILLING SHALL FOLLOW THE MINERAL REMOVAL BY NOT MORE THAN 60 DAYS OR 3000 FEET FROM PIT.	TO BE ESTABLISHED AS SOON AS POSSIBLE WHEN THE SEASON IS PRACTICAL.
FEDERAL	NOT TO EXCEED 5 YEARS	NOT REQUIRED	REASONABLE TIME	PROCEED AS CONTEMPORANEOUSLY AS POSSIBLE WITH THE MINING OPERATION.	ESTABLISH ON REGRADED AREA A DIVERSE, EFFECTIVE AND PERMANENT VEGETATIVE COVER.

FIG. 24 TIME INTERVAL ANALYSIS COMPARISON

78-59

STATE	TIME INTERVAL FOR BOND RELEASE	OTHER RELATED REQUIREMENTS	REGULATORY COMMENTS	OPERATOR COMMENTS
ALABAMA	60% RELEASED UPON COMPLETION OF REGRADING. 40% UPON MEETING COVER REQUIREMENTS AFTER 2 GROWING SEASONS.	THE COMMISSION MUST MAKE AN INSPECTION WITHIN 30 DAYS OF A REQUEST AND SUBSEQUENT EVALUATION; MUST BE MADE WITHIN 15 DAYS OF INSPECTION.	ONE YEAR PERMIT IS ADEQUATE.	SATISFACTORY FOR THE MOST PART. DOES NOT ALLOW FOR REMINING. TWO YEAR PERMIT WOULD BE BETTER.
ARKANSAS	UPON APPROVAL OF COMMISSION, BUT NOT TO EXCEED 10 YRS.	----	FELT TIME FRAME WAS ADEQUATE IN THAT REGULATOR CAN REQUEST OPERATOR MAINTAIN VEGETATION THAT HAS DECLINED AFTER BOND RELEASE.	SATISFACTORY
ILLINOIS	BOND LESS $100 ACRE RELEASED UPON REGRADING AND TOPSOILING. REVEGETATION BOND RELEASED UPON APPROVAL OF DEPT. NO SPECIFIC TIME FRAME.	MUST BE REVEGETATED WITHIN 2 YEARS OF GRADING.	REGULATORS ACTUALLY PRACTICE PARTIAL RELEASE IN THAT OPERATOR CAN ASK FOR RELEASE AFTER GRADING. USUALLY ONLY LARGE OPERATOR ASKS.	CONFLICTING VIEWS ON THREE-YEAR CYCLE.
INDIANA	PARTIAL RELEASE UPON APPROVED REGRADING. REVEGETATION BOND WILL CONTINUE TO BE POSTED UNTIL APPROVED. NOT TO EXCEED 15 YEARS.	THE OPERATOR MUST NOTIFY THE DEPARTMENT WITHIN 60 DAYS OF COMPLETION OF REGRADING.	AVERAGE TIME FOR RELEASE RUNS BETWEEN 3-5 YEARS. SINCE 1972 THERE HAS BEEN NO PARTIAL RELEASE AFTER REGRADING.	SATISFACTORY FOR MOST PART. WOULD LIKE QUICKER TURN-AROUND ON PERMIT APPROVAL AND REGRADING INSPECTION (ALLOWS FOR EROSION TO DEVELOP)
IOWA	ALL RECLAMATION MUST BE COMPLETED WITHIN 12 MONTHS AFTER MINING.	THE TIME FRAME FOR RECLAMATION MAY BE EXTENDED, IF NECESSARY	OPERATOR IS ALLOWED TO START MINING BEFORE PERMIT COMPLETE. BOND IS NOT RELEASED UNTIL RECLAMATION IS COMPLETE.	GENERALLY SATISFACTORY.
KANSAS	BOND RELEASED AFTER REGULATORY DETERMINATION REVEGETATION WILL BE INSPECTED AFTER ONE GROWING SEASON.	INSPECTION WILL BE MADE AS SOON AS POSSIBLE AFTER REQUEST.	GENERALLY 3 MONTHS IS MAXIMUM TIME FOR OBTAINING PERMIT. FEELS SITE SPECIFIC CONDITIONS CAUSE TIME DIFFERENCES IN RECLAMATION. NO TIME LIMIT FOR RECLAMATION-OPERATOR REQUESTS.	WOULD LIKE TO SEE PARTIAL RELEASE OF BOND UPON APPROVAL OF REGRADING.
KENTUCKY	FULL AMOUNT LESS $300 ACRE RELEASED UPON APPROVAL OF REGRADING. REMAINDER RELEASED NO SOONER THAN ONE GROWING SEASON.	USUALLY 2 TO 3 GROWING SEASONS FOR ESTABLISHING REVEGETATION	OPERATORS SHOULD BE ABLE TO COMPLETE RECLAMATION WITHIN TIME LIMIT. SOME ARE NOT.	TIME FRAME SATISFACTORY. WOULD LIKE TO SEE BOND DATED UPON APPROVAL RATHER THAN SUBMISSION DATE.
MARYLAND	VEGETATION CANNOT BE INSPECTED UNTIL AFTER 2 GROWING SEASONS.	----	CAN HOLD REVEGETATION BOND UP TO 5 YEARS MAXIMUM. BOND COULD BE RETURNED IN LESS THAN 2 YEARS FOR HIGHER LAND USE.	WOULD LIKE TO SEE PARTIAL RELEASE. TWO GROWING SEASONS MAY BE TOO LONG.
MISSOURI	CAN RELEASE 2/3 BOND ON REGRADING. VEGETATION MUST SURVIVE TWO GROWING SEASONS.	INVESTIGATION FOR BOND RELEASE MUST BE MADE WITHIN 30 DAYS OF A REQUEST BY THE OPERATOR.	IF GULLIES DEVELOP AFTER REGRADING AND PARTIAL RELEASE, REGULATOR RELUCTANT TO MAKE COMPANY CORRECT.	2 YEARS NOT ADEQUATE TO ESTABLISH GOOD VEGETATIVE COVER IN ACIDIC AREAS. MIGHT LIKE INCREASING PERMIT TO 3-4 YEARS.
OHIO	50% OF BOND RELEASED UPON SATISFACTORILY COMPLETING REGRADING. REMAINING BOND RELEASED UPON APPROVAL OF REVEGETATION BUT NO SOONER THAN 1 GROWING SEASON.	USUALLY 2 GROWING SEASONS REQUIRED	PERMITS ISSUED FOR 3 YEARS. MOST OPERATORS NOT UTILIZING FULL 3 YEARS.	GENERALLY SATISFACTORY.
OKLAHOMA	UP TO 80% OF BOND RELEASED UPON APPROVAL OF GRADING.	APPLICATIONS FOR PERMITS MAY BE FILED ONLY BETWEEN JUNE 1 AND JUNE 30	NO SPECIFIC COMMENTS.	WOULD LIKE TO SEE 80% OF BOND RELEASED UPON REGRADING.
PENNSYLVANIA	AS OUTLINED IN APPROVED MINING PLAN AND ONLY AFTER INSPECTION. 5% OF BOND MAY BE HELD FOR 5 YEARS FOR REMEDIAL WORK.	80% OF BOND CAN BE RELEASED AFTER REGRADING. 5% OF BOND MAY BE HELD FOR 5 YEARS USUALLY 2 GROWING SEASONS.	TIME FRAME IS ADEQUATE. LICENSE REVOCATION IS A POWERFUL TOOL.	GENERALLY SATISFACTORY.
TENNESSEE	PROVISIONS MADE FOR PARTIAL RELEASE UPON SATISFACTORILY BACKFILLING & REGRADING. COMPLETE RELEASE UPON APPROVAL-NO SPECIFIC TIME FRAME.	USUALLY 2 GROWING SEASONS.	SATISFIED WITH TIME FRAME. 75% OF OPERATORS GET BOND RELEASED IN 2ND YEAR.	WOULD LIKE TO SEE QUICKER TURN-AROUND ON PERMITS AND AUTOMATIC RELEASE OF REGRADING BOND.
VIRGINIA	VEGETATION MUST SURVIVE 2 GROWING SEASONS (18 MONTHS) BEFORE INSPECTION CAN BE MADE.	----	BIGGEST PROBLEMS ARE SURFACE MINING WITH UNDERGROUND PERMIT AND LACK OF CLEAR AUTHORITY TO GET VIOLATIONS CORRECTED.	SPEED UP INSPECTION AND RELEASE OF BOND.
WEST VIRGINIA	CANNOT BE INSPECTED UNTIL PLANTINGS HAVE SURVIVED 2 GROWING SEASONS. 3/4 OF BOND RETURNED AFTER BACKFILLING	A REVEGETATION PLAN IS TO BE PREPARED AND SUBMITTED FOR APPROVAL WITHIN 60 DAYS OF COMPLETION OF BACKFILLING.	SATISFACTORY	SATISFACTORY FOR MOST PART. 2 GROWING SEASONS SEEMS RATHER LONG.
FEDERAL	60% OF BOND UPON COMPLETION OF BACKFILLING, REGRADING AND DRAINAGE CONTROL. SOME TO BE DETERMINED TO BE RELEASED AFTER SUCCESSFUL REVEGETATION. RESPONSIBLE FOR SUCCESSFUL REVEGETATION FOR FIVE FULL YEARS AFTER LAST YEAR OF AUGMENTED SEEDING.	---	---	---

FIG. 24 TIME INTERVAL ANALYSIS COMPARISON (CONT'D)

78-59

b. Term of License

Licensing of surface mine operators was practiced in 5 states. The term of the license ranged from 12 months in Maryland, Ohio and Pennsylvania to continuous in Alabama and unlimited in Iowa (annual renewal). No license was required in 10 states. In 3 states; Iowa, Pennsylvania and Maryland, the regulatory personnel felt that licensing was a powerful tool in controlling adequate reclamation in that licensing kept less reliable operators out of the business. This was concurred with by the operators in those states. In the remaining states that had licensing, the regulatory personnel felt that permits were all that were necessary in that the permit was really a license. It is interesting to note that a large number of operators in various states felt that licensing may be a good way to insure that only qualified operators would be mining for longer periods of time. Indications are that licensing and permitting are taken to mean the same thing by the mining community. They can be different; for example, Pennsylvania issues permits on site-specific mining operations while the license is for the operator himself no matter how many permitted sites he has. License revocation can result in all of his permitted sites being shut down. It should be noted that in all the states any company or corporation must be licensed to do business, but this is separate from specific licensing for strip operators.

c. Review Time for Site Registration

This element deals with the time allotted to the regulatory authority to review permit applications and render a judgement. Many surface mine operators felt that this review cycle was too long and/or unpredictable. Even though maximum periods for review are set, often the decision extends beyond that period. This impacts on the yearly plans and economic base of the operators. The regulatory personnel indicated that lack of manpower was the major problem in turning permit applications around in less time.

Thirteen states specified the maximum time for permit application review. These ranged from 15 days to 120 days. In Tennessee, a range is given in that the application should be processed in no less than 20 days or not more than 30 days. In 2 states the length of time was not specified; these were Oklahoma and Pennsylvania. In Pennsylvania, which had a large number of permit applications pending, the reviewers are hampered by lack of personnel and the operators would like to see the process speeded up. In summary, the wide range in permit review times might indicate advantages for operators in certain states.

V. PHASE II - REVIEW AND ANALYSIS

A. FORMULATION OF NEW BONDING AND RELEASE CRITERIA

1. Objectives

The objective of this section is to develop new bond release criteria which will protect the environment and at the same time, provide equitable conditions for the operators in eastern and midwestern United States. Of major concern here is to develop a set of criteria that takes into account the sometimes wide range of physical conditions present in these coal mining regions. The criteria presented here are based upon the evaluation of reclamation effectiveness performed in Phase I and a review of pertinent reclamation research. These new criteria are presented in specific terms such as per cent cover, minimum pollutant levels and ultimate land use so that specific inspection techniques could be developed.

2. Approach

To accomplish the objectives mentioned above, those criteria which received favorable environmental and economic evaluations in Phase I were reviewed and analyzed. In addition, literature and research relating to sound reclamation practices were evaluated and pertinent information extracted. This information provided the major input to developing the specific bond release criteria outlined in this section. The bond release criteria listed have been divided into logical categories and, in most part, proceed in the order in which they occur during the reclamation process. It should be noted that many of the criteria follow very closely those listed in Public Law 95-87, The Surface Mine Control and Reclamation Act of 1977. Those criteria which are in disagreement with PL 95-87 are discussed under a separate heading at the end of this section.

3. Modified Bond Release Criteria

a. Backfilling and Regrading

(1) General Provisions

Contour Mining: The final regraded slopes on the disturbed area shall approximate pre-mining contour configuration unless engineering information indicates that returning to original contour will have a safety factor* of less than 1.5.[14,31] In this case the slope configuration in the approved reclamation plan shall be followed.

Area Mining: The final graded slopes on the disturbed area shall approximate the pre-mining contour configuration, unless the approved post-mining land use may permit all or portions of the final pit left open and filled with water for agricultural or recreational purposes. In the case of permitting the final pit to create an impoundment the highwall must be reduced to a 2:1 slope.

Mountaintop Removal: The final graded slopes on the disturbed area shall create an accessible gently rolling plateau with steeper than original sides. However, all slopes must maintain a factor of safety greater than 1.5.

(2) Burial of Toxic Materials

Acid-forming, toxic, or combustible material in spoil should be segregated during mining and must be covered by at least four feet of non-toxic, non-combustible material. Coal seams exposed in the resulting highwall after mining shall also be covered by at least four feet of non-toxic, non-combustible material.

Definitions:

Acid-forming - materials that when contact with water form dilute sulfuric acid. For the purposes of burying acid

---

* Much of the research in the area of slope stability and calculation of static safety factor is concerned with highway and building construction. Since this construction involves a permanent improvement, a safety factor of 1.5 is chosen to ensure stability of the slope. There are indications that this safety factor may be too stringent for surface mine operations where there is no permanent improvement downslope. This is an area where more research is needed to determine the safety factor and method of calculation best suited to surface mine operations.

forming materials, any spoil material having a pH of less than 4.5 shall be buried at least four feet as described above.

Toxic - materials that require greater than 5 tons calcium carbonate per ton of spoil are toxic and should be buried.[12] In other words, materials requiring greater than 4.5 tons calcium carbonate per acre or have a buffer pH of less than 6.1 are considered toxic.

Combustible - those materials which have the potential to spontaneously combust or those materials that will burn if they come in contact with other burning materials (i.e., garbage, wood). For the purpose of burying combustible material, any material having an ignition temperature of less than 1400°F shall be buried at least four feet as described above.[19]

If no non-toxic, non-acid non-combustible material is available, four feet of material may be treated to neutralize acidity, prevent combustion and toxicity and substituted for natural, non-acid, non-toxic, non-combustable material.

(3) Finish or Final Grading

Finish spoil grading should compliment subsequent topsoil replacement and seedbed preparation by providing a surface that will minimize runoff, maximize infiltration,* and provide a suitable environment for plant roots. Final grading shall be done along the contour in order to minimize erosion. The regulatory authority may approve regrading in a direction other than along the contour if it is found that grading along the contour represents a danger to the operator, however the regulatory agency should be notified for approval. For the purposes of preventing topsoil slippage and to create small depressions that aid in water retention and retard erosion the spoil surface may be scarified. The final scarified surface must be traversable with farm equipment with depression measurements not exceeding 16 inches in width, 36 inches in length, and 8 inches in depth.[13] No rocks greater than six inches in length shall

*In certain steep slope areas maximizing infiltration may lubricate slippage planes and cause failure of the slope. This condition should be considered and documented for those operators mining under these circumstances and corrective measures recommended to the regulatory authority.

be present on the final graded surface. (Some land uses may preclude any rocks on surface.) No more than 4 gullies averaging 6 inches in depth will be permitted on any one square acre. Any gully greater than 9 inches will not be accepted.

(4) Spoil Amendments

In order to provide an environment conducive to plant root growth and vigor, it may be necessary to treat the spoil material on or near the surface. This section is included to cover those areas where the amount of topsoil to be replaced is not sufficiently thick to allow for root development. In the case where the topsoil is thin,[1] roots will contact potentially acid spoil material and die back. This condition will eventually kill the plant.

In order to avoid this situation, as soon as the spoil has been final graded, spoil samples representing 10 acres shall be sent to the approved state cooperating agency for lime requirement analysis.[2] The results of this analysis will provide the basis for application to the surface of the spoil material. This lime will be evenly spread and incorporated into the spoil by discing. If greater than 20 tons lime/acre is suggested, one disking for every 20 tons/acre will be required.

(5) Topsoil Handling

Stored topsoil shall be evenly spread over the disturbed area without excessive compaction of the soil and spoil and in a manner that prevents erosion before vegetation establishment. In order to help protect the soil from excessive erosion, distribution of topsoil shall be done parallel to the contour unless this presents a danger to the equipment operator. "Tracking in" topsoil will be permitted only with prior approval of the regulatory agency.

(6) Lime Requirements[28]

(a) Soil samples representing areas of not more than 10 acres should be sent to the state cooperating agency for analysis. In order to avoid delays, these samples may be taken from stored topsoil piles.

---

[1] 1"-6" topsoil adequate to cover course textured non-toxic spoil while at least 24" of topsoil is required to cover an extremely acid site.[27]

[2] See Appendix B for a list of names and addresses of state cooperating agencies.

(b) Lime and fertilizer applications should be based upon soil analysis results. Provisions are made for those operators who desire to use sewage sludge, fly ash, or other means of fertilization provided the effectiveness is documented and approval obtained from the regulatory official.

(c) Lime shall then be spread evenly over the entire area to be planted and disced into the soil.

(7) Summary

This ends the backfilling and regrading portion of the bond. Inspection should occur within 2 weeks in order to prevent development of erosion. If site cannot be visited by the appropriate inspection team approval may be given by the field inspector. However, every attempt should be made by the appropriate inspection team to inspect the site. If notice to proceed to the operator does not occur within 2 weeks, the regrading portion of the bond becomes automatically released and the operator shall proceed immediately with revegetation. Should the inspector determine that remedial action is necessary, the operator shall complete this action and again request inspection.

b. Revegetation

Permanent vegetative cover compatible with the approved post-mining land use will be established on all land disturbed by surface coal mining as soon as favorable conditions exist after approval of backfilling and regrading. Operators are encouraged to select species compatible with the post-mining land use and, equally important, species that will provide a quick vegetative cover so as to prevent any soil loss and erosion development. Native species are preferable, however, introduced species that have been proven compatible with a site's physical, chemical and climatic conditions may be accepted.

(1) Fertilizing

Normally, fertilizer should be applied a few days before or after seeding. However, seeding done during the winter months should not be fertilized until germination takes place. Samples of topsoil representing not more than 10 acres should be taken from topsoil storage piles and sent to the state cooperating agency (see Appendix B for name and address of state cooperating agency) for analysis. Results will indicate amounts of fertilizer to be applied.

(2) <u>Plant Growth and Survival Standards</u> [28]

Wildlife: Wildlife plantings generally consist of alternating strips or blocks of trees or shrubs and of grasses and legumes. Strips should be 30'-50' wide with a tree/shrub spacing such that at maturity the shrubs will form a continuous crown. In order to provide a quick vegetative cover appropriate grasses and legumes should be sown in the strips with trees and shrubs as well. Vegetative cover over the entire area must be greater than 70%. Percentage of specific grass and legume species shall be ± 10% of those presented in the reclamation plan.

Productive Forest: Species and spacing requirements will follow those presented in the reclamation plan. In order to determine a standard for survival rate, a one acre undisturbed test site[1] shall be planted adjacent to the disturbed area. The same species and spacing shall be utilized in this reference plot. Survival rate on the disturbed area shall be greater than 90% of the reference area.

Grassland or Pasture: Species mix shall follow those in the reclamation plan. Percentage of specific grass and legume species shall be ±10% of those presented in the reclamation plan. Greater than 70% cover will be required over the entire disturbed area. Bare areas shall not exceed 25 feet across in any direction.

Cropland: Crops to be planted will be those presented in the reclamation plan. In order to determine a standard for yield for each crop, a one acre undisturbed test plot shall be planted adjacent to the disturbed area. Yield from the disturbed area will be greater than 90% of the undisturbed test plots.

Recreation, Industrial, and Other Higher Land Uses: Species mix shall follow those presented in the reclamation plan. Vegetative cover shall be greater than 70% on all disturbed area even though some of this area may be disturbed by future development. Specific species percentages shall be ± 10% of those presented in the reclamation plan. Bare areas shall not exceed 25 feet across in any direction.

---

[1] Undisturbed Test Site - An undisturbed test site shall be defined as a minimum one acre control plot adjacent to the disturbed area. It should be noted that the inspector may require a larger control plot for extremely large sites. Specifically, equipment, seeding rate or tree spacing and other factors should be the same or as close as feasible to that of the disturbed area. Although fertilizer requirements may be different between the control plot and disturbed area, the physical and chemical conditions present after fertilizing will be the same between the two plots.

c. Water Quality

Effluent limitations have been set forth in the Public Law 95-87 for active surface mines and extended to include strip-mined lands undergoing reclamation. However, the appropriateness of these guidelines is untested in relationship to reclamation and subsequent bond release. The data necessary to determine such effluent limitations is not yet available and, therefore, beyond the scope of work conducted during this study. Currently the U.S. Environmental Protection Agency is gathering data on the nature of effluents from surface mined areas that have regraded but not released from bond. These data should facilitate developing guidelines appropriate to effluents from surface mined lands at the time of bond release. The following paragraphs discuss the regulations concerning water quality in Public Law 95-87 and evaluate the relevancy of these pollutants to the coal mining industry and environmental protection.

Specifically, the interim surface mining reclamation of enforcement provisions dictate that, except in the case of a precipitation event larger than a 10-year, 24-hour frequency event, "Discharge from areas disturbed by surface coal mining and reclamation operations must meet all applicable Federal and State laws and regulations and, at a minimum, the following numerical effluent limitations:"[44]

Effluent Limitations[44]
(mg/l, except for pH)

Effluent Characteristics	Maximum Allowable	Average of daily values for 30 consecutive discharge days[1]
Iron, total	7.0	3.5
Manganese, total	4.0	2.0
TSS	70.0	35.0
pH[2]	within the range 6.0-9.0	------------------------------

[1]Based on representative sampling

[2]Where the application of neutralization and sedimentation treatment technology results in inability to comply with the manganese limitations set forth, the regulatory authority may allow the pH level in the discharge to exceed to a small extent the upper limit of 9.0 in order that the manganese limitations will be achieved.

Iron is a pollutant commonly found in untreated acid mine drainage. Excessive ferric and ferrous iron concentrations in water can result in the precipitation of iron hydroxide ("yellowboy"). This precipitate is devastating to aquatic life, coating streambeds and disrupting food chains. Fish introduced to such an environment usually die within a few hours, probably as a result of the iron hydroxide precipitates coating their gills.[41] The recommended limit of iron in domestic water supplies in the United States has been set at 0.3 mg/l, based not on the physiological considerations, but rather on aesthetic and taste considerations of iron in water.[41] Iron is an abundant element in the earth's crust and an essential nutrient for all forms of life.

Although ores of manganese are relatively abundant, manganese is rarely present in surface waters in concentrations exceeding 1.0 mg/l.[33] (The recommended limit for manganese in drinking water in the United States is 0.05 mg/l).[33] Nevertheless, it is common knowledge that manganese is often present in ferruginous coal mine drainage. These relatively high levels of manganese, although of questionable toxicological significance,[33] are sufficient to create a general nuisance by staining plumbing fixtures, spotting laundered clothes, and accumulating in distribution systems.[23]

Suspended solids in water can be inorganic (e.g., sand, silt, and clay) or organic (e.g., vegetable and animal wastes). While aesthetically displeasing in suspension, these solid particles can settle to form deposits of sludge on stream bottoms which are damaging to aquatic life. Sediment is widely considered the largest source of water pollution in the United States. Surface mining, like other massive earth-moving operations, has the potential to release large volumes of sediment into surface waterways.

Essentially, pH is a measure of the acidity or alkalinity of the effluent, where a pH of 7.0 indicates neutral conditions, or in other words, a balance between free hydrogen and hydroxyl ions. Technically, the pH of the mine effluent is the negative logarithm of the hydrogen ion concentration in the waste water. Acidic waters can create stress conditions for aquatic organisms. Even moderate deviations from accepted pH levels can produce detrimental effects in some organisms. In addition, acidic waters are corrosive and tend to leach metals from soils and sediments.

Strictly based on information gathered in this study, some apparent weaknesses of the current guidelines should be discussed. The question should be raised, is it necessary to regulate levels of iron and manganese in discharge from surface mine areas which have been regraded? Presumably, if the procedures for burying toxic and acid-forming materials, backfilling, topsoil application, and liming are conscientiously followed, acid, or ferruginous, mine drainage will be nonexistent from regraded lands. In addition, acid mine drainage is a regional problem, restricted to Maryland, Pennsylvania, Ohio, and northern West Virginia, with isolated occurrences in western Kentucky and along the Illinois-Indiana border.[41] For the 51 sites in 15 states visited in Phase I of this study, only 17 sites in 9 states had surface water with a pH less than 6.0. However, these figures are somewhat misleading for two reasons: 1) Seventeen of the 51 sites visited did not have surface water present, and therefore no water quality data were obtained; 2) Of the 34 sites where water was present, often it was present only as puddles. Because the eastern half of the United States has predominantly acid rainfall,[10] these data are of questionable interpretive value.

However, based on the assumption that acid mine drainage is a localized phenomenon, perhaps a suitable revision of the present federal guidelines would be to require that pH be monitored at all sites. Also, in those instances where drainage continues to be acidic, despite implementation of best management practices during the reclamation process, iron and manganese should also be monitored to determine whether additional treatment measures might be necessary. This change would be in keeping with current regulations for the active coal mining point source category, which limit iron and manganese discharge levels <u>only</u> in the case of acid or ferruginous mine drainage.

Of prime concern during the reclamation process, particularly during the early stages of revegetation, is the problem of erosion and sedimentation. In a study conducted by Hittman Associates, Inc., for the U.S. Environmental Protection Agency,[17] nine sedimentation ponds were studied in three eastern coal-mining states (i.e., Pennsylvania, West Virginia, and Kentucky) under two different operating conditions (i.e., a baseline and rainfall event). Approximately one-half of the ponds sampled did not meet the federal effluent limitations during the measured baseline and storm conditions. This poor performance was attributed in part to poor pond construction and maintenance. However, the question still arises, are the discharge limitations set on suspended solids realistic, or will the majority of operators be in violation during normal rainfall events? If so, enforcement of such regulations becomes almost impossible. At present, sufficient data are lacking to resolve this issue.

d. Permanent Earthen Structures

Any approved permanent earthen structure must comply with the construction, drainage and/or revegetation requirements set forth in this section. Permanent earthen structures include, but may not be limited to diversion ditches, impoundments or ponds, fill structures, and haulroads.

(1) Diversion Ditches [22]

Design and construction specifications must comply with those set forth in the approved reclamation plan. Design criteria such as bottom width, depth, grade, side slopes and top width must meet the designed specifications. Stabilization procedures such as vegetation in the ditch or temporary barriers must be present if called for in the reclamation plan. The ditches should be cleared of debris or excessive sedimentation that may potentially block or clog the flow of water. In addition, the sides of the ditches should be free of protrusions such as large boulders that may obstruct or deviate flow.

(2) Impoundments [32]

Design and construction specifications must comply with the approved reclamation plan. Embankment slopes, spillway construction, riser construction, amount of freeboard and so on must comply with specifications in the reclamation plan. Vegetative cover should be greater than 70% on the embankment and mowed as necessary to allow easy access for maintenance and inspection. Risers or standpipes should be water tight with the top opening free from sticks or any potentially clogging material. The emergency spillway should be constructed according to the specifications and stabilized with rip-rap or vegetation to prevent any deterioration.

(3) Fill Structures

Fill structures, whether on or off of the reclaimed mine site, must meet all construction and design specifications as outlined in the reclamation plan. Particular attention should be paid to achieving a safety factor of 1.5 on these structures.

In addition, all toxic, and/or combustible material must be buried at least four feet. Procedures for amending spoil and/or topsoil are the same as those listed in the previous section. Vegetation cover must be greater than 70% over the fill site. Any rock drains must be clear of excessive sediment buildup and other diversion ditches or water channels must meet the specifications for construction as described in the reclamation plan, and meet the criteria described above.

(4) Haulroads

All haulroads must be removed and reclaimed unless the regulatory agency has approved that the roads may remain on site, serving some useful purpose. If the road is to remain as a permanent feature, the construction and drainage plan must meet the specificiation as outlined in the approved reclamation plan. If the road is to be removed it must meet original contour, topsoil, final grading, liming, revegetation and all other requirements set forth under the back-filling and revegetation sections previously mentioned.

4. Regional Aspects of New Bond Release Criteria

a. General Discussion

Phase I of this report presented a regionalization of important physical factors which affect the ease and success of reclamation activity. Soil type, slope distribution, pH conditions in the overburden, geology of the overburden, mean annual precipitation, and mean annual runoff are graphically presented on pages 38, 40, 43, 45, 47, and 48, By weighing each of these factors a composite map expressing the relative ease of reclamation is presented on page 53. A general trend of increasing severity of reclamation conditions in the Appalachian coal fields is evident.

These maps can be used to identify areas where specific factors are more critical. Figure 12 on page 43 shows that pH conditions in the overburden are more critical in Virginia coal fields than in Oklahoma coal fields.[1] More effort toward pH detection and spoil management planning is needed in Virginia than in Oklahoma! It is easily seen that some areas have greater problems than others and that specific factors can be mapped to show critical areas.

[1] Maps of this scale offer insight for regulatory program management, but are far too general as an aid to the inspector.

Other factors which the Phase I report did not mention would include land use, land values, population density, mean annual income, and others. When making decisions concerning acceptable final land use, the necessity of returning to approximate original contour and other factors relating chiefly to aesthetic land values it would be pertinent to look at these factors. If the relative land value can be increased through changes in the land use by mining and reclamation activity necessitating changes from the original contour should be allowed if their engineering is sound. Public services such as access roads, fire roads and impoundments should be encouraged where they are needed. Aesthetic damage is a function of the incidence to which it is encountered. In sparsely populated areas with poor access the cost of aesthetic improvements is less justified than for mining areas close to urban centers or major highways.

This section will discuss the regional aspects of the new bond release criteria. Areas of disagreement with the federal interim regulations will be highlighted and explained. Allowing more flexibility to the state managed reclamation authorities is suggested as a remedy. The two areas of disagreement with federal regulations are 1) the use of reference areas for grassland cover and 2) the requirement of return to approximate original contour and high wall reduction in all cases.

b. Disagreement With the Federal Regulations

Based on the varying physical conditions present among the coal mining states under consideration, certain bond release criteria will be more applicable to one region than to another. For example, in some of the midwestern states, such as Kansas and Iowa and portions of several others, there is very little contour mining and no mountaintop removal mining. Therefore, the provisions in the criteria relating to these types of mining need not be considered. Extending this example to include vegetation will show that many areas in these states are considered prime agriculture lands, and particular attention should be paid to the provision that states "Yield from the disturbed area shall be greater than 90% of the undisturbed test plot." A large portion of the land in the Midwest is amenable to the creation of an impoundment in the final cut of the mines. If the land owner desires an impoundment and the operator can show that the water quality will be acceptable, the regulatory agency should allow the impoundment to be created. To carry this further if the impoundment is to be used strictly for agricultural purposes consideration might be given to relaxing the criteria relating to highwall reduction.

PL95-87 Section 515 (b) requires that the highwall be reduced in all situations.

In most areas of the Appalachian Region, the physical conditions and land uses are somewhat different than in the Midwest. The pH conditions of the overburden are particularly low and specific provisions relating to burial of toxic materials should be adhered to in order to ensure proper vegetative cover. In order to prevent erosion in most areas of this region, percent vegetative cover is more important than yield and, therefore, emphasis should be placed on gaining an adequate cover as soon as possible. In addition, in a forested area further land must be distrubed in creating a reference area that will put into grassland (if that is the indicated land use). For these reasons, percent cover is utilized as criteria rather than as stated in PL95-87, Section 715.20. Finally, especially on steep slope contour mines, means are available to mask or screen the displeasing aesthetic effects created.[26] Again, PL95-87, Section 515(D) leaves no recourse but to completely cover the highwall.

In summary, the bond release criteria developed are intended to cover the wide range of physical (environmental) conditions in the fifteen states under consideration. However, there are instances when consideration might be given to allow for some flexibility or to grant a variance to an operator who can prove that the benefit of the exception outweighs the criteria as stated. In short, this is a regulatory and legal problem that must be evaluated before final rules and regulations are promulgated.

B. DEVELOPMENT OF BOND RELEASE INSPECTION TECHNIQUES

1. Objectives

Ideally, the objective of bond release inspection techniques would be to provide quantitative information concerning post-mining conditions related to bond release criteria. However, operational constraints of manpower and money prevent the use of some techniques in a quantitative sampling design for characterization of an entire site that is to be released from bond. The techniques which are too costly to use in a quantitative mode can be used as a spot check. An inspection technique which is being used as a spot check still has a tremendous enforcement value because the operator knows he could be found in violation.

Most of the techniques discussed in the following sections are designed to be used in a quantitative fashion. However, some of the inspection techniques for regrading and topsoiling are spot check techniques and they are identified as such.

2. Approach

The approach for the development of the techniques was fairly straight-forward. The first step involved discussions with all of the regulatory agencies from the states used in this study to determine quantitative techniques which are currently in use. The second step involved an evaluation of the techniques which are currently in use to determine if they are the optimum techniques for the intended inspection. This evaluation was accomplished based on our experience and information gathered from research literature.

The next step involved defining techniques that should be used for criteria which are not currently being inspected in a quantitative manner by state regulatory agencies. This step was also accomplished by reviewing research literature and using our own experience.

Almost all of the techniques described below are proven procedures which have been used for years, but have not necessarily been applied to strip mine reclamation inspections. For instance the drop-point sampling technique has been used by plant ecologists for many years to determine percent vegetative cover, and the slope map concept which we propose to compare pre and post-mining slope conditions has been used successfully by the Soil Conservation Service (SCS) of the USDA for decades.

It is important to remember that most of these techniques have not been used for strip mine inspections, and actual field testing and step by step "cookbook" instructions were beyond the scope of this project. We strongly recommend that future testing and a more complete development of these techniques should be accomplished for the benefit of both mine operators and strip mine inspectors.

3. Results

a. Regrading

Proper regrading of a surface mined area is important because regrading practices will affect revegetation. If acid-forming materials are not buried with at least four feet of non-toxic spoil material the establishment of a permanent vegetative cover, capable of protecting the spoil and topsoil material from the erosive forces of water is made difficult. In addition, slopes which are steeper than those approved in the reclamation plan are objectionable because of increased erosion potential and a decrease in accessability and utility of the reclaimed site.

The objectives of inspection for regrading quality are twofold: 1) to determine if toxic and or potentially acidic materials have been buried with a minimum of at least four feet of nontoxic, nonacid-forming material, and 2) to determine if the final slopes are in agreement with slopes approved in the reclamation plan.

(1) Burial of Toxic/Acidic Materials

Inspections to determine if toxic/acidic materials have been buried and meet the bond release criteria are difficult to accomplish. A complete inspection, verifying that all toxic acidic materials are buried at the proper depth, would require that an inspector be present taking spoil samples during the entire backfilling and regrading operation. This type of inspection is not possible because of manpower and monetary constraints, therefore, post-backfilling sampling techniques must be used to determine to the best extent possible if toxic materials are buried. The two tests that should be used on mine spoil to determine toxicity are pH which is an indicator of current toxic conditions; and the acid-base account which is an indicator of future toxic spoil conditions.

Inspectors should be present on a site after backfilling but before topsoil is replaced. Spoil pH samples should be taken throughout the entire area that is being considered for bond release. Spoils that are different in color or composition should be sampled as separate units. About 10 samples are needed to characterize the pH conditions on 3-4 acres of spoil that are uniform in appearance.[3] The pH determinations can be made in the field with a suitable technique such as the LaMotte-Morgan method or in the office or laboratory with a pH meter.[3] The pH meter is the most accurate method of determining pH, therefore any pH determinations with a field test procedure which are found to be in violation of the bond release criteria should be verified with a pH meter.

If spoil samples are found in violation of the pH criteria an acid-base test should also be conducted to determine potential future acidic conditions or potential deficiency of calcium carbonate equivalent per 1000 tons of spoil material.[36] The acid-base test consists of two measurements: (1) total or pyritic sulfur and (2) neutralization potential. The test balances maximum potential acidity which is calculated from the sulfur content against total neutralizers. This test can be conducted by any reputable soils analysis laboratory, such as those maintained by Agricultural Extension Services of USDA, associated with land grant colleges (See Appendix B).

In addition to the pre-topsoiling surface tests, sites should be spot checked with a truck-mounted soil auger or a hand auger in areas where large rocks are not numerous. One sample hole for every 100 acres should be drilled at a randomly selected location. The truck-mounted soil auger can be used to drill a hole 4 ft. in depth. Samples of spoil that are brought to the surface during the drilling operation should be collected. At least 4 samples should be collected: one for each foot of drill depth. Spoils of different colors and textures should be sampled separately. Determinations of pH and acid-base accounting should be made for each sample.

(2) Slope Measurements

A slope class system similar to that which is used by the Soil Conservation Service should be used to compare pre-mining contour with post-mining contour. The slope code as used by SCS is shown in Table 1.

TABLE 1

Code	Percent Slope
a	0-3
b	4-7
c	8-15
d	16-25
e	26-35
f	>35

The regulatory authority should require that a pre-mining slope map be submitted by the operator with the mine permit maps. It would include a delineation of all the slope classes within the permit area and the total acreage of each slope class that is present.

The inspector will have to traverse the post-mining site during the regrading inspection and produce a similar slope class map. This can be accomplished by walking perpendicular to the contours on the site using a hand level to determine where the slope class boundry lines exist. These boundry lines can be delineated on a copy of the permit map or directly onto an aerial photograph if one is available.

The total acreage for each post-mining slope class can be determined by planimetering the delineations. The post-mining acreages in any one slope class should not exceed the pre-mining acreages by more than 10% unless approved in the reclamation plan. In addition, no slope classes higher than the highest pre-mining slope class shall exist unless approved in the reclamation plan. Post-mining slope classes that are lower than the highest pre-mining class, but which did not exist in the pre-mining situation may not exceed 10% of the total permit area unless approved in the reclamation plan.

(3) Erosion

The inspector should visually inspect the entire site to determine if gully formation has advanced to the point where measurements should be made to determine if the criteria are being violated. Figure 40 shows when the erosion inspections will be made. If within any square acre there are more than 4 gullies that are deeper than 6 inches and longer than 30 ft. the site does not meet the criteria. Gully depth is measured by taking 10 depth measurements evenly spaced along the length of the gully and if the average is greater than 6 inches and 3 other gullies are present within the same acre (208.7 x 208.7 ft) that are deeper than 6 inches the site is in violation. The depth measurements can be accomplished with a rule and the length measurements for both the gully and the length and width of the acre can be accomplished with a range finder.

Gullies over 9 inches in depth are always in violation of the criteria and 10 depth measurements spaced evenly along the gully should be used to quantify depth.

b. Topsoiling

Topsoiling procedures and soil/spoil amendments are key tasks in the revegetation process. If adequate topsoil thickness is not replaced or if the proper quantities of spoil amendments are not added revegetation may be difficult.

Three questions must be answered by a topsoil inspection: 1) Has the soil been tested properly by the mine operator and have the necessary soil amendments been added? 2) Is the topsoil thickness in agreement with the approved thickness in the reclamation plan? and 3) Is the size of surface rocks in agreement with the criteria?

(1) Soil and Spoil Sampling

The operator is required to sample the surface material to determine the amounts of soil/spoil amendments necessary to establish the approved vegetative cover on the mine site. The results of these tests and the interpretation of the results should be forwarded to the regulatory authority. The acreage represented by each sample should be shown on a map, a copy of which should also be forwarded to the regulatory authority.

After all amendments have been added, inspectors should spot check the area that is to be released from bond by randomly collecting five samples. These samples are used to determine if the operator has added the necessary soil amendments. The samples should be sent to a reputable soil analysis lab for analysis and amendment recommendations. Tests that should be performed are soil pH, acid-base accounting, pounds/acre of available phosphorus, and concentrations in milliequivalents of potassium, magnesium, and calcium ions. Results of the tests should include specific amendment recommendations for limestone, phosphorus, potassium, and magnesium for the specific vegetation types that are planted. The inspector should compare the results and recommendations with the pre-amendment results and recommendations provided by the operator to determine if the recommended soil amendments have been added to the surface material.

Additional soil/spoil sampling by the inspector will occur only if low vigor symptoms appear on the reclamation vegetation or if the final percent cover is unacceptable. Low vigor symptoms are discussed in more detail in the vegetation inspection section below.

(2) Topsoil Thickness

A topsoil thickness sampling scheme must be used to determine if topsoil amounts approved in the reclamation plan have been placed on the site.

Soil sampling tubes or soil sampling hand augers can be used to extract a core of soil which can be measured. A soil sampling spade can also be used to dig a profile trench in which a soil thickness measurement can be made.

One or two samples for each acre that is being inspected should be taken. A quick visual inspection of the site will reveal any thin spots in the topsoil where spoil is visible. If thin areas are frequent or extensive they should be noted. The topsoil thickness samples should be averaged and compared to the acceptable thickness in the reclamation plan.

Concurrently with the topsoil thickness inspection the inspector should note the presence of surface rocks which are larger than the maximum allowable size.

c. Water

The inspection of water quality is extremely important because the major source of offsite environmental degradation resulting from strip-mining is water containing pollutants which has left the mine site. Research indicates that when stream pH goes below 6.0 and iron concentrations are above 1.5 ppm, abnormalities appear in both warm and cold water fish populations (i.e., certain fish species are eliminated, benthic communities are reduced, fish growth rates are slowed, and spawning success is decreased).[1] Siltation and sediment adversely affect fish populations.[5]

The objective of water inspection and sampling is to determine if pH and concentrations of Fe, Mg, and suspended solids are within the limits set by the law. Accurate water testing procedures are available.[40,42] There is a basic lack of research data for establishing a sample design. The design for sampling of strip mine effluent is based upon our experience and is subject to change based upon new research data concerning pollutant concentrations and rates of change of pollutant concentrations in strip mine effluent.

The inspection of water quality criteria is an expensive procedure. The new federal surface mining regulations place this burden directly upon the operator. Procedures or tests for determining specific pollutant concentrations are well documented.[40,42] However, very little research data is available for devising sampling designs for obtaining representative samples of effluent leaving surface mined sites.

Sampling - Sampling design should be based on known trends concerning pollutant concentrations. If effluent pollutant concentrations change slowly over time, the sampling frequency for that effluent can be low. A nationwide study of pollutant concentrations in daily samples of effluent collected from surface mine sites is needed to adequately devise a sampling scheme which will provide representative samples of surface mine effluent for testing purposes. Based on our experience with acid mine drainage and sediment the following sampling scheme is proposed.

Samples should be taken at all points where effluent leaves the surface mined area. This is usually at the point where effluent leaves the sedimentation pond. The operator should take a grab sample every day that flow is present. A grab sample is defined as a single sample taken at a point in time. The sample can be taken using a pump, scoop, vacuum, or other suitable device.[43] Individual samples should be preserved with nitric acid and cooled to $4^{o}C$.[42] At the end of one week the daily grab samples should be mixed to provide a weekly sequential composite. A sequential composite is defined as a series of short period grab samples each of which is held in an individual container, the composited (mixed) to cover a longer period of time.[43] The weekly composite sample should be sent to a qualified laboratory for testing.

In addition to the daily grab sample, a grab sample will also be collected during significant rainfall events. A significant rainfall event is difficult to define in terms of the effect on water quality leaving a mine site. Based on our experience a 2/10 of an inch rainfall event significantly affects water quality in a sediment pond, however, we recommend more research be conducted in this area to determine when rainfall events significantly affect water quality.

The sample which is collected during the rainfall event should be large enough so that part of sample can be used as the regular daily sample and used to form the weekly composite. The remainder should be sent to the laboratory for testing as a daily sample.

Testing Procedures - The tests that should be used to determine concentrations of total suspended solids, total iron, and total manganese are those procedures approved by EPA.[40,42]

The test that should be used for total suspended solids is entitled total non-filterable residue. This test involves filtering the sample with a standard glass fiber filter disk and weighing the residue that is collected by the filter. A minimum sample volume of 100 ml. is necessary to perform this test.

The procedure recommended by EPA for determining total iron and magnesium is atomic absorption spectroscopy. This test is accomplished by atomizing a portion of the sample and aspirating the atomized sample into a flame. A light beam is directed through the flame into a monochromator, and into a detector that measures the amount of light that was absorbed. Since the wavelength of the light beam is characteristic of only the metal that is being tested for, the light energy that is absorbed is a measure of the concentration of the metal in the sample. A 100 ml. sample is adequate to test for iron and manganese.

All pH tests should be made with an electronic pH meter which has a glass electrode in combination with a reference potential (saturated calomel electrode) or a combination electrode (glass and reference). Samples must be analyzed as soon as possible, preferably with a few hours after collection. Because of this time limit, it is advised that the mine operator purchase a pH meter to conduct this test, or be certain that any pH tests are conducted within the required time limits.

Reporting - The results of the water tests must be submitted to the regulatory agency every 60 days.

All results must be reported, including the seven day composite sample pollutant concentrations and the concentrations of pollutants found in daily samples collected during significant rainfall events.

d. Vegetation

Vegetation is one of the key pollution control methods for surface mined lands. A well established vegetative cover provides erosion control as well as partial control of chemical pollution which results from the reaction of water and oxygen with spoil materials buried beneath the vegetation. In addition, the proper types of vegetation will restore the land to a productive use and contribute an aesthetic improvement to surface mined lands.

Vegetation is the main retarder of soil erosion because it will bind the soil together with root systems, impede the overland movement of surface water, and protect the soil surface from the impact of raindrops.[8,13,22,34]

Vegetation types that provide a continuous cover promote water intake and discourage runoff. The vegetation species and types are of less importance than the percent cover.[30] Research has indicated that a minimum percent cover of 65-85% is needed for effective erosion control.[8,20,21,24]

Dense vegetative cover produces organic materials in the form of litter and plant leachates which serve as a growth medium for soil microflora and fauna. The soil microflora and fauna and the plants themselves utilize free oxygen. This soil ecosystem can serve as a partial oxygen barrier and help prevent oxygen from infiltrating down to the spoil, thus helping to prevent chemical pollutant formation.[22]

The final vegetation inspection should accomplish three objectives:

(1) Determine if the plant species present on the site are in agreement with the reclamation plan.

(2) Determine if vegetation is growing in a vigorous manner.

(3) Determine if percent cover of herbaceous species is acceptable. If trees are present determine if the number of living trees per acre is acceptable. If row crops are planted on the site determine if harvest productivity is acceptable.

(1) Determination of Approved Species

The planting or reclamation plan which must be submitted to the regulatory authority before mining can begin will list the approved species for the permitted area. The approved species must be compared to the vegetation that is actually present on the site. Inspectors should possess enough familiarity with reclamation species so that they can recognize them by sight. However, it is advisable that inspectors maintain a herbarium with typical examples of all the reclamation species currently in use in their area of jurisdiction. This inspection for species compliance with the reclamation plan can be conducted concurrently with the percent cover and/or trees/acre inspection.

Although reclamation species can be identified on sight by an inspector who is familiar with reclamation vegetation, it can be quite difficult to distinguish between varieties of a particular species. Quite often there is no morphological difference between varieties bred for different climate zones or different pH tolerances. Because variety identification can be a problem the regulatory authority should request the seed analysis lables from the seed mixtures which have been planted in the permit area. The seed analysis label will list the species and varieties (where applicable), mixture percent of each seed type, percent germination of each seed type. A sample of a typical seed analysis label is shown in Figure 36.

SPECIAL SEED MIXTURE — LOT NO. RBM-631

% PURE	SEED	% GERMINATION
39.80	TIMOTHY SEED	85
29.40	KENTUCKY 31 TALL FESCUE	85
9.80	ALSAKE CLOVER - INOC. ORIGIN - CANADA	85+5 HS=90
7.35	IMPORTED BIRDSFOOT TREFOIL-INOC.	70+15 HS=85
7.35	EMPIRE BIRDSFOOT TREFOIL - INOC. ORIGIN - CANADA	70+15 HS=85
4.60	REDTOP	85
.21	CROP SEED	
1.30	INERT MATTER	NET WEIGHT 50 LBS.
.19	WEED SEED	TESTED 3/76

FIG. 36 EXAMPLE OF A SEED ANALYSIS LABEL

78-59

Plant Vigor Determination - Vegetative vigor can be difficult to determine from a single observation such as a final inspection, however, there are certain plant symptoms which can indicate a decline in vegetative vigor. Certain leaf discolorations, and abnormalities in leaf shape and size are indicators that problems exist and vegetative vigor may be declining. In soils that have become highly acidic, calcium and magnesium deficiencies, aluminum and manganese toxicities can occur.[4,38]

Herbaceous legumes are the most sensitive species to toxicities and deficiencies. Calcium deficiencies are indicated by newly emerging leaves becoming severely distorted, with tips hooked back and edges curled. Leaves may be pale and chlorotic (yellow).[38] Magnesium deficiencies are indicated by legume leaves turning orange and red. In grasses the symptoms are chlorosis (yellowing) starting at the older leaf tips and margins.[38] Manganese toxicity to legumes is manifested by extremely chlorotic to white leaves.[4,38] Aluminum toxicity to legumes closely resembles calcium deficiencies.[38] If any of the above symptoms have a widespread occurrence on a site that is being inspected particular attention should be paid to the soil tests in those areas.

In addition to the above symptoms the inspector should observe plant and leaf size. If plants and leaves are smaller than average for a particular reclamation species, this is another indicator that plant vigor is not optimum and problems may be present. The cause of these symptoms may be climatic, such as low rainfall or a cool unfavorable spring.[38] The cause of any low vigor symptom can not be determined until soil test results and growing season climate have been evaluated.

It is suggested that a checklist of symptoms be formulated by the inspector for use in the field during inspection. The presence of non-vigor symptoms could be noted on the checklist and would indicate that soil tests and vegetation should be evaluated closely.

(2) Productivity, Percent Cover, and Living Trees/Acre Measurement Techniques

Many sampling techniques have been used for estimating percent cover of herbaceous plants.[7,35] These techniques are used to sample percent cover of a part or portion of a plant population which is presented as evidence of percent cover for the entire population. If the sampling procedure is conducted in an unbiased manner and if the sample population is of an adequate size a valid estimate of the total population mean and variance will be obtained.

There are only two methods that would be feasible for regulatory agencies to use for percent cover estimation given the time and monetary constraints under which the regulatory agencies operate. The two methods are line transect and point analysis or drop-point.

The line transect method consists of taking observations on a line or lines laid out randomly or systematically over the study area. The method normally involves stretching a line, usually a steel tape, between two stakes 50 to 100 m apart. The total amount of plant material bisected by the tape is recorded. The total linear measurement of plant material divided by the total length of the line or lines will provide percent cover.[7,25,35] Species composition can be determined if linear measurements are recorded by species.

The point analysis method is usually accomplished with an apparatus consisting of pins that are held in a vertical position on a cross-bar (Fig. 37). The pins are lowered to the ground and each pin that contacts vegetation is counted as a hit. The total number of hits divided by the total number of pins lowered to the ground provides a percent cover estimate.[7,25] If hits are recorded by species percent species composition can be obtained.

A variation of the point analysis method is currently being utilized by the regulatory agency in Illinois.[37] Twenty starting points are randomly selected within the area that is being inspected. A twenty foot engineers measuring tape is extended directly south from each random point. Each .2 $ft.^2$ segment along the line is observed. If a plant or any part of a plant occurs in a segment that segment is counted as a hit. This procedure tends to inflate the percent cover estimate because the observation point is 28 $in.^2$ and if any portion of a plant is found in the square, 100% cover is assumed for that point. An additional source of error may arise because the sample population may be too small. With this procedure there are 45 sample points per transect and only twenty transects are used regardless of the size of the area to be sampled.

The point frame method (Fig. 37) is the recommended procedure. An inspector can traverse back and forth across an area to be inspected and lower the frame at predetermined intervals and take observations. Past experience indicates that 150 points per acre should be taken if the vegetative cover $\geq$ 50%. If vegetative cover is < 50% more points may be needed to accurately estimate percent cover.

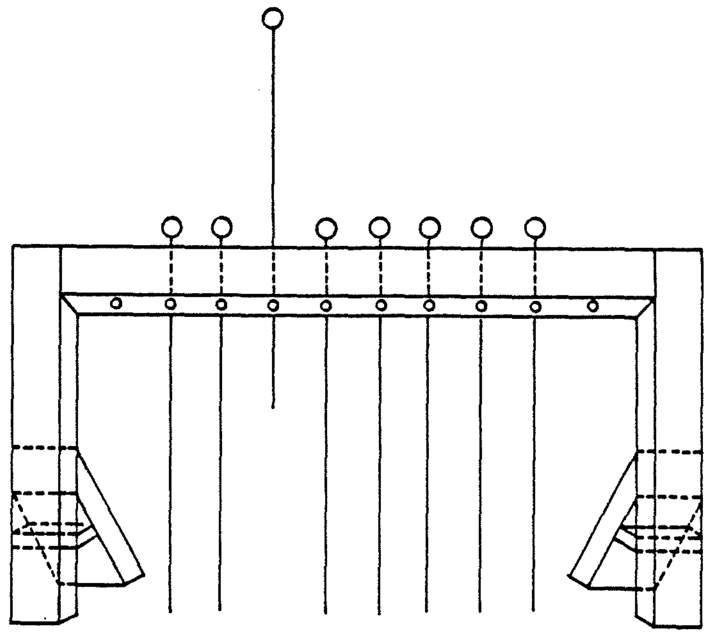


FIG. 37 POINT FRAME FOR PERCENT COVER ANALYSIS

78-59

To be certain that the sample population size is large enough to characterize the whole population, a percent cover-observation curve can be plotted. Figure 38 is an example of this type of curve where percent cover is charted against number of observations. When the curve flattens out enough observations have been made to characterize the area in question.

In the example in Figure 38 a 10 acre plot was sampled and the curve flatened at 70% cover after 1400 to 1500 observations. This would indicate that 150 observations per acre are sufficient to estimate percent cover when the cover is 70%. As an inspector gains experience he will not have to produce the curves because he will know how many samples he needs based upon past experience. The general rule is, as percent cover decreases observation necessary to quantify percent cover will increase.

The actual sampling plan can be laid out on a map of the area before going into the field. Figure 39 shows a systematic sampling plan for an 11-acre plot. The sampling rate is 150 observations per acre. The sampling sites on the map are spaced 34 ft. apart along the lines, and the lines are 100 ft. apart. By varying the width between lines and spacing between sampling sites an inspector can increase or decrease the sample population.

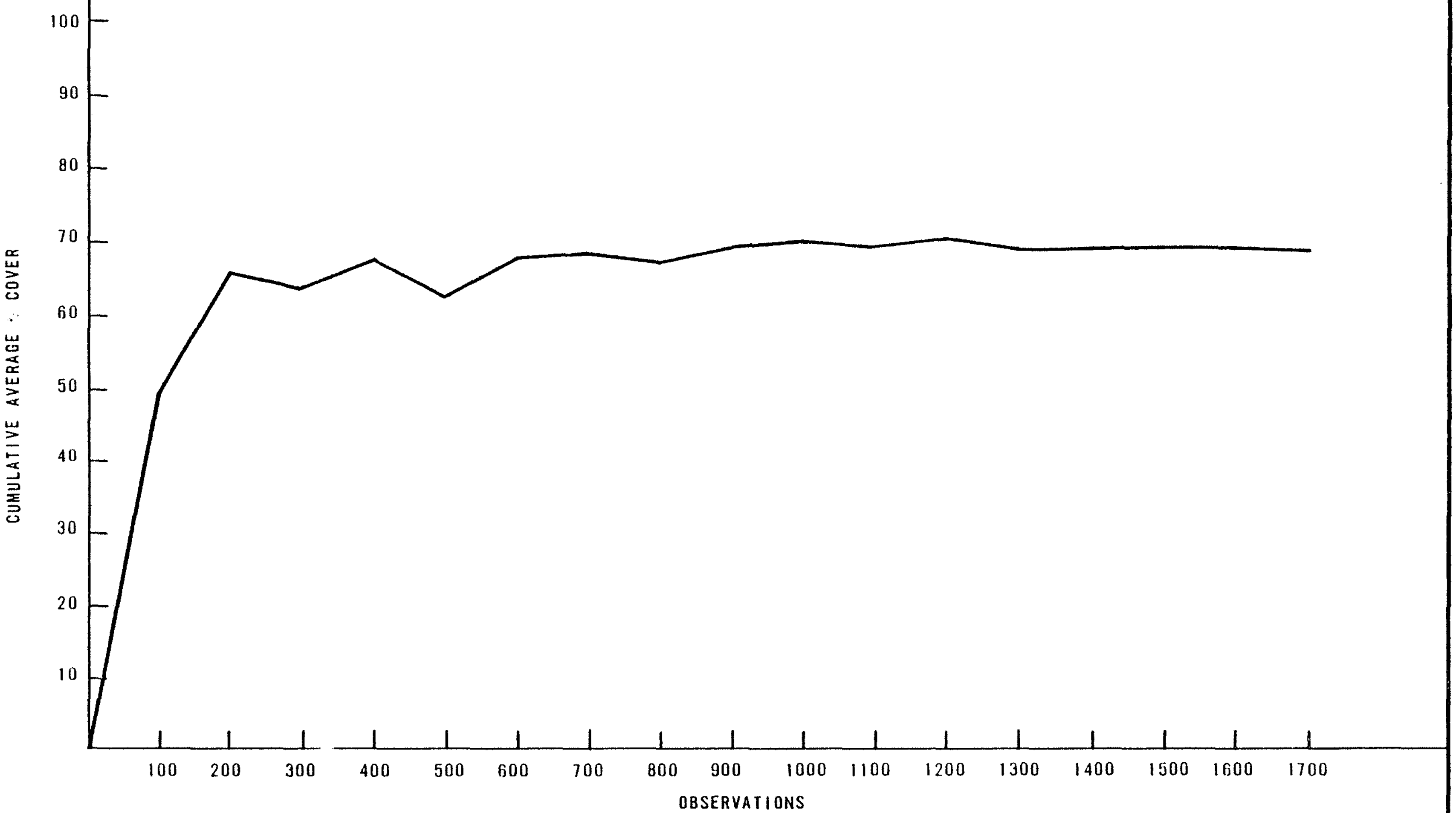
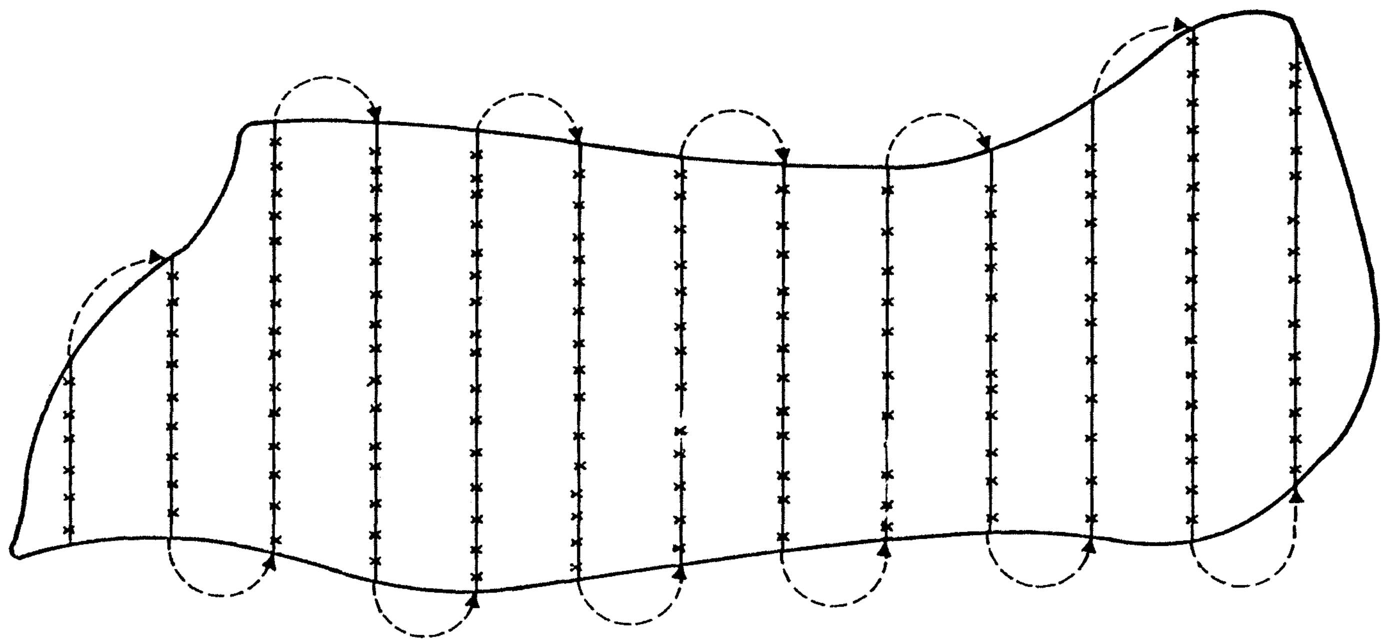


FIG. 38 PERCENT COVER OBSERVATION CURVE

78-59



EACH X REPRESENTS THE APPROXIMATE LOCATION WHERE A 10 PIN FRAME WILL BE LOWERED TO THE GROUND AND HITS RECORDED

FIG. 39 SAMPLING PLAN FOR AN 11-ACRE PLOT

78-59

In the field, pace the distances and take the observations by lowering a 10 pin frame to the ground and noting the number of hits. If it is necessary to determine the percent cover of legumes as well as the total percent cover the inspector can keep a separate tally of the number of legume hits.

By dividing the number of hits by the total number of observations taken, percent cover can be calculated.

While collecting the point frame observation data the inspector should note the presence of bare areas and measure those that approach the legal size limit.

(3) Living Trees/Acre

The following sampling procedure should be used to determine the number of living trees/acre when trees are planted in a grid pattern. Determine the average spacing between planted rows and between trees within rows. From this calculate the number of planting spots per acre (and for the area to be examined) as shown below:

$$\frac{43{,}560 \times \text{number of acres to be inspected}}{\text{Spacing between rows (feet)} \times \text{Spacing between trees in row (feet)}} = \text{planting spots/acre}$$

Determine the number of planting spots that must be examined to constitute a 10 percent sample.

Plot four randomly selected lines across the area, perpendicular to the planted tree rows. All planted species will be taken into consideration. Based on the number of rows across a given area, determine the number of rows that must be examined for the 10 percent sample, assuming that 10 or 20 planting spots will be examined along each row. The plotted lines will be transects. The transect's width will extend on either side of a planted row halfway to the adjacent rows. Each planting spot on the transect will be examined and if a living tree, either planted or an acceptable volunteer, occurs then that spot will be tallied as "living" on a tally meter. A planting spot will be considered as a rectangle defined by the transect boundaries and extending along a row from a given planted tree half way to adjacent planted trees. After transect tallies have been completed, calculate living trees/acre with the following equation:

$$\frac{100}{\text{percent of sample (usually 10\%)}} \times \frac{\text{no. of living trees tallied}}{\text{no. of acres inspected}} = \text{living trees/acre}$$

If the trees are not planted at regular intervals (grid pattern) the following sample procedure should be used. Randomly locate square plots (33 x 33 ft.) and count the number of living trees within the plot. Four plots per acre are necessary for a 10% sample. Each plot has an area of 1089 $ft.^2$ To determine the number of living trees/acre use the following equation:

$$\frac{\text{Total no. of living trees counted} \times 43560 \text{ sq. ft./acre}}{\text{No. of sample plots} \times 1089 \text{ ft.}^2} = \text{Living trees/acre}$$

(4) Productivity

To determine if productivity of cropland is acceptable, reference areas must be selected and treated exactly the same as the reclaimed crop area except that they will not be mined. The reference areas shall be no smaller than 2 acres and shall be selected so that soil types, vegetative cover, slope, and aspect are similar to the premining mine site conditions.

All seed bed preparation, planting, and cultivation procedures should be identical for the reclaimed site and the reference area. In addition, key plant nutrients such as nitrogen, phosphorus, and potassium should be maintained at approximately the same levels on the reference area and reclaimed site.

After harvesting, the two areas should be compared on a production per acre basis (i.e. lbs./acre, bu/acre, etc).

e. Impact of the Proposed Inspection Program on the Regulatory Authorities

A comparative impact between the proposed program and past state programs is impossible to show because of lack of historical data. In lieu of this, an attempt has been made to quantify the man hour requirements for conducting the proposed inspection techniques. It must be remembered that the figures presented here reflect time requirements to perform the basic planning and preparation, fieldwork, and corresponding office work for each inspector technique. The estimates exclude time allotments for administrative time, travel time, interviewing time, etc.

The following discussion is broken into three parts: 1) summary of inspection techniques, 2) time requirements for each inspection technique, 3) impact on regulatory authorities.

(1) Summary of Inspection Techniques

The proposed inspection techniques are divided into four areas depending upon when they appear in the bond release cycle. Figure 40 summarizes the inspection program for bond release. They are 1) grading, 2) vegetation, 3) final and 4) water. The four designations, grading, vegetation, final and water appear in the left hand column. References to the pertinent criteria and inspection techniques are given in columns 4 and 5.

a. Inspection Techniques for grading release

The proposed inspection techniques for grading release are divided into two parts, those that occur prior to topsoil replacement and those that occur after topsoil replacement. Before topsoil replacement the spoil banks should be sampled for pH and acid base account at their surface. Since the surface spoil tests will require much field work it is advised to do the slope mapping at the same time since the slopes should not change significantly during top soil placement. The surface spoil tests are conducted to verify that toxic material was buried properly and involes spoil pH and acid-base account tests. Slope mapping is done by the regulatory authority at this time to compare with the slope map submitted by the operator for the permit application.

		NAME OF INSPECTION TECHNIQUE	PURPOSE	CRITERIA PAGE	INSPECTION TECHNIQUES PAGE	HOURS/100 ACRES PLANNING	FIELD	OFFICE	FREQUENCY PER 100 ACRES	RESPONSIBILITY	SPOT CHECK
GRADING	BEFORE TOP SOIL REPLACEMENT	SURFACE SPOIL SAMPLING	VERIFY BURIAL OF TOXIC MATER.	154	165	4	8	4		R	
		SLOPE MAPPING	VERIFY COMPLIANCE W/SLOPE LIM.	152	166	0	2	3	---	R	
	AFTER TOP SOIL REPLACEMENT	HOLE SAMPLE-TOXIC MATERIAL	VERIFY BURIAL OF TOXIC MATER.	152-153	166	0	1	1	1	R	X
		PRE-AMENDMENT SURFACE SAMPLING	DETERMINE AMENDMENT REQUIRE.	154	168	0	0	2	---[1]	O	
		POST AMENDMENT SURFACE SAMPLING	VERIFY AMENDMENT ADMINISTRATION	154	168	0	½	1	5	R	X
		TOP SOIL THICKNESS	VERIFY TOPSOIL THICKNESS	154	168-169	0	7	2	100-200	R	
		EROSION INSPECTION	MEASURE EROSION DAMAGE	153	167		2		---[2]	R	
		SURFACE ROCKS	VERIFY ABSENCE OF LARGE ROCKS	153	169		1			R	
VEGETATION		APPROVED SPECIES DETERMINATION	VERIFY PROPER SPECIES MIX	155	172		½	½	---[2]	R	
		PLANT VIGOR	DETERMINE HEALTH OF VEGETATION	155-156	173		1.0		---[2]	R	
		PERCENT COVER	DETERMINE % COVER	156	174	4	50	8	10-15/ ACRE	R	
		TREES/ACRE	DETERMINE TREE SURVIVAL/ACRE	156	179	4	80	8	1/10 OF TOTAL AREA	R	
		PRODUCITIVTY	DETERMINE % PRODUCITVITY	156	180	0	8	1	1	R	
		EROSION INSPECTION	MEASURE EROSION DAM. AND POT.	153	167	0.	2	0	---[2]	R	
FINAL		PLANT VIGOR	DETERMINE HEALTH OF VEGETATION	155-156	173	0	1	0	---[2]	R	
		PERCENT COVER	DETERMINE % COVER	156	174	4	50	8	100-150/AC	R	
		TREES/ACRE	DETERMINE TREE SURVIVAL/ACRE	156	179	4	80	8	1/10 OF TOTAL ACRE	R	
		PRODUCTIVITY	DETERMINE % PRODUCTIVITY	156	180	0	8	1	1	R	
WATER		WATER SAMPLING	TO DETERMINE IF EFFLUENT IS MEETING WATER QUALITY GUIDELINES	157	169			2[3]	CONTINUOUS	O	
									DAILY	O	
									SIG EVENT	O	

[1] UP TO OPERATOR, DEPENDS ON HOMOGENEITY OF SPOIL [2] VISUAL INSPECTION OF WHOLE SITE [3] ASSUMES ONLY ONE SAMPLING SITE

FIG. 40 SUMMARY OF PROPOSED INSPECTION PROGRAM

78-59

The techniques to be used after topsoil placement are 1) a spot check hole sample for toxic material, 2) pre-amendment soil tests, 3) post-amendment soil test spot check, 4) topsoil thickness check, 5) erosion inspection and 6) surface rock size check. The hole sample for toxic material and post amendment soil tests are spot checks to verify operator compliance with toxic material burial and soil amendment application guidelines. The pre-amendment soil tests are conducted by the operator at a sample frequency that is up to his discretion. The topsoil thickness check is to verify that the operator has put down the specified thickness of topsoil. The erosion inspection and surface rock size check are simply visual checks to verify compliance.

b. Inspection Techniques for Vegetative and Final Release

The same tests are involved in the vegetation release inspection and the final release inspection except that the former also requires a species determination and erosion check. The inspector must determine that adequate cover is present and that the cover is healthy. If a tree cover is used, a tree survival per acre measurement is needed along with percent cover. Productivity alone is needed for crop lands.

c. Water sampling and testing

The water testing program occurs continuous over the life of the project to determine whether the site is contributing pollution and sediment to nearby streams. Tests are made daily and during or as soon as possible after significant rainfall events.

(2) Time Requirements for Each Inspection Technique

Figure 40 presents estimates of the hours required to conduct each technique for a 100 acre site (columns 6, 7 and 8). These estimates are just for the time spent planning and preparing for the tests, field work and for office time to conduct tests and analyze results of the particular test involved. They do not include general administrative time, time making appointments, time to manage data and maintain files, time to handle contests of results, travel time, etc.

a. Surface spoil

The 4 hours preparation and planning and the 8 hours field time are based upon actual experience in the field using the Lamotte-Morgan Method for determining soil/spoil pH. The four hours in the office after field work is the time needed to verify low pH samples with a pH meter and to prepare samples for shipping for laboratory analysis.

b. Slope Mapping

The two hours in the field is based upon actual field experience with slope mapping using the six SCS categories. The rapidity of this procedure is enhanced by the inspector's familiarity with the area and the unobscured view presented by strip-mines.

c. Hole sample for toxic material burial spot check

The one hour estimate for field work is based upon past experience with the same type of truck-mounted auger used for percolation tests. This is a spot check and no preparation and planning is required. The one hour in the office is for taking pH and shipping samples.

d. Pre amendment surface sampling

The burden is on the operator for sampling the surface material to determine if and what amendments are necessary. The 2 hours in the office are for the inspector to review the sampling results provided by the operator.

e. Post amendment surface sampling spot check

The 1/2 hour in the field is based on actual experience with sample collecting on strip mines. The hour in the office is for preparing and mailing samples and for reviewing results when they return.

f. Topsoil thickness-surface rock size

This estimate of 8 hours is based upon soil thickness mapping techniques used by SCS which we have verified in the field. The two hours in the office are for compiling the data and determining average thickness. The inspection for surface rocks larger than the maximum size allowed by criteria is a visual inspection that occurs concurrently with the topsoil thickness sampling.

g. Erosion inspection

We have no previous experience with this technique. We have in the past measured gully and rill erosion depth and used range finders for area measurements and our estimates are based upon this experience.

h. Approved species determination

This estimate is based upon vegetation mapping we have conducted on strip mines and is contingent upon the inspector being familiar with the reclamation species in use in his area of jurisdiction. The 1/2 hour in the office is to review seed analysis labels.

i. Plant vigor

This estimate is based upon our actual field experience. The inspector is not expected to diagnose problems or causes of varying degrees of vigor.

j. Percent cover

The estimates for planning, fieldwork, and statistics compilation in the office are based upon our experience with drop-point sampling methods.

k. Trees/acre

This estimate is based upon our experience with the use of quadrats and line sampling methods, however we have no actual experience or backup data available for sampling trees per acre.

l. Productivity

The field hours are necessary to observe harvesting in both the reference area and the mined site to insure that harvesting techniques are the same for both areas. The office time is for comparing productivity and treatment differences between the two areas.

m. Water sampling

The burden for sampling is placed on the operator. Sample and testing results are submitted to the inspector on a monthly basis for review.

(3) Impact on the Regulatory Authority

The following analysis is the impact of the proposed inspection techniques on regulatory authorities, dealing with the time requirement to perform each task. The time requirements will vary greatly from site to site, inspector to inspector, and according to the weather conditions at the time of the inspection. The analysis presented, therefore, is very general and should not be related to any specific situation.

The analysis is presented in three scenarios, each in turn, assuming 1) all grassland, 2) all timberland, and 3) all cropland final uses of the land. The data is presented in terms of person hours/100 acre site and person years of effort on annual expected release of 2000 acres. The figures represent the time required to conduct planning and preparation for field investigation, field investigation and office time to complete tests and analyze data.

a. Scenario I - Grassland

The inspection techniques pertinent to the grading, vegetation and final bond release of grasslands are 1) surface soil sampling, 2) slope mapping, 3) hole sample spot check, 4) pre amendment surface sampling of topsoil, 5) post amendment sampling of topsoil, 6) topsoil thickness, 7) erosion, 8) surface rocks inspection, 9) species determination, 10) plant vigor, 11) percent cover, 12) productivity, and 13) water sampling. The time required on the average is 12 hours for preparation and planning, 126 hours for field work, and 29 1/2 hours for office work for a total of 167 1/2 hours. Assuming an average annual release of 2000 acres for the model regulatory authority the total hours consumed is 3360 hours or 1.7 person years of work (2000 hrs. = 1 person year).

b. Scenario II - Timberland

Final land uses with tree cover require all the tests that are needed to inspect grasslands, as well as inspecting for tree survival per acre during the vegetation inspection and final inspection. The time required for a 100 acre inspection is 354 hours which breaks down to 20 hours for preparation and planning, 284 hours for field work, and 50 hours for office work. The number of hours per year required are 7080, hours or 3.5 person years.

c. Scenario III - Cropland

Cropland requires all the inspection techniques required for grassland except that the productivity inspection is required in place of percent cover. The total time required to inspect a 100 acre site of cropland is 64 hours which is broken down to 4 hours planning and preparation, 42 hours of field work, and 18 hours of office work. For an average of 2000 acres released per year, 1280 hours of inspection would be required or 0.6 person years.

These figures do not reflect the total hours needed to conduct a bond release inspection program. A number of time consuming items have not been included. The analysis assumes a 100 acre average size permit area and only 2000 acres per year for a regulatory authority.

The time consuming items not included can be divided into general administrative time and time devoted to inspection preparation and enforcement not considered above. The general administration time consists of time spent filling out time cards, expense reports and other general office reporting, procuring supplies and interdepartmental communications. Inspection items that were not included are travel time, appointment making time, time spent with the operator, preparing reports, and managing the data received. The analysis also optimistically assumes no violations are discovered which will require further inspections, and if violations are detected, that they are not contested.

A good estimate for an increase in person hours to accomodate these excluded time consuming activities could be from 200-300%. Assuming a 250% increase in time required the grasslands area would require 4.2 person years of effort for a 2000 acres average annual release, 8.9 person years for timberland and 1.6 person years for cropland.

It must be noted that this is an estimate of the effort to conduct bond release inspection only. This excludes the routine inspections of active and inactive mining sites. For this reason the study team feels it is advisable for a regulatory authority to train and equip a special team to handle bond release inspections only. This would lower the cost of special training and also lower special equipment costs. A byproduct of this arrangement would be to relieve the routine inspector of the duty to judge final reclamation. This takes pressure off him in his day to day intercourse with the operator. It also puts the burden of judgement upon an inspector not influenced by his relationship with the operator, hence a more objective observer.

The assumption of a 100 acre average permit size also is far too simplifying since there are returns to scale for inspection operations. The inspection techniques themselves tend to vary in relation to the acres released, and many of the unincluded inspection items such as travel time, time spent making appointments, and time discussing the site with the operator depend more on the number of sites rather than on their size. States with many small sites rather than fewer large ones will be disadvantaged. If the average permit size is greater than 100 acres the inspection program will have a lower unit cost.

The assumption of an annual average release of 2000 acres for the model reclamation authority was taken from the total acres released from the state of Pennsylvania for 1976, rounded to the nearest thousand. Large mining states such as Illinois, Ohio, Pennsylvania, and West Virginia may average more than this. The new emphasis toward conversion to coal will increase the number of acres surface mined per year. States with smaller production such as Arkansas, Iowa, and Virginia will require less effort.

C. DEVELOPMENT OF A GRADUATED BONDING SYSTEM

1. Objective

The objective of this section is to develop a prototype graduated bonding system. A graduated bonding system varies the bond rate, or per acre liability of the bond, according to pertinent physical, technical and economic variables. A graduated bonding system is preferred to a fixed rate bonding system because it more accurately approximates the cost of reclamation for individual mine sites and it can be used to influence favorable operator performance.

2. Approach

The approach used in this section follows the framework established for Phase I of this study. Discussions with regulatory authorities and operators conducted for the Phase I Data Collection were examined for information on bonding practices and methods. Supplementary discussions were held with regulatory authorities to verify and document past bonding practices. A systematic approach to developing a graduated bonding system is presented. A game theory decision matrix is utilized.

3. Results

a. Background and History

A bonding system can be administered in two ways. The bond rates are usually set on a per acre basis using a fixed fee or a graduated scheme to determine the level of bond per acre. The graduated bond system not only offers a method to insure proper performance of reclamation but, by proper application of the rate schedule, can offer the most appropriate incentive to the operator. A graduated bonding system is also a more efficient system for estimating the true cost of reclamation for a specific site.

In the past, state regulatory agencies have employed both fixed and graduated bonding system. Figure 25 lists the bonding practices of each state. The states of Alabama, Arkansas, and Maryland use fixed rate bonding at $1200/acre, $500/acre, $1600/acre, respectively. The states of Illinois, Indiana, Iowa, Kansas, Kentucky, Missouri, Ohio, Oklahoma, Pennsylvania, Tennessee, Virginia and West Virginia have experience with graduated bonding systems of various degrees of sophistication and effectiveness.

Fixed rate bonding systems impose the same per acre bond rate upon all operators regardless of a permit's site characteristics or mining practices to be employed. In terms of the cost of reclamation criteria, the fixed rate should express the average cost of reclamation for the state. This type of bond rate determination is easy to administer for the regulatory agency but it has some decided drawbacks. Fixed rate systems may, if improperly administered, provide an economic disincentive to do proper reclamation. Fixed rate bond systems lack the ability to adjust to changing operator specific and site specific characteristics. The opportunity to modify operator behavior by bond rate variation is lost in a fixed rate bond system. Finally, because of the fixed rate bonding systems inflexibility it is many times inequitable.

If the bond rate is set lower than the cost of reclamation, an operator would have an economic incentive to forego the reclamation and default on the less costly reclamation bond. This tendency is mitigated by the fact that regulatory agencies are empowered to deny permits to operators who default on bonds. Therefore, an operator who wishes to remain in business must win bond releases in order to get new permits. There is no such protection where the operator plans to quit mining anyway or who is on the verge of bankruptcy.

There are other factors that lower the amount of bond necessary to be effective. Modern integrated mining techniques place many reclamation duties concurrent to the mining process. Therefore, a company who completes his mining operation has already satisfied a portion of the reclamation requirements. Also the planning or engineering expense for reclamation is done prior to permitting and is therefore complete before permission is given to mine. If the regulatory agencies inspection and operators use integrated mining systems, the bond need only exceed the cost of the residual reclamation.

Fixed rate bonding is inflexible and does not offer incentives to do good reclamation. An operator who has a spotless reclamation record is bonded the same amount as an operator who has a long history of reclamation problems. Even in criminal bail bonds the amount of the bond will vary according to the judge's perception of the severity of the crime and the risk of flight.

The regulatory authority also is precluded from using the bonding system to modify an operator's reclamation practices. Operators who choose to mine on steep slopes in acid producing overburden using mining techniques that are not favorable to these conditions will pay the same bond as an operator who has minimized the severity of his site specific variables through site selection and is using optimal mining and reclamation methods. The fixed rate system fails to provide incentives for desirable operator behavior.

Also, since operators who have utilized good reclamation practices and who lower risks of default are treated the same as less favorable operators; a fixed bonding system is not wholly equitable.

The graduated bonding system provides the flexibility that the fixed rate bonding system lacked. The costs and risks of each individual operator and permit site can be more exactly approximated. The operator can be rewarded for good reclamation, punished for bad and given incentives to do certain reclamation practices.

The level of sophistication of graduated bonding systems employed by state regulatory agencies in the past has varied greatly. In many cases the agency is limited by its empowering legislation or by budgetary constraints. The states of Tennessee, Virginia and West Virginia all have bond rates that are essentially fixed rate systems. Their enabling legislation specified a minimum-maximum range over which the agency could set bonds with the proviso that the bond rate be set according to the estimated cost of reclamation. In each case the estimated cost of reclamation exceeded the maximum allowable bond. Prior to 1977, Virginia charged an $800/acre bond, $200/acre less than their maximum. This resulted from the fact that due to fines and time constraints the agency felt it could not do site specific cost of reclamation estimates. In each of these cases, the legislature's intent to use a graduated bonding system was frustrated.

The bond rate can be graduated according to three types of criteria. They are (1) economic or operator characteristics, (2) mining methods, and (3) site specific variables. The earliest graduated bonding systems merely required the reclamation authority to relate the bond amount to the estimated cost of reclamation. In most cases a legally allowable range was specified in the law. The specified criteria for Iowa, Missouri and Oklahoma is to estimate the cost of reclamation. Missouri and Oklahoma have set ranges but Iowa has no such limit. In these states, the regulatory agency or reclamation committee has the responsibility to set bond rates. The specific criteria for rate setting in these states is not known, however.

Arkansas has a specified range graduated bond that is varied according to the depth of overburden and the type of equipment to be used. The state is characterized with gently to moderately rolling land primarily using area mining techniques. The depth of overburden is important as it is a good measure of the total volume of material moved.

Pennsylvania has a bond rate structure that increases with the height of the high wall or depth of the pit. Page 193 shows this rate structure.

Ohio relates the bond rate to the depth of overburden and slope of the site. The type equipment used is important as was mentioned for Arkansas. Ohio also takes into account the past reclamation record of each operator.

The most sophisticated state graduated bonding system is that of Indiana. Each operator fills out a "Bonding Evaluation Factor Sheet" (Form R-501-D, of the State of Indiana). This is a checklist of 10 criteria which, if answered yes, add an increment to the per acre bond rate. Form R-501-D is presented on page 104.

Items 1, 2, 3 and 7 of Form-501-D can be classified as economic or operator characteristics. They cover questions of (1) the previous compliance record of the operator, (2) the length of time the operator has functioned under the existing corporate charter, (3) the number of years experience the operator has mining within the state, and (7) the presence of attachable assets. If all the economic or operator characteristics are answered unfavorably the total stated increment to the bond rate is $4750.

The mining method criteria appears in items 4A, 5, and 8. These add an increment to the bond rate if the operator uses a dozer/front-end loader combination exclusively, if the permit area is below a specified size and if the operator does not plan to segregate the top soil. The total increment to the bond rate if all these factors are unfavorable is $1750.

COMMONWEALTH OF PENNSYLVANIA

Area Code 717
787-4827

DEPARTMENT OF ENVIRONMENTAL RESOURCES
POST OFFICE BOX 2063
HARRISBURG, PENNSYLVANIA 17120

February 10, 1977

TO: ALL LICENSED SURFACE MINE OPERATORS

The Surface Mining Conservation and Reclamation Act, as amended, took effect on January 1, 1972. As defined under Sections 3 and 4, the surface mining of anthracite coal, bituminous coal, and non-coal mineral operations, are subject to the license, bond, and permit provisions of the Act. Prior laws on coal stripping operations, defined the minimum and maximum rate per acre for bonding. Section 4(c) of the present Act, does not specify a rate, but does provide that the bond shall be based upon the total estimated cost to the Commonwealth to complete the reclamation plan and no bond shall be filed for less than five-thousand dollars ($5,000.00).

This is to inform you, that the Department will use the rates of liability for surface mining bonds outlined below. The bonding schedule shall apply to all coal and non-coal surface mine operations, with the exception of non-coal quarry-type pits, where blasting and sloping is necessary to carry out the approved reclamation plan. A bonding schedule, for non-coal quarry-type pits, is presently being drafted.

The maximum highwall height or depth of the open pit, shall be used as the basic guide for establishing the appropriate rate of liability. The following guidelines, are considered minimum amounts and may be increased in specific cases, at the discretion of the Department, where the nature of the operation requires a higher bond:

Highwall or Depth	Bond
0 to 60 feet	$1,000 per acre
60 to 75 feet	$1,500 per acre
75 to 100 feet	$2,000 per acre
100 to 125 feet	$2,500 per acre
125 to 150 feet	$3,000 per acre
Excess of 150 feet	$3,500 per acre

Items 4B, 4C and 6 of Form R-501-D are site specific factors. They relate to the depth of overburden, seam thickness and the percent of overburden that is consolidated. If all the site specific factors are answered unfavorably, then the bond rate is incremented \$750/acre. All totaled, \$7250/acre can be accumulated if all ten are unfavorable, of which economic or operator characteristics account for 66%, mining methods 24%, and site specific factors 10%.

The legal maximum bond rate is \$5000/acre in Indiana. Each operator submits a completed R-501-D with every permit. The reclamation authority reviews the permit application, mine plan, reclamation plan and Bonding Evaluation Factor Sheet to make a recommendation to the Reclamation Commission who has the final word. The Indiana Division of Reclamation reported that if an operator is well established with a good record, his bond will probably run between \$1000-\$2000/acre, new operators around \$3000-\$4500/acre and operators with bad reclamation records \$5000/acre.

The bonding rate schemes presented above were taken from personal and telephone interviews with state reclamation authorities. Those programs not described in detail may have explicit or implicit bond rate schedules but their criteria did not surface during the interviews. In many cases the person contacted declined to, or was unable to, elaborate on the particular program.

The goal of a graduated bonding system is to insure the public against environmental damage from poor reclamation. This is estimated by the cost of reclamation. Rather than doing an engineering cost projection for reclamation work for each proposed mining site a graduated bonding system is proposed that varies the bond rate according to selected variables.

These variables can be divided into two categories; site specific factors and mining factors. Developing a graduated bonding system essentially involves choosing these variables that most reflect the cost of reclamation and the risk of default.

A graduated bonding system also should reflect the risk of default and the land value at stake. These concepts can be viewed from the analogies of a bail bond and an insurance policy. In a bail bond the judge requests a higher bail for the criminals that (1) create a greater risk to public safety and (2) are more likely to "jump" bond, default in the case of reclamation bonds. A risky operator should therefore receive a higher bond rate. If one insures a house and a car, the house is insured for a higher amount than the car owing to the higher value of the house. In surface mine reclamation, a mine site that was once farmland is of a higher intrinsic value than that which was scrub pine. It should therefore have a higher bond rate.

Each government agency charged with regulating surface coal mining should develop its own bonding system. The Surface Mine Control and Reclamation Act of 1977 (37), allows states to administer their own regulatory program in lieu of a federally administered program within the state. Whether a program is federally administered or state managed, each region should design their own bonding program to meet their own needs and problems. Federal regulations should give guidelines as to how to set up these programs.

Developing a graduated bonding system is a two stage process: (1) selecting pertinent variables upon which to graduate the bond rates and (2) weighting each factor so as to approximate the cost of reclamation.

b. Selection of Variables

The variables upon which the bonding system is graduated can be divided into two kinds; those that are easily and of necessity regionalized and those which need not be regionalized. The latter can be specified by the federal regulations, but the regionalized factors concerning difficulty of reclamation must be selected by each regulatory authority so as to approximate the cost of reclamation for its area of jurisdiction.

(1) Factors to be Regionalized

Factors that can be regionalized fall into two broad categories; site specific factors of geology, topography, etc. and factors associated with the mining process. Figure 41 lists some examples of these variables.

(2) Site Specific Variables

Site specific variables are those geologic, hydrologic and cultural features unique to any site. They have been divided into six categories; slope,

VARIABLES			UNITS	SIGN OF THE VARIABLES EFFECT ON THE BOND RATE
SITE SPECIFIC VARIABLES	SLOPE	AVERAGE SLOPE, BEFORE MINING	° OR %	+
		AVERAGE SLOPE, AFTER MINING	° OR %	+
		MAXIMUM SLOPE, AFTER MINING	° OR %	+
		LENGTH OF MAXIMUM SLOPE, AFTER MINING	FT	+
	AMOUNT OF OVERBURDEN	STRIPPING RATIO	YD^3 O'BURDEN PER TON COAL	+
		THICKNESS OF THE OVERBURDEN	FT	+
		VOLUME OF THE OVERBURDEN	YD^3	+
	ACID POTENTIAL	PRESENCE OF ACID FORMING MATERIAL IN THE OVERBURDEN	Y/N	+
		PRESENCE OF ACID NEUTRALIZING MATERIAL IN THE OVERBURDEN	Y/N	-
		COAL QUALITY	% S	+
		ACID-BASE ACCOUNT		+
	EROSION-SEDIMENT POTENTIAL	PRECIPITATION	IN/YR	+
		RUNOFF	%	+
		SLOPE	° OR %	+
	SEAM THICKNESS		FT. OR IN.	-
MINING VARIABLES	MINING METHOD USED		TYPE	+/-
	MINING EQUIPMENT USED		TYPE	+/-
	SEASON OF OPERATION		SEASON	+/-
	HEIGHT OF THE HIGHWALL		FT.	+
OPERATOR CHARACTERISTICS	PAST RECLAMATION RECORD		# OF NOTICE	+
	YEARS OF EXPERIENCE	YEARS OPERATING WITHIN THE STATE	YES	-
		YEARS OPERATING UNDER THE CURRENT CORPORATE CHARTER	YES	-
	FINANCIAL HEALTH OF THE OPERATOR		NET WORTH	+/-
LAND VALUE	LAND VALUE BEFORE MINING		$/AC	+/-
	LAND VALUE AFTER MINING		$/AC	+/-
	NET LAND VALUE		$/AC	+/-
USE OR DISUSE OF SPECIAL OR EXPERIMENTAL MINING TECHNIQUES			Y/N	+/-

FIG. 41 GRADUATED BONDING VARIABLES

78-59

overburden, acid potential, erosion-sediment potential, value of the land and economic considerations. Some of the variables listed below are pertinent to more than one category and are mentioned twice.

(a) Slope: Slope is an important consideration in the pre-mining and post-mining configuration of permit area. The following four slope-related variables are offered as candidates to be used as a measure of slope:

- average slope before mining
- average slope after mining
- maximum slope after mining
- length of maximum slope after mining

In reviewing an operator's application for permit the regulatory authority can measure these on the topographical map used in the mine plan and after mining slopes can be estimated from the reclamation plan. In contour mining areas the first measure is probably the most important while the third and fourth have been used in the Midwest.

This measure is important because it expresses the difficulty of mining and reclamation. Steep slope mining, i.e., mining on slopes greater than 20°, is more difficult than area mining on gentle slopes. Slope limits the maneuverability of machinery and increases the area disturbed to mine a unit of coal. Slope also affects the erosion potential. Accordingly, the bond rate should increase as the slope increases. Area mining has less of a problem as it characteristically is associated with flat to gently sloping land.

(b) Amount of Overburden: The amount of overburden is an estimate of the volume of material to be excavated and moved to expose the coal. This can be expressed as:

- stripping ratio
- average thickness of overburden
- volume of overburden to be moved

The first two have been used in the Midwest where area mining is common while Kentucky has pioneered the third. The greater the volume of material moved the more space required for spoil banks, the greater the erosion potential and the less the profit potential. The higher the volume of material moved, the greater the bond rate should be.

(c) Acid Potential: The potential of a site to yield acid mine drainage is an important factor in the potential for environmental damage. The acid-forming potential of the spoil affects mining costs by requiring special placement of acid-forming materials. A high sulfur content also diminishes the stability of the coal. The variables proposed are:

- presence of acid forming material in the overburden
- presence of acid neutralizing material in the overburden
- coal quality

The lower the coal quality and more acid forming material in the overburden the higher the acid potential of the mine site and therefore the higher the bond rate required. The presence of acid neutralizing material diminishes the acid potential and should therefore reduce the amount of the bond rate.

(d) Erosion-Sedimentation Potential: The potential for erosion and sedimentation on a mine site is chiefly affected by the slope and precipitation and natural runoff of a mine site. High runoff, precipitation and slope augment the erosion potential of a mine site. The higher these factors are the greater the erosion potential, and the higher the bond rate should be.

- precipitation
- runoff
- slope

(e) Economic Factors: The thickness of the seam, stripping ratio and the coal quality will directly influence the profitability of a mining enterprise. Firms operating or proposing to operate mines in thin coal seams with large stripping ratios for poor quality coal have a higher risk of bankruptcy and thus higher risk for default. The higher the stripping ratio, lower the seam thickness and lower the coal quality the higher the bond rate should be.

- strip ratio
- seam thickness
- coal quality

(3) Mining Variables

Variables in the mining operation can affect the potential for environmental degradation and ease of reclamation. The analysis included:

(a) Method of Mining: Coal can be mined by various methods of area mining, contour mining or mountain top removal. Each method can further be broken down such as contour mining into conventional contour, modified block cut and haulback methods. Of the three contour mining methods the haulback method provides the greatest environmental protection and therefore should have a lower bond than an operator who is using conventional contour methods. In general, area mines have less severe sedimentation problems than contour mines.

(b) Equipment Set: The choice of equipment to operate a mine will affect the area disturbed to mine the same unit of coal. As was stated before, several Midwestern States incorporated a provision for higher bond rates for operators who used a dozer/front-end loader operation exclusively. The reasoning here is that dozer capabilities are restricted in the degree of slope they can traverse, as opposed to a shovel or dragline operation. They therefore require a more disturbed area to uncover the same amount of coal.

(c) Schedule of Operation: The spring season has a very high rainfall and therefore increases the erosion potential. An operator who begins to surface mine an area in the spring opens the earth to the ravages of the spring rains. If an operator schedules his reclamation operation for the summer months after the spring rains, the lower flows of water will have a lower erosion potential. If areas become dry in the summer, acid mine drainage may be aborted as less water is allowed to come in contact with acid forming material when it is exposed during the mining operation. If operations can be finished by early fall, the fall growing season can be used to establish a cover.

Putting aside considerations of seasonal effects the timely scheduling of mining and reclamation activities can affect the success of reclamation. Operators who present a mining plan with an unfavorable schedule of operation should be assessed a higher bond.

(d) Height of the Highwall: The Pennsylvania bond rate schedule discussed above (pp. 192-193) is entirely based upon the height of the highwall or depth of the pit at its maximum. This is a measure of the amount of overburden removed as discussed above, but expresses the operator's intent to mine using the specified highwall. In contour or mountain top removal mining the maximum highwall is more an indication of the difficulty of reclamation than the volume of overburden handled.

(e) Size of the Permit: The size of acreage to be mined must be large enough to be able to profitably be mined. An operator is more apt to forget or neglect reclamation work on a small plot than a large one. Also there are returns to scale in mining and reclamation, with smaller sites having higher unit costs of production.

(4) Operator Characteristics

Operator characteristics are important in determining an individual operator's probability of default. Our review of default trends showed a trend toward small and new firms to default on reclamation performance. Bankruptcy was the most common reason for default. High-risk operators should be assessed a higher bond rate.

(a) Operator Reclamation Record: By far the most important of the operator characteristics is his past reclamation history. Operators who constantly are in noncompliance or are uncooperative should be charged a higher bond rate. Operators who have forfeited bonds in the past could be denied new permits. Operators with records of poor reclamation should pay higher bond rates.

(b) New Operators: New operators do not have an established history on which to judge their probable future performance. This creates a greater risk and therefore a higher bond is in order. Secondly, new operators may lack the expertise to do good reclamation. New operators tend to be marginal entrants to the market with a higher probability of bankruptcy than established firms. Indiana's Form R-501-D discriminates against new firms in two ways, by newness of its corporate charter and newness in operating within the state. (See Items #2 and #3.)

(c) The Size of the Operator: The scale of operation in coal mining has risen because of environmental requirements, safety requirements, long term contract buying and other economic factors as well as technological improvements in larger dozers, larger pan scrapers, larger front-end loaders, and larger haulage trucks. Small mines are at a disadvantage. Generally then, small mines have a higher risk of bankruptcy and default. They should be charged a higher bond rate. The "significant size" criterion, though, will change from region to region. A small mine in Illinois may be considered large in eastern Kentucky. Each state (or region) should set their own threshold level in tons per year capacity.

(d) Financial Health of the Operator: Bankruptcy was the most common cause noted for bond forfeiture so the financial ability of a company to perform reclamation and to compensate for damages is important. Alabama has required that operators be able to post a $250,000 bond or show a net worth of $25,000 in order to get a license. Indiana incorporated Item #7 on Form R-501-D that increments the bond rate by $1000/acre if the operator has no attachable assets within the state. Item #7, however, does not specify a minimum value for these assets.

The problem of this variable is that it is difficult to gauge. Net worth, total attachable assets and other measures are difficult to measure. Limits on net worth to legally enter the market will place a barrier to new entrants.

(5) Determining Weights for the Variables

Once a regulatory agency has determined a set of variables with which to formulate the bond rate, he must now determine the proper weights to give each variable. This can be done with various degrees of rigor, using the sophistication of multivariate statistical analysis all the way down to educated guesses.

(a) Multivariate Statistical Analysis: If the regulatory agency has recent historical data on reclamation costs, a multivariate statistical approach is advised. A sample step-wise regression analysis, commonly found in the package software of most computer facilities, is a simple tool for selecting the most significant variables and placing weights upon them.

SPSS, SAS, StatPac, and Biomed are some commercial software packages offering step-wise regression routines. IBM and other computer manufacturers also offer similar routines as part of their standard software packages. Most regulatory authorities would have access to such a computer system equipped with a step-wise regression package.

The cost of reclamation is the dependent variable and the list of site specific and mining variables are the independent variables. In selecting which variables to use one must be sure that all the variables chosen are independent of each other. For instance, thickness of overburden and volume of overburden would be highly correlated and would thus interfere with the statistics. Only one of the two measures should be used.

Variables that are essentially yes/no questions would be inputted as dummy variables with "1" signifying yes and "0" for no. The pertinent variables such as slope, overburden volume, etc. can be obtained from the mining and reclamation plans for each site for which historical costs are available.

DEPENDENT VARIABLE	INDEPENDENT VARIABLES					
COST OF RECLAMATION	PREMINING AVE SLOPE	VOL OF O'BURDEN	SEAM THICKNESS	% S	LIMESTONE IN O'BURDEN	# ACRES IN PERMIT
\$10,000/ACRE	30°	4M YD^3	59"	.9	1	20
\$4000/ACRE	10°	50M YD^3	60"	1.5	0	400
\$5000/ACRE	10°	10M YD^3	70"	3.0	0	40
\$3000/ACRE	5°	40M YD^3	30"	1.5	1	200

FIG. 42 INPUT TABLE FOR BOND DATA

78-59

Figure 42 is an example of how an input table might look. The step-wise routine would select the most significant variables according to the statistical criteria given. Step-wise routines (forward) select the most significant single variable first, then in subsequent steps add the most significant variable in explaining the remaining variance. Variables are selected until an F-test criteria is not met and the program terminates. The resulting regression equation has the most significant variables selected and the beta coefficients are the weights in dollars to assign each factor.

$$Y = b_o + b_1 x_1 + b_2 x_2 + \ldots + b_n x_n$$

for example

$$Y = \$1000 + \$100/^\circ \text{ slope} + \$250/\text{mYd}^3 + \$500/1\%S = \$500 \left(\begin{matrix} 1 \text{ yes} \\ 0 \text{ no} \end{matrix} \left| \begin{matrix} \text{Presence of} \\ \text{Limestone} \end{matrix} \right| \right)$$

Using this equation a site with 20° slope, 2 mYd^3 overburden, 1% sand and limestone in the overburden would yield a bond rate of \$3500/acre = $\$1000 + 20^\circ \cdot \$100/^\circ + \$250/\text{mYd}^3 \cdot 2\text{mYd}^3 + \$500/1\%S.1\% - \$500 \cdot 1$

A regulatory agency could require each operator to record his estimated reclamation cost for each permit area as it is released from bond. Each year new bond rate criteria could be calculated using the previous 2 or 3 years cost information from released permit areas. In this way bond rates keep up with inflationary trends and changes in cost from better technology since they are reevaluated yearly.

Reclamation costs are usually difficult to determine. Most operators do not segregate costs according to unit operations and thus cannot identify costs specifically attributable to reclamation. It is difficult to decide what costs should be identified as mining and what costs as reclamation. Reclamation costs probably will not be available to the regulatory authority. Also the new Federal regulations will create new cost items and alter old cost items in reclamation. No historical cost data is available for operating under the Federal regulations. This precludes the use of rigorous statistical determination of factor weights. However, by requiring cost information from operators a statistical system could be used.

See Recommendations for Future Research, Section VI for a discussion of the costs of reclamation.

(b) Cost Estimation from Limited Data: Given the lack of cost data, estimations of the cost of reclamation and the weights to be assigned to each factor are difficult. In essence this is what has been done in the past. Regulatory authorities estimated the effect on reclamation of each of the factors they used in bond rate determination and made their assessment. For instance, Indiana placed a weight $1000/acre if an operator used a dozer/front-end loader operation exclusively or $500/acre if the permit size was less than 25 acres (See items 4a and 5 of Page 104). These determinations would have to be made from experienced operators and regulatory personnel.

(c) Items not Related to the Cost of Reclamation: The concept of risk of default does not relate to the cost of reclamation but to the risk of default of the particular operator. Data on forfeitures should be used to characterize the most probable forfeiting operator. In Chapter IV-F of this report it was found that most regulatory agencies had some history available on bond forfeitures, that small and new operators were more likely to default, and that bankruptcy was the most common cause for forfeiture.

The Indiana scheme had a total possible bond rate, that could be checked off on the Bonding Evaluation Factor Sheet (p. 104), of $7250. The maximum allowable by law was $5000/acre. Of the possible $7250, $4750, or 65% was attributable to operator characteristics (items 1, 2, 3 and 7). $1750 was attributed to mining factors and $750 to site specific factors. Regulatory authorities would have to determine those characteristics of an operator that most reflect the risky operator and weight them accordingly.

(6) Modifying Operator Performance

The extent to which bonding can be used to modify operator performance is debatable. Some argue that the incremental cost of bonding is insignificant when compared to the total cost of mining and reclamation. Many operators contradicted this however, and said that bonding requirements were a burden to their operations. Bonding costs are a very real and managable cost. Operators can reduce their bonding costs by three ways, (1) by reducing the number of acres disturbed per ton of coal, (2) by getting faster releases, or (3) by reducing the bond rate. A fixed rate bonding system only offers the first two opportunities.

By graduating the bonding rate schedule operator performance can be modified in three ways; site selection for the mine and support facilities, mining methods and practices, and entry into the coal market. The operators site selection is modified by the provisions to increase bonding where the natural slope exceeds a specified limit, where farmland is involved, where the site is close to roads or residences or where the overburden is acid bearing.

To some, the effect of graduated bonding on site selection is insignificant since the physio-geographical conditions of a mine site are usually just accepted. One usually secures what reserves are available and mines it come what may, as long as a profit can be had. This argument is very convincing and the effect of bonding on site selection is admittedly small. Selection of features such as haul roads, valley fills or refuse banks for underground mines need not be restricted to the area of reserves and thus more site selection opportunities are present.

The mining method can be altered by the provisions for increased bonds for mines that do undesirable mining practices or decrease bonds for operators who do extraordinary reclamation work. In this way operators can be given incentive for carrying reclamation practices beyond what is mandated by the law. Operators can be induced to decrease the size of rocks permitted in the surface material, to do extra soil testing, to limit the final high wall, or to do many other environmentally beneficial tasks.

The operator himself may be affected by the bonding scheme. The bond rate increments for the size of mine and for tonnage produced per company will help to discourage operators and mines that are too small to do good reclamation. Unfortunately, bond increments for new and inexperienced firms will impede their entry into the coal markets.

(7) Land Values and Reclamation

An important aspect seldom considered is the value or use of the land before mining. If the premining use of the land was farmland, there is a greater loss from mining than if the land were scrub forest. Figure 43 shows the relative land values of different watersheds before mining according to land uses as provided by the Interior Dept. in 1976 on page 207. It is evident that the values of land and the distribution of land uses vary from region to region quite drastically. The unusually high land value for the Tug Fork watershed indicates the relative scarcity of flat, usable land. Over 90% of this region has steep slopes in excess of 25% (map reference on page 40) and is essentially unusable mountain forest land. Also, approximately 60% of its production comes from slopes between 20°-30° (reference 9 p. IV-130).

To lose an acre of cropland in the Tug Fork region is 7.5 times the loss in the Allegheny watershed. Land uses that are more valuable then should be protected by higher bonds that reflect the value of the asset. If one were to insure a diamond ring worth $10,000 he would insure it for at least its replacement cost. The minimum bond then should reflect the value of the land.

LAND USE →	CROPLAND		PASTURE		FOREST		URBAN		OTHER
WATERSHED ↓	%	VALUE $/ACRE	%	VALUE $/ACRE	%	VALUE $/ACRE	%	VALUE $/ACRE	%
ALLEGHENY	21	400	5	250	58	100	6	13000	8
BIG MUDDY	32	675	18	305	29	125	3	17770	18
MONONGAHELA	6	425	20	470	62	250	4	6250	8
MUSKINGUM	21	655	23	230	47	125	5	9850	5
TUG FORK	2	3000	2	800	91	100	1	26000	4

FIG. 43 PREMINING LAND VALUES

78-59

An operator can increase the land value by changing its use. The Interior Dept. 1976 study, (figure 44), also listed values of reclaimed lands taken from tax assessors records and other sources.

	FOREST $/ACRE	PASTURE $/ACRE	CROPLAND $/ACRE
ALLEGHANY	80	150	250
BIG MUDDY	100	180	340
MONONGAHELA	100	280	370
MUSKINGGUM	100	150	325
TUG FORK	90	500	1500

FIG. 44 POSTMINING LAND VALUES

78-59

If a Tug Fork operator mined forest land and reclaimed it to pasture, a net increase in value would be 500-100 = 400. Such performance could be influenced by giving the operator an incentive of lower bond rates or faster release for such combinations.

In summary, the bond rate structure should be graduated to reflect the cost of reclamation, the risk inherent to each operator, and the premining value of the land. To do this, features such as seam thickness, thickness of overburden, acid-forming potential, and others are used to indirectly predict the cost of mining. The risk of default for each operator is measured by his reclamation record, number of years of experience and size operation. The land value and prior and future land uses are also important.

(8) Implementation of the Graduated Bonding System

Having selected pertinent mining and site specific variables to reflect the cost of reclamation, choosing operator characteristics to reflect the risk of default and choosing types of performance to be fostered or penalized, a bond rate schedule can be organized.

Figure 45 is an algorithm for a graduated bond system. Square or rectangular boxes represent statements or operations. Hexagonal boxes are decision boxes that direct the flow. Arrows show the direction of flow. Figure 46 gives an example operation and uses the algorithm presented above to derive the bond rate and the total bond. This is meant only as an example. Each regulatory authority would have to select these parameters that most affect operations within their state.

The bond rate algorithm begins by reading the data for a particular mine site. In this case, the data required is the total number of acres permitted by the permittee on all permits the year before and the total number of notices of non-compliance he received for all permits over the prior year. The number of years the operator has been operating within the state is necessary as well as his prior years' annual production from all operations. The number of acres in the proposed permitted area, the maximum slope of the premining topography and the average seam thickness is needed. Finally, the height of the maximum expected highwall, the prior land use, and the value of the land before mining must be known.

Next, the program sets the bond rate and the total bond amount equal to zero to begin the computation.

Item A of the Bond Rate Algorithm relates the past history of the operator in performing reclamation. If an operator averages more than 8 notices of non-compliance per 100 acres permitted for any year, the algorithm will deny him any further permits. If the operator has less than eight notices of non-compliance per 100 acres, his bond rate is incremented $500/acre times his average number of notices of non-compliance per 100 acres.

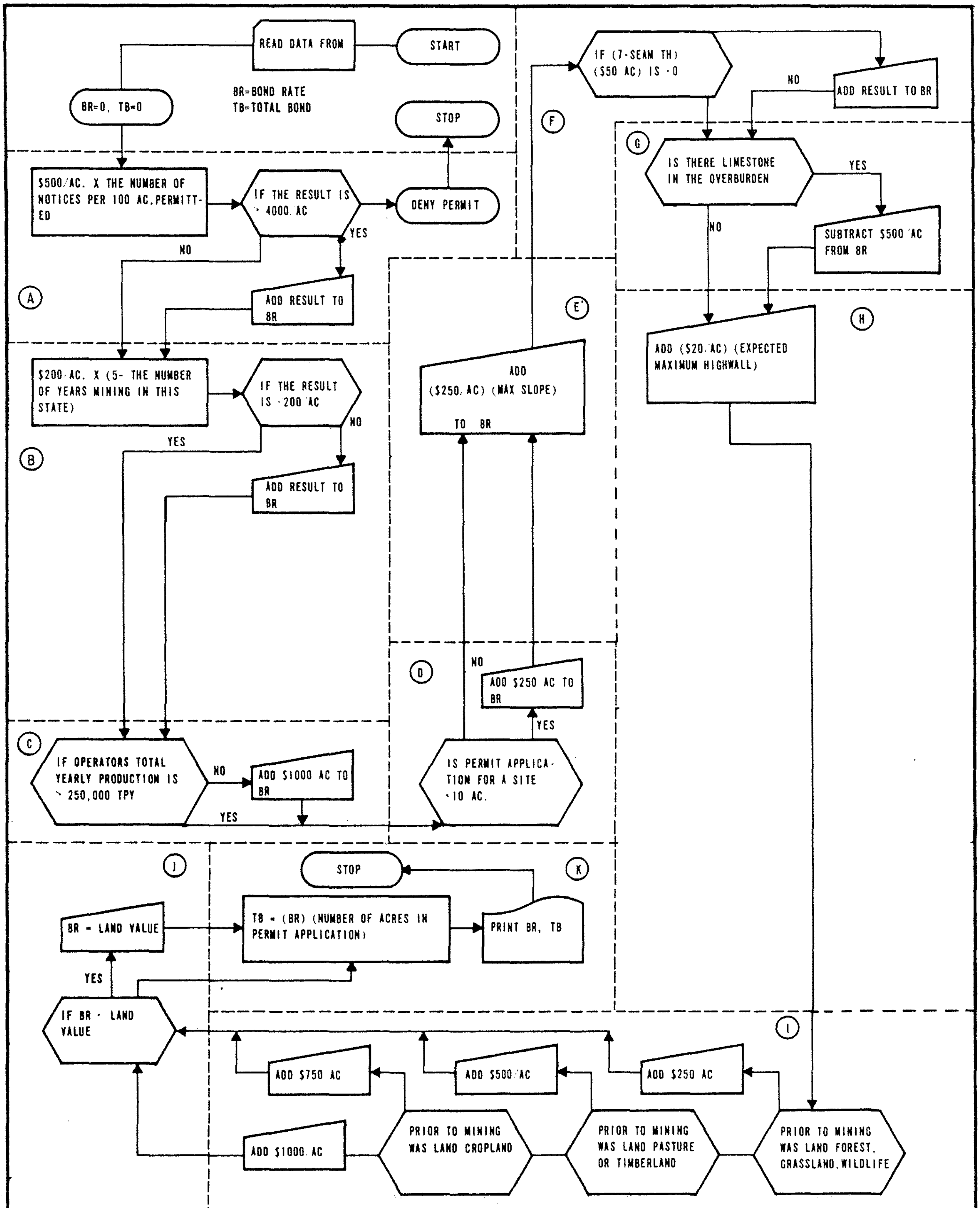


FIG. 45 BOND RATE ALGORITHM

78-59

Item B relates the years of mining experience the operator has, and Item C, the operator's size to the bond rate. In the former, the operator is assessed \$200/acre for each year under five years experience he has had. Item C increments an operator's bond by \$1,000/acre if his total yearly production from all instate mines is less than 250,000 tpy.

Item D increments the bond rate of \$250/acre if the permit area proposed is less than 10 acres. Item E adds \$250/acre to the bond rate for every 5^{o} slope in the maximum slope of the premine contour of the site. Item F allots for seam thickness and Item G to the presence of limestone in the overburden. Item H increments the bond rate of \$20/acre for every foot in height of the expected maximum highwall.

Item I assigns various bond rate increments depending upon the premining land use. Item J compares the calculated bond rate to the premining land value and selects the greater. Item K multiplies the selected bond rate by the number of acres to be permitted to yield the total bond.

Figure 46 gives an example using the algorithm for a mine site with 50 acres to be permitted. The example operator has 8 notices of noncompliance on 200 total acres and 300,000 tpy the year prior. He has operated in the state for 10 years. The maximum premine slope is 15^{o}, with a 4' seam and a 60' expected maximum highwall. Limestone is present in the overburden, the land was previously timberland with a market value of \$1000/acre. The rate derived from these factors using the bond rate algorithm is \$3850/acre or \$192,500 for all 50 acres.

(9) <u>Administering a Graduated Bonding System</u>

To reduce the cost of bonding to the operator, bonds should not be required to be posted until the permit is approved but prior to when it is issued. This reduces the period over which the operator is obligated to pay premiums and bypasses the possibility of paying bond premiums for permit applications which are denied.

To be effective as a source of behavior modification, a graduated bonding system must be explicitly understood by the operator. Many states implicitly weigh factors of geology, topography, and mining when setting their bond rates but this procedure is not explicitly understood by the operator. The operator must understand that he can win a reduced bond rate by choosing sites

ITEM	INFORMATION REQUIRED	EXAMPLE	OPERATIONS	INCREMENTS (DOLLARS/ACRE)
A	TOTAL NUMBER ACREAS PERMITTED BY OPERATORS FOR PREVIOUS YEAR	200 ACRES	500X8/200	2000
	TOTAL NUMBER OF NOTICE OF NONCOMPLIANCE FOR OPERATOR FOR PREVIOUS YEAR	8 NOTICES	200X(5-10)<200	0
B	NUMBER OF YEARS EXPERIENCE OPERATING IN STATE	10 YRS	100X(5-10)<100	0
C	PRODUCTION FROM ALL OPERATIONS FOR PREVIOUS YEAR IN TPY.	300,000 TPY	50 > 10	0
D	NUMBER OF ACRES TO BE PERMITTED IN THIS APPLICATION	50 ACRES	NO	0
E	MAXIMUM SLOPE OF PERMIT AREA PRIOR TO MINING	15^0	250X(15/5)	750
F	SEAM THICKNESS IN FEET	4'	(7-4)50	150
G	PRESENCE OF LIMESTONE IN OVERBURDEN	LMST PRESENT	YES	-500
H	MAXIMUM EXPECTED HIGHWALL	60'	60 X 20	1200
I	FORMER LAND USE PRIOR TO MINING	TIMBERLAND	YES	250
J	PREMINE VALUE OF LAND	$1000/ACRE	NO	---
K	NUMBER OF ACRES TO BE PERMITTED ON THIS APPLICATION	50 AC	---	---

BOND RATE 2000+750+150-500+1200+250 $3850/ACRE

TOTAL BOND 3850 x 50 $192,500

FIG. 46 EXAMPLE OF USING BOND RATE ALGORITHM

78-59

with lower slope, having less overburden, and no acid-formation problem; or by using special mining techniques such as topsoiling. Operators should be cognizant of the fact that their past reclamation record counts. The Indiana method of having the operator fill out a Form-501-D makes the operator aware of how these 10 factors affect his bond rate. Pennsylvania sent out a memorandum (page 193) to all operators within the state outlining the bond rate scheduling criteria. Of these two methods of notification the Indiana method is best as it forces the operator to see the effect of each factor on his bond rate.

The criteria for bond release and the inspection techniques for the release are discussed in the prior two chapters. The next chapter concerns the time frame for bonding. It will discuss the types of recommended bond releases and the time frame for these releases.

In closing this discussion it is important to note the consequences of a poorly run bonding schedule. The July 12, 1978 Centre Daily Times reports that the Great American Coal Company operating in the anthracite fields of eastern Pennsylvania will default on $11.5 million dollars worth of reclamation work with only $946,000 in surety bonds. The State will have to make up the difference. The State continued to grant permits and allow low bond rates even in the face of continued poor reclamation by the subsidiaries of Great American. Under the proposed bonding system permits would be denied firms forfeiting bonds or having poor reclamation records. Bonds would be incremented to fit site specific, mining and operator characteristics so they would more closely approximate the cost of reclamation. Bonding practices can make a difference.

D. TIMING INTERVAL FOR BOND RELEASE

1. Objectives

The objective of this task is to evaluate and recommend an effective time frame for the bonding cycle. The time frame for bonding should vary according to the ultimate land use to which the reclaimed land is to be put to use. Various land uses will be considered here.

2. Approach

The results of the time interval analysis conducted in Phase I (See Section IV D) were utilized as a major input to the evaluation conducted in this task. In addition, a number of personal contacts made with regulatory personnel, mine operators, and developers were used to gain further insights into the problem of time intervals for bond release. Timing of bond release for a number of final land use categories were considered.

Land use categories defined in Section 715.13 of the interim regulations for the Office of Surface Mining are:

1) Heavy Industry
2) Light Industry
3) Public Services
4) Residential
5) Cropland
6) Rangeland
7) Hayland or pasture
8) Forest land
9) Impoundments of water
10) Fish and Wildlife habitat and recreation lands
11) Combined uses

This division is very good in terms of identifying land functions. However, it should be noted that in the past 5 years well over 90% of the lands that have been released from bond have gone into some type of revegetative land use. The majority of the reclaimed lands have been reclaimed into grassland or pastureland. The study team adopted the following land use categories to facilitate the discussion of the time frame for bonding.

Nonagricultural Nonintensive Uses: 1) Wildlife habitat 2) grassland 3) forest land

Agricultural Uses: 1) timberland 2) pastureland 3) extensive cropland 4) row crops

Intensive Uses 1) residential 2) industry 3) public service 4) parkland 5) urban

Multiple land uses

Impoundments have been excluded as a unique use since in most cases a water impoundment would occur in conjunction with another land use. Rangeland was excluded since the study only covers the Interior and Eastern Coal Provinces.

Each final land-use category was analyzed in light of the time interval required to determine successful reclamation. In addition, various mechanisms for speeding up the release of the coal operation from the responsibility and burden of reclamation bonds in the case of alternative land uses are addressed. The results of the analysis are discussed below.

3. Results

The results will be discussed in two parts. The first part will deal with a general time frame for bond release for all bonds while the second part will recommend time intervals for bond release for the different land use categories presented above.

a. General time frame for bond release

The time frame analysis presented in Phase I determined that most regulatory authorities and operators agree that a two-year period is needed to establish a sufficient vegetative cover. The State laws and regulations concerning bonding requirements are given on page 106.

The Federal interim regulations (46) do not contain any direct references to the bonding cycle but PL 95-87, the Surface Mining Control and Reclamation Act of 1977 (37), does spell out some guidelines for performance bonding and the release of the bond. The pertinent references are contained in sections 509, 515 (a)20, and 519. Figure 47 paraphrases the highlights of these sections.

Sections 515(a)20 and 519 set guidelines for the release of bonds. They allow up to 60% of the bond to be returned after grading approval and further release after the 90% (519(c)) vegetative cover criteria is met. However, sufficient bond must be retained to cover the cost of a third party to reestablish vegetation 5 years after the date of the last augmented seeding. (515(a)20). The reason for holding the bond an extra five years is to assure that vegetation is maintained.

This research group concurs with the three-phased bond release as proposed in PL 95-87 section 519(c). However, we propose that the 5-year extended liability begin not with the last augmented seeding but with the approval of the establishment of vegetative cover for the second phase of the bond release. In this way the operator is insuring the 90% cover for a period of five years and not just the seeding. By placing the time of record for the final release on the date of the last augmented seeding the operator has a disincentive to do such seeding since it would prolong his bond edge.

Provisions in Section 515(a) and (c) allow bond releases to be effected for a portion of a permitted area. The breaking down of a permit area into smaller groups to allow faster release of portions of a permit area can be used to reward operators with speedy reclamation. This tactic, however, places a burden on the regulatory authority by multiplying the number of inspections and paper work. The remaining unreclaimed portions, if they are small and scattered, could be lost in the paper work. Operators could request partial acreage release to improve their percent cover by excluding areas of poor revegetation success.

The study team proposes to allow the release of portions of a permitted area for grading release as long as the criteria for maintaining $10,000 minimum bond and a 2-acre minimum size is not violated. Areas released as a unit for grading purposes should be considered as indivisable for the vegetation and final release.

SEC. 509

(a)
- AFTER APPROVAL PERMIT
- BOND AREA TO BE MINED IN INITIAL TERM OF THE PERMIT
- AMOUNT TO DEPEND UPON RECLAMATION REQUIREMENTS, GEOLOGY, HYDROLOGY, TOPOGRAPHY, REVEGETATION POTENTIAL
- AMOUNT HIGH TO LET REGULATORY AGENCY COMPLETE RECLAMATION
- NOT LESS THAN $10,000 TOTAL BOND

(b)
- LIABILITY FOR DURATION OF MINING, RECLAMATION AND REVEGETATION
- EXECUTED BY OPERATOR & CORPORATE SURETY
- OR EXECUTED AS A COLLATERAL BOND
- ACCEPTABLE ITEMS

(c) SELF BONDING IF GOOD AND SOLVENT

(d) CASH AND SECURITIES

(e) BOND ADJUSTMENTS

SEC. 515. (a) 20.
- ASSUME RESPONSIBILITY FOR SUCESSFUL REVEGETATION FOR A PERIOD OF 5 FULL YEARS AFTER THE LAST YEAR OF AUGMENTED SEEDING, FERTILIZING, IRRIGATION.
- IF PRECIP IS $<$20 IN/YR THEN FOR 10 YRS.
- IF AGRICULTURE-INTENSIVE THEN COMMENCE 5 YEARS OF INITIAL PLANTING
- PROVISIONS OF 515 (a) 19 CAN BE WAIVED BY REG AUTHORITY PER INTENSIVE AGRICULTURE.

SEC. 519.

(a)
- PERMITTEE FILES FOR A REQUEST FOR RELEASE FOR ALL OR PART OF A PERMITTED AREA.
- W/I 30 DAY OF APPLICATION OP. MUST GIVE NOTICE IN NEWSPAPER
- ALSO INFORM ADJOINING LAND OWNERS, LOCAL GOVERNMENT PLANNING AGENCIES, SEWAGE & WATER CO

(b) REGULATORY AUTHORITY WILL (W/I 30 DAYS) CONDUCT INSPECTION AND EVALUATE WORK. MUST NOTIFY W/I 60 DAYS IF NO PUBLIC HEARINGS FROM (a) ABOVE, 30

(c) CAN RELEASE WHOLE OR PART
- UP TO 60% AFTER GRADING & DRAINAGE CONTROL
- AFTER ESTABLISHED VEGETATION (90% COVER)-HOLD ENOUGH FOR 3RD PARTY TO REESTABLISH.

CAN NOT TOTALLY RELEASE TILL AFTER 5 YEARS, OF LAST SUBSEQUENT SEEDING

(d) MUST NOTIFY OF REASONS FOR DISAPPROVAL AND RECOMMENDED CORRECTION SECTION

(e) REGULATORY AUTHORITY NOTIFY LOCAL GOVERNMENT 30 DAYS BEFORE RELEASE

(f) IF OBJECTED TO THEN HEARINGS

(g) W/O PREJUDIES

(h) CAN SUBPOENA, OATHS, COMPEL ATTENDENCE, MUST RECORD HEARING.

REFERENCES TO BONDING TIME INTERVAL IN PL95-87

78-59

In this way, portions of permitted area can be released to reward the speedy completion of the reclamation work but cannot be used to accomodate poor revegetation success.

Section 515(a)20 also reveals two incentives to preparing reclaimed lands for intensive agricultural use. It states that 1) the 5-year liability for vegetative cover begins at the initial planting-not at the last augmented seeding, and 2) that the regulatory authority can waive the requirements of section 515(a)19 of the act at its discretion for lands to be returned to intensive agriculture. The research group concurs with these efforts and cites them as an example of modifying operator decisions through economic incentives as presented in the previous chapter. However, these incentives should be weighed against the goals of the Department of Agriculture's price support programs such as the wheat and feed grains set aside program. It would seem futile and counter-productive to create new farmlands only to have the Department of Agriculture pay the owner not to cultivate them. For further discussion of the topic of policy implications see chapter IV-F.

In summary, the research group proposes a three-phased bond release: 1) after grading, 2) after establishing vegetation, and 3) final release. The projected time frame for bond release of a grassland type vegetative cover is:

1) grading release, up to 60%, when final grading is approved

2) vegetative cover release, a portion of the remaining bond such that enough bond is left for a third party to reestablish vegetation, two years after final grading.

3) final release, the remainder of the bond, five years after the release of the vegetative cover.

The proposed bond release time-frame would adequately insure that reclamation standards are met and maintained. The burden on operators is reduced by the three-phased release that would hold only that bond that is necessary to insure the remaining reclamation work.

b. Time frame for bond release for alternative land uses.

Alternative land uses are defined in section 515(a)2 of PL 95-87(37) and Section 715B of the regulations (46) as other "higher or better uses" of the land. In the past the occurrence of other uses has been very minimal. Operators have to reclaim land to the land use that allows the most rapid and easiest release from bond. The owner of the land may alter the land use after final release of the land but this does not fit the criteria here as the land use change occurs after the regulatory authority has relinquished control of the site.

(1) Magnitude of the Problem

In the 1976 Annual Report of the Illinois Division of Land Reclamation the Division(18) reported that between the years 1971 to 1976 81% of the land released from bond was reclaimed to pasture, 14% to cereal grains, and 4% of the released area was put to refuse disposal. The remaining 1% was for all other uses. From 1962-1971 the distribution was Cropland and Pasture - 44%, Pasture - Strike off 45.6%, Forest 6%, Recreational and Industrial 3% and Refuse .6%. Approved permits for 1976 listed the final land use as 90.5% Agriculture, 5.9% Forest, 2.8% Industrial, 0.7% Recreation and 0.1% Wildlife.

It is easy to see that grassland or pasture is the most common land use for Illinois strip lands. In the steep hills of Central Appalachia the land is usually brought to a grass cover with some agricultural and little industrial or recreational uses. James E. Rowe(29) listed several urban, agricultural, recreational and other special uses. However, Mr. Rowe considered many projects whose land use was changed after the termination of the bonding cycle. Even so, the number of strip mined areas converted to unique uses is limited.

(2) Federal Regulations

The Federal regulation of alternative land uses is contained in section 515(a)2 of PL 95-87 (37) and section 715.13 of the regulations (46). In essence the requirements an operator must satisfy to alter the land use are as follows:

1) proposed land use must be compatible to the adjacent land use
2) must show economic and engineering feasibility of the proposed land use.
3) provision must be made to provide necessary public services
4) good financial backing must be proven for the proposed use
5) the plan must be designed by a professional engineer
6) the proposed use cannot present hazard to public health or safety
7) the proposed use cannot entail an unreasonable delay in reclamation
8) must have approved measures to prevent or mitigate adverse effects on wildlife
9) if changing to a cropland use, or other use requiring maintenance, a) a written commitment to maintain must be secured, b) sufficient water must be available, and c) soils must be compatible
10) Public notice and hearings required[1]

The study team concurs with these requirements but wishes to recommend exceptions to the bond release cycle to reduce the cost of bonding to the operator and facilitate the selection of higher land uses for reclaimed strip mined lands.

(3) Alternative Land Uses and Bonding Time Intervals

This task will recommend exceptions to the general bond release time interval presented above. Each land use group will be discussed. Approximately 98% of all reclaimed land has been reclaimed to some type of revegetated land use such as Nonagricultural Nonintensive uses and Agricultural uses. Figure 48 presents a flow diagram for the major land use groups.

a) Nonagricultural Nonintensive Uses: This group includes such uses as grassland and forest land for which agricultural return is expected. In the Appalachian mountains this is the most common final land use. In these steeply sloped areas of sparse population no other land use is economically justifiable.

[1] 715.13 (d) 1-10/

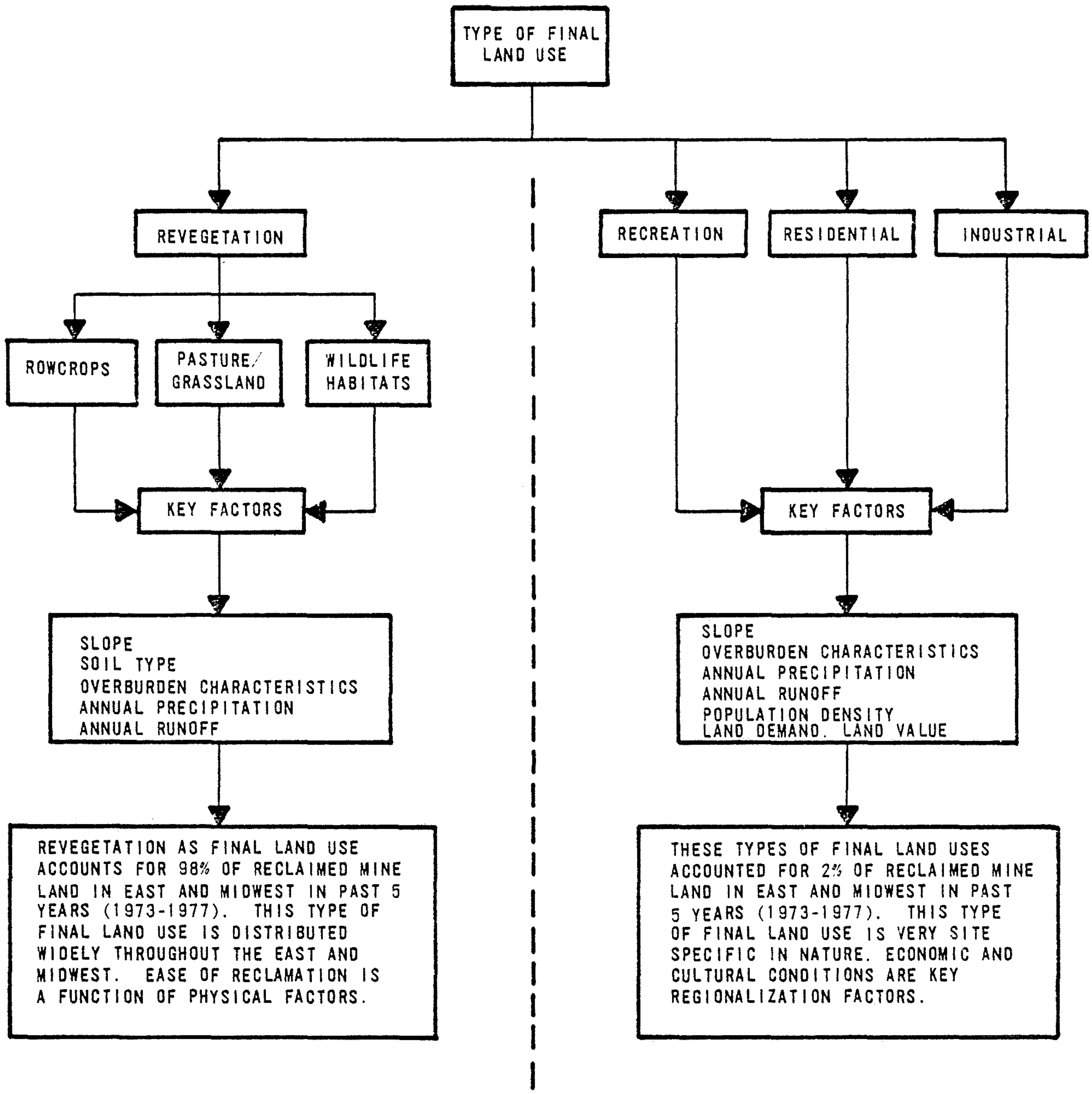


FIG. 48 CRITERIA FOR SELECTION OF POSSIBLE LAND USES

78-59

This class also includes wildlife and nonintensive recreational lands such as hunting grounds and forestland. In many states the grass or forest-land discussed above is considered a wildlife land use where others require special species for planting. But today because urban and mining development places more and more pressure upon wildlife habitats, a more comprehensive and ecologically minded concept of wildlife plantings must be addressed in reclamation planning.

The bond release time interval recommended for these land uses is the same as the general bond release time interval presented above. Since these lands are essentially unused after reclamation there is no conflict between operator and owner-developer rights and responsibilities. No divergence from the general bond release time interval is necessary.

In order to provide an incentive for the coal operator to consider wildlife habitats as a potential final land use the following elements related to timing of bond release are recommended.

- Cooperation in planning the wildlife habitat should be provided by each county's SCS/ASCS office. The wildlife habitat plan to be included in the reclamation plan should be produced by the cooperating agency.
- Assistance should be provided by the cooperating agency in obtaining the proper plantings from state nurseries in order to establish the plantings as soon after regrading as possible.
- If the operator enters into a cooperative agreement to establish a wildlife habitat the plantings should be inspected by the cooperating agency 2 years after initial planting and if any replanting is required it should be done as soon as possible after notification. After the inspection and completion of remedial measures, the total remaining bond should be released. This timing would allow the operator to be completely released from bond 2 years after planting of the wildlife habitat.

(b) Agricultural Uses: In the Interior Coal Province and the Northern and Southern Appalachian coal fields significant acreages of agricultural lands have been mined to recover their mineral value. These lands if returned to an equal agricultural use are not alternative land uses since no change has taken place. Areas that were formerly uncultivated due to lack of access, steep slopes or poor soil could be reclaimed to agricultural use. This would be a net increase in land use and land value. It might be beneficial to reclaim such formerly unused lands to agricultural use. Section 515(a)20 of PL 95-87 provides incentives to reclaim land to intensive agricultural use by tying the 5-year final bond cycle to the initial planting and allowing the regulatory authority to waive the requirements of section 515(a)19 for lands reclaimed to intensive agricultural use. The study team concurs with the use of the bonding cycle to promote such higher land uses. The research group also recognizes the need to assure maintenance of such lands since they require more care than grass or forest-land. The erosion potential for agricultural uses such as row crops is much higher since the lands must be left bare for periods of the agricultural cycle.

Federal regulations 715.13(d)9 regulate the designation of intensive agriculture as an alternative use. The regulations require a written commitment to maintain the areas be presented by the operator or future owner/farmer. A conflict of rights and responsibilities between the operator and owner/farmer is created here that is not remedied by just a statement of commitment. Without a change of liability the operator is left with the liability for reclamation work and yet is at the mercy of the diligence of the owner/farmer.

The study team proposes that if an agricultural use is designated, the opportunity to transfer the bond obligation to the owner/farmer be permitted. Conflicts between landowner and operator were cited many times in the operator and regulatory agency interviews. In many cases the land owner will be impatient to get use of the land from the operator. Cases were mentioned where landowners would overgraze reclaimed lands preventing good vegetative cover from being established and preventing the operator from being able to get the area released from bond.

The study team proposes that the landowner be enjoined from use of the land over the two year period of vegetation reestablishment. If the landowner wishes use of the land over the five-year period of vegetation maintenance he should be made to be the insurer of the vegetative cover. To protect the landowner from being duped into assuming this responsibility against his wishes and welfare such a convenant should be contingent upon the approval of the regulatory agency. The landowner or prospective cultivator would post sufficient bond to allow a third party to reestablish the vegetation as provided in Section 519(c) of PL 95-87. The operators could therefore be released from any liability and his bond released. This type of provision for an outside party's use of the land is important for land being reclaimed to agricultural uses.

In summary land reclaimed to an agricultural land use should meet three prerequisites:

1) the land and soil and market conditions are compatible
2) there is a written and bonding commitment to maintain the land as agricultural land
3) conflicts between the rights and responsibilities of the landowners/farmers and operators should be remedied.

(c) Intensive landuses: Intensive land uses have the most stringent economic and cultural restrictions. For any residential or industrial use to be feasible, sufficient demand must be present to justify the facilities and the necessary public services must be present or provided for. The provisions of section 715.13(a)1-8 are mainly addressed to the problem of justifying and proving such alternative uses.

There has been very little actual industrial, residential, public services land use development in conjunction with the reclamation and bonding cycle. In most instances of urban industrial development after mining has been after the fact, after the area has been totally released from bond. However, there have been some residential areas, airports and refuse areas that have been planned as the final end use of the land during the mining-reclamation stages of an operation, prior to bond release. As stated before, in Illinois over the years 1971-1976, 4% of the reclaimed areas were reclaimed to refuse disposal.

The key factors concerning these land uses are the economic and engineering feasibility. If structures are intended to be built, the soil must be stable enough and strong enough to provide a good foundation. For any industrial or residential complex sufficient public services such as water, electric and roads must be present to make the proposed use viable. The demand for the goods or services to be provided by the proposed facilities must be strong enough to warrant the project. If these provisions are not realized the project will fail. These requirements essentially constitute a "prudent man" test. The engineering and economic factors must be such that a prudent man would accept the project.

This is not sufficient criteria to insure the success of such a project or that proper reclamation will be done and maintained. As provided in Section 715.13(a) all the necessary state, local and regional governments and planning authorities must be contacted for their approval prior to mining. Sufficient financial commitment must be assured. The engineering must be detailed to prevent the excavation and surface use of acid bearing spoil during excavation activity for the alternative land use.

The problem of conflicts between the rights and responsibilities of the operator and developer are present in these alternative land uses. The research group proposes that upon approval of such an alternative land use provision be made to relieve the operator of the liability for reclamation after the developer begins to assume control of the lands. This can be done by transferring the bond requirements to the developer and releasing the operators bond. These provisions do not absolve the developer of reclamation responsibilities should he decide to forego development. An alternative reclamation plan should be specified in advance in case of this eventuality.

Incentives promoting the intensive uses are thus provided. The operator can then gain release from bond much earlier. There is a great difficulty in preparing such a complicated three-party mining and reclamation plan for a permit application. For a potential developer such a project would merely add an extra layer of regulation and review. Although attractive to the mine operator the developer may not be as enthused with planning developments through the reclamation regulation authorities. There are, however, some economies a potential developer could realize through such a program. In areas where no access roads exist, mining activities create roads of access, roads a potential developer would have to build in the absence of prior mining activity. The mining and reclamation plan can be so designed as to reduce the developer's excavation costs. In areas such as central Appalachia where flat land for development is rare and expensive, surface mining activity may transform inaccessible steeply sloping mountainside to stable developable land.

The reclamation of mined lands for higher land uses such as residential, commerical and industrial development has long been an issue especially in the Appalachian Region where development land has been at a premium. There has been little incentive within the bonding cycle for the operator to consider such land uses especially within the reclamation cycle. In order to provide some incentives for the mine operator to consider higher land-uses, the following mechanisms are recommended to speed-up the operators release from bond obligation if higher land uses are proposed:

1. All approvals from planning authorities should be be submitted as part of the reclamation plan. In addition, the developer must state that he is prepared to begin site development within seven years after regrading. In addition the developer must present signed statements that he will accept the bond responsibility until final revegetation inspection is completed. If the developer plans to begin site development prior to the two-year period previously mentioned, he must be willing to take over the remaining bond obligation of the operator.

2. The operator could then be released from his bond obligation after the 24-month period between regrading and revegetation and the final revegetation inspection. If the developer plans to initiate development in the period between regrading and final release inspection, then the developer must take over the remaining bond obligation from the operation.

3. In order to fully implement such a procedure, one must allow for amended reclamation plans in the event 1) a developer agrees to proceed with development during mining or active reclamation, or 2) the developer defaults or withdraws his involvement.

(d) Multiple land uses: The trend today is toward multiple land use of resource areas. The scale of mining operations has increased such that larger and larger permit areas are required. Permit areas in some areas are already large enough to accommodate multiple land uses. The problems in this type of development are essentially the same as that for intensive-use land.

(e) Summary: In summary, the time interval for bond release can be used as an instrument to promote desired land uses. The bond cycle must be adjusted to remedy conflicts in the rights and responsibilities of the operator and the landowner. Sufficient assurances must be made for the financial commitment to follow through on proposed alternative land uses of reclaimed lands. The engineering and economic conditions of a mine site must be favorable for such an alternative land uses.

E. PHASE II CONCLUSIONS

1. Data relating to effluent quality and quantity over the period from regrading to final release is lacking. There are no effluent limitation guidelines to cover this period.

2. Standardized inspection techniques related to various bond release criteria have not been developed for surface coal mine situations. There is little uniformity in inspection or documentation of the success of reclamation.

3. Incentives for good reclamation are generally lacking at present. Systems such as the proposed graduated bonding system are needed to reward good reclamation and punish poor reclamation.

4. There is a conspicuous lack of statistically valid cost data relating to the cost of reclamation and the cost of regulatory programs.

5. The incentive for reclaiming land to alternative higher land uses during the bonding cycle are not strong enough to encourage this activity. The costs and risks the developer assumes by dealing through the reclamation authority outweigh the gain from incentives which generally accrue to the operator not the developer.

VI. RECOMMENDATIONS FOR FURTHER RESEARCH AND DEVELOPEMENT

During the course of this study it became apparent that there exists several areas that require further research and developement. Areas that need to be researched further include 1) costs of reclamation 2) water quality criteria related to reclamation and 3) criteria for selection of alternative land uses for reclaimed land. Developement of 1) a manual of reclamation inspection techniques 2) a manual for regulatory authorities 3) a manual for inspectors and 4) a manual for operators is suggested. Each of these topic areas is discussed below.

A. AREAS FOR FURTHER RESEARCH

1. Costs of Reclamation

The analysis of the impact of bonding and the bond release cycle on the operator was impaired by a general lack of knowledge of the variable costs of mining. The most important question has been, "Where does the active mining cease and reclamation begin in the new integrated surface coal mining systems?" It is essentially an accounting problem of which unit operation to assign reclamation expenses. Available data resulting from recent research on the costs of reclamation has shown a wide range of reclamation costs even within the same region. Each researcher has been at the mercy of the limited record keeping of mining establishments and has independently chosen what elements to include as reclamation costs.

The study team proposes that the Bureau devise a standard accounting procedure for the assignment of costs to mining and reclamation unit operations. Operators should then be taught to use the accounting procedures and reply to either voluntary Bureau questionnaires or mandatory reporting requirements should be promulgated .

In the graduated bonding system proposed previously, the regulatory authority will need accurate reclamation cost data to update its bond rate structure. Perhaps a state-run data collection program in conjunction with reclamation agencies using Bureau-derived cost accounting guidelines is preferable. This plan would also enable the costs of mining and reclamation for each permit open to be related to the site specific and mining characteristics of each site and to operator characteristics. Procedures would have to be developed to maintain confidentiality of company cost data.

The data base so derived would be an invaluable asset to operators, regulatory authorities and contract and academic researchers.

2. Water Criteria Related to Reclamation

The impact of water quality and quantity on-site and off-site is a key element in successful reclamation. Current effluent guidelines that are used for water monitoring during the reclamation process have been developed for active surface mining situations and may not necessarily apply to reclamation process. In order to arrive at definitive effluent guidelines for water criteria, a definitive study is recommended to research the actual water conditions at surface mining sites in the period from regrading to final release. Daily water samples for a period of time should be collected from a number of sites in the various coal regions that are in the regrading to release cycle. Consideration should be given to hourly samples during significant rainfall events. Such research should also include a detailed site characterization in order to correlate site conditions to observed water quality and quantity conditions. The recommended study would produce a data base of information from which analyses could be conducted in order to arrive at definitive effluent guidelines geared specifically toward surface mine reclamation conditions from regrade to release.

3. Criteria For Alternative Land Uses

There have been indications that criteria for alternative land uses such as wildlife habitats and residential developments have not been delineated in sufficient detail to allow an operator to fully understand the requirements of opting for alternative land uses in the reclamation process. Historically, the operator or land owner proposes to reclaim in the normal manner (grass and pasture) then proceeds after release of bond to develop the site in an alternative land use if he so desires. It is recommended that a definitive set of criteria for alternative land uses be developed. In addition, incentive mechanisms should be developed which would make alternative land uses attractive to the reclaimer within the actual reclamation activity.

B. DEVELOPMENT OF INSPECTION TECHNIQUES

1. Manual of Reclamation Inspection Techniques

Federal and State criteria have generally been promulgated without inspection techniques with which to conduct standardized inspections for bond release and reclamation success. Reference number 42 is a similar study developed by the Environmental Protection Agency for water quality testing. Such a manual should give instructions on inspection techniques for 1) sampling and testing mine spoil and topsoil, 2) slope mapping, 3) determination of percent cover, productivity and tree survival, 4) percent plant species determination and 5) inspection for erosion, plant vigor and surface rock size. The concepts and procedures for statistically valid sampling and size of sampling should be explained to allow for statistically valid testing that would be acceptable as evidence in court. The manual should stress proper report writing and data management for each inspection technique. A determination should be made of the person hours needed to perform the inspection techniques under different conditions and presented to aid the inspector in planning his schedule and in determining the impact of the methods on regulatory authorities. This would be a manual of techniques that can be used with different criteria and with flexibility to be adapted to fit site specific situations. The benefits of such a manual would be greater consistency and accuracy of inspection activity.

2. Manual for Regulatory Authorities

Interior's Office of Surface Mining (OSM) should develop a manual for state regulatory agencies to clarify the legal requirements and criteria that are required of PL 95-87 and OSM's rules and regulations. The manual should outline the lines of communication and technical support available from the Bureau of Mines, OSM and other Federal agencies. Sources of Federal grant moneys should be identified along with instructions for obtaining such funds. The most-needed topic to be covered is the establishment of a data management system that will best suit the administrative needs of the operator, the regulatory agency, OSM and the Bureau of Mines as well as other private and public users. Where federal law and regulations offer the regulatory agency flexibility in setting criteria, guidelines should be given on how to select criteria. The management and operation of a comprehensive inspection program that will meet federal enforcement and reporting requirements should be covered. The development and management of a graduated bonding system should be discussed. Regulatory techniques should be discussed and the distinction between cooperative management and advisory management stressed. The study team favors the use of cooperative management techniques. A format for Annual Reports and data collection should be standardized to allow easy comparisons. Finally, impact of the regulatory program on various national policies should be presented and policy priorities explained. The benefit of such a manual is the greater consistency in operation and management of regulatory activity, easier data retrieval and comparison, better run regulatory programs, more consistency with and sympathetic to national policy goals.

3. Manual for Inspectors

This manual would be supplemented to the Manual of Inspection Techniques discussed above. It is proposed that these manuals be prepared on a state-by-state basis. It should cover the legal requirements of the new Federal law and discuss in full the permitting and licensing requirements of the State program. Evaluating mining and reclamation plans for their effectiveness and ability to meet state criteria should be discussed. The manual should cover inspection techniques and inspection program management for routine inspections of active and inactive sites and bond release inspections. Vegetation standards, selection and diagnostics should be discussed. Reporting requirements and standards should be spelled out. Proper data management and accounting should be stressed. The inspector should be instructed how to deal with operators effectively and should know their power and their limitations. Procedures for handling violations and for violation follow-ups should be presented. The benefit of such a program would be a more consistent and equitable inspection of mined sites. The quality of inspection and the quality of reclamation would be enforced. The cost of reclamation and inspection might also be reduced.

4. Manual for Operators

The most neglected agent in the regulatory scheme has been the operator. In many cases we have found the operator to be ignorant of the workings of the regulatory agency and the regulations. In many cases the operator's negative feelings toward inspectors stems from a misconception of the purpose and usefulness of various requirements. As with the inspector's manual, it is suggested the operator's manual be prepared state by state. An operator's manual should be developed that not only tells the operator what the requirements are, but the "Why?" or rationale. The manual should describe the permitting and licensing requirements for each state and outline how to prepare mining and reclamation plans. Soil tests and water tests should be discussed, their requirements, sampling and use. Reclamation bonds should be discussed and reporting requirements listed. Of prime importance is the explanation of the inspector, his role, responsibilities and an explanation of the rights and responsibilities of the operator. The benefit of this manual would be to promote better reclamation, more consistent with federal regulations and a better understanding and cooperation between the operator and the inspector. The technical manual for the operator should also be published covering topics of erosion control, vegetation, and water testing and sampling.

The manual of inspection techniques and the manual for regulatory authorities could be done in a national scope by a single agency or contractor. The inspector's manual and operator's manual should be done on a state-by-state basis to allow each manual to reflect each state's laws and regulations and site regional factors such as slope, topography, etc. Funding for the state manuals could be allowed under section 705 of PL 95-87.

C. RECLAMATION DATA CENTER

The final recommendation is for the establishment of an Interagency Reclamation Data Center to accomodate data from various state and federal agencies concerning surface mining, its effects on the environment and its regulation. Information about the number of permits, acres mined, coal produced, seams mined, violations given, bonds forfeited, costs of mining, acres reclaimed and other pertinent information could be centralized. Standardized data forms could be used that would facilitate key punching to access the data to a computer file. The benefit of such a program would be to allow centralized data retrieval and storage of important reclamation information. The interagency cooperation required for this undertaking is mandated in Sections 307 and 413 of PL 95-87. The idea of a control data bank for surface mining information is expressed in Section 307 of PL 95-87.

D. FIELD VERIFICATION OF FEDERAL REGULATIONS

It is recommended that a complete field verification by on-site analyses and interviews with operations and inspector be initiated 12 months after final federal regulations are promulgated. The results of such a study could be used to compare bonding, bond release, and reclamation success under these regulations. Recommended changes to the regulatory structure should be made to adjust problem areas that may be revealed.

APPENDIX A

GLOSSARY OF TERMS

Bond Amount--The total amount of bond assessed for a permit area. Equal to the product of the bond rate and the number of acres in the permit.

Bonding Cycle--The sequence of events of permit application, bond submittal, mining, reclamation, inspection and release.

Bond Forfeiture--An action taken by the operator in recognition of the fact and his intention to not complete the required reclamation work. Commonly a result of bankruptcy of the operator who finds he is financially unable to complete his obligation. He forfeits all collateral posted as bond or his corporate surety must reimburse the state sufficient funds.

Bond Rate--The per acre amount of liability assessed the operator for each acre in a permit area.

Bond Release--Release from obligation upon completion and approval of reclamation work of monies set aside for surety of performance. Bond release usually occurs in stages, (1) after approval of grading (2) after establishment of vegetation and/or (3) after final approval of reclamation.

Box Cut--The initial cut driven in a property, where no open side exists; resulting in a highwall on both sides of the cut.

Chlorosis--A yellowing of plant tissue due to failure of chlorophyll synthesis or chlorophyll destruction.

Coal Bearing Sequence--A geographically discrete succession of major rock units containing coal deposits that were deposited under related environmental conditions.

Colloidal Material--Organic or inorganic matter having very small particle size and a correspondingly large surface area per unit of mass.

Cover Crop--A close-growing crop grown primarily for the purpose of protecting against erosion and improving soil nutrients.

Cut-and-Fill Terrace--An embankment (or combination of an embankment and channel) constructed across an uneven slope to control erosion by diverting or storing surface runoff instead of permitting it to flow uninterrupted with increasing velocity down the slope; whereby the process of construction is by excavating high areas (cut)and moving this material to low areas (fill), resulting in a low-velocity flow terrace.

Diversion Ditch--A ditch constructed to intercept surface water and channel this water to a specified point. Generally used to control water and erosion.

Fill Structure--Earthen structure devised to hold the excess spoil as a result of swell factor.

Final Cut or Pit--The last excavation on a property or mine site.

Final or Finish Grading--The last shaping or grading of the spoil surface before replacement of topsoil.

Final Land Use--The land use for which the permit area is to be reclaimed and used after mining. Same as ultimate land use.

Final Release--Release of all or the remainder of the bond after approval of the completed reclamation work. Ends all obligation of the operator.

Freeboard--The vertical distance from the pool level in an impoundment or sediment pond to the bottom of the emergency spillway.

FWPCA--Federal Water Pollution Control Administration.

Grading Bond Release--Release of a portion of the bond after approval of the final grading of the spoil and topsoil. Is a partial release from obligation for the operator.

Graduated Bonding System--A system to set bond rates according to site specific physical and economic factors, mining factors and operator characteristics. They are designed to approximate the costs of reclamation for a mine site and the risk of default associated with the individual operator. Better than fixed rate bond systems because they offer more flexibility over diverse mining conditions.

Gully Erosion--The erosion process whereby water accumulates in narrow channels and, over short periods, removes the soil from this narrow area to considerable depths, ranging from 1 to 2 feet to as much as 75 to 100 feet.

Herbarium--A collection of dried plants classified, mounted, and used for comparison to living specimens.

Impoundment--A reservoir for the collection of water. In surface mining the term describes a reservoir that is used to trap trailings or sediment.

Leachant--Liquid that has percolated through a soil and that contains substances in solution or suspension.

Line Transect--A vegetation analysis technique by which percent cover, plant frequency, and plant density are determined from observations of plants bisected by a line.

Notice of Noncompliance--An official notice of noncompliance with reclamation standards or specifications of the reclamation plan issued by the inspection or regulatory authority to the operator. A specified period for remedy is given in which to correct the problem. Fines can be assessed with each notice.

Percent Cover--The percentage of the area of the ground surface covered or shaded by vegetation.

Permit--Grant of permission to mine a specific mine site granted by the regulatory agency upon approval of the mining and reclamation plans and upon submittal of sufficient surety bond or posting of collateral as surety of performance.

Permit Area--The area to be covered by the mining permit. Includes all areas disturbed for mining, overburden placement, haulroads, and support facilities.

Plant Varieties--Subdivision of plant species; plants of the same species which differ in phenotypic expression.

Recoverable Strippable Reserves--The recoverable strippable resource adjusted to conform to the stripping ratio, which varies by area. Coal that cannot be mined because of proximity of natural or man made features is also excluded. The recoverable strippable resource is the total original coal resource under a specified maximum depth of overburden and reduced by depletion computed from past strip and auger mining operation multiplied by a mining recovery factor. The recovery factor is the proportion of the resource that is technically capable of being produced, usually expressed as a percent.

Rill Erosion--An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently cultivated soils.

Safety Factor--The quotient of the resisting forces divided by the sliding forces on a slope. A safety factor greater than one implies the slope is stable, a factor of less than one indicates the slope will fail.

Scarified--To create small depressions in spoil surface before spreading topsoil over the area. The small depressions aid water retention, erosion control and topsoil slippage.

SCS--Soil Conservation Service of the U.S. Department of Agriculture.

Sediment Pond--A pond that is used to trap sediment that is carried in runoff from the surface mined site.

Spot Check--An inspection technique which is not used to quantify a particular characteristic of an entire site, but rather a qualitative estimate of that characteristic.

Standpipe--A vertical pipe used to maintain a normal pool level in an impoundment. It is also termed a riser.

Swell Factor--The quotient of the volume of a particular weight of broken material (broken rock) divided, the volume of that weight of material unbroken.

Tracking In--A procedure generally applied to steep slopes whereby bulldozers or cleated equipment move perpendicular to the contour for the purpose of stabilization of topsoil.

Vegetation Bond Release--Release of a portion of the bond after approval of the established vegetation but before final release. Is a partial release of obligation for the operator.

Water Bars--Any generally earthen, constructed structure, in or opon a haul or access road for the purpose of channeling or deverting the flow of water off the road.

APPENDIX B

STATE SURFACE MINING AND RECLAMATION AGENCIES

State	Agency	Commercial Telephone No.
Alabama	Alabama Surface Mining Commission c/o Department of Industrial Relations Montgomery, Alabama 36104	205/221-4130
Arkansas	Pollution Control Board 8001 National Drive Little Rock, Arkansas 72001	501/371-1701
Illinois	Department of Mines and Minerals Springfield, Illinois 62706	217/782-4970
Indiana	Department of Natural Resources Division of Reclamation 613 State Office Bldg. 100 N. Senate Avenue Indianapolis, Indiana 46204	317/633-6217
Iowa	Department of Soil Conservation Mines and Minerals Division Grimes State Office Building Des Moines, Iowa 50309	515/281-5774
Kansas	Mineral Resources Section State Geological Survey University of Kansas Lawrence, Kansas 66044	913/864-4991
Kentucky	Department of Natural Resources and Environmental Protection Division of Reclamation Frankfort, Kentucky 40601	502/564-2141
Maryland	Geological Survey - Bureau of Mines Westernport, Maryland 21562	301/359-3057
Missouri	Department of Natural Resources Land Reclamation Commission P.O. Box 1368 Jefferson City, Missouri 65101	314/751-3241

STATE SURFACE MINING AND RECLAMATION AGENCIES - Continued

State	Agency	Commercial Telephone No.
Ohio	Department of Natural Resources Division of Reclamation Fountain Square Columbus, Ohio 43224	614/466-4850
Oklahoma	Department of Mines 252 Capital Building Oklahoma City, Oklahoma 73105	405/521-3859
Pennsylvania	Department of Environmental Resources Bureau of Land Protection and Reclamation Division of Mine Reclamation Fulton Bldg. 7th Floor P.O. 2063 Harrisburg, Pennsylvania 17120	717/787-5103
Tennessee	Department of Conservation Division of Surface Mining 2611 West End Avenue Nashville, Tennessee 37203	615/741-1046
Virginia	Division of Mined Land Reclamation Post Office Drawer U Big Stone Gap, Virginia 24219	703/523-2925
West Virginia	Department of Natural Resources Division of Reclamation Charleston, West Virginia 25305	304/348-3267

STATE CONSERVATION OFFICES

State	Address	Commercial Telephone No.
Alabama	Wright Building 138 South Gay Street P.O. Box 311 Auburn, Alabama 36830	205/887-8070
Arkansas	Federal Building, Room 5029 700 West Capitol Street P.O. Box 2323 Little Rock, Arkansas 72203	501/378-5445
Illinois	Federal Building 200 West Church Street P.O. Box 678 Champaign, Illinois 61820	217/356-3785
Indiana	Atkinson Square-West Suite 2200 5610 Crawfordsville Road Indianapolis, Indiana 46224	317/633-7201
Iowa	823 Federal Building 210 Walnut Street Des Moines, Iowa 50309	515/284-4260
Kansas	760 South Broadway P.O. Box 600 Salina, Kansas 67401	913/823-9535
Kentucky	333 Waller Avenue Lexington, Kentucky 40504	606/252-2312
Maryland	Room 522, Hartwick Building 4321 Harwick Road College Park, Maryland 20740	301/344-4180
Missouri	Parkade Plaza Shopping Center (Terrace Level) P.O. Box 459 Columbia, Missouri 65201	314/442-2271
Ohio	311 Old Federal Building Third and State Streets Columbus, Ohio 43215	614/469-6785

STATE CONSERVATION OFFICES - Continued

State	Address	Commercial Telephone No.
Oklahoma	Agriculture Building Farm Road and Brumley Street Stillwater, Oklahoma 74074	405/253-4204
Pennsylvania	Federal Building and Courthouse Box 985 Federal Square Station Harrisburg, Pennsylvania 17108	717/782-2297
Tennessee	561 U.S. Courthouse Nashville, Tennessee 37203	615/749-5471
Virginia	Federal Building, Room 7408 400 North 8th Street P.O. Box 10026 Richmond, Virginia 23240	804/782-2457
West Virginia	75 High Street P.O. Box 865 Morgantown, West Virginia 26505	304/599-7151

LOCATION OF STATE EXTENSION SERVICE DIRECTORS

State	Address	Commercial Telephone No.
Alabama	Auburn University Auburn, Alabama 36830	205/826-4444 or 821-1314
Arkansas	P.O. Box 391 Little Rock, Arkansas 72203	501/376-6301
Illinois	University of Illinois Urbana, Illinois 61801	217/333-2660
Indiana	Purdue University West Lafayette, Indiana 47907	317/749-2413
Iowa	Iowa State University Ames, Iowa 50010	515/294-4576
Kansas	Kansas State University Manhattan, Kansas 66506	913/532-5820
Kentucky	University of Kentucky Lexington, Kentucky 40506	606/257-4772 or 257-2833
Maryland	University of Maryland College Park, Maryland 20742	301/454-3742
Missouri	University of Missouri 309 University Hall Columbia, Missouri 65201	314/882-4561 or 882-4662
Ohio	Ohio State University 2120 Fyffe Road Columbus, Ohio 43210	614/422-6891 or 422-6181
Oklahoma	Oklahoma State University Stillwater, Oklahoma 74074	405/372-6211
Pennsylvania	The Pennsylvania State University University Park, Pennsylvania 16802	814/863-0331
Tennessee	University of Tennessee P.O. Box 1071 Knoxville, Tennessee 37901	615/974-7114
Virginia	Virginia Polytechnic Institute and State University Blacksburg, Virginia 24061	703/951-6705
West Virginia	West Virginia University 294 Coliseum Morgantown, West Virginia 26505	304/293-5691

APPENDIX C

REFERENCES TO PHASE I

References in this section are not intended to be a complete bibliography for the subjects of bonding, bond release and reclamation. These references were utilized during the described effort in this document. The references are listed under various categories for ease of location.

LEGISLATION, RULES & REGULATIONS (STATE)

Alabama

Alabama Surface Mining Act of 1969.

The Alabama Surface Mining Reclamation Act of 1975.

State of Alabama - Surface Mining Reclamation Commission - Rules of Practice and Procedures, Adopted September 30, 1977.

Alabama Surface Mining Reclamation Commission 1977 Rules and Regulations to be proposed for Public Comment.

State of Alabama, Surface Mining Reclamation Commission, Application for Surface Mining Permit.

State of Alabama, Surface Mining Reclamation Commission, Application for Coal Surface Mining License.

Arkansas

Arkansas Open Cut Land Reclamation Act (Act 236 of 1971).

Instructions for Implementation of the Open Cut Mining Law for Administrative Purposes, Arkansas Pollution Control Commission, Effective June 1, 1971.

Open Cut Land Reclamation Act (Act 336 of 1977).

An Act to Amend Section 12 of Act 336 of 1977 Relating to the Reclamation of Lands Disturbed by Open Cut Mining (Act 824 of 1977).

Illinois

Rules and Regulations Related to the Surface - Mined Conservation and Reclamation Act of 1971, Effective April 4, 1972.

Surface-Mined Land Conservation and Reclamation Act (PA78-1295), Effective July 1, 1975.

Rules and Regulations Related to the Surface-Mined Conservation and Reclamation Act, Effective March 18, 1976.

Indiana

Guidelines Respecting the Administration of An Act Regulating Surface Mining of Coal, Clay and Shale, (Chapter 344, Act of 1967, as Amended by Acts of 1974, Approved on March 21, 1974).

Guidelines Respecting the Administration of an Act Regulating Surface Mining of Coal, Clay and Shale, (Indiana Code 12-4-6, as Amended by Acts of 1977), Approved on August 31, 1977.

Iowa

Code of Iowa, Chapter 83A, 1975

Senate File 314, Relating to the Regulation of Coal Mining, Imposing Additional Fees and Providing a Penalty for Violation of the Act, Amends Chapter 83A of the Code of Iowa, Effective May 15, 1975.

Kansas

Mined-Land Conservation and Reclamation Act, July 1, 1-68, Authorized by Kansas Statutes Annotated-1969, Effective January 1, 1972.

Rules of Practice and Procedures of the Mined-Land Conservation and Reclamation Board of Kansas, Authorized by Kansas Statutes Annotated 1973, Amended January 1, 1975.

Kentucky

Kentucky Revised Statutes (KRS), Chapter 350, Strip Mining, 1974.

Kentucky Administrative Rules (KAR), Chapter 402, Surface Mine Regulations, Effective July 2, 1975.

Maryland

Natural Resources Strip Mine Law, Annotated Code of Maryland, Department of Natural Resources, Title 7, Subtitle 5, Strip Mining, 1974.

Bituminous Coal Strip Mine and Auger Mine Regulations, Promulgated by Maryland Bureau of Mines, 1974, with Amendments; June 17, 1975, June 15, 1976, August 15, 1976, October 1, 1976 and October 18, 1976.

Guidelines Manual For Surface Coal Mine Operators, August, 1975 Revision.

Missouri

Revised Statutes of Missouri, Chapter 444, Rights and Duties of Miners and Mine Owners, Reclamation of Mining Lands, January 1, 1972.

Ohio

Revised Code of Ohio, Chapter 1513, Strip Mining and Reclamation of Mined Land, April 10, 1972.

Ohio Strip Mine Rules, May 25, 1973.

Revised Code of Ohio, Chapter 1513, Strip Mining and Reclamation of Mined Land, Effective September 27, 1974.

Rules for Ohio Surface Mine Law, March 11, 1975.

Oklahoma

The Mining Lands Reclamation Act, June 12, 1971, Amended by House Bill No. 1590, April 7, 1972.

Pennsylvania

The Clean Streams Law of Pennsylvania, including Amendments of 1970.

Surface Mining and Reclamation Act, 1971 with Amendments to 1973.

Title 25, Rules and Regulations, Department of Environmental Resources, Chapter 77, Subchapter A, Planting following Open Pit Mining of Bituminous Coal, August 1971.

Tennessee

The Tennessee Surface Mining Law, March 23, 1972, with 1974 Amendments.

Regulations Pertaining to Surface Mining, June 17, 1974.

Regulations Pertaining to Surface Mining, December 12, 1975.

Virginia

Virginia Coal Surface Mining Regulations, July 1972.

Code of Virginia, Chapter 17 of Title 45.1 Surface Mining of Coal, as Amended 1974.

Proposed Revisions to the Coal Surface Mining Regulations, October 15, 1976.

Drainage and Sediment Control Handbook for Coal Surface Mining, October 15, 1976.

West Virginia

Code of West Virginia, Article 6 & 6A, Chapter 20, West Virginia Surface Mining and Reclamation Act, as Amended, Passed March 13, 1971.

West Virginia Surface Mining Reclamation Regulations, Department of Natural Resources, Chapter 20-6, Series VII, 1971.

State of West Virginia, Department of Natural Resources, Division of Reclamation, Code of Violations, April 1974.

LEGISLATION, RULES & REGULATIONS (FEDERAL)

Federal Register, Wednesday, September 7, 1977, Pages 44920-44957, Proposed Rules - Surface Mining Reclamation and Enforcement Provisions

Federal Register, Tuesday, December 13, 1977, Pages 62639-62716. Final Rules - Surface Mining Reclamation and Enforcement Provisions.

U.S., Congress, House, 1977. Surface Mining Control and Reclamation Act of 1977. H. Report 95-493 to Accompany H.R.2, 95th Congress, 1st session.

PROFESSIONAL PAPERS, INFORMATION CIRCULARS, BULLETINS

U.S. Geological Survey and U.S. Bureau of Mines, 1968. Mineral Resources of the Appalachian Region. U.S. Geological Survey Professional Paper 580.

U.S. Bureau of Mines, 1971. Strippable Reserves of Bituminous Coal and Lignite in the United States, U.S. Bureau of Mines Information Circular 8531.

U.S. Bureau of Mines, 1974. The Reserve Base of Bituminous Coal and Anthracite for Underground Mining in the Eastern United States. U.S. Bureau of Mines Information Circular 8655.

U.S. Bureau of Mines, 1975. The Reserve Base of U.S. Coals by Sulfur Content. U.S. Bureau of Mines Information Circular 8680.

U.S. Bureau of Mines, 1975. U.S. Bureau of Mines Information Circular 8693.

U.S. Bureau of Mines, 1975. Coal Surface Mining Reclamation Costs: Appalachian and Midwestern Coal Supply Districts. U.S. Bureau of Mines Information Circular 8695.

U.S. Bureau of Mines, 1977. Coal Surface Mining Reclamation Cost in the Western United States. U.S. Bureau of Mines Information Circular 8737.

Monthly

Coal Age, McGraw-Hill Inc., New York, New York.

Coal Mining and Processing, Maclean-Hunter Publishing Corp., Chicago, Ill.

Kentucky Coal Journal, Coal Operators & Associates, Pikeville, Kentucky.

Mining Engineering, Society of Mining Engineers of the AIME, Salt Lake City, Utah.

Quarterly

Green Lands Quarterly, West Virginia Surface Mining and Reclamation Association.

Annual Publications

Keystone Coal Industry Manual, Mining Informational Services, McGraw-Hill, 1977.

Keystone Coal Industry Manual, Mining Informational Services, McGraw-Hill, 1976.

Keystone Coal Industry Manual, Mining Informational Services, McGraw-Hill, 1975.

Calendar Year 1976 - 54th Annual Report - Maryland Bureau of Mines.

Calendar Year 1975 - 53rd Annual Report - Maryland Bureau of Mines.

Annual Report of the Office of Mines and Land Protection, Pennsylvania Department of Environmental Resources, 1976.

Annual Report of the Office of Mines and Land Protection, Pennsylvania Department of Environmental Resources, 1975.

1976 Annual Report, Surface-Mined Land Conservation and Reclamation, Illinois Department of Mines and Minerals.

1975 Annual Report, Surface-Mined Land Conservation and Reclamation, Illinois Department of Mines and Minerals.

OTHER REFERENCES

Brooks, David B., 1970. Analysis: Surface Mine Regulation. Coal Mining and Processing, V.7, N.3, Pages 38-51.

Data from National Weather Records Center, 1977. National Oceanic & Atmospheric Administration, Ashville, N.C.

Davies, W. E., and others, 1976. Map showing engineering aspects of Karst in the United States. Scale 1:75 million. U.S. Geological Survey Open File Map 76-623, U.S.G.S., Reston, Va.

Environment Regulation Handbook. Special Studies Division of Environment Information Center, Inc., New York, N.Y.

Hammond, E. H., 1964. Analysis of Properties in Land Form Geography. Annals of Association of American Geographers 53(1964):11-23.

Hammond, E. H., 1964. Classes of Land Surface Form in the 48 States, U.S.A. Annals of Association of American Geographers 54(1964), Map Supp. No. 4.

King, Philip B, and Helen M. Beikman, 1974. Geologic Map of the United States. Scale 1:250,000. U.S. Geological Survey, Reston, Va.

Reclamation Factors to Keep in Mind When Planning Surface Mine Operation, Coal Age, November, 1974.

Schenck, George K. Cost Estimation in the Evaluation of Mineral Ventures. Unpublished paper.

U.S.D.A., Soil Conservation Service

- Soil Classification, A Comprehensive System
  7th Approximation, 1960

- Supplement, 1967

- National Cooperative Soil Survey Classification, 1967

APPENDIX D

REFERENCES TO PHASE II

1. Appalachian Regional Commission, 1969. Acid Mine Drainage in Appalachia, Impact of Mine Drainage on Recreation and Stream Ecology Appendix F. Washington, D. C.

2. Argonne National Laboratory, 1974. Surface Mined Land in the Midwest. A Regional Persepctive for Reclamation Planning. Argonne, IL.

3. Berg, W. A., 1969. Determining pH of Strip Mine Spoils: U.S. Dept. of Agriculture, Forest Service, Northeast Forest Experimental Station. Research Note NE-98, 7 pp.

4. Berg, W. A., and Vogel, W. G., 1973. Toxicity of Acid Coal-Mine Spoils To Plants, in Hutnik, R. J. and Davis George (eds), Ecology and Reclamation of Devasted Land, vol. 1: Gordon and Breach, New York, pp. 57-68.

5. Branson, B. A. and Batch, D. L., 1974. Additional Observation on the Effects of Strip Mining on Small-Stream Fishes in East Central Kentucky: Transactions of the Kentucky Academy of Science, Vol. 35, (3-4) p. 81-83.

6. Centre Daily Times, July 12, 1978. 3400 E. College Ave., State College, PA.

7. Cook, C. W. and Bonham, C. D., 1977. Techniques for Vegetation Measurements and Analysis for a Pre- and Post-Mining Inventory: Colorado State University, Range Science Department, Science Series No. 28, 93 pp.

8. Curtis, W. R., 1971. Vegetating Strip-Mine Spoils for Runoff and Erosion Control, in Proceedings Revegetation and Economic Use of Surface-Mined Land and Mine Refuse Symposium. Dec. 2-4, 1971, Pipestem State Park, W. VA, p. 40-41.

9. Energy and Environmental Analysis, Inc., 1977. Benefit/Cost Analysis of Laws and Regulations Affecting Coal. Office of Minerals Policy and Research, U.S. Department of Interior, Washington, D. C.

10. Environmental and Natural Resources Policy Division, Congressional Research Service, 1977. Environmental Challenges of the President's Energy Plan, Implication for Research and Development. Subcommittee Congres, First Session, October 1977, p. 25.

11. Environment Reporter, V. 9 N. 1, May 5, 1978, and Vo. 9 N. J, June 2, 1978.

12. Grandt, Alten F., 1978. Mined-Land Reclamation in the Interior Coal Province, in Journal of Soil and Water Conservation. March-April 1978.

39. United States Congress, 95th Congress, 1975. Federal Surface Mining Control Act of 1977. Washington, D. C.

40. U.S. Environmental Protection Agency, 1973. EPA Testing Regulations. 40 CRF, 136FR, Oct. 16, 1973.

41. U.S. Environmental Protection Agency, 1977. Coal Mining Point Source Category-Effluent Limitation Guidelines for Existing Sources: Federal Register, Vol. 42, No. 80, pp. 21380-21390.

42. U.S. Environmental Protection Agency, 1974. Manual of Methods for Chemical Analysis of Water and Wastes. Environmental Monitoring and Support Laboratory Environmental Research Center, Cincinnati, OH, 298 pp.

43. U.S. Environmental Protection Agency, 1976. Handbook for sampling and Sample Preservation of Water and Wastewater. Environmental Monitoring and Support Laboratory, Environmental Research Center, Cincinnati, OH, 258 pp.

44. U.S. Office of Surface Mining Regulations and Enforcement. Surface Mining Reclamation and Enforcement Provisions. Federal Register: Vol. 42, No. 239, Dec. 13, 1977, p. 62685.

Rules and Regulations Related to the Surface-Mined Conservation and Reclamation Act, Effective March 18, 1976.

Indiana

Guidelines Respecting the Administration of An Act Regulating Surface Mining of Coal, Clay and Shale, (Chapter 344, Act of 1967, as Amended by Acts of 1974, Approved on March 21, 1974).

Guidelines Respecting the Administration of an Act Regulating Surface Mining of Coal, Clay and Shale, (Indiana Code 12-4-6, as Amended by Acts of 1977), Approved on August 31, 1977.

Iowa

Code of Iowa, Chapter 83A, 1975

Senate File 314, Relating to the Regulation of Coal Mining, Imposing Additional Fees and Providing a Penalty for Violation of the Act, Amends Chapter 83A of the Code of Iowa, Effective May 15, 1975.

Kansas

Mined-Land Conservation and Reclamation Act, July 1, 1-68, Authorized by Kansas Statutes Annotated-1969, Effective January 1, 1972.

Rules of Practice and Procedures of the Mined-Land Conservation and Reclamation Board of Kansas, Authorized by Kansas Statutes Annotated 1973, Amended January 1, 1975.

Kentucky

Kentucky Revised Statutes (KRS), Chapter 350, Strip Mining, 1974.

Kentucky Administrative Rules (KAR), Chapter 402, Surface Mine Regulations, Effective July 2, 1975.

Maryland

Natural Resources Strip Mine Law, Annotated Code of Maryland, Department of Natural Resources, Title 7, Subtitle 5, Strip Mining, 1974.

Bituminous Coal Strip Mine and Auger Mine Regulations, Promulgated by Maryland Bureau of Mines, 1974, with Amendments; June 17, 1975, June 15, 1976, August 15, 1976, October 1, 1976 and October 18, 1976.

Guidelines Manual For Surface Coal Mine Operators, August, 1975 Revision.

Missouri

Revised Statutes of Missouri, Chapter 444, Rights and Duties of Miners and Mine Owners, Reclamation of Mining Lands, January 1, 1972.

Ohio

Revised Code of Ohio, Chapter 1513, Strip Mining and Reclamation of Mined Land, April 10, 1972.

Ohio Strip Mine Rules, May 25, 1973.

Revised Code of Ohio, Chapter 1513, Strip Mining and Reclamation of Mined Land, Effective September 27, 1974.

Rules for Ohio Surface Mine Law, March 11, 1975.

Oklahoma

The Mining Lands Reclamation Act, June 12, 1971, Amended by House Bill No. 1590, April 7, 1972.

Pennsylvania

The Clean Streams Law of Pennsylvania, including Amendments of 1970.

Surface Mining and Reclamation Act, 1971 with Amendments to 1973.

Title 25, Rules and Regulations, Department of Environmental Resources, Chapter 77, Subchapter A, Planting following Open Pit Mining of Bituminous Coal, August 1971.

Tennessee

The Tennessee Surface Mining Law, March 23, 1972, with 1974 Amendments.

Regulations Pertaining to Surface Mining, June 17, 1974.

Regulations Pertaining to Surface Mining, December 12, 1975.

Virginia

Virginia Coal Surface Mining Regulations, July 1972.

Code of Virginia, Chapter 17 of Title 45.1 Surface Mining of Coal, as Amended 1974.

Proposed Revisions to the Coal Surface Mining Regulations, October 15, 1976.

Drainage and Sediment Control Handbook for Coal Surface Mining, October 15, 1976.

West Virginia

Code of West Virginia, Article 6 & 6A, Chapter 20, West Virginia Surface Mining and Reclamation Act, as Amended, Passed March 13, 1971.

West Virginia Surface Mining Reclamation Regulations, Department of Natural Resources, Chapter 20-6, Series VII, 1971.

State of West Virginia, Department of Natural Resources, Division of Reclamation, Code of Violations, April 1974.

LEGISLATION, RULES & REGULATIONS (FEDERAL)

Federal Register, Wednesday, September 7, 1977, Pages 44920-44957, Proposed Rules - Surface Mining Reclamation and Enforcement Provisions

Federal Register, Tuesday, December 13, 1977, Pages 62639-62716. Final Rules - Surface Mining Reclamation and Enforcement Provisions.

U.S., Congress, House, 1977. Surface Mining Control and Reclamation Act of 1977. H. Report 95-493 to Accompany H.R.2, 95th Congress, 1st session.

PROFESSIONAL PAPERS, INFORMATION CIRCULARS, BULLETINS

U.S. Geological Survey and U.S. Bureau of Mines, 1968. Mineral Resources of the Appalachian Region. U.S. Geological Survey Professional Paper 580.

U.S. Bureau of Mines, 1971. Strippable Reserves of Bituminous Coal and Lignite in the United States, U.S. Bureau of Mines Information Circular 8531.

U.S. Bureau of Mines, 1974. The Reserve Base of Bituminous Coal and Anthracite for Underground Mining in the Eastern United States. U.S. Bureau of Mines Information Circular 8655.

U.S. Bureau of Mines, 1975. The Reserve Base of U.S. Coals by Sulfur Content. U.S. Bureau of Mines Information Circular 8680.

U.S. Bureau of Mines, 1975. U.S. Bureau of Mines Information Circular 8693.

U.S. Bureau of Mines, 1975. Coal Surface Mining Reclamation Costs: Appalachian and Midwestern Coal Supply Districts. U.S. Bureau of Mines Information Circular 8695.

U.S. Bureau of Mines, 1977. Coal Surface Mining Reclamation Cost in the Western United States. U.S. Bureau of Mines Information Circular 8737.

U.S. Geological Survey, 1976. A Guide to State Programs for the Reclamation of Surface Mined Areas. U.S. Geological Survey Circular 731.

U.S. Bureau of Mines, 1975. Bituminous Coal and Lignite, A Chapter from Mineral Facts and Problems, 1975 Edition. U.S. Bureau of Mines Bulletin 667.

U.S. Geological Survey, 1975, Coal Resources of the United States, January 1, 1974. U.S. Geological Survey Bulletin 1412.

REPORTS

Argonne National Laboratory, 1974. Surface Mined Land in the Midwest: A Regional Perspective for Reclamation Planning.

Dames & Moore, 1976. Development of Pre-Mining and Reclamation Plan Rationale for Surface Coal Mines. The Rationale for Data Acquisition, Vol. I, 125 pages. Methods of Data Acquisition, Vol. II, 136 pages. Legal Controls of Surface Mining, Vol. III, 194 pages.

Despard, Thomas L., 1974. Avoid Problem Spoils Through Overburden Analysis. USDA Forest Service General Technical Report NE-10. Northeastern Forest Experiment Station, Upper Darby, Pa.

Doyle, John C., Jr., 1977. State Strip Mining Laws: An Inventory and Analysis of Key Statutory Provisons in 28 Coal-Producing States. 104 pages.

Environmental Protection Agency, 1974. Environmental Protection in Surface Mining of Coal. Environmental Protection Technology Series, EPA 670/2-74-093, Natural Environmental Resources Center, Office of R&D, U.S.E.P.A, Cincinnati, Ohio

Grandt, A.F., and A.L. Lang, 1958. Reclaiming Illinois Strip Coal Land with Legumes and Grasses. Bulletin 628, University of Illinois, Agricultural Experiment Station, Urbana, Ill.

Hittman Assoicates, 1976. Erosion and Sediment Control; Surface Mining in the Eastern U.S., Vol I- Planning. Environmental Protection Agency, EPA Technology Transfer Seminar Publication, EPA-625/3-76-006, Contract No. 68-03-2213.

Hittman Associates, 1976. Erosion and Sediment Control; Surface Mining in the Eastern U.S., Vol. II-Design. Environmental Protection Agency, EPA Technology Transfer Seminar Publications, EPA-625/3-76-006, Contract No. 68-03-2213.

ICF, Inc., 1976. The National Coal Model Description and Documentation. Federal Energy Administration, PB-263334, Contract No. CO-05-50198-00.

Mathematica, Inc., 1976. Evaluation of Current Surface Coal Mining Overburden Handling Techniques and Reclamation Practices. U.S. Bureau of Mines, Contract No. S0144081.

NUS Corporation, 1977. Coal Mining Cost Modules - Surface Mines, Volume II. Electric Power Research Institute, EPRI EA-437, Project 435-1.

Plass, William T., and Willis G. Vogel, 1973. Chemical Properties and Particle Size Distribution of 39 Surface-Mine Spoils in Southern West Virginia. USDA Forest Service Research Paper NE-276. Northeastern Forest Experiment Station. Upper Darby, Pa.

Plass, William T., and Willis G. Vogel. 1974. Revegetation Research in the Eastern Kentucky Coalfields. Field Manual, Task Five, Research and Demonstration of Improved Surface Mining Techniques for the Eastern Kentucky Coalfields. USDA Forest Service, Northeastern Forest Experiment Station, Berea, Ky.

Smith, Richard M., and others, 1976. Extensive Overburden Potentials for Soil and Water Quality. U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio.

State of Ohio, 1974. Land Reborn. For Board on Unreclaimed Strip-Mined Lands and Department of Natural Resources, 91 pages.

U.S. Department of Interior, 1966. Surface Mining and Our Environment.

U.S. Government Printing Office, 1973. Coal Surface Mining and Reclamation; An Environmental and Economic Assessment of Alternatives, pages 91-829.

U.S. Government Printing Office, 1973. Factors Affecting the Use of Coal in Present and Future Energy Markets. Congressional Research Service, pages 93-293.

U.S. Government Printing Office, 1973. Regulation of Surface Mining, Parts I & II. Hearings on Regulation of Surface Mining, pages 96-352.

University of Maryland, 1972. Legal Problems of Coal Mine Reclamation. A Study in Maryland, Ohio, Pennsylvania, and West Virginia.

University of Tennessee, 1973. Strip Mining and the Three E's, Appalachian Resources Project Publication #19.

University of Tennessee, 1974. Bonding Requirements for the Surface Mining of Coal. Appalachian Resources Project Publication #25, 13 pages.

University of Tennessee, 1974. Benefits and Costs of Surface Coal Mine Reclamation in Appalachia. Appalachian Resources Project Publication #27, 7 pages.

University of Tennessee, 1974. A Progress Report on NSF/RANN Funded Research Related to Environmental and Economic Aspects of Coal Production. Appalachian Resources Project Publication #29.

West Virginia University, 1974. The Potential of Coal Based Fuel and Energy Complexes; a Regional Appraisal.

University of Tennessee, 1975. The Regional Economic Impact of a Ban on High Slope Coal Surface Mining. Appalachian Resources Project Publication #34.

University of Tennessee, 1976. Economic Impacts of Surface Mine Reclamation. Appalachian Resources Project Publication #40.

University of Tennessee, 1976. Environmental Aspects of Coal Production in the Appalachian Region. Appalachian Resources Project Publication #44.

University of Tennessee, 1976. The Economic Impact of Back to Contour Reclamation of Surface Coal Mines in Appalachia: The TVA Massengale Mountain Project. Appalachian Resources Project Publication #50, 107 pages.

University of Tennessee, 1977. Economic and Environmental Impacts of Back to Contour Reclamation of Surface Coal Mines in Central Appalachia. Appalachian Resources Project Publication #51, 11 pages.

University of Tennessee, 1977. Environmental Aspects of Coal Production in the Appalachian Region. Appalachian Resources Project Publication #52.

Virginia Polytechnic Institute and State University, 1974. Impact of Higher Ecological Costs on Surface Mining. U.S. Bureau of Mines, PB-240441, Contract No. G0133102.

West Virginia University, 1976. Extensive Overburden Potentials for Soil and Water Quality. Environmental Protection Technical Series, EPA 600/2-76-184, Research Lab of R & D, U.S.E.P.A., Cincinnati, Ohio.

PERIODICALS

Weekly

Coal Week, McGraw-Hill, Inc., Washington, D.C.

Energy Users Report, The Bureau of National Affairs, Washington, D.C.

Environment Reporter, The Bureau of National Affairs, Washington, D. C.

Monthly

Coal Age, McGraw-Hill Inc., New York, New York.

Coal Mining and Processing, Maclean-Hunter Publishing Corp., Chicago, Ill.

Kentucky Coal Journal, Coal Operators & Associates, Pikeville, Kentucky.

Mining Engineering, Society of Mining Engineers of the AIME, Salt Lake City, Utah.

Quarterly

Green Lands Quarterly, West Virginia Surface Mining and Reclamation Association.

Annual Publications

Keystone Coal Industry Manual, Mining Informational Services, McGraw-Hill, 1977.

Keystone Coal Industry Manual, Mining Informational Services, McGraw-Hill, 1976.

Keystone Coal Industry Manual, Mining Informational Services, McGraw-Hill, 1975.

Calendar Year 1976 - 54th Annual Report - Maryland Bureau of Mines.

Calendar Year 1975 - 53rd Annual Report - Maryland Bureau of Mines.

Annual Report of the Office of Mines and Land Protection, Pennsylvania Department of Environmental Resources, 1976.

Annual Report of the Office of Mines and Land Protection, Pennsylvania Department of Environmental Resources, 1975.

1976 Annual Report, Surface-Mined Land Conservation and Reclamation, Illinois Department of Mines and Minerals.

1975 Annual Report, Surface-Mined Land Conservation and Reclamation, Illinois Department of Mines and Minerals.

OTHER REFERENCES

Brooks, David B., 1970. Analysis: Surface Mine Regulation. Coal Mining and Processing, V.7, N.3, Pages 38-51.

Data from National Weather Records Center, 1977. National Oceanic & Atmospheric Administration, Ashville, N.C.

Davies, W. E., and others, 1976. Map showing engineering aspects of Karst in the United States. Scale 1:75 million. U.S. Geological Survey Open File Map 76-623, U.S.G.S., Reston, Va.

Environment Regulation Handbook. Special Studies Division of Environment Information Center, Inc., New York, N.Y.

Hammond, E. H., 1964. Analysis of Properties in Land Form Geography. Annals of Association of American Geographers 53(1964):11-23.

Hammond, E. H., 1964. Classes of Land Surface Form in the 48 States, U.S.A. Annals of Association of American Geographers 54(1964), Map Supp. No. 4.

King, Philip B, and Helen M. Beikman, 1974. Geologic Map of the United States. Scale 1:250,000. U.S. Geological Survey, Reston, Va.

Reclamation Factors to Keep in Mind When Planning Surface Mine Operation, Coal Age, November, 1974.

Schenck, George K. Cost Estimation in the Evaluation of Mineral Ventures. Unpublished paper.

U.S.D.A., Soil Conservation Service

- Soil Classification, A Comprehensive System 7th Approximation, 1960

- Supplement, 1967

- National Cooperative Soil Survey Classification, 1967

APPENDIX D

REFERENCES TO PHASE II

1. Appalachian Regional Commission, 1969. Acid Mine Drainage in Appalachia, Impact of Mine Drainage on Recreation and Stream Ecology Appendix F. Washington, D. C.

2. Argonne National Laboratory, 1974. Surface Mined Land in the Midwest. A Regional Persepctive for Reclamation Planning. Argonne, IL.

3. Berg, W. A., 1969. Determining pH of Strip Mine Spoils: U.S. Dept. of Agriculture, Forest Service, Northeast Forest Experimental Station. Research Note NE-98, 7 pp.

4. Berg, W. A., and Vogel, W. G., 1973. Toxicity of Acid Coal-Mine Spoils To Plants, in Hutnik, R. J. and Davis George (eds), Ecology and Reclamation of Devasted Land, vol. 1: Gordon and Breach, New York, pp. 57-68.

5. Branson, B. A. and Batch, D. L., 1974. Additional Observation on the Effects of Strip Mining on Small-Stream Fishes in East Central Kentucky: Transactions of the Kentucky Academy of Science, Vol. 35, (3-4) p. 81-83.

6. Centre Daily Times, July 12, 1978. 3400 E. College Ave., State College, PA.

7. Cook, C. W. and Bonham, C. D., 1977. Techniques for Vegetation Measurements and Analysis for a Pre- and Post-Mining Inventory: Colorado State University, Range Science Department, Science Series No. 28, 93 pp.

8. Curtis, W. R., 1971. Vegetating Strip-Mine Spoils for Runoff and Erosion Control, in Proceedings Revegetation and Economic Use of Surface-Mined Land and Mine Refuse Symposium. Dec. 2-4, 1971, Pipestem State Park, W. VA, p. 40-41.

9. Energy and Environmental Analysis, Inc., 1977. Benefit/Cost Analysis of Laws and Regulations Affecting Coal. Office of Minerals Policy and Research, U.S. Department of Interior, Washington, D. C.

10. Environmental and Natural Resources Policy Division, Congressional Research Service, 1977. Environmental Challenges of the President's Energy Plan, Implication for Research and Development. Subcommittee Congres, First Session, October 1977, p. 25.

11. Environment Reporter, V. 9 N. 1, May 5, 1978, and Vo. 9 N. J, June 2, 1978.

12. Grandt, Alten F., 1978. Mined-Land Reclamation in the Interior Coal Province, in Journal of Soil and Water Conservation. March-April 1978.

13. Grim, Elmore C. and Hill, Ronald D., 1974. Environmental Protection in Surface Mining of Coal. Office of Research and Development, U.S. EPA, Cincinnati, OH.

14. Highway Research Board, 1967. Classification, Safety Factor, and Bearing. National Academy of Sciences, National Academy of Engineering, Washington, D. C.

15. Hill, R. D., Methods for Controlling Pollutants. Industrial Environmental Research Laboratory, U.S. EPA, Cincinnati, OH.

16. Illinois Department of Mines and Minerals, 1976. 1976 Annual Report Surface-Mined Land Conservation and Reclamation. prepared by Division of Land Reclamation of the Illinois Department of Mines and Minerals, Springfield, IL.

17. Kathruia, D. V., Nawrocki, M. A. and B. C. Becker, 1976. Effectiveness of Surface Mine Sedimentation Ponds. Prepared by Hittman Associates, Inc., for U.S. Environmental Protection Agency, August 1976, 100 pp.

18. L. Robert Kimball, Consulting Engineers, 1976. Debris Basins for Control of Surface Mine Sedimentation. U.S. Environmental Protection Agency, Cincinnati, OH.

19. Leonard, Joseph W. and David R. Mitchell, 1968. Coal Preparation. The American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., New York, NY.

20. Marston, R. B., 1952. Ground Cover Requirements for Summer Storm Runoff Control on Aspen Sites in Northern Utah. Journal of Forestry, 50:303-307.

21. Meevwig, R. O., 1965. Effects of Seeding and Grazing on Infiltration Capacity and Soil Stability of a Subapline Range in Central Utah. Journal of Range Management, Vol. 18:173-180.

22. Mills, Thomas R. and Michael Clar., 1976. Erosion and Sediment Control-Surface Mining in Eastern U.S. prepared by Hittman Associates for U.S. Environmental Protection Agency, Cincinnati, OH.

23. National Academy of Sciences and National Academy of Engineering. Water Quality Criteria 1972. Washington, D. C., 1972.

24. Packer, P. E., 1951. An Approach to Watershed Protection Criteria. Journal of Forestry, 49:639-644.

25. Phillips, E. A., 1959. Methods of Vegetation Study. Henry Holt and Company, Inc. 107 pp.

26. Plass, W. T., 1971. Highwalls - An Environmental Nightmare: Proceedings of the Revegetation and Economic Use of Surface Mined Land and Mine Refuse Symposium. Pipestem State Park, W. VA.

27. Plass, W. T., 1978. Reclamation of Coal-Mined Land in Appalachia. Journal of Soil and Water Conservation, March-April 1978.

28. Powell, James L., Barnhisel, Richard; Akin, W.; and M. Wayne Ebelhar, 1977. The State-of-the-Art of Reclaiming Surface Mined Land in the Western Kentucky Coal Field. Fifth Symposium on Surface Mining and Reclamation. NCA/BCR Coal Conference, Louisville, KY.

29. Rowe, James F., 1973. An Inventory of Unique Land Uses for Reclaimed Strip Mined Land in the Appalachias. Appalachian Regional Project Publication No. 33, Appalachian Regional Project, University of Tennessee, Knoxville, Tennessee, pp.

30. Sartz, R. S., 1969. Folklore and Bromides in Watershed Management. Journal of Forestry, Vol. 67:366-371.

31. Schroeden, W. L., 1975. Soils in Construction. John Wiley & Sons, N.Y., NY.

32. Scherard, James L., Woodward Richard J.; Gizienski, Stanley F.; and W. A. Dlevenger, 1963. Earth and Earth Rock Dams-Engineering Problems of Design and Construction. John Wiley & Sons, N.Y., NY.

33. Shelly and Loy Engineers and Consultants, Inc., 1976. Development of Interior Final Effluent Limitation Guidelines and New Source Performance Standards for the Coal Mining Point Source Category: U.S. Environmental Protection Agency, Washington, D. C., 288 pp.

34. Shelly and Loy Engineers and Consultants, Inc., and Penn Environmental Consultants, Inc., 1973, Processes, Procedures and Methods to Control Pollution from Mining Activities: U.S. Environmental Protection Agency, Washington, D. C.

35. Smith, R. L., 1974. Ecology and Field Biology. Second Edition, Harper and Row, Publishers, Inc., New York, NY, 850 pp.

36. Sobek, A. A., Schuller, W. A., Freeman, J. R., and Smith, R. M., 1978. Field and Laboratory Methods Applicable to Overburden and Minesoils: prepared by the West Virginia University in cooperation with the West Virginia Geological and Economic Survey for the Industrial Environmental Research Laboratory, U.S. Environmental Protection Agency, Rept. No. EPA-600/2-78-054.

37. State of Illinois, Dept. of Mines and Minerals, 1975. Surface Mined Land Conservation and Reclamation Act. (PA 78-1295) Rule 1202, Para. (b).

38. Treshaw, M., 1970. Environment and Plant Response. McGraw-Hill Book Company, New York, NY, 422 pp.

39. United States Congress, 95th Congress, 1975. Federal Surface Mining Control Act of 1977. Washington, D. C.

40. U.S. Environmental Protection Agency, 1973. EPA Testing Regulations. 40 CRF, 136FR, Oct. 16, 1973.

41. U.S. Environmental Protection Agency, 1977. Coal Mining Point Source Category-Effluent Limitation Guidelines for Existing Sources: Federal Register, Vol. 42, No. 80, pp. 21380-21390.

42. U.S. Environmental Protection Agency, 1974. Manual of Methods for Chemical Analysis of Water and Wastes. Environmental Monitoring and Support Laboratory Environmental Research Center, Cincinnati, OH, 298 pp.

43. U.S. Environmental Protection Agency, 1976. Handbook for sampling and Sample Preservation of Water and Wastewater. Environmental Monitoring and Support Laboratory, Environmental Research Center, Cincinnati, OH, 258 pp.

44. U.S. Office of Surface Mining Regulations and Enforcement. Surface Mining Reclamation and Enforcement Provisions. Federal Register: Vol. 42, No. 239, Dec. 13, 1977, p. 62685.