Annotated Bibliography on the Ecology and Reclamation of Drastically Disturbed Areas

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The Author

MIROSLAW M. CZAPOWSKYJ, a native of Ukraine and a United States citizen since 1957, received a Diplomforstwirt degree from Ludwig-Maximilians University, Munich, Germany, in 1949. He obtained an M.S. degree in forestry from the University of Maine in 1958 and a Ph.D. degree in soils from Rutgers University in 1962. He joined the Northeastern Forest Experiment Station in 1961 as a research forester and was assigned to the strip-mine reclamation project at Kingston, Pa., for 11 years. In 1973 he was transferred to the Station's project in culture of northeastern conifers with emphasis on spruce and fir, at Orono, Maine.

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ABSTRACT

This bibliography contains 591 annotated references to literature, mainly on mining effects and reclamation in the coal regions of the United States. Each reference is indexed by area, material (coal, ore waste, etc.), and general subject.

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by
Miroslaw M. Czapowskyj

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INTRODUCTION

THE UNITED STATES of America is fortunate in having a wealth of both renewable and nonrenewable natural resources. The latter — coal, metal ores, kaolin clay, phosphate, gravel and sand, and many others—are being mined continuously.

Surface-mining is the most common and perhaps the oldest, safest, and most economical method of recovering the commodity. But it drastically disturbs the land surface, spoils the landscape, and creates serious environmental problems.

Although estimates vary, available sources indicate that there are nearly 4 million acres of disturbed lands in the United States. In many Eastern States these disturbed areas are a significant component of the landscape. Because these lands contribute to an overall degradation of the environment, they have become a matter of great concern to many people and to government agencies at various levels.

While there has been substantial growth and expansion in the mining industry, the urgency of land reclamation has been recognized. Reclamation laws have been passed by State and local governments, and the surface-mining industry has faced up to the problems of disturbed-land reclamation.

However, in contrast to the technological advances in the recover and processing of natural resources, reclamation of drastically disturbed areas for diversified land use has not kept pace.

Attempts to rehabilitate surface-mined lands are not unknown to the strip-mining industry. Published reports on these efforts can be traced back to the turn of this century. Small-scale tree plantings and the establishment of other vegetation were the first attempts to correct the situation. The results were variable and erratic, and it was recognized that organized research was essential to land reclamation. Consequently, many universities, experiment stations, and Federal, State, and industrial institutions have initiated research programs designed to approach the many problems and to seek practical solutions to them. As a result, vast acreages of disturbed land have been turned into usable areas, and some have become community assets.

The activity in rehabilitation research of drastically disturbed lands has developed rapidly, yielding a voluminous literature. Several bibliographies, listing references on restoration of disturbed lands and associated problems in coal mining, have been compiled. Limstrom *(1953)* listed 135 references; Funk *(1962)* revised and expanded Limstrom's bibliography and listed 172 citations; Kieffer *(1972)* listed 700 citations, including M.S. and Ph.D. theses, mimeographed reports, and newspaper articles; and Munn *(1973)* compiled more than 600 references. A few bibliographies have appeared as appendices to printed reports. Other people have compiled listings dealing mainly with European work.

Special mention should be made of Mine Drainage Abstracts *(1964-73)* a bibliography published by Bituminous Coal Research Inc., of Monroeville, Pa., and supplemented annually. It contains lists and abstracts of literature dealing with mine-drainage research.

All these bibliographies are valuable sources of reference. However, with the exception of the bibliography on mine drainage and Munn's bibliography, none of them were annotated or systematically indexed. In addition, the supply of some of them is exhausted, and others are limited to narrow fields. Information is scattered in numerous professional and scientific publications, many of which are not readily available.

This bibliography grew from the need for an up-to-date compilation of the important research literature dealing with the ecology of lands disturbed by surface mining.

Both basic and applied research findings, as well as reports on economic and political considerations pertaining to the problems, are included. The bibliography lists 591 references to publications by university, government, and industrial researchers. However, the major emphasis has been placed on research publications illustrating the accomplishments and the progress leading to improvement of the environment by minimizing erosion, alleviating air and water pollution, and improving the esthetics of affected areas.

Prime attention has been directed to work accomplished in the coal regions of the Inited States. Publications dealing with ther than coal commodities or dealing with reas outside the United States have been ncluded, provided they are relevant.

ARRANGEMENT

This bibliography is presented in alphaetical order, by authors. Each reference ontains an annotation — the essence of the ublication.

For the convenience of those using this bliography, each reference is followed by group of key words and symbols. These present three codes: to (1) area, (2) aterial, and (3) subject.

For example, **U. S.-PA : coal-B : VI-B** eans that this reference deals with land sturbance in the United States, in Pennsylnia : the commodity is coal, bituminous : d the subject matter is reclamation, regetation.

The codes follow:

Area

UNITED STATES

U.S.	United States
AL	Alabama
AZ	Arizona
CA	California
CO	Colorado
DE	Delaware
FL	Florida
GA	Georgia
HI	Hawaii
ID	Idaho
IL	Illinois
IN	Indiana
IA	Iowa
KS	Kansas
KY	Kentucky
ME	Maine
MD	Maryland
MI	Michigan
MS	Mississippi
MO	Missouri
MT	Montana
NV	Nevada
NM	New Mexico
ND	North Dakota
OH	Ohio
OK	Oklahoma
PA	Pennsylvania
TN	Tennessee
TX	Texas
UT	Utah
VA	Virginia
WV	West Virginia
WY	Wyoming

CANADA

Canada

AB	Alberta
BC	British Columbia
NB	New Brunswick
ON	Ontario

(Note: other countries are spelled out.)

Material

Coal:
- A Anthracite
- B Bituminous
- L Lignite
- R Breaker refuse

Kaolin clay
Phosphates
Ore waste
Sand and gravel
Bauxite
Fuel ash
Other

Subject

I. GEOLOGY AND PHYSIOGRAPHY
- A. Coal reserves and seam nomenclature
- B. Surveys

II. MINING OPERATIONS
- A. Equipment
- B. Methods
- C. Spoil placement
- D. Roads

III. SPOIL CHARACTERISTICS
- A. Classification and survey
- B. Chemistry, acidity, toxicity, minerology, and fertility
- C. Physics and mechanics
- D. Microbiology

IV. HYDROLOGY
- A. Infiltration
- B. Surface runoff
- C. Subsurface flow
- D. Streamflow
- E. Erosion and sedimentation
- F. Geochemistry
- G. Biology
- H. Impoundments

V. ENVIRONMENT
- A. Air pollution
- B. Water pollution
- C. Landslides

VI. RECLAMATION
- A. Land treatment
- B. Revegetation

VII. LAND USES FOR RECLAIMED AREAS
- A. Esthetics
- B. Watershed protection
- C. Agriculture
- D. Forests
- E. Wildlife habitat
- F. Recreation
- G. Fish habitat

VIII. MISCELLANEOUS
- A. Political considerations
- B. Economic considerations
- C. Research programs
- D. Symposium proceedings
- E. Bibliographies

LITERATURE REFERENCES

1. Adams, L. M., J. P. Capp, and E. Eisentrout.
1971. **Reclamation of acidic coal-mine spoil with fly ash.** U.S. Dep. Inter. Bur. Mines Rep. Invest. 7504. 29 p., illus.

The spoils were treated with fly ash and were planted with a variety of grasses, legumes, trees, and shrubs. Greatest promise for growth was shown by Ky-31 fescue, rye, red top grasses, and birdsfoot trefoil, a legume. Survival of trees and shrubs was negligible. Addition of fly ash increased spoil pH to a range tolerable to plant growth and improved the physical characteristics of the spoil.

U.S.-WV : coal-B : VI-B

2. Adams, L. M., J. P. Capp, and D. W. Gillmore.
1972. **Coal mine spoil and refuse bank reclamation with powerplant fly ash.** Compost Sci. 13 (6) : 20-26.

Reclamation of coal-mine spoil and mine refuse with powerplant fly ash produced the following benefits: partial neutralization of acid spoil materials and increased moisture-holding capacity and pore space. A quick cover of certain grasses and legumes reduced erosion and stream-pollution potentials. The forage yields were comparable with yields from undisturbed areas.

U.S.-WV, PA : coal-B : VI-B

3. Agnew, Allen F., and Don M. Corbett.
1973. **Hydrology of a watershed containing flood-control reservoirs and coal surface-mining activity, Southwestern Indiana.** *In* Ecology and Reclamation of Devastated Land vol. 1: 159-173. Gordon and Breach Sci. Publ., New York.

Studies in Indiana showed that surface mining for coal can provide additional supplies groundwater, aid in flood control, and alter e water quality. Proper management of eases of water by the mining process can nedy the problem of acid mine drainage.

S.-IN : coal-B : IV

. Aguar, Charles E.
1971. **Mining and reclamation as related to state, regional and national land use plans, goals and requirements.** Rehabil. Drastically Disturbed Surf. Mined Lands Symp. Proc.: 11-14. Ga. Surface Mined Land Use Board. Macon.

ıe author discusses the national, state and gional reclamation use plans, goals, and quirements. He reports ". . . presently ere are few clear cut, State, Regional or ıtional Land Use Plans, Goals and Requireents to which mining and reclamation *can* late."

S.-GA : other : VIII-A

. Aharrah, Ernest C., and Richard T. Hartman.
1973. **Survival and growth of red pine on coal spoil and undisturbed soil in western Pennsylvania.** *In* Ecology and Reclamation of Devastated Land vol. 1: 429-444. Gordon and Breach Sci. Publ., New York.

omparisons were made of 20-year-old red ne (*Pinus resinosa* Ait.) plantations growg on spoil and on an adjacent old-field site. olume increment, total volume, height, 5ar intercept, and diameter parameters were ported for each stand. The old-field site ality exceeded that of the spoil. Percent rvival was higher on the spoil than in the l field, though the old field showed greater owth.

S.-PA : coal-B : VI-B

. Aldon, Earl F., O. D. Knipe, and George Garcia.
1973. **Revegetating devastated sites in New Mexico with western wheatgrass transplants.** USDA For. Serv. Res. Note RM-243. 3 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Western wheatgrass survived well and produced daughter plants from rhizomes during the first year when good seeds were grown to 3-month-old transplants then transferred to sandy or clay loam sites at elevations of about 7,500 feet.

U.S.-NM : other : VI-B

7. Aldon, Earl F., and H. W. Springfield.
1973. **Revegetating coal mine spoils in New Mexico: a laboratory study.** USDA For. Serv. Res. Note RM-245. 4 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Emergence and early growth of mountain rye and fourwing saltbush were studied in untreated 3-year-old mine spoils and in spoils to which organic matter or fertilizer had been added under greenhouse conditions. Emergence and growth were satisfactory from untreated spoils; adding amendments had no effect on seedling emergence or early growth.

U.S.-NM : coal : VI-B

8. Allen, Natie, Jr.
1973. **Experimental multiple seam mining and reclamation on steep mountain slopes.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 98-104. Bitum. Coal Res., Inc., Monroeville, Pa.

TVA was given the responsibility for planning a mining and reclamation method that would permit mining on *stripped slopes* but avoid the problems of unstable piles and highwalls. The method was tested in an area where four seams could be stripped and augered. Excess spoil was hauled to a previously mined pit. As stripping and augering progressed, overburden was used to fill in vacated pits. A bench on the outer slope was kept clear of spoil for a roadway. The final slope was graded and hydroseeded.

U.S.-AL : coal-B : II-C

9. Alverson, Kent.
1973. **Cattle and catfish on surface-mined land.** Soil Conserv. 34 (4): 4-6, illus.

A story of a successful fish-farming operation in strip-mine ponds, and cattle raising on reclaimed spoil banks.

U.S.-IL : coal-B : VII-C+G

10. Arata, Andrew A.
    1959. **Ecology of muskrats in strip-mine ponds in southern Illinois.** J. Wildl. Manage. 23 (2) : 177-186.

The biology and ecology of muskrats in strip-mine ponds were studied. Averages of 2.8 dens per acre and 2.4 dens per 1,000 feet of shoreline were recorded. Cattail, sweet clover, broom-sedge, and goldenrod formed the summer diet, and cattail rootstocks and willows composed the winter diet. Intensive management for muskrats on strip-mined lands is not recommended.

U.S.-IL : coal-B : VII-E

11. Ashby, William C., and Malchus B. Baker, Jr.
    1968. **Soil nutrients and tree growth under black locust and shortleaf pine overstories in strip-mine plantings.** J. For. 66 : 67-70.

Tree growth and soil-nutrient levels were studied in a southern Illinois strip-mined area. Heights of black walnut, yellow-poplar, silver maple, and osage orange underplanted in a black locust plantation were greater than heights on shortleaf pine plots. Soil from the locust plantation was more productive than soil from the pine plantation. Nitrogen added to the plots tended to equalize plant growth on the two soils; adding phosphorus with nitrogen greatly enhanced growth on both soils.

U.S.-IL : coal-B : VI-B

12. Ashby, William C., Malchus B. Baker, Jr., and John B. Casteel.
    1966. **Forest cover changes in strip-mine plantations.** Tree Planters' Notes 76: 17-20 p.

Describes changes in numbers and basal area in a black locust and shortleaf pine plantation on surface-mined land following severe climatic stress. An extremely cold winter was followed by a drought. Changes in understory planted and volunteer species composition were also noted.

U.S.-IL : coal-B : VI-B

13. Augustine, Marshall T.
    1966. **Using vegetation to establish critical areas in building sites.** Soil Conserv. 32 (4) : 78-80, illus.

The capabilities and limitations of lower vegetation for stabilizing road cuts and building sites are discussed. Successful examples are given.

U.S.-MD : other : V-C + VII-A

14. Averitt, Paul.
    1970. **Stripping-coal resources of the United States — January 1, 1970.** U.S. Geol. Surv. Bull. 1322. 34 p.

An analysis, by states, of the geologic and technologic sources of information about stripping coal as of 1 January 1970. The remaining coal recoverable by stripping in the U.S. in the 0- to 150-foot-thick overburden totaled 128 billion tons. The estimated recoverable coal is distributed in 26 states. Large amounts are concentrated in the northern Great Plains, North Dakota, Montana, Wyoming, Illinois, and the northern half of the Appalachian Basin.

U.S. : coal : I-A

15. Baker, Michael, Jr., Inc.
    1973. **Analysis of pollution control costs.** Appalachian Reg. Comm. 436 p. Washington, D. C.

This report provides the data needed by the Appalachian Regional Commission for estimating costs of pollution abatement in the Monongahela River basin. The subject matter is divided into two parts: (1) abatement of coal-mine drainage pollution and mining-related problems; and (2) abatement of pollution from sources other than coal mining. The report contains about 275 references to publications and nearly 200 tables and figures.

U.S.-WV, PA, MD, OH : coal-B : VIII-B

16. Barnhisel, R. I., and H. F. Massey.
    1969. **Chemical, mineralogical and physi-**

cal properties of eastern Kentucky acid-forming coal spoil materials. Soil Sci. 108: 367-372.

Spoil materials are characterized with respect to chemical, mineralogical, and physical properties. The extreme acidity of spoils and toxic levels of Fe, Mn, Cu, and Zn pose a problem in the establishment of plant cover. The deep burial of potentially toxic ion-producing material or the addition of limestone to neutralize the acids is suggested.

U.S.-KY : coal-B : III-B

17. Barnhisel, R. I., and Armine L. Rotromel.
1974. **Weathering of clay minerals by simulated acid coal spoil-bank solutions.** Soil Sci. 118(1): 22-27.

Kaolinite and mica-clay minerals were subjected to simulated sulfuric acid coal strip-mine solutions for periods up to 6 months. These data indicate that the mode of attack of the acid on both clays was at the edges. The acid released Al, Fe, K, Si, and possibly other ions to the solution phase, thereby serving as one possible explanation for the large amounts of AL^{3+} found in coal spoil solutions. It seems that for mica the dissolution of the edges (octahedral layer) precedes the removal of K^+ from the interlayer positions. The rate of dissolution of kaolinite and mica were similar, and one would not expect large changes in mineralogies of natural spoil-bank materials from acid dissolution when these spoil materials are dominated by these two minerals.

U.S.-KY : coal-B : III-B

18. Barry, Frank J.
1965. **Federal and state regulation and the legislative picture.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 35-41. University Park.

A discussion of existing restrictions on blight, pollution, and despoilation caused by strip-mining, summarizing the similarities and recent changes of state strip-mine-reclamation laws and criticism of these laws and their administration. Provisions of the Appalachian Regional Development Act of 1965 are presented. Alternatives for the prevention of future damage from surface mining are considered.

U.S. : Coal : VIII-A

19. Bartee, L. D.
1964. **Evaluation of mulch materials for establishing vegetation on small dams.** J. Soil and Water Conserv. 19 (3): 117-118.

Mulch materials (hay, wood pulp, and forage sorghum) were used in establishing vegetation on small dams. All mulch material used resulted in satisfactory stands of vegetation. Some cost figures are given.

U.S.-TX : other : VI-B

20. Bauer, Anthony M.
1965. **Simultaneous excavation and rehabilitation of sand and gravel sites.** Nat. Sand and Gravel Assoc. Silver Spring, Md. 60 p. illus.

Industry views on site and operational factors of the sand and gravel industry. Factors that usually influence the planning process, and procedures for development of the ultimate use of sand and gravel sites, are discussed.

U.S. : Sand and gravel : VI

21. Bauer, Hermann Josef.
1973. **Ecological aerial photo interpretation for revegetation in the Cologne lignite district.** *In* Ecology and Reclamation of Devastated Land vol. 2: 469-476. Gordon and Breach Sci. Publ., New York.

It is more effective to identify the ecological factors by aerial-photo interpretation — together with terrestrial investigations — than by use of maps. Diagnosis of the ecological structure of the mined area permits a statistical assessment of the ecotopes and evaluation of their natural potential. Photo-interpretation can be used to identify ecologically important ecotopes that merit protection. It promotes a development of landscape planning on an ecological basis and of different measures for reclamation.

Germany : coal-L : I

22. Bauer, Hermann Josef.
1973. **Ten years' studies of biocenological succession in the excavated mines of the Cologne lignite district.** *In* Ecology and Reclamation of Devastated Land vol. 1: 271-283. Gordon and Breach Sci. Publ., New York.

Analysis of the various ecotopes with respect to soil microclimate, plants, and animals gave insight into the sequence of the biocenological succession. The abiotic factors of spoils — extreme edaphic, hydrologic, and microclimatic conditions—render the development of vegetation difficult. Yet there is a spontaneous colonization of plants; ecological conditions are changing; and there are successions in plant associations and animals. New lakes and their environs affect the ecoclimate and provide new areas for plants and animals. Associations come into existence that were unknown before mining.

Germany : coal-L : VI-B

23. Beattie, James M.
1957. **Foliar analysis shows value of spoils bank for fruit plantings.** Ohio Farm and Home Res. 42: 65-67.

Spoil and foliar-analyses techniques were used to predict fertilizer needs for fruit crops. It was found that neutral and slightly alkaline spoils are suited for the growth of peach trees provided ¼ pound of 33-percent N carrier per year of tree age is added. Alkaline spoils require addition of Mn. Very acid sands and shales are not suited for fruit trees. Freedom from frost damage should be considered.

U.S.-OH : coal-B : VI-B

24. Beck, R. E.
1973. **The North Dakota Surface Mining Control and Reclamation Law.** *In* some environmental aspects of strip mining in North Dakota. ND Geol. Surv. Educ. Ser. 5: 109-118.

The Surface Mining Control and Reclamation Law and its implication are discussed.

U.S.-ND : coal : VIII-A

25. Bengtson, G. W., D. A. Mays, and T. G. Zarger.
1971. **Techniques useful in establishing vegetative cover on reclaimed surface-mined lands.** Rehabil. Drastically Disturbed Surf. Mined Lands. Symp. Proc.: 79-86. Ga. Surface Mined Land Use Board. Macon.

Reclamation authorities, landowners, and the general public are demanding a professional job of land restoration and revegetation. The land reclaimer is expected to bring skills of agronomy and modern silviculture into play to establish a vigorous attractive cover. Methods adopted for soil do not always work on spoils. This is a comprehensive report on the present state of reclamation knowledge.

U.S. : coal, other : VI-B

26. Bengtson, G. W., D. A. Mays, and J. C. Allen.
1973. **Revegetation of coal spoil in northeastern Alabama: effects of timing of seeding and fertilization on establishment of pine-grass mixtures.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 208-214. Bitum. Coal Res., Inc., Monroeville, Pa.

One hundred plots were laid out so that a comparison could be made of all possible combinations of the following variables: seeding of three different grass species; no grass seeding; grass seeding in either of 2 consecutive years; fertilization at the rate of 0, 50, or 100 pounds N/acre; fertilization either all in the first year of the study or half in the first year and half in the following year; grading of plots several months before seeding; and grading at the time of seeding. All test plots were seeded to loblolly pine at the start of the tests. Results of the 3-year study showed that, where grasses and pines were seeded together, pine seedlings had difficulty surviving. Where pine was seeded alone, there seemed to be better germination and survival.

U.S.-AL : coal-B : VI-B

27. Bengtson, G. W., S. E. Allen, D. A. Mays, and T. G. Zarger.
1973. **Use of fertilizers to speed pine establishment on reclaimed coal-mine spoil in northeastern Alabama: I. Greenhouse experiments.** *In* Ecology and Reclamation of Devastated Land vol. 2: 199-225. Gordon and Breach Sci. Publ., New York.

Results of greenhouse experiments where coal-mine spoils were used as media for seeding loblolly pine. Seedlings responded to complete fertilizer, and the response was enhanced when fresh pine duff was added. N and P were found to be the only inorganic nutrients limiting pine growth. An evaluation was made of effects of concentrated superphosphate and several N-P fertilizer mixtures applied at the time of seeding.

U.S.-AL : coal-B : VI-B

28. Berg, William A.
1961. **Determining pH of strip-mine spoils.** USDA For. Serv. Res. Note NE-98. 7 p., illus. Northeast For. Exp. Stn., Upper Darby, Pa.

For determining spoil pH, the LaMotte-Morgan method produced results that usually agreed fairly well with results from using a pH meter on a 1:2 spoil:distilled water mixture. Results obtained with Soiltex and Hellige-Truog methods often deviated from the pH meter readings; and the Hydrion papers and the Kelway pH tester often gave results that were considerably different.

U.S.-KY : coal-B : III

29. Berg, W. A.
1965. **Plant-toxic chemicals in acid-spoils.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 91-94. University Park.

Hydrogen ions, aluminum, sulfate, total salts, Fe, and Mn and their importance to plant growth on acid coal-mine spoils are discussed. Al and Mn coming into solution as a result of extremely acid conditions are the elements most likely to cause plant toxicities on acid spoils.

U.S.-KY : coal-B : III-B

30. Berg, W. A.
1972. **Vegetative stabilization of mine wastes.** Colo. Min. Assoc. Min. Yearb. 1972: 24-26. Denver.

A brief report on vegetative stabilization of spoils and tailings in Colorado. Tailings vary considerably in physical and chemical characteristics, and in many places stabilization by means other than growing vegetation directly on the tailings is being used. Revegetation problems on spoils are not as complex as on tailings. Revegetation problems, besides limited moisture on spoils, include deficiency of N and often P.

U.S.-CO : coal, Ore waste : VI-B

31. Berg, William A.
1973. **Evaluation of P and K soil fertility tests on coal-mine spoils.** *In* Ecology and Reclamation of Devastated Land vol. 1: 93-104. Gordon and Breach Sci. Publ., New York.

The Bray test for P on 63 spoils from the southern Appalachian area was significantly correlated with plant growth response to added P. P extracted with 0.05N HCl + 0.025N H_2SO_4 or with 0.15N H_2SO_4 was not correlated with response to added P. There was no yield response to K in these greenhouse studies. K-extracting solutions of 1N ammonium acetate, 0.15N H_2SO_4, and 0.05N HCl + 0.025N H_2SO_4 all gave similar results on the spoil.

U.S.-KY : coal-B : III-B

32. Berg, W. A., and E. M. Barrau.
1972. **Composition and production of seedings on strip-mine spoils in Northwestern Colorado.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 215-224. Bitum. Coal Res., Inc., Monroeville, Pa.

Alfalfa dominated vegetation on strip-mine spoils in northwestern Colorado (about 7,000 feet elevation, 17 inches average annual precipitation) seeded 2 to 8 years previously with a mixture of grasses and legumes. Dry-matter production on spoils and soil-covered spoils was comparable when alfalfa was the dominant species. Total nitrogen in the soil-size fraction of the spoils ranged from 545 to 1,205 ppm N as compared to 2,700 ppm for the surface soils in the area. The spoils contained about 70 percent coarse fragments and possibly have a more favorable moisture regime for growth of deep-rooted plants than the moderately fine to fine-texture soils common to the area.

U.S.-CO : coal : VI-B

33. Berg, W. A., and R. F. May.
1969. **Acidity and plant-available phosphorus in strata overlying coal seams.** Min. Congr. J. 55(3): 31-34, illus.

Extremely acid strata were found in the burden on each of six coal strip-mines in eastern Kentucky. On four of the mines the extremely acid strata were rider coal seams or bone coal; on two mines the acid strata included shales. The overburden on all the mines was dominated by strata testing very low in plant-available phosphorus; however, there were strata on every mine that tested moderate in phosphorus.

U.S.-KY : coal-B : III-B

34. Berg, W. A., and W. G. Vogel.
1968. **Manganese toxicity of legumes seeded in Kentucky strip-mine spoils.** USDA For. Serv. Res. Pap. NE-119. 12 p., illus.

The occurrence of Mn toxicity was studied on six legumes grown in 46 acid strip-mine spoils from Kentucky. This toxicity was characterized by a distinct paling (chlorosis) on the leaf margins, readily seen on young leaves of all the species except Kobe lespedeza. Spoil pH was useful in predicting Mn toxicity on these legumes; water-soluble Mn extracted from the spoil was not.

U.S.-KY : coal-B : III-B

35. Berg, William A., and Willis G. Vogel.
1973. **Toxicity of acid coal-mine spoils to plants.** *In* Ecology and Reclamation of Devastated Land vol. 1: 57-68. Gordon and Breach Sci. Publ., New York.

Mn toxicity was observed on legume seedlings grown in extremely acid Pennsylvania strip-mine spoils. Al toxicity to seedlings grown on acid spoils was indicated by growth of stubby roots without laterals. Mulching of extremely acid spoils with hardwood chips resulted in significant decreases in total soluble salts and water-soluble Al.

U.S.-KY : coal-B : III-B

36. Beverly, R. G.
1968. **Unique disposal methods are required for uranium mill waste.** Min. Eng. 20(6): 52-56.

Special methods for disposing of liquid effluents and stabilizing inactive uranium mill tailings are described.

U.S.-CO : Ore wastes : VI-A, B

37. Beyer, L. E., and R. J. Hutnik.
1969. **Acid and aluminum toxicity as related to strip-mine spoil banks in western Pennsylvania.** Pa. State Univ. Spec. Res. Rep. SR-72. 79 p., illus.

A report on the chemical properties of selected toxic spoils. Growth of birch and pine seedlings growing in nutrient solution was inversely proportional to spoil pH and concentration of Al. Comprehensive literature review.

U.S.-PA : coal-B : III-B

38. Biesterfeldt, R. C., and W. F. Mann, Jr.
1969. **New hope for strip-mine reclamation.** For. Farmer August 1969. 6-8.

Success was reported in establishing southern pines on strip-mine spoils with aerial sowing of coated seeds. The key to success was a seed coating that repels birds, rodents, and insects.

U.S.-AL : coal-B : VI-B

39. Bituminous Coal Research, Inc.
1964-1973. **Mine drainage abstracts — a bibliography.** Pa. Dep. Environ. Resour. Annu. Suppl. Harrisburg.

This series of annual abstracts contains more than 2,300 citations about the formation, abatement, and effects of water pollution related to both surface and underground mining of coal. The material is arranged according to year of publication and is indexed by individual author, subject classification, geographic features, and organization.

U.S. : coal : IV + VIII-E

40. Blevins, R. L., H. H. Bailey, and G. E. Ballard.
1970. **The effect of acid mine water on floodplain soils in the western Kentucky coalfields.** Soil Sci. 110: 191-196.

P applied in the presence of lime to acid-contaminated spoils produced higher yields of corn than either lime or P applied alone. To reclaim mine-contaminated soils, install adequate drainage, protect the area from further contamination, adjust the pH to 6.0 to 6.5 with lime, and supply P and other fertilizers.

U.S.-KY : coal-B : VII-C

41. Boccardy, Joseph A., and Willard M. Spaulding, Jr.
1968. **Effects of surface mining on fish and wildlife in Appalachia.** U.S. Dep. Inter. Bur. Sport Fish. and Wildl. Resour. Publ. 65. 20 p., illus.

A report dealing with the extent and existing conditions of strip-mined land in Appalachia and the effects on fish and wildlife.

U.S.-AL, KY, OH, PA, TN, VA, WV : coal-B : VII-E

42. Boesch, Mark J.
1974. **Reclaiming the strip mines at Palzo.** Compost Sci. 15(1) : 24-25.

Application of sewage sludge and contouring were essential for successful revegetation of strip-mine spoils.

U.S.-IL : coal-B : VI-B

43. Bowden, Kenneth L., and Richard L. Meier.
1961. **Should we design new "badlands"?** Landscape Archit. 51 (4): 224-229.

The authors suggest that we turn the strip-mined lands into useable recreational areas by creating new "badland areas" especially in the monotonous Midwest.

U.S. : coal-B : VII-F

44. Boyce, Leon.
1972. **Results of soil stabilization tests with fly ash and calcium sulfate sludge.** Univ. Kans. State Geol. Surv. Spec. Distrib. Publ. 65: 3-6. (1972 Mined Land Workshop Proc.)

Application of soil-stabilization techniques to mine spoils by using fly ash and calcium sulfate sludge is suggested.

U.S.-KS : coal-B : VI-B

45. Boyce, Stephen G., and Robert W. Merz.
1959. **Tree species recommended for strip-mine plantations in western Kentucky.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 160. 12 p., illus. Columbus, Ohio.

Twelve species of trees, mainly hardwoods, were planted on strip-mined lands in western Kentucky. Ten-year results showed that all were suitable for plantings on at least some spoil-bank sites. Survival and growth varied widely among sites and species. For optimum survival and growth, species should be selected carefully for the various sites, and only the best stock should be used.

U.S.-KY : coal-B : VI-B

46. Boyce, Stephen G., and David J. Neebe.
1959. **Trees for planting on strip-mined land in Illinois.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 164. 33 p., illus. Columbus, Ohio.

Seventeen species of trees were found suitable for planting on strip-mined land in Illinois. Ten species were suitable for planting in all parts of the State; seven additional species were suitable for the southern counties. The best performance was obtained where species were selected for the various sites and the best quality stock was planted. The species selected and their suitability are summarized.

U.S.-IL : coal-B : VI-B

47. Braley, S. A.
1952. **Experimental strip mines show no stream pollution.** Min. Congr. J. 38(9) : 50, 67, illus.

Acid pollution of streams could be minimized by following three rules: (1) keep surface water from the surrounding area out of the pit by a ditch circling the mine on the uphill side; (2) keep sulfur-bearing material out of the way of flowing water; and (3) while backfilling, bulldoze the sulfur-carrying material against the foot of the highwall and cover it with several feet of compacted material removed from the surface.

U.S.-PA : coal-B : V-B

48. Braley, S. A.
1954. **Summary report of Commonwealth of Pennsylvania (Department of Health) Industrial Fellowship 1 to 7 incl. Mellon Ins. Ind. Res. Fellowship 326B.** 279 p. Pittsburgh.

Results of investigation on the nature and composition of coal-mine discharge; the source and reaction by which it is found; the role of bacteria; the methods by which acid is carried through and from mines; the relationship between concentration and volume of flow on a seasonal basis; the seasonal effects on streams; and the effects of self-purification on streams.

U.S.-PA : coal-B : VIII-C

49. Braley, S. A.
1954. **Acid mine drainage: problem.** Mechanization 18 (1): 87-89.

Water is today one of our most valuable natural resources. Conservation of this resource and the prevention of pollution is becoming an increasingly important problem of American industry.

U.S.-PA : coal-B : V-B

50. Braley, S. A.
1954. **Acid mine drainage: source.** Mechanization 18 (2): 113-115.

This second of a series of articles deals with the materials and chemical reactions involved in the formation of acid in mine water, explaining why these reactions occur more rapidly in mines than under laboratory conditions.

U.S.-PA : coal-B : V-B

51. Braley, S. A.
1954. **Acid mine drainage: sampling and analysis.** Mechanization 18 (3): 96-98.

A method of taking a proper representative sample of mine or stream water and how to handle it prior to analysis. Also described are laboratory methods of determining the acidity and pH of the sample. The relationship between actual acidity and pH of the stream samples is discussed.

U.S.-PA : coal-B : V-B

52. Braley, S. A.
1954. **Acid mine drainage: composition and flow.** Mechanization 18 (4): 137-138.

A list of sample data obtained from the sampling of streams into which acid mine water is discharged. The author demonstrates how such data must be interpreted and concludes that each mine must be studied separately to determine its effect on stream pollution. No overall rule can be established that will cover all cases of mine-water discharge.

U.S.-PA : coal-B : V-B

53. Braley, S. A.
1954. **Acid mine drainage: control of mine acid.** Mechanization 18 (5): 97-98.

There is no known economical or practical method for positive control of mine acid discharge from underground bituminous coal mines, although various methods have been tried.

U.S.-PA : coal-B : V-B

54. Braley, S. A.
1954. **Acid mine drainage: control of oxidation.** Mechanization 18 (6): 105-107.

The results obtained from samplings of drainage and atmosphere from sealed and abandoned mines over a 5-year period. Results of these experiments indicate that sealing of mines to control oxidation, and therefore acidity, is of doubtful value unless the mine is below drainage level.

U.S.-PA : coal-B : V-B

55. Braley, S. A.
1954. **Acid mine drainage: strip mines.** Mechanization 18 (8) : 101-103.
A practical method by which formation of acid water in open-pit mines may be eliminated or greatly reduced. The prescribed method, involving proper drainage, segregation of the sulfuritic material, and proper backfilling, can be accomplished with little additional cost to the mine operator.

U.S.-PA : coal-B : V-B

56. Braley, S. A.
1957. **Evaluation of mine drainage water.** Min. Eng. 9 (1) : 76-78.
Sulfate salts of Fe and Al are prime causes of water acidity. The author discusses the methods of determining the quality of mine drainage and the criteria that are used; pH, free acidity, and total acidity, the last being one factor most valuable for determining the quality of mine water.

U.S.-PA : coal-B : V-B

57. Braley, S. A.
1965. **The Humphrey project.** Acid Mine Drain. Res. Symp. 1 Proc.: 167-176. Bitum. Coal Res., Inc., Monroeville, Pa.
Discusses an experiment on handling the water underground by transporting it in pipes, so that there is no chance of its running into open ditches or contacting the bottom of the mine or coming in contact with oxidizable material. This experiment is based on the theory "that if the water entering the mine from underground channels is alkaline, it will remain so if contact with acidic materials can be prevented."

U.S.-WV : coal-B : IV-C + V-B

58. Bramble, W. C.
1949. **Strip mining—waste or conservation?** Am. For. 55(6) : 24-25, 42-43, illus.
Strip-mining is the most economical and safest way to mine coal, but it despoils the land. The way Pennsylvania is meeting the problem is reported in this article.

U.S.-PA : coal-B : VI

59. Bramble, William C.
1952. **Reforestation of strip-mined bituminous coal land in Pennsylvania.** J. For. 50: 308-314.
Site factors that affect tree survival on coal-mine spoils are: fine soil content, acidity, wind exposure, soil temperature, slope, and forest material. An aspen-fire cherry community is the initial stage on ungraded spoils. Successful reforestation is possible in spring and fall with many tree species. Reclamation programs are discussed.

U.S.-PA : coal-B : III + VI-B

60. Bramble, W. C., and R. H. Ashley.
1950. **Spoil bank planting — fall, 1949.** Pa. State Coll. Agric. Exp. Stn. Prog. Rep. 24. 6 p., illus.
Survival ranged from unsatisfactory to good, depending on spoil type and acidity. Strongly acid carbonaceous shale and acid sandstone spoils produced low survival; moderately acid shales and glacial till spoils gave satisfactory results. A scheme for determination of spoil types is given.

U.S.-PA : coal-B VI-B

61. Bramble, William C., and Roger H. Ashley.
1955. **Natural revegetation of spoil banks in central Pennsylvania.** Ecology 36: 417-423, illus.
The pioneer community was dominated by trees and shrubs capable of invading the spoils by seeds transported by wind and animals. An aspen-fire cherry community has been found as the most common on upland spoil banks. Blackberry, sweetfern, sumac, and prairie willow were characteristic shrubs. Herbs and grasses formed the ground layer. The game food and cover were of low value.

U.S.-PA : coal-B : VI-B

62. Bramble, William C., Henry R. Chisman, and Glenn H. Deitschman.
1948. **Research on reforestation of spoil banks in Pennsylvania.** Pa. State Univ. For. Sch. Res. Pap. 10. 6 p.

Good early survival has been obtained with red and Banks pines, Japanese larch, red oak, and black locust on acid shale and sandstone spoils. These species will grow well on a wide range of acid spoils, at least till 10 years of age. Black locust grows well up to 12 years and then begins to deteriorate.

U.S.-PA : coal-B : VI-B

63. Bramble, W. C., and Ward M. Sharp.
1949. **Rodents as a factor in direct seeding on spoil banks in central Pennsylvania.** J. For. 47: 477-478.

Rodent control seems to be necessary for successful fall seeding on strip-mine spoils.

U.S.-PA : coal-B : VI-B

64. Branson, Branley A., and Donald L. Batch.
1972. **Effects of strip-mining on small stream fishes in east central Kentucky.** Biol. Soc. Wash. Proc. 84(59): 507-517.

A low-level of acid mine drainage but a high level of siltation and turbidity was observed. Fishes were progressively eliminated from water downstream. Food organisms were reduced; reproduction was curtailed. Some fish species are resistant to silt and turbidity and are able to subsist despite silting of the bottom.

U.S.-KY : coal-B : VII-E

65. Brant, Russell A.
1964. **Geological description and effects of strip mining on coal overburden material.** Ohio J. Sci. 64 (2): 68-75.

Discusses the geology of the coal-bearing region of Ohio and the occurrence of the principal coal beds with respect to the geological groups in which they are found. The relationship of the geology to some of the physical and chemical changes that affect overburden material in strip-mine spoils is discussed.

U.S.-OH : coal-B : I + III

66. Brant, Russell A., and Richard M. DeLong.
1960. **Coal resources of Ohio.** Ohio Dep. Nat. Resour. Div. Geol. Surv. Bull. 58. 245 p., illus.

Estimates of coal reserves in Ohio. The coal is found in 24 beds of 14 or more inches thick, which occur in 32 counties in eastern and southeastern Ohio. Geography and geology of each county is given. Tables, maps, and appendices.

U.S.-OH : coal-B : I-A

67. Brant, Russell A., and Edward Q. Moulton.
1960. **Acid mine drainage manual.** Ohio State Univ. Eng. Exp. Stn. Bull. 179. 40 p., illus.

A summary of information about the acid drainage from Ohio coal mines. Fundamental factors of acid formation, geology, chemistry, minerology, bacteriology, hydrology, and coal-mine operations are discussed. The principles of alleviation procedures currently being employed such as good housekeeping, exclusions, flow regulation, reclamation, and treatment are described.

U.S.-OH : coal-B : III-B + VI

68. Breathitt, Edward T.
1965. **Strip mining in Kentucky.** Ky. Dep. Nat. Resour. Strip Mine Reclam. Symp. Proc.: 45-47. Frankfort.

Discusses involvement of the state agencies, coal industries, and others in reclamation efforts on strip-mined lands.

U.S.-KY : coal-B : VIII-A

69. Brooks, David B.
1965. **Spoil bank reclamation: some economic observations.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 64-71. University Park.

A discussion of economics in reclamation of coal-mine spoils, including potential usefulness of benefit-cost analysis for making decisions about the reclamation process.

U.S. : coal : VIII-B

70. Brooks, David B.
1966. **Strip-mine reclamation and economic analysis.** Nat. Resour. J. 6(1): 13-44.

It is suggested that a rational allocation of resources can be made through benefit-cost analysis. Goals used are national productivity, cultural and aesthetic values, and local employment.

U.S. : coal : VIII-B

71. Brown, Grover F.
1949. **Strip-mining and land restoration.** Soil. Conserv. 15 (5): 107-109, illus.

Discussing the use of open-cast coal-mining in England, the author suggests that some of the coal-mining methods used there should be applied in the United States.

Great Britain : coal : VI

72. Brown, James H.
1962. **Success of tree planting on strip-mined areas in West Virginia.** W. Va. Univ. Agr. Exp. Stn. Bull. 473. 35 p., illus. Morgantown.

Ten tree species planted on West Virginia strip-mine spoils were evaluated on a variety of spoil and site conditions. Many species survived well (49 to 80 percent). Black locust and Scotch, red, and white pines performed best. Survival was correlated with precipitation during early periods of the first growing season; black locust performance was correlated with slope.

U.S.-WV : coal-B : VI-B + VII-D

73. Brown, James H.
1971. **Use of trees for revegetation of surface-mined areas.** W. Va. Univ. Symp. Reveg. and Econ. Use of Surf.-Mined Land and Mine Refuse Proc.: 26-28. Morgantown.

An overall review of site factors affecting establishment and growth on strip-mine spoils and a discussion of performance of most commonly planted species.

U.S.-WV : coal-B : VI-B

74. Brown, James H.
1973. **Height growth prediction for black locust on surface-mined areas in West Virginia.** W. Va. Univ. Agric. Exp. Stn. Bull. 617. 11 p. Morgantown.

Sixty percent of the variation in height growth of black locust was accounted for for four of the variables: percent slope, aspect, elevation, and extent of regrading. Using a multiple-regression equation, a table was constructed that can be used for estimating the height growth of black locust on surface-minded spoils.

U.S.-WV : coal-B : VI-B

75. Brown, James H.
1973. **Site factors and seeding methods affecting germination and survival of tree species direct-seeded on surface-mined areas.** West Va. Univ. Agric. Exp. Stn. Bull. 620. 25 p. Morgantown.

Germination, survival, and percent stocking of direct-seeded, unscarified black locust were related to variations in moisture and temperature. Seed treatment, species, and seedbed condition also affected germination and survival.

U.S.-WV : coal-B : VI-B

76. Brown, James H., and E. H. Tryon.
1960. **Establishment of seeded black locust on spoil banks.** W. Va. Agric. Exp. Stn. Bull. 440. 34 p., illus. Morgantown.

A survey of West Virginia spoils seeded to black locust and of vegetation occurring naturally showed that only on 20 percent of the area seeded to black locust had adequate cover been obtained; average stocking was 40.4 percent. Thirty-seven woody species seeded naturally on spoils with pH 4.0 and above; below pH 4.0 there was no vegetation. Establishment of woody seedlings is indirectly related to percent of slope.

U.S.-WV : coal-B : VI-B

77. Brown, Ray W.
1973. **Transpiration of native and introduced grasses on a high-elevation harsh site.** *In* Ecology and Reclamation of Devastated Land vol. 1: 467-481. Gordon and Breach Sci. Publ., New York.

Transpiration rates of Kings fescue, smooth brome, and intermediate wheatgrass were measured in the Wasatch Mountains in Utah.

The highest rates were obtained by the smooth brome and wheatgrass. Diurnal changes in leaf temperature corresponded to the transpiration rates. Transpiration responses of plants to micro-environmental fluxes seem to be important in determining the adaptability of species to hard conditions.

U.S.-UT : other : VI-B

78. Bruce, R. R., and E. A. Thurn.
1955. **The potentialities of revegetating and utilizing agronomic species on strip mined areas in Illinois.** Univ. Ill. Agric. Exp. Stn. and Ill. Coal Strippers Assoc. 7th and 8th Yr. Prog. Rep. 34 p., illus.

A progress report on research into possibilities of revegetating and utilizing strip-mined lands for forage and grain crops. In this phase, studies were narrowed down, intensified, and limited to graded mine spoils. This report concerns principally the physical properties of leveled mined land, with attempts to determine any physical changes due to weathering or vegetative treatments that affect crop yields. Vegetative growth response to fertilizer was studied.

U.S.-IL : coal-B : III + VII-C

79. Buchauer, Marilyn J.
1973. **Contamination of soil and vegetation near a zinc smelter by zinc, cadmium, copper and lead.** Environ. Sci. and Tech. 7 (2) : 131-135.

Metal oxide fumes escaping from two zinc smelters in Palmerton, Pa., have contaminated soil and vegetation with Zn, Cd, Cu, and Pb. Within 1 km of the smelters, 135,000 ppm Zn, 1,750 ppm Cd, 2,000 ppm Cu, and 2,000 ppm Pb have been measured in the O_2 horizon. Approximately 90 percent of metals deposited on the soil surface have been retained in the top 15 cm of the soil profile. Depauperate trees within 2 km of the smelters contained up to 4,500 ppm Zn and 70 ppm Cd by weight in washed oven-dried foilage.

U.S.-PA : other : V-A

80. Buckner, E. R., and J. S. Kring.
1967. **A crop for mine spoils?** Keep Tenn. Green Assoc. J. 7 (1).

A possibility of growing Christmas trees on strip-mine spoils is discussed. Early performance of the test plantings showed great variation in growth and color.

U.S.-KY : coal-B : VII-D

81. Bullard, Fred B.
1967. **The coal industry in Kentucky.** Ky. Dep. Nat. Resour. Strip-Min. Symp. 7 p. Frankfort.

The history of coal mining in Kentucky, and the place of coal mining in the State economy.

U.S.-KY : coal-B : VIII-B

82. Burner, Charles C.
1973. **Fishery Management in strip-mine lakes.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 304-318. Bitum. Coal Res., Inc., Monroeville, Pa.

A study of 10 strip-mine lakes in Kansas and 6 in Indiana demonstrated that strip-mine lakes can support a good quality sport fishery. Fish populations can be established in lakes that have drainage from a fairly large watershed instead of only adjacent spoil banks; have an area greater than ½ acre; have a depth of over 5 feet; and have a pH no less than 6. Fish-stocking guidelines for these waters are given.

U.S.-KS, IN : coal-B : VII-G

83. Busby, Jack K.
1965. **The role of private utilities in planning and implementing the orderly development of a region.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 28-34. University Park.

The author describes the role of the Pennsylvania Power and Light Company in planning and developing its service area. A tree-planting program, "Operation Trees", was designed to screen the anthracite strip-mine spoils.

U.S.-PA : coal-A : VIII-B

84. Callahan, John C., and Jacqueline G. Callahan.
1971. **Effects of strip mining and technological change on communities and natural resources in Indiana's coal mining region.** Purdue Univ. Res. Bull. 871. 43 p.

The effects of the strip-mining operation on the local community — including expenditures by companies in the communities, their tax contribution, and their effects on the tax base, employment, and income — are discussed. The present and potential effects of strip-mining on land-use changes, and the impacts on local and regional growth, demographic patterns, and social institutions, are pointed out.

U.S.-IN : coal-B : VIII-B

85. Camin, Kathleen Q.
1972. **Data collected from the demonstration sites.** Univ. Kans. State Geol. Surv. Spec. Distrib. Publ. 65: 21-23. (1972 Mined Land Workshop Proc.)

Grasslands demonstration projects show that: extensive soil testing is necessary, and fall plantings of fescue have been much more successful than spring plantings. The recommended seeding time is September.

U.S.-KS : coal-B : VII-C

86. Campbell, Robert S., Owen T. Lind, George L. Harp, William T. Geiling, and John E. Letter, Jr.
1965. **Water pollution studies in acid strip-mine lakes: changes in water quality and community structure associated with aging.** Acid Mine Drain. Res. Symp. 1 Proc.: 188-198. Bitum. Coal Res., Inc. Monroeville, Pa.

A report of research in progress on strip-mine lakes in Missouri. The tentative conclusions suggest that: (1) the most acid strip-mine lakes are chemically similar to acid underground mine discharges; (2) as the strip-mine lakes age, there is a progressive decline in acidity; and (3) associated with this decline in acidity is a loss in dissolved substances, an alteration in thermal stratification, an increase in the diversity of the biota, and a potential for greater total productivity.

U.S.-MO : coal-B : IV-G

87. Capp, John P., and D. W. Gillmore.
1973. **Soil-making potential of power-plant fly ash in mined-land reclamation.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 178-186. Bitum. Coal Res., Inc., Monroeville, Pa.

Treatment of coal wastes from surface and deep mining with fly ash results in a soil cover that will sustain grasses and legumes. The beneficial effects of using fly ash for this purpose are discussed, along with techniques for reclaiming with fly ash. Fly-ash reclamation of strip spoil and refuse banks may be cheaper than alternative methods.

U.S.-WV : coal-B : VI-B

88. Carpenter, Carl M.
1944. **Forestry and strip-mining.** Am. For. 50(2): 70-72, 94, illus.

Serious land problems are created by strip-mining operations, covering thousands of acres annually. Such land can be made to produce forest, recreation, and wildlife areas. Implementation of reclamation laws is discussed.

U.S.-IN : coal-B : VII-D

89. Caruccio, Frank T.
1973. **Characterization of strip-mine drainage by pyrite grain size and chemical quality of existing groundwater.** *In* Ecology and Reclamation of Devastated Land vol. 1: 193-226. Gordon and Breach Sci. Publ., New York.

The acidity of mine drainage from strip mines in Pennsylvania is determined by the oxidation rate of pyrite in the coal and associated strata, the presence of iron bacteria, and the neutralizing capacity of the existing groundwater. The first factor is dependent upon the pyrite granularity, and the last two are a function of the chemical composition of the mine strata. These can be used to delineate three horizons within the Allegheny group, each producing a chemically characteristic mine drainage. By evaluating the pyrite in the mine strata and the chemistry of the existing groundwaters, areas can be outlined that will yield mine drainage that is (1) highly acid-high sulfate; (2) moderately acid-moderate sulfate; (3) neutral, negligible sulfate; and (4) neutral, moderate sulfate.

U.S.-PA : coal-B : IV-F

90. Cary, Herbert C.
1971. **Management plans.** Rehabil. Drastically Disturbed Surf. Mined Lands Symp. Proc.: 28-32. Ga. Surfaced Mined Land Use Board. Macon.

The development of a technically sound management plan is essential for successful reclamation. All options of land-use alternatives should be considered as well as short- and long-range aspects of mining and reclamation.

U.S.-GA : coal, other : VIII

91. Cederstrom, D. J.
1971. **Hydrologic effects of strip mining west of Appalachia.** Min. Cong. J 57(3): 46-50.

The author suggests the hydrologic advantages of disturbed ground. Strip-mined lands can be managed to diminish floods, increase low flow, and become a significant source of water.

U.S.-IN, IL : coal-B : IV

92. Chadwick, M. J.
1973. **Methods of assessment of acid colliery spoil as a medium for plant growth.** *In* Ecology and Reclamation of Devastated Land vol. 1: 81-91. Gordon and Breach Sci. Publ., New York.

Coal-spoil properties are discussed in relation to the chemical activity of detrital fraction, iron pyrites, ankerite, and amorphous material, and their interactions during the weathering process. A system is described that attempts to integrate these interactions by using a ratio between the total exchangeable acidity and cation exchange capacity on the one hand and the acid-extractable cations on the other. The results of controlled weathering are used to evaluate the system.

Great Britain : coal : III-B

93. Chadwick, M. J.
1973. **Amendment trials of coal spoil in the north of England.** *In* Ecology and Reclamation of Devastated Land vol. 2: 175-188. Gordon and Breach Sci. Publ., New York.

Six trials have been established on various spoil types. Liming, fertilizers, sewage sludge, shoddy, lagooned pulverized fuel ash, broiler manure, and cationic bitumen emulsion have been used as ameliorants. Trees, grass, and legume species have been sown. The effects of the ameliorants on spoil characteristics are considered, and the results of species performance are discussed and evaluated.

Great Britain : coal : VI-B

94. Chapman, A. G.
1944. **Forest planting on strip-mined coal lands with special reference to Ohio.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 104. 25 p., illus. Columbus, Ohio.

Three major groups of spoils were recognized. Group 1 — spoils of glacial till, sandstones, and acid silt shales; Group 2 — spoils of sandstones and acid silt shales; Group 3 — spoils of sandstones, mainly shales and limestone. Early performance of hardwoods and conifers as related to spoil material is given. Apparent causes of mortality and the management of black locust plantations are discussed.

U.S.-OH : coal-B : VI-B

95. Chapman, A. G.
1947. **Rehabilitation of areas stripped for coal.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 108. 14 p. Columbus, Ohio.

General discussion of strip-mine reclamation work in the Central States.

U.S. : coal-B : VI

96. Chapman, A. G.
1967. **Effects of spoil grading on tree growth.** Min. Congr. J. 53(8): 93-100.
The author discusses effects of spoil grading as related to compaction and the resulting effects on water absorption, erosion, and tree survival. Reports on tree species' performance on various spoil types and grading conditions.

U.S.-OH, KS, MO : coal-B : VI

97. Chapman, A. G.
1967. **How strip-land grading affects tree survival and growth.** S. Ill. Univ. Sch. Agric. Publ. 29. 34 p., illus.
The over-grading of strip-mine spoils high in plastic clay results in site compaction, which adversely affects both survival and growth of forest trees. The compacted spoils reduce air and water infiltration and increase water runoff; essential elements are less available; and biotic life is reduced. The spoils high in sand and in coarse fraction are not appreciably affected by grading. Physical and chemical characteristics of spoils are discussed.

U.S.-KS, OH, IL, MO : coal-B : III + VI

98. Charmbury, H. B.
1965. **Pennsylvania laws and reclamation programs.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 42-43. University Park.
The author reviews basic concepts of the Pennsylvania Bituminous Coal Open Pit Mining Conservation Act.

U.S.-PA : coal-B : VIII-A

99. Clark, F. Bryan.
1954. **Forest planting on strip-mined land in Kansas, Missouri and Oklahoma.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 141. 33 p., illus. Columbus, Ohio.
The author discusses the possibilities of using strip-mined areas for growing forest. Most of the mortality takes place during the first growing season. Fine-textured areas should be allowed to stabilize before planting. Tree performance was better on ungraded spoils and on slopes. Native species survived best. Recommendations for tree planting are presented.

U.S.-KS, OK, MS : coal : VI

100. Coal Industry Advisory Committee of the Ohio River Valley Water Sanitation Commission.
1964. **Principles and guide to practices in the control of acid mine-drainage.** Ohio River Valley Sanit. Comm. 30 p., illus.
A manual for the use of coal operators and officials of pollution-control agencies. Reviews the principles involved in the formation of acid mine drainage and presents a guide to control practices that will aid in ameliorating the effects of mine drainage on the streams and rivers of the Ohio Valley.

U.S.-OH : coal-B : IV

101. Coal Industry Advisory Committee to the Ohio River Valley Water Sanitation Commission.
1965. **Acid Mine Drain. Res. Symp. 1 Proc.:** 232. Bitum. Coal Res. Inc., Monroeville, Pa.
The volume contains 21 papers presented at the first symposium on acid mine drainage research held in May 1965 in Pittsburgh, Pa. Papers are grouped into following topics: (1) formation of acid mine water; (2) treatment of acid mine water; (3) control of acid mine drainage; (4) effects of acid mine drainage; (5) reclamation; and (6) Orsanco library.

U.S. : coal : IV + VIII-D

102. Coal Industry Advisory Committee to the Ohio River Valley Water Sanitation Commission.
1968. **Coal Mine Drain. Res. Symp. 2 Proc.** 406 p. Bitum. Coal Res., Inc., Monroeville, Pa.
The volume is a product of the second symposium on coal-mine drainage research held in May 1968 in Pittsburgh, Pa. It contains 27 papers grouped into following topics: (1) chemistry of mine drainage; (2) biology of mine drainage; (3) control measures; (4)

treatment techniques and (5) industry application of mine drainage control methods.

U.S. : coal : IV + VIII-D

103. Coal Industry Advisory Committee to the Ohio River Valley Water Sanitation Commission.
1970. **Coal Mine Drain. Res. Symp. 3 Proc.** 406 p. Bitum. Coal Res., Inc., Monroeville, Pa.

The volume is a product of the third symposium on coal-mine drainage research held in May 1970 in Pittsburgh, Pa. Most of the 28 reports include information not previously published. The reports are grouped under the following six topics, reflecting individual sessions: (1) neutralization of acid mine drainage; (2) formation of acid mine water; (3) novel approaches to mine drainage control; (4) demineralization of mine water; (5) abatement of mine drainage; and (6) sludge handling, disposal, and utilization.

U.S. : coal : IV + VIII-D

104. Coal Industry Advisory Committee to the Ohio River Valley Water Sanitation Commission.
1972. **Coal Mine Drain. Res. Symp. 4 Proc.** 435 p. Bitum. Coal Res., Inc., Monroeville, Pa.

This volume is a product of the fourth symposium on coal-mine drainage research held in April 1972 in Pittsburgh, Pa. It includes 31 papers grouped under six topics: (1) definition of the problem and some institutional approaches to the solution; (2) prevention and abatement; (3) new approaches to mine drainage treatment; (4) optimizing mine drainage neutralization; (5) detection and effects of coal mine drainage; and (6) application of technology and the results of research.

U.S. : coal : IV + VIII-D

105. Coates, William E.
1973. **Landscape architectural approach to surface mining reclamation.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 26-41. Bitum. Coal Res., Inc., Monroeville, Pa.

In the view of the landscape architect, strip-mining should be considered as an interim land use and provision must be made to return mined land to the highest and best use compatible with use of adjoining land. Advantages claimed for planning rehabilitation as part of the mining operation are low cost, reducing overburden handling and equipment movement, and minimal open raw areas at any time during the mining operation. The most immediate needs for vegetative cover, preventing erosion and improving the soil, can be met best by legumes and grasses. The author suggests the use of trees only for screening exposed highwall, for visual accents, or as sources of seed for volunteer seedlings where there is no nearby mature forest.

Canada : coal, other : V

106. Coleman, G. B.
1951. **A study of water infiltration into spoil banks in central Pennsylvania.** J. For. 49: 574.

An abstract of an M.S. thesis. It was found that the infiltration rates for dark shales were 65 to 397 inches per hour, Dekalb soil 17 to 60, and yellow shales 9 to 17.

U.S.-PA : coal-B : IV-A

107. Collier, Charles R., and others.
1964. **Influences of strip-mining on the hydrologic environment of parts of Beaver Creek Basin, Kentucky, 1955-59.** U.S. Geol. Surv. Prof. Pap. 427-B. 85 p., illus.

The preliminary results of investigation indicate that strip-mining for coal in the Beaver Creek Basin, Kentucky, has significantly changed the chemical quality of surface and groundwater, increased the sediment yield of the basin, altered the forest development, and has adversely affected the aquatic life of the stream.

U.S.-KY : coal-B : IV

108. Collier, C. R., R. J. Pickering, and J. J. Musser.

1970. **Influences of strip-mining on the hydrologic environment of parts of Beaver Creek Basin, Kentucky, 1955-66.** U.S. Geol. Surv. Prof. Pap. 427-C. 80 p., illus.

This report is third of a series on the environmental effects of strip-mining in Cane Branch Basin, McCreary County, Kentucky. It describes the results of the investigation from 1955 to 1966. Topics discussed: precipitation and runoff; groundwater; geochemistry of water; erosion and sedimentation; streambottom fauna; fish population; microbiology of streams; tree growth. Two maps attached.

See also: Mussner 1963 and Collier *et al*, 1964.

U.S.-KY : coal-B : IV

109. Collom, Robert H., Jr.

1971. **Dust control techniques useful in surface mining and related manufacturing.** Rehabil. Drastically Disturbed Surf. Mined Lands Symp. Proc.: 65-69. Ga. Surface Mined Land Use Board. Macon.

The State of Georgia is the largest producer of kaolin in the country. Manufacturing and processing of this material is troublesome. It is estimated that 80,000 tons per year is being emitted into the atmosphere. The collection of this fine dust is expensive but can be accomplished. A collection system can be paid for in a short time by recycling the dust.

U.S.-GA : kaolin : V-A+VIII

110. Contakos, James.

1962. **Restoration of areas affected by coal mining.** Nat. Symp. on Control of Coal Mine Drainage. Pa. Dep. Health Publ. 4: 48-52.

Describes the restoration of lands affected by coal mining as required by the Bituminous Coal Open Pit Mining Conservation Act of 1962.

U.S.-PA : coal-B : VIII-A

111. Cook, Larry.

1950. **New forests for Ohio.** Am. For. 56(11): 6-8, 31, 34, illus.

Describes the reclamation program of strip-mined lands by the Ohio Reclamation Association.

U.S.-OH : coal-B : VI

112. Copeland, Otis L., and Paul E. Packer.

1972. **Land use aspects of the energy crisis and western mining.** J. For. 70: 671-675.

An overall picture of deposits and the present and potential mining of fuels and minerals in the interior West. Present and potential developments, land ownership, mineral rights and mining claims, and the challenges in pre-planning and rehabilitation of stripped lands are discussed.

U.S. : coal-L : VIII

113. Corbett, Don M.

1968. **Ground-water hydrology pertaining to surface mining for coal—Southwestern Indiana.** Coal Mine Drain. Res. Symp. 2 Proc.: 164-189. Bitum. Coal Res., Inc., Monroeville, Pa.

The aquifers formed by surface mining reduce major flood flows and crests during wet periods, but increase flows during dry periods. Much of the water produced by the cast overburdens was captured by final cuts to form sizable lakes, and a large amount was retained in the overburden, replenishing annual losses by evaporation, seepage, and lake-outflow. Data on two Patoka River and three Busseron Creek tributaries (in Indiana) are discussed.

U.S.-IN : coal-B : VI

114. Corbitt, Robert A.

1971. **Design and operation of wastewater handling facilities.** Rehabil. Drastically Disturbed Surf. Mined Land Symp. Proc.: 70-73. Ga. Surface Mined Land Use Board. Macon.

In many areas of Georgia, muddy water is attributed to the surface mining industry. All waste waters must be treated to render them essentially free of suspended and settleable solids, and the pH should be in the range of 6.0 to 8.5. Engineering work to attain these goals is discussed.

U.S.-GA : kaolin : VIII

115. Cornwell, S. M., and E. L. Stone.
1968. **Availability of nitrogen to plants in acid coal mine spoils.** Nature 217: 768-769.
Highly acid anthracite black pyritiferous coal-mine spoils contain abundant available N for plant growth.

U.S.-PA : coal-A : III-B

116. Cornwell, Susan M., and Earl L. Stone.
1973. **Spoil type lithology and foliar composition of** ***Betula populifolia.*** *In* Ecology and Reclamation of Devastated Land vol. 1: 105-120. Gordon and Breach Sci. Publ., New York.
The availability of plant nutrients or possibly toxic elements to gray birch were assessed for five spoil types. Foliar concentrations of all elements except Cu differed significantly among spoil types, indicating that the lithological classification of spoils was meaningful in terms of plant uptake. Differences in N and P resulted from rock composition and weathering rate. Gray birch accumulated Zn to 400 ppm and Mn to 1,500 ppm without evidence of Zn, B, Al, or Mn toxicity.

U.S.-PA : coal-A : III-B

117. Cresswell, Christopher F.
1973. **Changes in vegetational composition, nutritional status, soils, and microbial populations with the establishment of vegetation on gold-mine dumps on the Witwatersrand.** *In* Ecology and Reclamation of Devastated Land vol. 2: 335-359. Gordon and Breach Sci. Publ., New York.
An account of the difficulties in establishing vegetation on gold mine dumps and the procedures adopted in establishing initial plant cover. The composition of the mine dump is discussed, and the nutrient requirements of the vegetation grown in pot culture using this media are considered. The effects of pH changes occurring due to the pyrite content are presented. Changes in microbial population with the establishment of vegetation are discussed.

S. Africa : ore waste : III + VI-B

118. Crowl, John M.
1962. **Reclamation of lands stripped by the opencut method of coal production.** Fifth World Forest. Congr. Proc. vol. 1: 611-615. Univ. Wash., Seattle.
A general discussion on strip-mining for coal and ore reclamation efforts and accomplishments by the industry and governmental agencies.

U.S. : coal-B : VI

119. Crowl, John M.
1965. **The Kentucky reclamation association.** Dep. Nat. Resour. Strip Mine Reclam. Symp. Proc.: 19-20. Frankfort.
Outlines the place of the Kentucky Reclamation Association in restoration of strip-mined lands. Revegetation efforts are described.

U.S.-KY : coal-B : VI

120. Croxton, W. C.
1928. **Revegetation of Illinois coal stripped lands.** Ecology 9: 155-175.
The vegetation of spoils is correlated with the acidity levels of the surface layer. It tends to become well established above pH 4.5 and fails below that point. There is little indication that the unproductivity of the bare areas is due to deficiency of nutrients. Plant succession on spoils of different acidity levels is discussed.

U.S.-IL : coal-B : VI-B

121. Culbertson, R. E., and Richard M. May.
1942. **Planting spoil banks and ditches.** Soil Conserv. 7 (10): 260.
Revegetation of drainage ditches and spoil banks by direct seeding of grasses is suggested. Useful species are listed.

U.S.-DE, MD : other : VI-B

122. Cummins, David G., William T. Plass, and Claude E. Gentry.

1965. **Chemical and physical properties of spoil banks in eastern Kentucky coal fields.** USDA For. Serv. Res. Pap. CS-17. 12 p. Cent. States For. Exp. Stn., Columbus, Ohio.

It was found that 60 percent of the material that passed a 1-inch screen was less than 2 mm in size. The soil fraction of individual spoils was classified either as loam or clay loam. The samples were medium to extremely acid, with low concentrations of soluble salts and organic matter. Exchangeable Ca was low, but Mg was abundant. Available K and P were low to adequate for growth. Available Fe, Mn, and SO_4 were high at several locations.

U.S.-KY : coal : III-B + C

123. Cunningham, J. M.

1965. **The Pennsylvania strip-mine reclamation program.** Ky. Dep. Nat. Resour. Reclam. Symp. Proc.: 21-22. Frankfort.

Comments on Pennsylvania's strip-mine reclamation laws, their major provisions and implementation.

U.S.-PA : coal-B : VIII-A

124. Currier, W. F.

1973. **Basic principles of seed planting.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 225-232. Bitum. Coal Res., Inc., Monroeville, Pa.

The following basic principles and their application to seeding critical areas, including land disturbed by strip-mining, are discussed: the use of adapted species; reduction of plant competition; preparation of a good seedbed; covering the seed to proper depth; evenness of seed distribution; proper timing for seeding; and sufficient plant nutrients for plant establishment and growth. The use of two main methods of seeding — drilling and broadcasting — is related to these basic principles.

U.S. : coal : VI-B

125. Curtis, Willie R.

1967. **Hydrology.** Ky. Dep. Nat. Resour. Strip-Mining Symp. Proc. 3 p. Frankfort.

A general description of the influences of strip-mining on the water resource.

U.S.-KY : coal-B : IV

126. Curtis, Willie R.

1971. **Terraces reduce runoff and erosion on surface-mine benches.** J. Soil and Water Conserv. 26 (5): 198-199, illus.

Terraces can effectively control runoff and erosion on surface-mine benches. On a shale spoil peak, flow on a terraced plot was 65 percent less than on control plot; sediment yield was 52 percent less, and total runoff was 42 percent less. Comparable figures for plots on sandstone spoil were 65, 70, and 6 percent respectively.

U.S.-KY : coal-B : IV-B + VI-A

127. Curtis, Willie R.

1971. **Strip-mining erosion and sedimentation.** Am. Soc. Agric. Eng. Trans. 14 (3): 434-436, illus.

Six small watersheds in eastern Kentucky are being used to evaluate the effects of strip-mining for coal. Sediment yield is greatest during active mining and is directly related to the percentage of area disturbed. A heavily mined watershed yielded over 46,000 ppm of suspended sediment.

U.S.-KY : coal-B : IV-E

128. Curtis, Willie R.

1971. **Vegetating strip-mine spoils for runoff and erosion control.** W. Va. Univ. Symp. Reveg. and Econ. Use of Surf.-Mined Land and Mine Refuse Proc.: 40-41. Morgantown.

Excessive runoff and erosion are now considered among the most important adverse effects of surface mining, and reclamation objectives are being directed more toward control of these factors. An adequate cover of vegetation that is quickly established can be effective in runoff and erosion control. In some cases, mechanical means may be necessary for initial control while a vegetative cover is being established for long-term control.

U.S.-KY : coal-B : IV-E

129. Curtis, Willie R.
1972. **Strip-mining increases flood potential of mountain watersheds.** Am. Water Res. Assoc. and Colo. State Univ. Nat. Symp. Watersheds in Transition Proc.: 357-360.

A study in eastern Kentucky indicated that surface mining for coal alters the natural processes and affects the water resources in small Appalachian watersheds. Peak flow rates increased by a factor of 3 to 5 after surface mining. Lag time was reduced, thus effecting an increase in the rate at which flood peaks move downstream. It appears that peak flow is directly and positively correlated with the percentage of area disturbed during surface mining.

U.S.-KY : coal-B : IV

130. Curtis, Willie R.
1972. **Chemical changes in streamflow following surface mining in Eastern Kentucky.** Coal Mine Drain. Res. Symp. 4 Proc.: 19-31. Bitum. Coal Res., Inc., Monroeville, Pa.

A study of the chemical quality of water in 6 small watersheds in Breathitt County, Ky., indicates that surface mining for coal may result in chemical pollution of the streams even in areas where acid is no problem. Among the elements showing greatest increases following mining are sulfate, Ca, and Mg. Al and Mn have increased, as have Fe and Zn. Some elements continue to increase at least up to 2 years after mining. Others peak rather quickly after the land disturbance and may soon return to pre-mining levels.

U.S.-KY : coal-B : IV-F

131. Curtis, Willie R.
1973. **Effects of strip-mining on the hydrology of small mountain watersheds in Appalachia.** *In* Ecology and Reclamation of Devastated Land vol. 1: 145-157. Gordon and Breach Sci. Publ., New York.

The effects of strip-mining on the water resources of small mountain watersheds were investigated in eastern Kentucky. Six subdrainages have been used to record pre-mining condition changes during active mining operations and the rate of recovery after mining. Stream turbidity and peak flows increase during mining, but on one subdrainage turbidity returned to near pre-mining conditions within 6 months after mining. Storm runoff durations apparently do not change. Sulfate and magnesium in the streamflow have increased since mining.

U.S.-KY : coal-B : IV-C

132. Curtis, Willie R.
1973. **Moisture and density relations on graded strip-mine spoils.** *In* Ecology and Reclamation of Devastated Land vol. 1: 135-144. Gordon and Breach Sci. Publ., New York.

A report on first-year results of a study to determine the disposition of subsurface moisture on leveled spoil banks in western Kentucky and to determine whether the moisture conditions can be changed through scarification and vegetative treatments. A significant difference was noted in density and available moisture between furrow ridge and valley locations. The lowest moisture values were noted in the surface foot. Surface scarification apparently has not affected moisture or density.

U.S.-KY : coal-B : IV-B

133. Curtis, Willie R., and William D. Cole.
1972. **Micro-topographic profile gage.** Agric. Eng. 53 (1): 17.

Simple equipment has been designed and constructed to permit rapid measurements of the spoil surface. Data so gathered can be used to plot surface section profile useful in erosion studies.

U.S.-KY : coal-B : IV

134. Czapowskyj, Miroslaw M.
1969. **Anthracite coal-mine spoils today —forests tomorrow.** Pa. For. 59(3): 81-83.

A brief history of reclamation work in the Anthracite Region, summarizing the results of research conducted by the U.S. Forest Service.

U.S.-PA : coal-A : VI-B

135. Czapowskyj, Miroslaw M.
1970. **Experimental planting of 14 tree species on Pennsylvania's anthracite strip-mine spoils.** USDA For. Serv. Res. Pap. NE-155. 18 p., illus. Northeast For. Exp. Stn., Upper Darby, Pa.

Survival and height growth of 11 coniferous and 3 hardwood species were studied on four strip-mine spoil types in both graded and ungraded conditions. Hardwoods survived better and attained better heights than conifers. Hybrid poplar, NE-388, performed best. Almost all species performed better on graded spoils than on ungraded spoils. Selected physical and chemical characteristics of the strip-mine spoils are discussed.

U.S.-PA : coal-A : III-B+C+VI

136. Czapowskyj, Miroslaw M.
1973. **Establishing forest on surface-mined land as related to fertility and fertilization.** USDA For. Serv. Gen. Tech. Rep. NE-3: 132-139. Northeast. For. Exp. Stn., Upper Darby, Pa.

Most spoils are not hostile to planted trees. Nearly all essential elements for plant growth were found in the spoils; their concentrations depend on lithology, acidity, and the rate and degree of spoil weathering. Planted and seeded forest trees respond strongly to application of N and P, both singly and in combination. Certain spoils will respond to K application. Extreme acidity and high concentrations of Mn, Fe, Zn, and Al are major factors limiting plant growth on coal-breaker refuse; but such areas are a small portion of the total area of disturbed land. Application of lime alleviates these problems.

U.S. : coal : III-B

137. Czapowskyj, Miroslaw M.
1973. **Performance of red pine and Japanese larch planted on anthracite coal-breaker refuse.** *In* Ecology and Reclamation of Devastated Land vol. 2: 237-245. Gordon and Breach Sci. Publ., New York.

Red pine and Japanese larch seedlings were planted on coal-breaker refuse in Shamokin, Pennsylvania. The site consisted of highly acid slaty shales and coal fragments and soil-sized particles — 28 percent. Lime application was essential for adequate survival and establishment of both tree species; neither mulch nor fertilizer contributed substantially to tree establishment and growth. After 5 years the pH value of the surface layer showed neutral reaction in the limed plots.

U.S.-PA : coal-A+R : VI-B

138. Czapowskyj, Miroslaw M., and William E. McQuilkin.
1966. **Survival and early growth of planted forest trees on strip-mine spoils in the anthracite region.** USDA For. Serv. Res. Pap. NE-46. 29 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.

A study of 6-year and older forest tree plantings on anthracite strip-mine spoils showed: (1) that average survival of all species was adequate; and (2) that the height growth was comparable to growth on natural soils of average productivity. A tentative spoil classification and a preliminary guide for tree planting were prepared.

U.S.-PA : coal-A : III-A+VI-B

139. Czapowskyj, Miroslaw M., John P. Mikulecky, and Edward A. Sowa.
1968. **Response of crownvetch planted on anthracite breaker refuse.** USDA For. Serv. Res. Note NE-78. 7 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.

Lime applications were essential to establishment of crownvetch on coal-breaker refuse in the Pennsylvania Anthracite Region, and mulch treatments were highly beneficial. Fertilizer applications had only slight effect on either establishment or growth.

U.S.-PA : coal-A : VI-B

140. Czapowskyj, Miroslaw M., and Edward A. Sowa.

1973. **Lime retention in anthracite coal-breaker refuse.** USDA For. Serv. Res. Note NE-154. 4 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.

Hydrated lime was applied to extremely acid anthracite coal-breaker refuse at rates of 2.5 and 5.0 tons per acre. The lime raised the pH to neutral range, and this range was still in evidence 7 years after treatment. The pH readings decreased with the depth of the refuse profile, and below 9 inches they approximated those of the control plots. The 2.5-tons-of-lime-per-acre treatment was almost as effective as the 5.0-ton treatment. Application of lime in establishing vegetation on coal-breaker refuse is recommended and encouraged.

U.S.-PA : coal-A : VI-B

141. Czapowskyj, Miroslaw M., and Ross Writer.

1970. **Hydroseeding on anthracite coal-mine spoils.** USDA For. Serv. Res. Note NE-124. 8 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.

Performance of selected species of legumes, grasses, and trees hydroseeded on anthracite coal-mine spoils in a slurry of lime, fertilizer, and mulch was evaluated. Hydroseeding failed on coal-breaker refuse, but was partially successful on strip-mine spoils.

U.S.-PA : coal-A : VI-B

142. Dale, Martin E.

1963. **Interplant alder to increase growth in strip-mine plantations.** USDA For. Serv. Res. Note CS-14. 4 p., illus. Cent. States For. Exp. Stn., Columbus, Ohio.

European alder is beneficial as a nurse crop to other tree species planted on strip-mined spoils. The nursing effect seemed to stimulate height growth, but had no effect upon survival.

U.S.-KY : coal-B : VI-B

143. Dalsted, Norman L., and F. Larry Leistritz.

1974. **A selected bibliography on coal-energy development of particular interest to the Western States.** ND Agric. Exp. Stn. Agric. Econ. Misc. Rep. 16. 82 p. Fargo.

This bibliography includes 486 citations on coal-energy development in coal-producing states, particularly in Montana, North Dakota, and Wyoming. The references are grouped under the following topics: (1) general references and bibliographies; (2) coal resources of the Western States; (3) demand for western coal; (4) surface coal mining; (5) spoil-bank reclamation; (6) mineral rights and public regulation of strip mining; (7) economic impact of strip-mining and power production; and (8) environmental impact of strip-mining and power production. The topic on spoil-bank reclamation lists 86 citations. Many references annotated.

U.S.-MO, ND, WY : coal : VIII-E

144. Darden, Sam.

1971. **The preparation and use of maps in reclamation work.** Rehabil. Drastically Surf. Mined Lands Symp. Proc.: 33-36. Ga. Surface Mined Land Use Board. Macon.

A brief description of the Georgia Surface Mined Land Use Board's requirements for land-use and reclamation maps. A map is a useful planning tool and essential to the rehabilitation of the site being mined.

U.S.-GA : coal, kaolin : VIII

145. Darmer, Gerhard.

1973. **Grasses and herbs for revegetating phytotoxic material.** *In* Ecology and Reclamation of Devastated Land vol. 2: 91-101. Gordon and Breach Sci. Publ., New York.

The overburden of Midgerman brown coal strip mines often contains marcasite (FeS_2). Extremely acid and toxic to plants, this component creates serious planting problems. After liming, seeding, and planting, these plants proved useful: *Phacelia tanacetifolia*

Festuca (spp)., *Lolium italicum*, *Bromus inermis*, and *Phalaris arundinacea*. On level ground, grasses did well. On steep slopes, woody plants and grasses can be combined.

Germany : coal-L : VI-B

146. Davidson, Walter H.
1970. **Deer prefer pine seedlings growing near black locust.** USDA For. Serv. Res. Note NE-111. 4 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.

Volunteer black locust on coal spoils appeared to make some species of pine seedlings more palatable to white-tailed deer. The nitrogen produced by the black locust may have caused more succulent tissue growth in the pines.

U.S.-PA : coal-B : VII-E

147. Davidson, Walter H., and Grant Davis.
1972. **Sprouting of thinned hybrid poplars on bituminous strip-mine spoils in Pennsylvania.** USDA For. Serv. Res. Note NE-147. 6 p. Northeast. For. Exp. Stn., Upper Darby, Pa.

Five-year-old hybrid poplar stands were thinned, using basal sprays, cutting, and stump spraying or simply cutting. Results indicate that hybrid poplar can be successfully regenerated under coppice management or can be easily removed for stand conversion.

U.S.-PA : coal-B : VII-D

148. Davidson, Walter H., and Edward A. Sowa.
[In press] **Container-grown seedlings show potential for afforestation of Pennsylvania coal-mine spoils.** Tree Planters' Notes.

Afforestation attempts with Ontario-type tubelings indicated that frost-heaving can be extremely detrimental on coal-mine spoils. Other types of containers — peat pots and Jiffy 7's — were found to be more resistant to frost-heaving. Compared with bare-root seedlings, seeded red pines in these containers survived and grew equally well.

U.S.-PA : coal : VI-B

149. Davis, Grant.
1964. **Second-year results of hybrid poplar test plantings on bituminous strip-mine spoils in Pennsylvania.** USDA For. Serv. Res. Note NE-19. 7 p. Northeast. For. Exp. Stn., Upper Darby, Pa.

A broad screening test was designed to determine the suitability of 60 clones of hybrid poplar for strip-mine plantings. Two-year results revealed great variability among the six planting sites, apparently related to differences in spoil acidity. Certain clones will be suitable for planting all but the most acid spoils.

U.S.-PA : coal-B : VI-B

150. Davis, Grant.
1965. **The cooperative research program in Pennsylvania.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 55-63. University Park.

The author describes the genesis of the Research Committee on Coal Mine Spoil Revegetation in Pennsylvania and how it is developing and conducting its research program. Research results and application in both the bituminous and the anthracite regions are reviewed.

U.S.-PA : coal : VIII-C

151. Davis, Grant.
1967. **Hydrology of contour strip-mines in the Appalachian region of the United States.** IUFRO Congr. 14 Proc. vol. 1, Sect. 11: 420-443, illus.

Contour strip-mining may have profound effects on streamflow, sediment load, and water quality of streams in a watershed. The degree of impact depends upon the proportion of area mined, hydrologic characteristics of the spoil material, and topography of the watershed. Because mining is extensive and subject to little experimental control, the multi-watershed approach offers hydrologic effects of such mining.

U.S.-KY, WV : coal-B : IV

152. Davis, Grant.
1973. **Comparison of fall and spring**

planting on strip-mine spoils in the bituminous region of Pennsylvania. *In* Ecology and Reclamation of Devastated Land vol. 1: 525-538. Gordon and Breach Sci. Publ., New York.

In 1961 a study was initiated to evaluate the relative success of fall versus spring planting of ten coniferous tree species and five hardwood shrub species on strip-mine spoils. Planting extended over a 2-year period and included tree planting dates in each season. In general, initial tree survival was better with spring planting than with fall planting, especially on the more acid sites. The shrubs survived well with both spring and fall planting on the better sites.

U.S.-PA : coal-B : VI-B

153. Davis, Grant, and Walter H. Davidson. 1968. **Coal-mine spoil banks offer good potential for timber and wildlife production.** Pa. For. 58 (1): 20-21, illus.

Lands strip-mined for coal are accessible and will grow a variety of trees, shrubs, and herbaceous species. Conifers and hybrid poplars are the best choices for pulp and timber. Plantings for game food and cover can be incorporated into reclamation plans.

U.S.-PA : coal-B : VII-D

154. Davis, Grant, and Rex E. Melton. 1962. **Plantations on strip-mine banks can yield timber products.** Pa. State Univ. For. Sch. Res. Pap. 29. 2 p.

An examination of ten 25-year-old plantations in the bituminous region of Pennsylvania showed that Scotch pine, Japanese larch, and white pine are potentially good timber producers on strip-mine banks. Eight other species in the study should produce some timber.

U.S.-PA : coal-B : VII-D

155. Davis, Grant, and Rex E. Melton. 1963. **Trees for graded strip-mine spoils.** Pa. State Univ. For. Sch. Res. Pap. 32. 4 p. University Park.

The results of a survey on performance ratings at 7 years of 10 coniferous and 5 hardwood species planted on graded bituminous spoils associated with coal seams. Better performance was observed on spoils associated with the Brookville, Upper and Lower Freeport, and Pittsburgh seams. Spoils from the Clarion and Lower and Middle Kittanning seams were less favorable. Japanese larch, Banks pine, and Scotch pine were the best conifers; black locust was best among hardwoods.

U.S.-PA : coal-B : VI-B

156. Davis, Grant, W. W. Ward, and R. D. McDermott, Editors. 1965. **Coal Mine Spoil Symposium Proceedings.** Pa. State Univ. Sch. Forest. Resour. 141 p. University Park.

This volume contains 21 papers presented at the symposium held at Pennsylvania State University in October 1965. The theme of the symposium was "Scientific Planning for Regional Beauty and Prosperity". Topics discussed were: national implications, legislative and regulatory considerations, engineering and site characteristics, and revegetation objectives and methods.

U.S. : coal-B : VIII-D

157. Davis, Joseph R., and Beecher J. Hines. 1973. **Debris basin capacity needs based on measured sediment accumulation from strip-mined areas in eastern Kentucky.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 260-276. Bitum. Coal Res., Inc., Monroeville, Pa.

Legislation has been passed in Kentucky requiring surface miners to store, catch, or trap the sediment carried by runoff from strip-mined lands. To aid in being able to project sediment yield so that adequate storage basins could be built, the Soil Conservation Service measured accumulations in some sediment debris basins less than 1 year old. The results indicated that sediment yield of 0.28 acre-feet per acre of disturbed land could be expected for a 3-year design period. It was assumed, based on research experience, that in 3 years a vegetative cover could be developed that would effectively control erosion.

The engineering standard for basin construction, developed by the Soil Conservation Service, is appended.

U.S.-KY : coal-B : IV-H

158. Dean, F. W.
1925. **The reclamation of stripped coal lands.** J. For. 23: 677-682.
A summary of the reclamation work on strip-mined lands accomplished by the Wayne Coal Co. The cost of tree planting was about $7.5 per acre. Remarkable growth of black locust was observed. Other species — pines, black walnut and yellow poplar — have shown little or no growth.

U.S.-OH : coal-B : VI-B

159. Dean, Karl C.
1971. **Potential productive use of lands affected by the mineral industry.** Rehabil. Drastically Disturbed Surf. Mined Lands. Symp. Proc.: 22-27. Ga. Surface Mined Land Use Board. Macon.
Mining and milling wastes affect extensive acreages of land in this country. These lands offer potential for productive uses. The excavated areas may be used for recreation or agriculture, or as containers for various wastes. Processing wastes may be used as raw materials for structural products or artificial soils.

U.S. : coal, other : VIII

160. Dean, Karl C., and Richard Havens.
1972. **Stabilization of problem mineral wastes.** U.S. Bur. Mines Salt Lake City Metall. Res. Cent. 15 p.
The authors summarize effective procedures for vegetating average tailings and the cost differential between the various methods, and also suggest procedures that may be applicable for stabilization of pyrite-containing wastes. The use of buried layers of sewage sludge is discussed.

U.S. : ore waste : VIII-B

161. Dean, Karl C., and Richard Havens.
1972. **Reclamation of mineral milling wastes.** U.S. Bur. Mines Salt Lake City Metall. Res. Cent. 7 p.
Chemical, vegetative, and combined chemical-vegetative procedures for stabilizing milling wastes are discussed. Costs of achieving reclamation using these procedures are compared with those of other physical and vegetative approaches. Chemical-vegetative procedure for establishing vegetation directly on fine-sized wastes compares favorably with other stabilization processes.

U.S.-UT : ore waste : VI-B

162. Dean, Karl C., and Richard Havens.
1973. **Methods and costs for stabilizing tailings ponds.** U.S. Bur. Mines Salt Lake City Metall. Res. Cent. 15 p.
This report summarizes effective procedures developed by the Federal Bureau of Mines for vegetating average tailings, the cost differential between various methods, and procedures that may be applicable for achieving stabilization of pyrite containing wastes. The use of buried layers of sewage sludge to prevent acidification is discussed.

U.S.-UT : ore waste : VI

163. Dean, Karl C., Richard Havens, and Kimball T. Harper.
1969. **Chemical and vegetative stabilization of a Nevada copper porphyry mill tailing.** U.S. Bur. Mines Rep. Invest. 7261. 14 p., illus.
Tests were made on stabilizing windblown tailings at McGille, Nevada. Legumes, winter wheat, wheatgrasses, and wild rye were seeded and protected with a resinous adhesive chemical until sprouting. Annual precipitation is about 8 inches; strong winds are common. The tailings were slightly basic (pH 7.3 to 7.5). Fertilizer was used; no irrigation. Costs were estimated at about $135 per acre and probably could be reduced.

U.S.-NV : ore waste : VI

164. Dean, K. C., R. Havens, K. T. Harper, and J. B. Rosenbaum.
1973. **Vegetative stabilization of mill mineral wastes.** *In* Ecology and Recla-

mation of Devastated Land vol. 2: 119-136. Gordon and Breach Sci. Publ., New York.

Physical, chemical, vegetative, and combination methods of stabilizing fine wastes have been developed. Major research emphasis has been directed toward developing vegetative and combined chemical-vegetative stabilization procedures. A resinous adhesive compound used in conjunction with selected vegetation seems to be exceptionally effective for achieving stabilization. Application of this procedure effectively stabilized the fine sands of copper tailings against wind erosion.

U.S. : ore waste : VI

165. Dean, Karl C., Richard Havens, and E. G. Valdez.
1969. **Utilization and stabilization of solid mineral wastes.** U.S. Bur. Mines Salt Lake City Metall. Res. Cent. 21 p.

Possible uses for solid metallic and nonmetallic wastes from mines, mills, and smelters are reviewed. Stabilization techniques by using the physical, chemical, vegetative, and combined methods are discussed; and the advantages and problems are pointed out. Revegetative research, including the deleterious effects of salts and heavy metals, is reviewed. Interactions of fertilizers with heavy metals, physical and chemical modifications, and dewatering effects were studied in detail. Combination tests of chemical and vegetative stabilization are described.

U.S. : ore waste : VI

166. Deely, Daniel J., and F. Yates Borden.
1969. **High surface temperatures on strip-mine spoils.** Pa. State Univ. Res. Briefs 4 (2): 15-17.

Surface temperatures were measured on dry spoil materials ranging from light sandstones to dark bituminous coal. Maximum temperatures reached 50 to 55°C on the lighter materials and 65 to 70 C on the darkest materials. Results indicate that heat injury to planted seedlings is possible on all bituminous spoils, but on the black materials the threat is especially serious.

U.S.-PA : coal-B : III-C

167. Deely, Daniel J., and F. Yates Borden.
1973. **High surface temperatures on strip-mine spoils.** *In* Ecology and Reclamation of Devastated Land vol. 1: 69-79. Gordon and Breach Sci. Publ., New York.

Surface temperatures of strip-mine spoil material consistently reached 50 to 55°C on the lightest colored materials, and 65 to 70°C on the darkest materials. The average temperature difference observed between the lightest and the darkest spoil materials was approximately 15°C. Spoil materials that underwent the largest decreases in surface moisture content experienced the greatest rises in surface temperature following rain, maximum surface temperatures generally increasing at an average rate of 2 to 4°C per day for the first 6 to 10 days after rain. The surface temperatures recorded indicated that heat injury to plant seedlings is a very real possibility on spoil materials, and especially on the black material.

U.S.-PA : coal-B : III-C

168. Deely, Daniel J., Orville R. Russell, and Frank J. Wobber.
1973. **Applications of aerial and orbital remote sensing to the study of mined lands.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 15-25. Bitum. Coal Res., Inc., Monroeville, Pa.

Various kinds of remote-sensing imagery have been investigated for their ability to provide information about mining operations and their usefulness in monitoring reclamation. The use of black and white low-altitude photography is well known and is often used for field reference maps and recording baseline and operating conditions. Earth Resources Technology Satellite imagery, which records in four spectral bands, distinguishes vegetation from bare land and can identify bodies of water 100 feet at the narrowest dimension. The advantage of ERTS imagery is repetitive coverage, which shows continuing changes such as seasonal effects on vegetation and moisture. High-altitude aerial photography gives more detail and is more accurate than ERTS imagery. Color infrared film is considered at present to be best for the majority of uses.

U.S.-PA : coal-B : I-B

169. Deitschman, Glenn H.
1950. **Comparative survival and growth of trees planted under three types of overhead cover on strip-mined land in southern Illinois.** USDA For. Serv. Cent. States For. Exp. Stn. Note 63. 2 p. Columbus, Ohio.

Beneficial effects of cover upon the early development of underplanted species—fairly tolerant to shading—were demonstrated.

U.S.-IL : coal-B : VI-B

170. Deitschman, Glenn H.
1950. **Seedling survival and height growth on graded and ungraded strip-mined land in southern Illinois.** USDA For. Serv. Cent. States For. Exp. Stn. Note 62. 2 p., illus. Columbus, Ohio.

Tree plantings were made to compare survival and height growth on graded versus ungraded spoils. The grading did not affect survival, but growth was better on ungraded spoils.

U.S.-IL : coal-B : VI-B

171. Deitschman, Glenn H.
1956. **Growth of underplanted hardwoods in black locust and shortleaf pine plantations.** USDA For. Serv. Cent. States For. Exp. Stn. Note 94. 2 p. Columbus, Ohio.

Native hardwoods planted under black locust were taller than those planted under shortleaf pine. Early results are presented.

U.S.-IL, IN : coal-B : VI-B

172. Deitschman, Glenn H., and Richard D. Lane.
1952. **Forest planting possibilities on Indiana coal-stripped lands.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 131. 57 p., illus. Columbus, Ohio.

This survey report lists and describes the extent and major conditions on Indiana coal-stripped lands that affect forest plantings and presents tentative forest-planting guides and recommendations for the more important bank types and conditions. Recommendations are based upon a reconnaissance of strip-mined lands, an examination of older plantings and natural forest, and the results of forest planting experiments. The work is beneficial in evaluating site factors on stripped lands for future plantings.

U.S.-IN : coal-B : III+VII-D

173. Deitschman, Glenn H., and J. W. Neckers.
1953. **Identification and occurrence of sulfides on land stripped for coal.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 136. 21 p., illus. Columbus, Ohio.

A field test for estimating the concentration of sulfides in overburden materials is reported. Results obtained by the test correlated with laboratory analyses for total S. Sulfides were found to be highest in dark carbonaceous spoils and in strata laying near coal seams. Prediction of mine-bank acidity has to be based on sulfide content, initial pH, and physical properties of spoil.

U.S.-IL, IN : coal-B : III

174. DenUyl, Daniel.
1962. **Survival and growth of hardwood plantations on strip mine spoil banks of Indiana.** J. For. 60: 603-606.

Eleven growing seasons is not enough time to determine suitability of certain hardwood species for extensive plantings. Only cottonwood reached crop-tree size. Longer periods of time and more carefully controlled experiments are needed before species selection can be done with certainty.

U.S.-IN : coal-B : VI-B

175. Despard, Thomas L.
1974. **Avoid problem spoils through overburden analysis.** USDA For. Serv. Gen. Tech. Rep. NE-10. 4 p. Northeast. For. Exp. Stn., Upper Darby, Pa.

Indiscriminate placement of toxic overburden at the spoil surface creates reclamation problems. Evaluation of material before mining has begun is suggested. This can be done by core-drilling the area and analyzing the core samples for toxic strata. Mining plans can be devised that will insure burial of such material.

U.S.-KY : coal-B : III

176. Deul, Maurice.
1968. **Turbidity measurements as an indicator of solids content of neutralized mine water.** Coal Mine Drain. Res. Symp. 2 Proc.: 35-38. Bitum. Coal Res., Inc., Monroeville, Pa.

Turbidity measurements are accurate indicators of suspended solids content only for a narrow range of sizes and solids composition. For acid mine waters neutralized with lime or limestone, the suspended solids content, as estimated by a Jackson candle turbidity apparatus, diverges greatly from the actual solids content determined gravimetrically. The experimental results show that turbidity measurements do not give an accurate estimate of the concentration of suspended solids in neutralized mine water effluent.

U.S. : coal-B : IV-E

177. Dickerson, John A., and W. E. Sopper.
1973. **The effect of irrigation with municipal sewage effluent and sludge on selected trees, grasses and legumes planted in bituminous strip mine spoil.** Pa. State Univ. Sch. For. Res. Res. Briefs 7 (1) : 1-4.

Municipal sludge and sewage effluent can be used to ameliorate harsh site conditions found on bituminous spoil banks.

U.S.-PA : coal-B : VI-B

178. Dickman, Irving J.
1964. **The strip-mine reclamation program in Ohio.** Ohio J. Sci. 64 (2) : 165-168.

Discusses the provisions of the Strip Coal Mining Act of 1948 and the requirements of the new and amended laws passed in 1949, 1955, and 1959. The factors affecting mining and the ultimate use of reclaimed lands are outlined.

U.S.-OH : coal-B : VIII-A

179. Dietrich, I. T.
1973. **An historical overview of strip mine reclamation in North Dakota.** *In* Some environmental aspects of strip mining in North Dakota. N.D. Geol. Surv. Educ. Ser. 5: 49-51.

Success in revegetation has been variable. Leveling and placing topsoil adds greatly in revegetation of spoil area.

U.S.-ND : coal-L : VI-B

180. Dravkovic, Dragoljub.
1973. **Reclamation methods to prevent water pollution in the Morava River Watershed.** *In* Ecology and Reclamation of Devastated Land vol. 2: 361-378. Gordon and Breach Sci. Publ., New York.

Damages caused by sediments from eroded lands and mined areas in the Morava Watershed in Serbia are discussed. Slope terracing and establishment of vegetative cover were effective in achieving stabilization, reducing pollution problems, and minimizing sediment loads. Plant species used are listed. Discussion on economic evaluation of the problem.

Yugoslavia : coal, other : IV-E+VI-B

181. Eck, H. V., R. F. Dudley, R. H. Ford, and G. W. Gnatt, Jr.
1968. **Sand dune stabilization along streams in the southern Great Plains.** J. Soil and Water Conserv. 23 (4): 131-134.

Although basic principles apply to sand dune stabilization everywhere, the exact procedure followed and materials used may have to be altered somewhat to achieve dune stability in a specific location. Procedures followed, plant materials, fertilizers, and mulches used in the stabilization of sand dunes are discussed.

U.S.-TX, OK : sand and gravel : VI-A

182. Edmunds, William E.
1972. **Coal reserves of Pennsylvania:**

total, recoverable, and stripable (January 1, 1970). Pa. Dep. Environ. Resour. Bur. Topog. and Geol. Surv. Inf. Circ. 72. 35 p.

Data on coal reserves in both bituminous and anthracite coal fields. Estimates on Pennsylvania's readily minable, recordable reserves are: deep mining 8 to 9 billion tons, strip-mining 1 billion tons. At the present rate of mining, these reserves represent about 50 years of strip mining and 150 years of deep mining.

U.S.-PA : coal : I-A

183. Edgerton, Barry R., and W. E. Sopper.
1974. **The effects of municipal sewage effluent and liquid digested sludge on the establishment of grasses and legumes on bituminous coal strip-mine spoils.** PA. State Univ. Coll. Agric. Exp. Stn. Res. Briefs 8(1) : 6-9.

Treated effluent and sludge irrigation makes possible the establishment and growth of grasses and legumes on highly acid strip-mine spoils. They supply valuable nutrients, increase pH, and decrease the concentrations of toxic metals.

U.S.-PA : coal-B : VI-B

184. Einspahr, Dean William.
1956. **Coal spoil-bank materials as a medium for plant growth.** Iowa State Coll. J. Sci. 30 (3) : 352-353.

Abstract of a Ph.D. thesis, characterizing Iowa coal mine spoils as a medium for plant growth.

U.S.-IA : coal-B : III+VI-B

185. Emrich, Grover H., and Gary L. Merritt.
1969. **Effects of mine drainage on ground water.** Ground Water 7 (3) : 27-32.

Acid mine drainage adversely affects the groundwater quality. It increases the iron and sulfate content, particularly in the vicinity of strip mines.

U.S. : coal : IV

186. Engineering and Mining Journal.
1961. **Cyanamid reclaims land as it mines in Florida's phosphate fields.** Eng. and Min. J. 162 (12) : 99.

Reclamation of mined lands by Cyanamid Company is carried out simultaneously with mining.

U.S.-FL : phosphates : VI

187. Errington, J. C., and Jack V. Thirgood.
1971. **Anyox smelter fumes long gone revegetation now under study.** N. Miner Annu. Rev. 5 p., illus.

Preliminary report on the extent of destruction of vegetation due to smelter fumes during the early years of this century in the vicinity of Anyox, British Columbia, and subsequent recovery of vegetation half a century later.

Canada-BC : other : V-A+VI-B

188. Eshbaugh, Fred P.
1949. **The place of research in relation to certain phases of strip-land reclamation in Kansas.** Kans. Acad. Sci. Trans. 52 (2) : 149-159.

The author discusses the development of spoil-reclamation research conducted by the U.S. Forest Service. Examples of studies in progress, information gained, and the areas of needed research are pointed out. An operational plan of research supported by mining industries and state and federal governments is suggested. The necessity of effective reclamation laws and an active program for strip-mine reclamation in Kansas are pointed out.

U.S.-KS, MO, OK : coal, other : VIII-C

189. Feiss, Julian W.
1965. **The national strip mine study.** Ky. Dep. Nat. Resour. Strip Mine Reclam. Symp. Proc.: 28-30. Frankfort.

Briefing on strip-mining for coal and other commodities and reclamation problems on a nationwide scale.

U.S. : coal : VIII-A

190. Feiss, Julian W.
1965. **Coal mine spoil reclamation, scientific planning for regional beauty and prosperity, national implications—scientific planning.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 12-23. University Park.

A discussion of the subject related to the total environment, in the prespective of the world, national, and coal-mining problems. The need of a land ethic, an understanding of man's relationship to the earth, water, and the air that we breathe is strongly emphasized.

U.S. : coal : VIII

191. Fenton, M. Robert.
1973. **Landscape design principles for strip-mine restoration.** *In* Ecology and Reclamation of Devastated Land vol. 2: 485-495. Gordon and Breach Sci. Publ., New York.

The Moraine State Park in western Pennsylvania contained areas that had previously been strip-mined. These areas had to be reclaimed so that they would blend in with the surrounding unmined areas. Grading, drainage control, and planting of vegetation were used to reduce pollution and to enhance the scenic values of the park. Design principles such as spatical characteristics, land forms, type and arrangement of vegetation, and location of walks and overlooks were considered in the overall plan. Actual reclamation was done on a work-unit basis, but the units were arranged in sequence to provide a continuous experience for the park visitor.

U.S.-PA : coal-B : VI

192. Finn, Raymond F.
1952. **The nutrient content of leaves and tree growth as affected by grading on three strip-mined areas.** USDA For. Serv. Cent. States For. Exp. Stn. Stn. Note 70. 2 p., illus. Columbus, Ohio.

White ash and yellow-poplar grew equally well on graded and ungraded spoils derived from sandstones and shales. Growth was significantly better on ungraded spoils derived from limestone. No marked differences in foliar N, P, and Cu between graded and ungraded spoils were noted.

U.S.-OH : coal-B : VI-B

193. Finn, Raymond F.
1953. **Foliar nitrogen and growth of certain mixed and pure forest plantings.** J. For. 51: 31-33.

Foliar N and the growth of certain forest species were compared in various covers. Some species showed greater heights and foliar N when associated with tree covers on old fields or bare spoils. Black locust was superior cover. Yellow-poplar, black walnut, and black cherry made the greatest response to improved N provided by black locust.

U.S.-OH : coal-B : VI-B

194. Finn, Raymond F.
1958. **Ten years of strip-mine forestation research in Ohio.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 153. 38 p., illus. Columbus, Ohio.

Ten-year results of tree-planting studies conducted on coal-mine spoils in southeastern Ohio are summarized. Species adaptation, mixed plantings, direct seeding, planting methods, and effect of spoil grading are discussed.

U.S.-OH : coal-B : VI-B

195. Fisher, Wilson.
1972. **Airborne infrared detection and mapping of coal mine drainage.** Coal Mine Drain. Res. Symp. 4 Proc.: 331-339. Bitum. Coal Res., Inc., Monroeville, Pa.

Airborne infrared (IR) imaging systems were used to detect and map acid mine water and fresh water sources and their drainageways. Seasonal experiments over a subwatershed illustrate the utility of this approach in establishing the relative quantity of acid mine water with seasonal hydrologic change. Although the method does not discriminate between acid water and fresh water, most of the acid water sources are recognized by association with deep-mine or strip-mine features.

U.S. : coal : I-B+IV

196. Foreman, John W.

1972. **Evaluation of mine sealing in Butler County, Pennsylvania.** Coal Mine Drain. Res. Symp. 4 Proc.: 83-95. Bitum. Coal Res., Inc., Monroeville, Pa.

Two projects on deep-mine sealing are discussed. On the basis of this experience it is reasonable to anticipate that, while the success of individual seals may vary widely, the overall effect of a deep-mine sealing project will reduce acid loadings by more than 60 percent. Some cost figures are given.

U.S.-PA : coal-B : VI

197. Foreman, John W., and Earl G. Tarr.

1968. **Moraine State Park mine drainage project.** Coal Mine Drain. Res. Symp. 2 Proc.: 246-254. Bitum. Coal Res., Inc., Monroeville, Pa.

Describes the work under way on 16,000-acre demonstration area known as Moraine State Park, for rehabilitation of coal-mined lands in Pennsylvania.

U.S.-PA : coal-B : VI

198. Foresman, Frank J.

1952. **Stripped land rehabilitation.** Am. Min. Congr. Coal Mine Mod. Year. 7 p.

Describes how strip pits have been converted into forest, farming and pasture lands, and recreational areas.

U.S.-KS : coal-B : VII

199. Fowler, Dale K., and Charles H. Peery, III.

1973. **Three years' development of a public use wildlife area on a mountain coal surface mine in southwest Virginia.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 319-333. Bitum. Coal Res., Inc., Monroeville, Pa.

The 9,760-acre Hagy Wildlife Management Area was established in Wise County, Va. The purpose was to demonstrate that coal-mine spoil could be developed as an integral portion of a public-use wildlife area. Cooperating agencies were: Penn Virginia Corp., Virginia Division of Mined Land Reclamation; Virginia Commission of Game and Inland Fisheries, and TVA. The terms of cooperative agreement, and the function and responsibilities of the cooperators are described; and the early results of reclamation and the technique used are discussed.

U.S.-VA : coal-B : VII-E

200. Fox, Alfred C.

1971. **Development and impoundment of drastically disturbed surface mined lands for fishing.** Rehabil. Drastically Disturbed Surf. Mined Lands Symp. Proc.: 109-111. Ga. Surface Mined Land Use Board. Macon.

Development of surface-mined lands for fisheries use is a widely utilized method of useful reclamation. Methods for impoundment management on surface-mined lands will have to be improved considerably before the use of these areas can be maximized. Very little work has been done in Georgia to evaluate impoundment management in kaolin mining areas.

U.S.-GA : coal, other : VII-G

201. Francis, James M.

1973. **Stabilizing iron-ore tailings with vegetation.** *In* Ecology and Reclamation of Devastated Land vol. 2: 451-455. Gordon and Breach Sci. Publ., New York.

An area of 200 acres of iron ore mine waste was successfully planted with grasses, shrubs, and trees. A 7-year report.

U.S.-PA : ore waste : VI-B

202. Frank, Robert M.

1964. **A guide for screen and cover planting of trees on anthracite mine-spoil areas.** USDA For. Serv. Res. Pap. NE-22. 50 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.

Areas disturbed by coal mining were mapped and classified according to kind of spoil, density of natural tree cover, and visibility. Potential sites for screen and cover plantings were delineated, and the number of tree seedlings needed for planting programs was estimated.

U.S.-PA : coal-A : III-A+VI-B+VII-A

203. Frawley, Margaret L.
1971. **Surface mined areas; control and reclamation of environmental damage.** U.S. Dept. Inter. Bibliogr. Ser. 27. 63 p.
This bibliography lists 387 references about soil shifts, chemical modification, and water pollution resulting from surface mining and the restoration of mined areas. Only material published in the United States during the period from June 1960 to June 1970 is included. The material is arranged in four categories: (1) general, (2) environmental effects, (3) protective measures and (4) reclamation. Name and subject indexes are included.

U.S. : coal : VIII-E

204. Freese, Frank.
1954. **Tree species for planting spoil banks in North Alabama.** Tree Planters' Notes 17: 15-18.
Sycamore and loblolly pine are the most promising species for the afforestation of spoil banks in North Alabama. The gain from fertilizing is too slight to justify the effort. A lack of spoil stability contributed to the failure of direct seeding of pines.

U.S.-AL : coal-B : VI-B

205. Funk, David T.
1962. **A revised bibliography of strip-mine reclamation.** USDA For. Serv. Cent. States For. Exp. Stn. Misc. Release 35. 20 p. Columbus, Ohio.
A list of nearly 100 references on strip-mine reclamation published since 1953 when Limstrom's original bibliography was issued, plus more than 70 technical citations that appeared in the original.

U.S. : coal : VIII-E

206. Funk, David T.
1963. **Hybrid poplars on Ohio spoil banks.** USDA For. Serv. Res. Note CS-8. 4 p. Cent. States For. Exp. Stn. Columbus, Ohio.
Fourteen selected clones of hybrid poplars survived better and grew faster on Sewickley-spoils derived from shales and sandstones than on Pittsburgh spoils derived from limestone and clay. The growth differences (after 10 years) seem to reflect spoils physical characteristics which were more favorable on Pittsburgh sites. Partial grass and herb cover apparently had a depressing effect on hybrid poplar growth. Among the best parents were: *P. deltoides*, *P. maximowiczii*, *P. nigra*, and some of its cultivars.

U.S.-OH : coal-B : VI-B

207. Funk, David T.
1973. **Growth and development of alder plantings on Ohio strip-mine banks.** *In* Ecology and Reclamation of Devastated Land vol. 1: 483-491. Gordon and Breach Sci. Publ., New York.
European alder plantations containing several seed sources performed well on strip-mined areas with pH ranging from 4 to 5. After 7 years, trees from southern Germany were larger than those of northern Germany, Belgium, Denmark, or Sweden. All seed sources grew better on lower slopes than on upper slopes. *Alnus glutinosa* should be suited for use as nitrogen-fixing nurse tree; other alder species may be useful for pulpwood production.

U.S.-OH : coal-B : VI-B

208. Funk, David T., and Martin E. Dale.
1961. **European alder: a promising tree for strip-mine planting.** USDA For. Serv. Cent. States For. Exp. Stn. Stn. Note 151. 2 p. Columbus, Ohio.
European alder looks like a valuable nurse species for planting on extremely acid strip-mine spoils.

U.S.-KY, OH : coal-B : VI-B

209. Funk, David T., and Rodney H. Krause.
1965. **Fertilizing strip-mine plantings**

benefits some hardwoods. Tree Planters' Notes 71: 21-22.
Plantings on graded strip-mined lands in Ohio were fertilized with ⅓-ounce high N fertilizer pellets. Early results showed reduced survival, but total heights of fertilized American sycamore, European alder, yellow-poplar, and red oak were significantly greater than those of unfertilized trees.

U.S.-OH : coal-B : VI-B

210. Gadgil, Ruth L.
1969. **Tolerance of heavy metals and the reclamation of industrial waste.** J. Appl. Ecol. 6: 247-259.
The Zn or Cu tolerance of grasses growing on mine spoils was tested, and the results were compared with growth on slag tips. The mine-spoil plants were more tolerant to Cu or Zn than those found on slag tips or on uncontaminated soil. Statistical comparisons were made. Factors other than toxicity of a single heavy metal seem to limit plant growth. A drip-culture apparatus, suitable for use in solution tests, is described.

Great Britain : ore waste : III-B+VI-B

211. Georgia Surface Mined Land Use Board.
1971. **First symposium on the Rehabilitation of Drastically Disturbed Surface Mined Lands.** 126 p. Macon, Ga.
A collection of papers presented at the symposium by individuals representing universities, industries, and various levels of government. A wide range of reclamation and rehabilitation subjects are discussed.

U.S.-GA : kaolin : VIII-D

212. Geyer, Wayne A.
1971. **Reforesting Kansas coal spoils.** Kans. State Univ. Agric. Exp. Stn. Circ. 399. 10 p., illus. Manhattan.
Burr oak, sycamore, cottonwood, loblolly pine, and shortleaf pines are the promising species. Other pines are difficult to establish. Black walnut should be used sparingly in plantings. Spoil grading restricts tree growth.

U.S.-KS : coal-B : VII-D

213. Geyer, Wayne A.
1972. **Timber growth on graded and ungraded strip-mine spoil banks in southeast Kansas.** Kans. Acad. Sci. Trans. 74 (3 and 4): 318-324, illus.
Twenty-two years of growth and development of 13 forest species on graded and ungraded spoils are described. The grading of fine-textured spoils adversely affected the performance of trees. Spoil-grading concept is discussed.

U.S.-KS : coal-B : VII-D

214. Geyer, Wayne A.
1972. **Mined land potential for raising timber crops.** Univ. Kans. State Geol. Surv. Spec. Distrib. Publ. 65: 18-21. (1972 Mined Land Workshop Proc.)
Raising timber on coal spoils should be considered for two land forms: (1) unleveled land with established woody vegetation and (2) recently graded lands. Trees grown on unleveled lands produce cottonwood, pulpwood, firewood, charcoal wood, and sawtimber. On recently graded lands, short-term crops—cottonwood, pulpwood, southern pine posts, and Christmas trees — can be grown; and combination nut-log-grazing programs show promise.

U.S.-KS : coal-B : VII-D

215. Geyer, Wayne A.
1973. **Tree species performance on Kansas coal spoils.** *In* Ecology and Reclamation of Devastated Land vol. 2: 81-90. Gordon and Breach Sci. Publ., New York.
An evaluation of survival and growth of 22-year-old forest plantations on strip-mined lands in a prairie-forest transition zone of Kansas. Of 13 species tested, sycamore, eastern redcedar, burr oak, loblolly pine, and shortleaf pines performed best. Some analytical data on spoils.

U.S.-KS : coal-B : VI-B

216. Geyer, W. A., and G. G. Naughton.
1970. **Growth and management of black walnut (*Juglans nigra* L.) on strip-mined**

lands in southeastern Kansas. Kans. Acad. Sci. Trans. 73 (4): 491-501, illus.

Black walnut plantations on strip-mined lands have been established from seed. After 32 years the trees are 6.1 inches dbh and 33 feet high; site index is 40 to 45 feet. Low thinning and single-tree release more than tripled dbh growth compared to unreleased trees. Single-tree release response was best at 0.18 inch. Management of poor-site walnut trees should include early selection of high-quality trees for release and pruning.

U.S.-KS : coal-B : VI-B

217. Geyer, Wayne A., and Nelson F. Rogers. 1972. **Spoils change and tree growth on coal-mined spoils in Kansas.** J. Soil and Water Conserv. 27 (3): 114-116.

Black locust, burr oak, sycamore, loblolly pine, and shortleaf pine performed best after 22 years. Tree height increased from lower to upper portions of slopes. Spoil leveling reduced tree growth and form. After 20 years, pH and percentage of soil-sized particles had increased, but P had decreased.

U.S.-KS : coal-B : VII-D

218. Gifford, Gerald F., Don D. Dwyer, and Brien E. Norton. 1972. **A bibliography of literature pertinent to mining reclamation in arid and semi-arid environments.** Utah State Univ. 23 p. Logan.

This bibliography lists 312 citations, grouped under 27 headings. Reclamation group covers: ash spoils, coal spoil banks, coppermill tailings, gold from mine tailings, Lignite spoil banks, oil-field waste, oil-shale workings, sand and gravel operations, sandy soils, slag heaps, stone and quarry dust, tin-mine workings, uranium tailings, zinc and lead mining waste. Some foreign sources pertaining to the subject are listed.

U.S. : coal, ore waste : VIII-E

219. Given, Ivan A. 1962. **The future in open-pit mining and stripping in the United States.** *In* Conservation — a key to world progress. Soil Conserv. Soc. Am. Proc.: 93-97. Des Moines, Iowa.

A forecast of trends in open-cut and strip mining in the United States by 1970. Metal and nonmetal mineral production will rise and the area affected will increase to 6,000 acres. Sand, gravel, and stone output will increase one-third and the area affected will increase on the same scale as metal and nonmetal mining. Coal output will increase 50 percent, increasing the area affected to 30,000 acres per year.

U.S. : coal, other : VIII

220. Good, D. M., V. T. Ricca, and K. S. Shumate. 1970. **The relation of refuse pile hydrology to acid production.** Coal Mine Drain. Res. Symp. 3 Proc.: 145-151. Bitum. Coal Res., Inc., Monroeville, Pa.

The hydrology of a coal-breaker refuse and the acid production were studied. It was observed that: (1) the refuse pile is reactive only at the surface; (2) between rains, the pyrite oxidation reaction proceeds at a uniform rate, the acid products accumulating in the outer mantle; (3) when the storm occurs, about 70 percent of acid salts appear in the runoff and the remainder is carried into the interior of the pile, eventually reappearing as seepage; (4) the rate of acid formation in the pile is 185 pounds acidity per acre day as $CaCO_3$.

U.S.-IL : coal-R : IV

221. Goodman, Gordon T., Carole E. R. Pitcairn, and Raymond P. Gemmell. 1973. **Ecological factors affecting growth on sites contaminated with heavy metals.** *In* Ecology and Reclamation of Devastated Land vol. 2: 149-173. Gordon and Breach Sci. Publ., New York.

Factors that prevent or retard germination, establishment, or growth of plants on mine-working dumps in the Swansea Valley are: "sand blasting" wind-barking; diurnal temperature extremes; water stress; low pH; metal toxicity; macronutrient deficiency; and vandalism. To counteract these, N-P-K fertilizer and organic matter were added, and grass was sown. Trees and shrubs were also grown on the less toxic sites. Heavy metal-tolerant genotypes of grasses were planted. Results show that the latter require less soil treatment and are more productive and persistent than nontolerant grass varieties. However, even highly tolerant grass varieties are of little value on very toxic sites without incorporation of an organic amendment.

Great Britain : ore waste : III+VI-B

222. Gooley, Walter.
1974. **What happens after the gravel's gone.** N. Logger 22 (7) : 22, 26.

White and red pine planted on graded gravel pits show promise in turning barren land into productive forest.

U.S.-ME : sand and gravel : VI-B

223. Gordon, Alan G., and Eville Gorham.
1963. **Ecological aspects of air pollution from an iron-sintering plant at Wawa, Ontario.** Can. J. Bot. 41: 1063-1078, illus.

Vegetation has been damaged severely by SO_2 pollution from iron-sintering plants. It is traceable for 20 miles in a northeasterly direction from the plant, being severe within 11 miles and very severe within 5 miles of the plant. Ground flora declines markedly with respect to the number of plants per unit area and the number of plant species present. The most tolerant species to air pollution are *Polygonum cilinode* and *Sambucous pubens*. Waters up to 5 miles northeast of the plant are strongly acid.

Canada-ON : ore waste : V-A

224. Gordon, J. M.
1969. **Erosion control at Hollinger Mine tailing site.** Can. Min. J. 90 (6): 46-50, illus.

Establishing a vegetative cover on mill tailings is discussed. Fertilizer rates, seedings, and grass species are listed. A novel aspect is use of sewage sludge on the area; highly successful. Scrub trees are planted as a windbreak, and conifers will be planted in subsequent years.

Canada : ore waste : VI-B

225. Gorham, Eville, and Alan G. Gordon.
1960. **Some effects of smelter pollution northeast of Falconbridge, Ontario.** Can. J. Bot. 38: 307-312.

Strong sulfate accumulation in the surface soil occurred within 1 mile of the chimneys emitting SO_2 while effects upon the soil-drainage waters are marked to a distance of 2 miles, and still clearly evident 10 miles away. The number of plant species declines within 4 miles of the smelter, but certain species disappear at much greater distances. Most tolerant are *Acer rubrum, Quercus rubra, Sambucus pubens,* and *Polygonum cilinode*.

Canada-ON : ore waste : V+V-A

226. Gorham, Eville, and Alan G. Gordon.
1960. **The influence of smelter fumes upon the chemical composition of lake waters near Sudbury, Ontario, and upon the surrounding vegetation.** Can. J. Bot. 38: 477-487.

Analyses for sulfate, Ca, and pH have been made on waters from the lakes in the Sudbury metal smelting district. Sulfur pollution is high within 5 miles of the smelters, exhibiting from 3 to 10 times sulfate concentration normal for this area. Polluted waters are acid, with pH 3.3. Damage to terrestrial vegetation is marked within 5 miles of smelters. Severe damage occurs chiefly within 2 miles of the smelters.

Canada-ON : ore waste : V-B

227. Gorham, Eville, and Alan G. Gordon.
1963. **Some effects of smelter pollution upon aquatic vegetation near Sudbury, Ontario.** Can. J. Bot. 41: 371-378.

The numbers of macrophyte species present in ponds and lakes are inversely related to dissolved sulfates. Although pollution leads to strong acidification, numbers of species are low even where H_2SO_4 is almost wholly neutralized. It is suggested that increases in concentration of heavy metals reach the toxic levels near the smelters.

Canada-ON : ore waste : V-B

228. Grandt, Alten F.

1948. **The potentialities of revegetating and utilizing agronomic species on strip mined areas in Illinois.** Univ. Ill. Agric. Exp. Stn. and Ill. Coal Strippers Assoc. 1st Yr. Prog. Rep. 32 p., illus.

This report deals principally with the proposed scope and plan of attack on the problem, a statewide survey of spoils, and preliminary reports on a number of seeding projects.

U.S.-IL : coal-B : I-B+VII-C

229. Grandt, Alten F.

1949. **The potentialities of revegetating and utilizing agronomic species on strip mined areas in Illinois.** Univ. Ill. Agric. Exp. Stn. and Ill. Coal Strippers Assoc. 2nd Yr. Prog. Rep. 56 p., illus.

This progress report presents further information on spoils, comparing spoil materials with surface soils on adjoining unmined land. Preliminary results are presented on studies of comparative gains made by animals pastured on spoil banks with those pastured on undisturbed blue grass and highly improved grass-legume pasture. The adaptation of various forage species to spoil is discussed.

U.S.-IL : coal-B : VII-C

230. Grandt, Alten F.

1950. **The potentialities of revegetating and utilizing agronomic species on strip mined areas in Illinois.** Univ. Ill. Agric. Exp. Stn. and Ill. Coal Strippers Assoc. 3rd Yr. Prog. Rep. 39 p., illus.

Additional information for comparing spoils with soils. Adaptation of forage species to spoils is discussed along with the chemical composition of forage species. Animal weight gains are discussed.

U.S.-IL : coal-B : VII-C

231. Grandt, Alten F.

1951. **The potentialities of revegetating and utilizing agronomic species on strip mined areas in Illinois.** Univ. Ill. Agric. Exp. Stn. and Ill. Coal Strippers Assoc. 4th Yr. Prog. Rep. 70 p., illus.

A review of previous annual reports, updating information about forage-crop species adaptation to spoils, spoil chemistry, and weight gains of grazing animals.

U.S.-IL : coal-B : III-B+VII-C

232. Grandt, Alten F.

1952. **The potentialities of revegetating and utilizing agronomic species on strip mined areas in Illinois.** Univ. Ill. Agric. Exp. Stn. and Ill. Coal Strippers Assoc. 5th Yr. Prog. Rep. 56 p., illus.

This report summarizes chemical and physical characteristics of strip-mine spoils. Species-adaptation trials are further summarized as are forage yields and animal weight gains. Some effects of liming are presented. Different spoil-grading methods were shown to influence water infiltration.

U.S.-IL : coal-B : III+VI-A+VII-C

233. Grandt, Alten F.

1965. **Reclamation for pasture and agricultural crops.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 124-128. University Park.

Mined lands in Illinois are readily adapted to pasture and hay land uses. Other crops can be grown successfully. Spoils can be classified on the basis of acidity and texture. With the exception of N, the plant nutrients are high. Reclaimed spoils are used as pasture for beef cattle. Certain steers gained 2 pounds per day in a 180-day grazing period. Carrying capacity is about 2 acres per animal.

U.S.-IL : coal-B : VII-C

234. Grandt, Alten F.

1967. **Agriculture crops.** Ky. Dep. Nat. Resour. Strip Mining Symp. 5 p. Frankfort.

Crops adapted to spoil materials are the forage species — legumes and grasses. Grain crops are rarely used. The kind of crop to be used depends on spoil characteristics.

U.S.-KY : coal-B : VII-C

235. Greczta, Jan.
1973. **The recultivation of post-industrial territories.** *In* Protection of Man's Natural Environment. Pol. Acad. Sci. 417 p. Warsaw.

The author analyzes the problems of managing post-industrial wastelands in Poland, discussing trends in the liquidation of post-industrial wastelands; classification of wastelands; the recultivation of wastelands; and legislation and the organization of work in the field of recultivation. Reclamation of coal-mine spoils is emphasized.

Poland : coal : III+VI

236. Greszta, Jan, and Stanislaw Morawski.
1972. **Rekultywacja nieuzytkow poprzemyowych (Reclamation of post-industrial waste lands).** State Publ. Co. for Agric. and For. 263 p. Warsaw.

The authors discuss the reclamation efforts of coal-mine spoils for agriculture, forestry, and recreation purposes in Silesian industrial areas of Poland. Physical and chemical characteristics of spoil materials, natural plant succession, physical stabilization of spoils, planting, and planting materials suitable for recultivation are discussed.

Poland : coal : III+VI

237. Grim, Elmore C.
1967. **Kentucky's reclamation program.** Ky. Eng. 30(1): 9. Univ. Ky. Coll. Eng., Lexington.

The strip-mining methods employed to recover coal in Kentucky are described, and the implementation of mining and reclamation laws is discussed.

U.S.-KY : coal-B : II-B+VI

238. Grim, Elmore C.
1967. **Kentucky after one year.** Ky. Dep. Nat. Resour. Strip Mining Symp. 6 p. Frankfort.

The key provisions of the strip-mining law, passed in 1966, and administration of the law and working relationships with the industry and governmental agencies are discussed.

U.S.-KY : coal-B : VIII-A

239. Gronow, Clive W.
1971. **Reclamation problems and needs of the surface mining industry.** Rehabil. Drastically Disturbed Surf. Mined Lands Symp. Proc.: 116-126. Ga. Surface Mined Land Use Board. Macon.

A big problem of the industry is the conservationist's emotionalism. To combat this, the industry must bridge the communication gap by educating the general public. Technical and practical problems are: (1) nature of the overburden, (2) climate, (3) mining methods and reclamation costs, and (4) the law.

U.S.-GA : kaolin : VIII

240. Grube, Walter E., Jr., Richard M. Smith, Rabindar N. Singh, and Andrew A. Sobek.
1973. **Characterization of coal overburden materials and mine soils in advance of surface mining.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 134-152. Bitum. Coal Res., Inc., Monroeville, Pa.

Chemical analyses of sequential samples of the overburden have provided information about acid-producing potential of different zones of the overburden, and simplified laboratory and field test for determination of (1) pyritic S content, using total S after sulfate removal by leaching; (2) peroxide method to estimate potential acidity; (3) use of color evaluation to measure presence of reduced S; and (4) reaction with dilute acid. Soil testing procedures used for Na, K, Ca, Mg were adequate to evaluate availability of these nutrients for plant growth. The usefulness of the sodium bicarbonate extraction technique for measuring available P is substantiated.

U.S. : coal : III-B

241. Guernsey, Lee.
1958. **Reclamation of strip-mined lands**

in Vigo County, Indiana. Ind. Acad. Sci. Proc. 67: 215-224, illus.

Topping of the ridges to about 8 feet wide is the procedure for grading spoil banks to be planted in trees. Mixed pines and hardwoods will produce high-quality forests on spoil banks. More intensive land uses can be accomplished by more complete grading and sowing of grasses and legumes. The compaction due to grading has been greatly exaggerated. Construction of dams in the last open cut can provide lakes for recreational areas.

U.S.-IN : coal-B : VI-A, B

242. Guernsey, Lee.
1960. **The reclamation of strip mined lands in western Kentucky.** J. Geog. 59 (1): 5-11, illus.

Outlines the provisions of the Strip Mining and Reclamation Act and discusses the advantages of spoil grading and the effects of tree planting and seeding of grasses and legumes. Potentials of reclaimed areas for recreational uses are pointed out.

U.S.-KY : coal-B : VI

243. Gwynn, Thomas A.
1965. **Reclaiming strip-mined land in North Dakota by establishing game management areas.** Knife River Coal Mining Co. 46 p., illus.

Report of Knife River Coal Mining Co. on lignite coal-mine spoils in North Dakota and on company's efforts to revegetate them for game food and cover. It is concluded that the spoils will support the growth of trees and shrubs and that the leveling of spoils is not recommended.

U.S.-ND : coal-L : VI-B

244. Gwynn, T. A.
1973. **Environmental implications of developing our coal reserves.** *In* Some environmental aspects of strip mining in North Dakota. N.D. Geol. Surv. Educ. Ser. 5: 87-107.

Environmental implications in strip-mining for lignite are discussed. Effective environmental protection requires a joining together of the best that industry, conservation groups, and government agencies have to offer.

U.S.-ND : coal-L : V

245. Hall, Dee.
1965. **Strip mine reclamation under the 1964 act (western Kentucky).** Ky. Dep. Nat. Resour. Strip Mine Reclam Symp. Proc.: 9-10. Frankfort.

Comments on strip-mine reclamation under the provisions of 1964 act as compared with 1962 act.

U.S.-KY : coal-B : VIII-A

246. Hall, Ernst P.
1965. **The Sheban project.** Acid Mine Drain. Res. Symp. 1 Proc.: 145-160. Bitum. Coal Res., Inc., Monroeville, Pa.

Water impounded in the strip-mine, and drained through the spoil bank, improved in quality and decreased in quantity with time. Consequently the acid and sulfate load on the receiving stream decreased. Data on physical background of the mine, geology, chemistry of impounded water, spoil biology, and limnology of the water discharged from the mine are presented.

U.S.-OH : coal-B : IV-H

247. Hall, Harry H.
1940. **The romance and reclamation of the coal lands of southeastern Kansas.** Kans. Acad. Sci. Trans. 43: 57-67.

A brief history of strip-mining for coal in Kansas. Examples of conversion of waste land for profit such as a quail farm, a state park, and orchards are discussed.

U.S.-KS : coal-B : VII

248. Hanna, George P., Jr.
1964. **The relation of water to strip-mine operation.** Ohio J. Sci. 64 (2): 120-124.

A discussion of the hydrologic properties affecting the acid mine problem, the techniques used in gathering data, and the application of these techniques to engineering procedures. Reference is made to the Beaver Creek study, in regard to application of such knowledge in evaluating the effect of hydrological conditions on water quality. Application of known alleviation methods under controlled conditions and the monitoring of the controls to continue evaluation of the various procedures are urged.

U.S.-OH : coal-B : IV

249. Hanson, Edward A.
1968. **Stabilizing eroding streambanks in sand drift areas of the Lake States.** USDA For. Serv. Res. Pap. NC-21. 12 p., illus. N. Cent. For. Exp. Stn., St. Paul, Minn.

Banks are stabilized to protect adjacent high-value items such as cabins and campgrounds or to reduce reservoir or lake sedimentation rates. Also, bank stabilization is undertaken as one part of fish-habitat improvement programs. Rock riprap is the best material for bank stabilization in most cases. It does not deteriorate with time, and it blends in well with surroundings. The upper part of the bank will revegetate naturally. However, sloping and seeding will accelerate vegetation.

U.S. : other : VI-B+VII-B

250. Hart, George E., and William R. Byrnes.
1959. **Performance of trees planted on coal-stripped lands in the bituminous region of Pennsylvania.** PA. State For. Sch. Res. Pap. 28. 2 p. University Park.

A summary of 10-year performance of 16 tree species planted on bituminous coal-mine spoils.

U.S.-PA : coal-B : VI-B

251. Hart, George E., and William R. Byrnes.
1960. **Trees for strip-mined lands.** USDA For. Serv. NE For. Exp. Stn. Pap. 136. 36 p., illus. Upper Darby, Pa.

Ten-year survival and growth data on 16 tree and 4 shrub species planted on coal-stripped lands in the bituminous region of Pennsylvania are reported. Performance of species is rated, and spoil characteristics are discussed.

U.S.-PA : coal-B : VI-B

252. Hashimoto, Nobuyoshi, Toshiro Kojima, Makoto Ogawa, and Tadashi Suzuki.
1973. **Effect of alder and acacia on devastated land.** *In* Ecology and Reclamation of Devastated Land vol. 1: 357-367. Gordon and Breach Sci. Publ., New York.

Hinoki (*Chamaecyparis obtusa* Sieb. and Zucc.), an important silvicultural tree in Japan, can grow vigorously on poor sites when planted with alder (*Alnus tinctoria* Sarg. var. *glabra* Call). After alder planting, soil structure developed strongly; the cation exchange capacity apparently increased and the N and C content of the surface horizon also increased. Acacia also changed the soil conditions but not so favorably.

Japan : other : III-B+VI-B

253. Havens, Richard, and Karl C. Dean.
1969. **Chemical stabilization of the uranium tailings at Tuba City, Ariz.** U.S. Dep. Inter. Bur. Mines Rep. Invest. 7288. 12 p.

Acid and basic uranium mill tailings were stabilized against wind erosion by use of an elastomeric polymer on the dike areas and a calcium magnesium lignosulfonate on the beach areas. Cost was $335 per acre. Details of application methods and cost breakdown are given.

U.S.-AZ : ore waste : VI+VIII-B

254. Haynsworth, Harry J.
1971. **Experience of Soil Conservation Service in revegetating drastically disturbed sites.** Rehabil. Drastically Disturbed Surf. Mined Lands Symp. Proc.: 104-108. Ga. Surface Mined Land Use Board. Macon.

With development of the small watershed program of the SCS, special attention was directed toward selection of plants for vegetating problem areas. As a result of this attention, standards and specifications have been developed for many critical sites in the state of Georgia. The standards and specifications include plant species, rate and dates of seeding, mixtures, fertilizers, lime, and mulch requirements.

U.S.-GA : other : VI-B

255. Heide, Gunther.
1973. **Pedological investigations in the Rhine brown-coal area.** *In* Ecology and Reclamation of Devastated Land vol. 2: 295-313. Gordon and Breach Sci. Publ., New York.
Manner and size of recultivation of brown coal spoils are determined by the extent and quantities of the overburden. The Pleistocene and Tertiary strata of sand and gravel are reclaimed for forest. For agriculture, the covering of overburden by loess layer is recommended. The chemical and physical characteristics of the new soils as well as a typological development toward "Parabraunerde" is shown. An increase in nutrient content and productivity under various methods of cultivation is discussed.

Germany : coal : III+VI-B

256. Heine, Walter N., and William E. Guckert.
1973. **A new method of surface coal mining in steep terrain.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 105-116. Bitum. Coal Res., Inc., Monroeville, Pa.
In the modified "block-cut" method of mining, work is planned so that overburden from the first cut is placed in a swale or gully on the hillside, and as mining progresses, overburden is deposited in previously mined sections. This method of mining is discussed in relation to the surface mining requirements of Pennsylvania, and it is pointed out that the impact of surface mining is minimized because overburden is not pushed downslope from the mined area to become subject to erosion and landslides.

U.S.-PA : coal-B : II-B

257. Hertsgaard, T. A., and F. L. Leistritz.
1973. **Environmental impact of strip mining: the economic and social viewpoint.** *In* Some environmental aspects of strip mining in North Dakota. N.D. Geol. Surv. Educ. Ser. 5: 73-85.
The economic and social implications of strip-mining for lignite are discussed.

U.S.-ND : coal-L : VIII-B

258. Higgins, Tom.
1973. **The planning and economics of mined-land use for agricultural purposes.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 287-293. Bitum. Coal Res., Inc., Monroeville, Pa.
The experience of Peabody Coal Company shows that strip-mined land can be restored successfully to agricultural use. Problems with toxic soil can be reduced by mining methods, soil treatment, and choice of plants for seeding. After the reclaimed land has been revegetated, its use depends on its relation to other land in the same area. By company policy, the agricultural land is organized into family farm units. Beef cow-calf operations of live-stock share leasing are used as an example of the costs and benefits incurred in one use of strip-mined land. Experiences with dairying and with farming of hay and row crops and cereal grain crops are also discussed.

U.S. : coal-B : VII-C

259. Hill, Lawrence W.
1960. **How precipitation affects strip-mine pond water levels in Southeast Ohio.** USDA For. Ser. Cent. States For. Exp. Stn. Columbus, Ohio.
Precipitation was related to resulting pond-level increase on a 16-acre watershed containing a 5-acre pond. Results showed a close correlation between precipitation and runoff of a strip-mined watershed. Pond level increases became greater as spoil bank : pond ratio became larger.

U.S.-OH : coal-B : IV-H

260. Hill, Ronald D.
1970. **Elkins mine drainage pollution control demonstration project.** Coal Mine Drain. Res. Symp. 3 Proc.: 284-303. Bitum. Coal Res., Inc., Monroeville, Pa.

A mine-drainage pollution-control demonstration project near Elkins, W. Va., is described. The effects on water quality of air-scaling, reclamation and reforestation, and diverting water from underground mines were studied. The air-scaling was with small exceptions unsuccessful, and the pollution loads have not decreased. The reclamation and revegetation showed some benefits, but the long-term effects have to be determined. Combined watersheds of Roaring Creek and Grassy Run showed over a 1,500-ton decrease in the acidity load.

U.S.-WV : coal-B+R : V-B

261. Hill, Ronald D., and John F. Martin.
1972. **Elkins mine drainage pollution control demonstration project — an update.** Coal Mine Drain. Res. Symp. 4 Proc.: 96-104. Bitum. Coal Res., Inc., Monroeville, Pa.

The Elkins Project has produced both encouraging and discouraging results. The reclamation and revegetation of surface mines and refuse piles have resulted in a decrease in the pollution load from that source. Several years will be required before all the residual pollutants are leached from the reclaimed spoil and the water approaches a stable condition.

U.S.-WV : coal-B+R : V-B

262. Hodder, Richard L.
1973. **Surface mined land reclamation research in eastern Montana.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 82-91. Bitum. Coal Res., Inc., Monroeville, Pa.

Rainfall in eastern Montana averages 12 inches per year. Several methods are discussed for making the most effective use of this sparse rainfall in land reclamation. Dryland planting innovations include condensation traps, supplemental root transplanting, and tubelings. Surface manipulation or configuration such as deep chiseling, gouging, or dozer basins are necessary to minimize erosion, relieve compaction, and improve the soil moisture reserve necessary to rapidly establish a desirable lasting vegetative cover.

U.S.-MT : coal-L : VI-B

263. Hodgson, D. R., R. Holliday, and F. Cope.
1963. **The reclamation of land covered with pulverized fuel ash: The influence of soil depth on crop performance.** J. Agric. Sci. 61:299-308.

From a study on the restoration of land covered with pulverized fuel ash, the effects of increasing depths of soil on agricultural crop production, and at a range of fertilizer levels, are reported. Results indicate the soil depths needed for successful restoration and the extent to which fertilizers can be used to replace soils.

Great Britain : fuel ash : VI-B

264. Hodgson, D. R., and W. N. Townsend.
1973. **The amelioration and revegetation of pulverized fuel ash.** *In* Ecology and Reclamation of Devastated Land vol. 2: 247-271. Gordon and Breach Sci. Publ., New York.

Methods of ameliorating adverse conditions of pulverized fuel ash are discussed. Revegetation of pulverized fuel ash is considered in the context of land restoration for agriculture and other uses. A preliminary classification of trees and shrubs according to ash tolerance and tentative results of trials are reported.

Great Britain : fuel ash : VI-B+VII

265. Hoffman, Glenn J., R. Bruce Curry, and Glenn O. Schwab.
1964. **Annotated bibliography on slope stability of strip mine spoil banks.** Ohio Agric. Exp. Stn. Res. Cir. 130. 92 p. Wooster.

This bibliography is compiled in alphabetical order by authors. It lists 366 citations on slope stability of strip-mine spoils and other banks on a global scale, including works in English, German, Russian, French, Italian, and other languages. About 40 references are annotated; subject index.

U.S. : coal : VIII-E

266. Hoffman, Glenn J., Glenn O. Schwab, and R. Bruce Curry.
1964. **Slope stability of coal strip mine spoil banks.** Ohio Agric. Exp. Stn. Ser. 8. 24 p. Wooster.
Steepness of slope, excessive soil moisture and a reduction in the shearing resistance of the soil due to severe weathering and freeze-thaw cycles appeared to be important facts in the stability of spoil banks. Numerous other factors make it difficulty to make recommendations on predicting spoil stability.

U.S.-OH : coal-B : VI-A

267. Hogg, J. L. E.
1971. **Mined-land reclamation in British Columbia.** For. Chron. 47 (6): 1-40.
The author discusses the mining industry, the adverse effects of mining operations, reclamation, and the reclamation legislation in British Columbia.

Canada-BC : coal : VI+VIII-A

268. Holland, Frank R.
1973. **Wildlife benefits from strip-mine reclamation.** *In* Ecology and Reclamation of Devastated Land vol. 1: 377-388. Gordon and Breach Sci. Publ., New York.
Coal strip-mined areas reclaimed with trees, shrubs, and grasses were compared with untreated spoils 3 years after planting. Large increases in plant basal area, plant canopy area, litter, pH, wildlife cover, and food and vertebrate and invertebrate animal populations were found in the planted areas. Ecologic succession of the test plots was estimated to be 10 years advanced over controls.

U.S.-TN : coal-B : VI-B

269. Hollister, Graham.
1962. **Future of federal programs in strip mining and restoration.** *In* Conservation—a key to world progress. Soil Conserv. Soc. Am. Proc.: 87-91. Des Moines, Iowa.
The author points out the magnitude of problems associated with strip mining of natural resources and discusses research needed. Collective action of industry and research and governmental agencies is encouraged. Government programs for research and action are under study.

U.S. : coal, other : VIII

270. Hollister, Graham.
1962. **Future of federal programs in strip mining and restoration.** Soil Conserv. Soc. Am. Proc. 1962: 87-91.
The magnitude of problems associated with strip-mining of natural resources is pointed out. Problems needing research are discussed. Collective action of industry and research and government agencies is encouraged. Government programs for research and action are under study.

U.S. : coal, other : VIII

271. Howard, Herbert A.
1971. **A measurement of the external diseconomies associated with bituminous coal surface mining.** Eastern Kentucky, 1962-67. Univ. N. M. Nat. Resour. J. 11 (1): 76-101.
External costs and internal expenses in bituminous coal surface-mining were compared. In recent years, the external costs were reduced, but the mining firm's internal expenses rose because of land reclamation. Data are discussed on a per-ton-mined and acreage-disturbed basis.

U.S.-KY : coal-B : VIII-B

272. Howland, John W.
1973. **New tools and techniques for reclaiming land.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 42-67. Bitum. Coal Res., Inc., Monroeville, Pa.
The design and test results of a new blade attachment to earth-moving equipment used in reclaiming strip-mined land. Conditions of spoil handling to be met by the new tool are discussed. A small blade is already in use, and a test on a 40-foot blade (40,000 pounds) was carried out successfully on some spoils.

U.S. : coal : II-A

273. Hudson, Charles H.

1971. **Experience of the highway department in revegetating slopes on drastically disturbed sites.** Rehabil. of Drastically Disturbed Surf. Mined Lands Symp. Proc.: 100-103. Ga. Surface Mined Land Use Board. Macon.

The State Highway Department of Georgia has not only gone all out in revegetating slopes, borrow pits, and other disturbed areas in the past few years: it has undertaken to protect these areas from erosion during construction by protective cover, such as temporary grasses and mulches, and also by the use of slope drains, check dams, and other methods.

U.S.-GA : other : IV-E

274. Hunt, Clifford F., and W. E. Sopper.

1973. **Renovation of treated municipal sewage effluent and digested liquid sludge through irrigation of bituminous coal strip mine spoil.** Pa. State Univ. Sch. For. Res. Briefs 7 (1): 11-14.

By irrigating spoils with sludge and effluent, the following effects were observed: (1) spoil removed P, K, Ca, Na, and organic N; (2) applied sludge may create nitrate pollution problems while the effluent alone did not; (3) irrigation with sludge and effluent decreases soluble Fe, Al, Mn, and B.

U.S.-PA : coal-B : III-B+VI-B

275. Hutnik, R. J.

1971. **Refuse bank reclamation studied for deep mines.** Sci. in Agric. 18 (3): 12-13, illus.

A review of problems and approaches in revegetation of coal refuse banks.

U.S. : coal-B+R : VI-B

276. Hutnik, Russell J., and Grant Davis, Editors.

1973. **Ecology and reclamation of devastated land.** Gordon and Breach Sci. Publ. Inc., New York. Vol. 1, 538 p. and vol. 2, 504 p.

The two volumes are proceedings from an International Symposium on Ecology and Revegetation of Drastically Disturbed Areas, held in 1969 in Pennsylvania. The symposium brought together 101 scientists from 14 different countries to exchange information and viewpoints on their common problems associated with disturbed areas. The proceedings include 66 formal papers and the discussion that followed each. Volume 1 includes physical and chemical properties, hydrology and pollution, biological changes, and effects on plants. Volume 2 includes species evaluation, modification of adverse conditions, and advances in reclamation. The editors are representatives of the two sponsoring organizations, The Pennsylvania State University School of Forest Resources and the U.S. Forest Service, Northeastern Forest Experiment Station.

U.S. : coal, other : VIII-D

277. Hyslop, James.

1964. **Some present day reclamation problems; an industrialist's viewpoint.** Ohio J. Sci. 64 (2): 157-165.

The industry's viewpoint on the problem of reclamation, with an analysis of the engineering and economic factors related to strip-mining in West Germany and Ohio. They are sufficiently different so that valid comparisons are difficult to make. A great deal of German experiences could be applied here.

U.S.-OH : coal-B : VIII

278. Illinois Strip Mine Investigation Commission.

1942. **Report of strip mine investigation commission to the 63rd General Assembly of Illinois.** 40 p.

Statistical data relating to the extent of damage done by strip-mining and the taxation aspect of those lands. The aspect and manner of strip-mining regulations, to be adopted, is reported.

U.S.-IL : coal-B : VIII-B

279. Immich, Charles.

1972. **Metal recovery from coal ash to defray costs of mined land reclamation.** Univ. Kans. State Geol. Surv. Spec. Distrib. Publ. 65: 28-29. (1972 Mined Land Workshop Proc.)

Analyses showed that elements Ge, Rb, Th, U, V, and Ti are present in coal ash in quantities sufficient to warrant extraction. The feasibility of such a program is discussed.

U.S.-KS : fuel ash : III-B

280. Jacoby, Hermann.

1973. **Growth and nutrition of beech trees on sites of different soil texture in the lignite area of the Rhineland.** *In* Ecology and Reclamation of Devastated Land vol. 1: 391-411. Gordon and Breach Sci. Publ., New York.

Large areas of surface-mined land in the Rhineland are being reclaimed for agriculture and forestry. In an investigation into the growth and nutrition of beech on mined lands, root growth and development was found to be strongly influenced by spoil texture. Differences in height growth between plants grown on spoils, undisturbed forest soil, and on toxic spoil were small. Beech appears to be well-suited for planting on alkaline spoil sites.

Germany : coal-L : VI-B

281. James, A. L.

1966. **Stabilizing mine dumps with vegetation.** Endeavor 25: 96.

The author describes experiments using vegetation to stabilize the waste materials from gold mines of the Witwatersrand in South Africa and the methods used to alter the chemical natures of the dumps so that the vegetation would form a permanent establishment.

S. Africa : ore waste : VI-B

282. Jamison, George M.

1965. **Mined area restoration of tomorrow.** J. Soil and Water Conserv. 20 (4): 186-188.

Principal aspects of restoration of mined areas: revegetation, spoil chemistry, hydrology, and earth movement are viewed in the perspective of future research challenge.

U.S. : coal : VI

283. Jewell, Samuel R., and Ronnie J. Haynes.

1973. **A survey of the status of Illinois coal surface-mined lands created prior to January 1, 1962 (pre-law).** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 334-350. Bitum. Coal Res., Inc., Monroeville, Pa.

The Cooperative Wildlife Research Laboratory of Southern Illinois University conducted in 1970 and 1971 a survey of the lands in Illinois affected by surface mining for coal prior to 1 January 1962 to update existing knowledge of the acreage, ownership, condition, and utilization of these lands. The total affected land encompassed 108,447 acres. Most of the affected land is in private coal-company ownership (81,063 acres) and is not utilized, in pasture, or in organized recreation use (85,921 acres). However, only a small percentage of the land constitutes a severe pollutional problem; and the reclamation of this land, although necessary, must be scientifically planned and executed to produce long-term environmental gains.

U.S.-IL : coal-B : I-B

284. Johnson, Edward A.

1965. **Research in strip mine reclamation.** Ky. Dep. Nat. Resour. Strip Mine Reclam. Symp. Proc.: 11-18. Frankfort.

Outlines research work conducted at U.S. Forest Service Laboratory in Berea. The project depends upon the cooperation of industry, universities, and other public agencies.

U.S.-KY : coal-B : VIII-C

285. Johnson, Edward A.

1965. **Forest restoration of strip-mined land: a research challenge.** Acid Mine Drain. Res. Symp. 1 Proc.: 199-206. Bitum. Coal Res., Inc., Monroeville, Pa.

An outline of the research program conducted by the USDA Forest Service on revegetation methods and techniques for stabilizing spoil banks by establishing vegetation to ascertain the nature of spoil chemical characteristics; to amend those conditions that retard vegetation or pollute water; to determine the hydrologic processes that influence the quality and quantity of water; and to develop standards for safeguarding, improving, and developing water resources.

U.S. : coal-B : VIII-C

286. Jonas, Frantisek.
1973. **Reclamation of areas damaged by mining activity in Czechoslovakia.** *In* Ecology and Reclamation of Devastated Land vol. 2: 379-394. Gordon and Breach Sci. Publ., New York.

Reclamation work on lands devastated by coal-mining is discussed from engineering and biological aspects. The engineering aspect consists of grading and leveling earth heaps, the biological deals with establishing vegetation for agriculture and forest uses. Examples of successful reclamation practices are given. Reclamation is viewed as an integral part of the coal-mining processes.

Czechoslovakia : coal-L : VI

287. Jones, W. G.
1959. **Progress report on the reclamation and reforestation of strip-mined areas in central Pennsylvania.** 12 p., illus. Cent. Pa. Open Pit Min. Assoc., Philipsburg.

A pictorial report on successful reclamation accomplishments by coal-mining industries.

U.S.-PA : coal-B : VII-D

288. Jones, W. G.
1970. **The new forest.** 58 p., illus. Offset Centre, Inc., Boalsburg, Pa.

This book offers a pictorial story of reclamation successes accomplished on strip-mined lands, to create a new forest with a multiple-use perspective.

U.S.-PA : coal-B : VII-D

289. Jones, J. N., Jr., W. H. Arminger, and G. C. Hungate.
1973. **Seed ledges improve stabilization of outer slopes on mine spoil.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 250-258. Bitum. Coal Res., Inc., Monroeville, Pa.

Stabilization of slopes by the establishment of persistent vegetation is demonstrated. Stair-step terraces and grooves constructed with hand tools were evaluated. Plots were limed and seeded or planted with birdsfoot trefoil, alone or with crownvetch. All plots were seeded with weeping lovegrass. Phosphate or superphosphate were used as fertilizers. It was suggested that the extra effort in transplanting the legumes is not necessary when a good stand of seeded weeping lovegrass and K31 fescue can be established. Improved soil-water relations in the grooves, the banding effect of the seed, and fertilizer favored rapid plant establishment and slope stabilization.

U.S.-WV : coal-B : VI

290. Jukkola, W. H., H. E. Steinman, and E. F. Young, Jr.
1968. **Coal mine drainage treatment.** Coal Mine Drain. Res. Symp. 2 Proc.: 376-385. Bitum. Coal Res., Inc., Monroeville, Pa.

Because of the geological and chemical factors involved in the formation of mine drainage, no two mines and no two drainage sources are exactly the same. In some cases proper mine engineering has resulted in drainage that causes no pollution. In many others, pollution exists in varying extents. Selection of a treatment scheme where pollution exists is very much a problem of the individual drainage, its volume, characteristics, and location.

U.S.-PA : coal-B : IV

291. Jurgens, Leonard.
1972. **Suitable plant materials for various uses on reclaimed mined land in southeast Kansas.** Univ. Kans. State Geol. Surv. Spec. Distrib. Publ. 65: 7-9. (1972 Mined Land Workshop Proc.)

Warm-season grasses can be established on newly smoothed strip-mined lands. A mixed stand is better than pure plantings. K-31 and southern brome require fertilization. Emerald crownvetch is good for erosion control and Cicer milkvetch for good cover.

Cardinal autumn olive and Tartarian or Amur honeysuckle are recommended for beautification and wildlife.

U.S.-KS : coal-B : VI-B

292. Kansas State Geological Survey.
1972. **Mined land workshop proceedings.** Univ. Kans. State Geol. Surv. Spec. Distrib. Publ. 65. 29 p.
This workshop report contains nine papers on various aspects of reclamation of strip-mined lands: agriculture, forestry, recreation, hydrological properties, soil compaction, and utilization of fly ash as a soil amendment.

U.S.-KS : coal-B : VIII-D

293. Kays, Carl E.
1967. **Strip-mined lands as fish and wildlife habitat.** Ky. Dep. Nat. Resour. Strip Mining Symp. 5 p. Frankfort.
Most of the evicted wildlife returns to strip-mined areas. The rate of reoccupation is related to the establishment of attractive food and cover. A list of native and exotic game food and cover plants readily invading the strip-mine spoils is given, and a list of the game species that use strip-mine habitat. Strip-mine lakes as fish habitat are discussed.

U.S.-KY : coal-B : VII-E

294. Kentucky Department of Natural Resources.
1965. **Strip-mining in Kentucky.** Ky. Dep. Nat. Resour. 56 p., illus.
An overview of strip-mining in Kentucky, including historical, geological, economic, legislative, and regulatory reclamation research and applied reclamation aspects of the strip-mining industry.

U.S.-KY : coal-B : VIII

295. Kentucky Department of Natural Resources.
1965. **Proceedings of the symposium on strip-mine reclamation.** Ky. Dep. Nat. Resour. 47 p., illus.
Contains 12 papers by mining company officials, researchers, and federal and state government officials on the status of coal surface mining and reclamation in Kentucky.

U.S.-KY : coal-B : VIII-D

296. Kentucky Department of Natural Resources.
1967. **Strip Mining Symp.** Ky. Dep. Nat. Resour. Div. Reclam. 104 p., illus. Frankfort.
This proceeding report contains 18 reports on a survey of state and federal agencies, industry, conservationists, and landowners for programs, policies, and operating techniques for achieving wise use and development of Kentucky's natural resources.

U.S.-KY : coal-B : VIII-D

297. Kentucky Division of Reclamation.
1972. **Surface mining and reclamation in Kentucky.** Ky. Div. Reclam. 48 p., illus.
An overview of the problems and progress in surface mining and reclamation in Kentucky, with emphasis on the mining of coal. Hypothetical examples are given of the legal, administrative, and technological aspects of surface mining and reclamation on both the eastern and western Kentucky coal fields.

U.S.-KY : coal-B : VI

298. Kentucky Legislative Research Commission.
1949. **Strip-mining in Kentucky.** Ky. Legis. Res. Comm. Publ. 5. 54 p., illus.
A report and recommendations on strip-mining in Kentucky with a view to enactment of legislation in compliances with Senate Resolution 74 of the 1948 General Assembly.

U.S.-KY : coal-B : VIII-A

299. Kentucky Legislative Research Commission Research Staff.
1954. **Strip mining: a 1954 legislative problem.** Ky. Legis. Res. Comm. Inf. Bull. 10. 15 p.
Relates problems and recommendations for regulating surface mining in Kentucky.

U.S.-KY : coal-B : VIII-A

300. Kieffer, F. V.

1972. **A bibliography of surface coal mining in the United States.** 71 p. Forum Associates, Columbus, Ohio.

This bibliography lists about 730 citations dealing with surface coal mining and the ecology of disturbed lands. The citations are subdivided into 10 sections: bibliography; books; academic publications, symposium proceedings and other works; federal government publications and studies known to be contracted by federal government agencies; master's theses and doctoral dissertations; newspaper articles; popular magazines; professional and scholarly journals; state government publications; trade journals and industry publications.

U.S. : coal : VIII-E

301. King, Robert.

1967. **Forestry.** Ky. Dep. Nat. Resour. Strip Mining Symp. 3 p. Frankfort.

The experiences, views, and concerns of a practicing forester involved in growing, culturing, and harvesting the forest on strip-mined lands.

U.S.-KY : coal-B : VII-D

302. Kinney, Edward C.

1964. **Extent of acid mine pollution in the United States affecting fish and wildlife.** U.S. Dep. Inter. Bur. Sport Fish. and Wildl. Circ. 191. 27 p., illus.

Data on the waters in the United States having potential for fish and wildlife which are deleteriously affected by acid mine pollution. It was found that 5,890 miles of streams and 14,967 acres of impoundments have a potential for fish and wildlife habitat if the acid pollution were sufficiently reduced.

U.S. : Coal : IV-G

303. Knabe, Wilhelm.

1962. **The reclamation of lands stripped for brown-coal.** Ohio Agric. Exp. Stn. For. Dep. Ser. 49.

A summary of Knabe's work translated from German by P. Keller. A discussion of the problem of strip-mining, its consequences and reclamation in East Germany, and an outline of the soil-testing methods used in reclamation of spoils.

Germany : coal-L : VI

304. Knabe, Wilhelm.

1964. **Methods and results of strip-mine reclamation in Germany.** Ohio J. Sci. 64: 75-105.

A report on trends in mining and land reclamation in Germany. Topics discussed are: coal-mining areas; reclamation as an integral part of strip-mining; the agricultural value of the overburden; mining equipment and its effect on reclamation; agricultural reclamation; afforestation; and amelioration of spoil banks.

Germany : coal-B : II+VI+VII

305. Knabe, Wilhelm.

1964. **A visiting scientist's observations and recommendations concerning strip-mine reclamation in Ohio.** Ohio J. Sci. 64: 132-157.

Observations and recommendations on reclamation of strip-mined lands in the United States: mining and reclamation have to be an inseparable unity; reclamation has to be preplanned; because it is an economic matter, costs and results of reclamation have to be in proper balance; we cannot continue the bad practice of wasting the land; voluntary cooperation of the mining companies, and training the people of industry, farmers, and foresters in various aspects of reclamation and land management is suggested.

U.S.-OH : coal-B : VI

306. Knabe, W.

1965. **Observations on world-wide efforts to reclaim industrial waste-land.** *In* Ecology and the industrial society. Brit. Ecol. Soc. Symp. 5. 296 p. Blackwell Sci. Publ., Oxford.

Observations on reclamation work in the United States and European countries. Studies indicate that the absence of vegetation and coal-mine spoils is due to either fresh disturbance or the detrimental effects of site factors such as toxic ingredients or the unstable nature of the spoils. The aims of reclamation are to return waste lands to economic or recreational use. Three approaches have been observed: (1) accepting the site conditions as they are and planting the area with pioneer plants of low site requirements. (2) Changing bad sites by reshaping the contours and by adding soil amendments before or after planting. (3) Planning future land use before displacing the waste and following this by restoring fertility to the site, which may become productive once again.

U.S. : other, coal : VI

307. Knabe, Wilhelm.
1973. **Development and application of the "Domsdorf ameliorative treatment" on toxic spoil banks of lignite opencast mines in Germany.** *In* Ecology and Reclamation of Devastated Land vol. 2: 273-293. Gordon and Breach Sci. Publ., New York.

Primary factors preventing plant growth on the lignite spoils in Eastern Germany are acidity, deficiency in main nutrients, excess of minor elements, and the water-repellant nature of the material. Ways of soil amelioration were found so that trees and other crops showed good growth. The treatments consisted of application of calcareous and hydroscopic ash from lignite-burning power plants, fertilization, and deep soil cultivation. Later improvements involve a more precise assessment of lime requirements and selection of the most calcareous ashes.

Germany : coal-L : III

308. Knabe, Wilhelm.
1973. **Investigations of soils and tree growth on five deep-mine refuse piles in the hard-coal region of the Ruhr.** *In* Ecology and Reclamation of Devastated Land vol. 1: 307-324. Gordon and Breach Sci. Publ., New York.

Slag heaps from deep coal mines, burned and unburned, have been investigated as to soil development and revegetation. Soils described as "Halden-Rohboden" and "Halden-Ranker" are characterized by high macroporosity (even deep underground), thermal activity, and weathering of pyrites. They are also affected by dustfall and acid precipitation in the Ruhr. Revegetated sites showed improved nutrient status and pH in the top layer. Some relationships between soil and tree growth are discussed. Suggestions for future plantings are given.

Germany : coal-R : III+VI

309. Knudsen, Lyle L.
1953. **A pine planting on old strip-mine banks.** Ohio Agric. Exp. Stn. For. Mimeo 5. 2 p.

Tests on a 17-year-old plantation of red and Scotch pines on Muskingum County spoils showed that under certain conditions pines can be grown successfully.

U.S.-OH : coal-B : VII-D

310. Knudsen, Lyle L., and Paul H. Struthers.
1953. **Stripmine reclamation research in Ohio.** Ohio J. Sci. 53: 351-355, illus.

A summary of early attempts to solve reclamation problems in Ohio. Research programs of the Ohio Agricultural Experiment Station and of the U.S. Forest Service Central States Forest Experiment Station, and the cooperative action of the Ohio Reclamation Association, are discussed.

U.S.-OH : coal-B : VIII-C

311. Knutson, Robert.
1970. **A look at the mine-timber market in the Appalachian Bituminous Coal Region.** USDA For. Serv. Res. Pap. NE-147. 9 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.

About 1 board foot of sawed timbers and 0.54 lineal foot of round and split timbers are now used for every ton of bituminous coal produced from underground coal mines in the Appalachian coal region. Favored species for mine timbers are the dense hardwoods such as oak, hickory, and beech. The tonnage of coal produced from underground mines is expected to increase in future years, so volume of wood used in coal mines is also expected some insight into the practicality of sludge treatment on strip-mined areas.

U.S.-IL : coal-B : VI

328. Limstrom, G. A.
1948. **Extent, character, and forestation possibilities of land stripped for coal in the Central States.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 109. 79 p., illus. Columbus, Ohio.

Results of reconnaissance in 1946 and 1947 of lands stripped for coal in the Central States. Basic site factors, acidity, texture, topography, and stability, as they affect reforestation practices, are discussed. A tentative guide recommends tree species for planting on the principal spoil types of different textures and in the various acidity classes. Problems that need further research are listed. Appendix contains statistics by state and counties showing extent of acidity and textural classes, coal seams, and character of vegetation.

U.S. : coal-B : III+VII-D

329. Limstrom, G. A.
1950. **Overburden analyses and strip-mine conditions in mideastern Ohio.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 117. 33 p. Columbus, Ohio.

A summary of the reconnaissance data for spoil-bank conditions in strip-mining District No. IV in Ohio. Tabulations show physical characteristics of individual strata along with acidity levels and P and K availability.

U.S.-OH : coal-B : III

330. Limstrom, G. A.
1950. **Overburden analyses and strip-mine conditions in northeastern Ohio.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 114. 44 p.

A summary of the reconnaissance data for spoil-bank conditions in strip-mining Districts No. I and II in Ohio. Tabulations show physical characteristics of individual strata along with acidity levels and P and K availability.

U.S.-OH : coal-B : III

331. Limstrom, G. A.
1952. **Effects of grading strip-mined lands on the early survival and growth of planted trees.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 130. 35 p., illus. Columbus, Ohio.

Results on survival and height growth of forest plantations and moisture conditions on graded and ungraded strip-mined lands in Ohio, Illinois, and Kansas, showing a harmful effect of grading on the early development of planted trees. The effects vary with the texture of spoil and climate conditions. On coarse-texture spoils in areas of uniform rain frequency, the differences in tree growth are negligible and on fine-texture spoils with extreme rainfall, variations in survival and growth were significantly better on the ungraded banks.

U.S.-OH, IL, KS : coal-B : III-C+VI-B

332. Limstrom, G. A.
1953. **A bibliography of strip-mine reclamation.** USDA For. Serv. Cent. States For. Exp. Stn. Misc. Rel. 8. 25 p. Columbus, Ohio.

A list of 135 papers published from 1918 to 1953 containing information about reclamation of coal-mine spoils, plus 113 additional references that may be useful in the study of specific phases of strip-mine reclamation.

U.S. : coal : VI+VIII-E

333. Limstrom, G. A.
1960. **Forestation of strip-mined land in the Central States.** USDA Handb. 166. 74 p., illus.

A summary of knowledge gained during the decades 1940-1960 and a guide for those engaged in forestation of strip-mined lands in Central States. Site characteristics and planting operations are discussed in considerable detail.

U.S. : coal-B : III+IV-E+VI-B+VII-D

334. Limstrom, G. A.
1964. **Revegetation of Ohio's strip-mined land.** Ohio J. Sci. 64 (2) : 112-119.

The success of strip-mine revegetation is influenced by the spoil parent material, the way the material is manipulated in mining and grading, site characteristics, and planting technique. Spoil texture, aggregation, topography, acidity, and grading have to be appraised prior to planting. The choice of species, planting methods, and planting-stock quality have to be considered.

U.S.-OH : coal-B : III+VI-B

335. Limstrom, G. A., and G. H. Deitschman.
1951. **Reclaiming Illinois strip coal lands by forest planting.** Univ. Ill. Agric. Exp. Stn. Bull. 547: 201-250, illus.

A survey report of existing plantations on lands strip-mined for coal. Performance was related to main site characteristics. Tree survival averaged about 60 percent. Eight conifers and ten hardwoods were tentatively recommended for plantings. Sweetgum was the most promising species. Black locust is a good indicator for site quality and a valuable nurse crop for black walnut, silver maple, and yellow-poplar, but not for cottonwood, sweetgum, or osage orange. Important site characteristics are discussed.

U.S.-IL : coal-B : VI-B

336. Limstrom, G. A., and R. W. Merz.
1949. **Rehabilitation of lands stripped for coal in Ohio.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 113. 41 p., illus.

The authors describe the varied and complex site conditions on strip-mine lands. Possible uses of these lands are suggested, and recommendations are made for forest planting.

U.S.-OH : coal-B : VI-B

337. Limstrom, G. A., and R. W. Merz.
1951. **Overburden analyses and strip-mine conditions in southeastern Ohio.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 127. 61 p., illus. Columbus, Ohio.

Summary of 1945-47 reconnaissance survey of lands stripped for coal in southeastern Ohio, including information about local geological conditions.

U.S.-OH : coal-B : I

338. Limstrom, G. A., and R. W. Merz.
1951. **Overburden analyses and strip-mine conditions in the northwestern district of the Ohio coal mining region.** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 124. 36 p., illus.

A summary of reconnaissance data for spoil-bank conditions in strip-mining District No. III in Ohio. Tabulations show physical characteristics of individual strata along with acidity levels and P and K availability.

U.S.-OH : coal-B : III

339. Lorenz, Walter C.
1962. **Progress in controlling acid mine water: a literature review.** U.S. Bur. Mines Inf. Circ. 8080. 40 p.

A review of literature relating to the problems of acid mine drainage from bituminous coal mines. It is evident that the coal industry has been offered many practical tools for diminishing pollution. The industry has applied many of the control measures, yet there are still many areas of conflicting thought. More information is needed for identifying and disposing of acid-forming material.

U.S. : coal : IV

340. Lorenz, Walter C., and Robert W. Stephan.
1967. **Factors that affect the formation of coal mine drainage pollution in Appalachia.** U.S. Bur. Mines. 17 p. Pittsburgh, Pa.

A literature review on the extent of the mine-drainage problem in Appalachia. It was found that pyrite is formed contemporaneously with the formation of coal, is associated with coal and rocks adjacent to the coal, and its oxidation produces stream pollutants. Current research on pyrite oxidation includes electrochemical reactions and the effects of iron-oxidizing bacteria on oxidation.

U.S. : coal : V-B

341. Lorenz, Walter C., and Robert W. Stephan.
1967. **The oxidation of pyrite associated with coal mines.** U.S. Bur. Mines. 21 p. Pittsburgh, Pa.

A survey of literature and current research on both the chemical and bacterial oxidation of pyrite. Factors affecting the rates of pyrite oxidation are oxygen concentration, particle size, temperature, moisture, pH, electrode potential of the reaction, and a possible catalyst. Iron- and sulfur-oxidizing bacteria increase the rate of oxidation. A number of methods are being developed to circumvent, inhibit, counteract, or abate the pollution of mine water. None of these have proved to be satisfactory. Research on electrochemical properties and the effects of bacteria and surface treatment of pyrite is promising.

U.S. : coal : V-B

342. Lorenz, Walter C., and Edward C. Tarpley.
1963. **Oxidation of coal mine pyrites.** U.S. Bur. Mines Rep. Invest. 6247. 13 p.

Samples of materials containing pyrite, taken from coal mines and coal beds, were studied for composition and oxidizing characteristics. The pyrites occurred in spherical clusters of small crystals. An iron-oxidizing bacterium acted as a catalyst, greatly increasing the oxidation rates. No definite correlation of results with the location of mines nor with the acidity or alkalinity of mine drainage was found.

U.S. : coal : V-B

343. Lorio, P. L., Jr., and G. E. Gatherum.
1965. **Relationship of tree survival and yield to coal-spoil characteristics.** Iowa State Univ. Sci. and Tech. Res. Bull. 535: 394-403, illus.

Performance of two hardwoods and five conifers was related to the chemical characteristics of coal-spoil material. Regression analyses revealed that tree survival was related to pH, soluble salts exchangeable Al, cation exchange capacity, and N; the yield of cottonwood was related to exchangeable Al and soluble salts; eastern red cedar to slope position, N and soluble salts; pitch pine to cation exchange capacity and exchangeable and soluble bases.

U.S.-IA : coal-B : III-B+VI-B

344. Lorio, P. L., Jr., and G. E. Gatherum.
1966. **Growth of eastern cottonwood in relation to coal-spoil characteristics.** Iowa State J. Sci. 41 (1): 41-53.

Growth of eastern cottonwood was related to the chemical characteristics of spoil material. The variables best related to total tree height were salt concentration, exchangeable and soluble Ca, and percentage of soil-size material. Foilage and spoil analyses and leader growth indicated N and P deficiencies.

U.S.-IA : coal-B : III-B+VI-B

345. Lorio, P. L., Jr., G. E. Gatherum, and W. D. Shrader.
1964. **Tree survival and growth on Iowa coal-spoil materials.** Iowa Agr. and Home Econ. Exp. Stn. Spec. Rep. 39. 12 p., illus. Ames.

Early results show that green ash survived better and cottonwood grew much faster than other species on a variety of spoils. On calcareous spoils, performance of red cedar was best, but pines grew and survived poorly. Pines preferred acid spoils.

U.S.-IA : coal-B : VI-B

346. Lowry, Gerald L.
1956. **Five-year study evaluates forest trees varieties for spoil banks.** Ohio Agric. Exp. Stn. Ohio Farm and Home Res. 41: 70-71., illus. Wooster.

Early performance of certain forest species planted on spoils is discussed.

U.S.-OH : coal-B : VI-B

347. Lowry, Gerald L.
1958. **Conifer growth and survival varies on acid spoils.** Ohio Agric. Exp. Stn. Ohio Farm and Home Res. 43 (311). 2 p. Wooster.

Seedling survival and height growth for 2-year-old conifer plantations are discussed. Spoil is described.

U.S.-OH : coal-B : VI-B

348. Lowry, Gerald L.
1960. **Conifer growth is best on acid spoils.** Ohio Agric. Exp. Stn. Ohio Farm and Home Res. 45 (3): 45. Wooster.

Growth of conifers is less than that of hardwoods. Spoils susceptible to erosion should be planted to hardwoods.

U.S.-OH : coal-B : VI-B

349. Lowry, Gerald L.
1960. **Conifer establishment on coal spoils as influenced by certain site factors and organic additions at planting time.** Soil Sci. Soc. Am. Proc. 24 (4): 316-318.

Eight conifer species were planted on spoils of different site characteristics. Root-mulch treatments were tried. After 2 years, significant differences in survival were noted between tree species and also due to mulching on very strongly acid sandy spoils. No differences in height growth were noted. A prediction equation for survival, based on site characteristics, is given.

U.S.-OH : coal-B : VI-B

350. Lowry, Gerald L.
1961. **Alder appears promising as spoil bank tree planting.** Ohio Agric. Exp. Stn. Ohio Farm and Home Res. 46 (4): 12, illus. Wooster.

European and speckled alders performed well when planted with other hardwoods on spoils of a wide textural range and of pH 3.5 and above.

U.S.-OH : coal-B : VI-B

351. Lowry, G. L., F. C. Brokaw, and C. H. Breeding.
1962. **Alder for reforesting coal spoils in Ohio.** Ohio J. For. 60: 196-199, illus.

Black and speckled alder survived and grew well on a wide range of Ohio spoils and other site conditions. Their ability to stabilize steep slopes is not as good as that of black locust. The prime deterrents to good performance of alders are excessive competition and extreme spoil acidity. Economic returns from alders are anticipated to be greater than those from black locust; thus the alders could replace black locust in future spoil-bank plantings.

U.S.-OH : coal-B : VI-B

352. Lowry, Gerald L., and James H. Finney.
1962. **A lysimeter for studying the physical and chemical changes in weathering coal spoil.** Ohio Agric. Exp. Stn. Res. Circ. 113. 17 p., illus.

Describes a lysimeter installation for studying the changes in physical, chemical, and biological properties of weathering coal spoils. Construction, instrumentation, and operation of the installation are treated in detail.

U.S.-OH : coal-B : III

353. Ludwig, Walter D.
1923. **Reforestation by coal companies in southwestern Pennsylvania.** J. For. 21: 492-496.

Industrial timber demands, reforestation needs, accomplishments, and obstacles encountered in tree-planting programs in southwestern Pennsylvania are discussed.

U.S.-PA : coal-B : VII-D

354. McCarthy, Richard E.
1973. **Preventing the sedimentation of streams in a Pacific Northwest coal surface mine.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 277-286. Bitum. Coal Res., Inc., Monroeville, Pa.

Because soil particles were claylike and tended to remain in suspension, polyelectrolyte flocculant treatment was used in addition to settling ponds. The method of treating the water and the laboratory and field work carried out in developing the treatment process are described. The process is designed to handle the extended periods of high runoff and occasional peak flows common to the area. It has also been automated to continually monitor the water flow and to add the correct amount of flocculant into the turbid water. Water analysis three times a day above and below the mine assures that the overflow from the final settling pond does not carry siltation that would destroy the migratory fish population.

U.S.-WA : coal : IV

355. McClain, Thomas J.
1972. **Preliminary results of hydrologic studies in southeastern Kansas coal fields.** Univ. Kans. State Geol. Surv. Spec. Distrib. Publ. 65: 24-26, illus. (1972 Mined Land Workshop Proc.)

Hydrologic reconnaissance in and around strip-mined areas showed that (1) the quality of groundwater in the spoil is rather poor, but it does have an alkaline pH; and (2) pond water is of better quality than spoil-bank water.

U.S.-KS : coal-B : IV

356. McCormick, Larry H., and F. Yates Borden.
1973. **Percolate from spoils treated with sewage effluent and sludge.** *In* Ecology and Reclamation of Devastated Land vol. 1: 239-250. Gordon and Breach Sci. Publ., New York.

Application of sewage-plant effluent and sludge singly and in combinations to spoils is discussed. Lysimeters were used to measure chemical changes of the percolate. The release of large quantities of ammonia, increase in pH, Ca, and K, and a decrease of S concentrations were related to the amount and method of application. The spoils have provided satisfactory renovation of most major chemical constituents of sludge and effluent.

U.S.-PA : coal-B : III-B+VI-B

357. McCreery, R. A.
1971. **Grasses and legumes useful for reclamation.** Rehabil. Drastically Disturbed Surf. Mined Lands Symp. Proc.: 87-88. Ga. Surface Mined Land Use Board, Macon.

Few sites are more drastically disturbed than those where highways are constructed. The author describes several treatments on highway cuts and fills in Georgia. Treatments consist of nurse and permanent species, along with added topsoil. Since the study was only one year old on half the sites, he lists observations rather than conclusions.

U.S.-GA : other : VI-B

358. McDougall, W. B.
1925. **Forests and soils of Vermillion County, Illinois, with special reference to the "striplands."** Ecology 6: 372-379.

The strip-mined bottomlands are first invaded by annual weeds. Under favorable conditions, forest is reestablished in about 24 years.

U.S.-IL : coal-B : VI-B

359. McKeever, Ivan.
1963. **Guide for classifying and revegetating strip mine spoil in Pennsylvania.** U.S. Soil. Conserv. Serv. 23 p., illus.

A classification of bituminous strip-mine spoils in Pennsylvania based on three factors: (1) degree of acidity, (2) slope, and (3) stoniness. Each of the factors is subdivided into groups. A guide for the vegetative species for each spoil group is suggested. Uses and planting guides are given for hayland and pasture, woodland, and wildlife.

U.S.-PA : coal-B : III-A

360. McQuilkin, William E.
1965. **Reclamation for aesthetics.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 97-105. University Park.

The author focuses attention on the concept of beautification of the country site which became a matter of national policy in the same manner as the conservation movement at the turn of the century. Discusses the White House Conference on National Beauty, a changing public attitude, community action, and industry cooperation in restoring esthetics in coal-mining regions.

U.S. : coal : V-C+VII-A

361. McWilliams, Jesse L.
1970. **Arnot bristly locust a new plant**

for conservation and beautification in Pennsylvania. U.S. Soil Conserv. Serv. 9 p., illus.

Arnot bristly locust planted on coal-mine spoils proved to be of value in providing protective cover on steep banks. Plant origin, growth habits, adaptation, use, and availability are described.

U.S.-PA : coal-B : VI-B

362. Magnuson, M. O., and R. L. Kimball.
1968. **Revegetation studies at three strip-mine sites in north-central Pennsylvania.** U.S. Bur. Mines R 7075. 8 p.

Revegetation tests were conducted at three backfilled strip-mine sites (El-Camton project). Trees, shrubs, and grass-legume mixtures were tested under various lime and fertilizer levels. Norway spruce, black locust, Japanese larch, pitch pines, and white pines performed best on sites with pH 4.5 and above. Grass-legume ground cover improved in the second growing season.

U.S.-PA : coal-B : VI

363. Martin, Cecil N.
1971. **Design and construction of eastern embankments used in establishing water supply or waste ponds.** Rehabil. Drastically Disturbed Surf. Mined Lands Symp. Proc.: 54-58. Ga. Surface Mined Land Use Board. Macon.

The discussion is limited to roll-filled dams with pipe drop inlet type principal spillway and vegetated earth emergency spillway. Various dam failures are explained as are surveys of area, site location, and subsurface investigations. Design factors, types of embankments, construction, and post-construction inspections are discussed.

U.S.-GA : others : VIII

364. Massey, H. F.
1972. **pH and soluble Cu, Ni, and Zn in eastern Kentucky coal mine spoils.** Soil Sci. 114 (3): 217-221.

On the basis of studies with four spoil materials, the effects of liming on solution concentrations of Zn, Cu, and Ni can be estimated roughly from pH measurements. More accurate estimates could be obtained by making a few determinations on each spoil material. Of the three elements studied, Ni appeared to be most likely to remain in the soil solution in toxic amounts once the pH has been adjusted to a point which would otherwise be satisfactory for plant growth.

U.S.-KY : coal-B : III-B

365. Massey, H. F., and R. I. Barnhisel.
1971. **Copper, nickel, and zinc released from acid coal mine spoil materials of Eastern Kentucky.** Soil Sci. 113 (3): 207-212.

Appreciable concentrations of Ni, Cu, and Fr are found in coal-mine spoils. Possible toxicities from these elements must be considered by those involved in coal-mine spoil reclamation.

U.S.-KY : coal-B : III-B

366. May, Morton.
1967. **Mine reclamation in the western States.** Min. Congr. J. 53 (8): 101-105.

Problems associated with mined-land reclamation in the western United States are reviewed and discussed. Lack of moisture, and the selection of suitable plant species, are the major problems. Research findings and needs are pointed out.

U.S.-WY : coal, ore waste : VI-B

367. May, Robert F.
1963. **Predicting outslopes of spoil banks.** USDA For. Serv. Res. Note CS-15. 4 p., illus. Cent. States For. Exp. Stn., Columbus, Ohio.

The slope length of the spoil bank is a function of the height of the highwall and the angle of the original mountain slope. The prediction equation is given.

U.S.-KY : coal-B : III

368. May, Robert F.
1964. **Surface-mine reclamation: continuing research challenge.** Coal Age March 1964: 98-99, 101, illus.

The problems and the research direction in revegetation, hydrology, earth movement and placement, soil mechanics, pyritic-material identification, mined-bank chemistry, and haulage roads are discussed.

U.S.-KY : coal-B : VIII-C

369. May, Robert F.
1965. **Strip-mine reclamation research —where are we?** Min. Congr. J. 51 (4): 52-55, illus.

A report on U.S. Forest Service research on coal-mine spoils reclamation through its project in Berea, Ky. Accomplishments are reviewed and present and future research objectives and demands are described.

U.S.-KY : coal-B : VIII-C

370. May, Jack T.
1971. **Selection and use of trees in reclamation.** Rehabil. Drastically Disturbed Surf. Mined Lands Symp. Proc.: 89-99. Ga. Surface Mined Land Use Board. Macon.

Research plantings on kaolin clay mining spoils indicate that loblolly, slash and Virginia pines, sycamore, sawtooth and white oak, and European black alder will survive and grow if adequately fertilized. Loblolly pine and sycamore have consistently given the best survival and growth.

U.S.-GA : kaolin : VI-B

371. May, J. T., H. H. Johnson, H. F. Perkins, and R. A. McCreery.
1973. **Some characteristics of spoil material from kaolin strip-mining.** *In* Ecology and Reclamation of Devastated Land vol. 1: 3-14. Gordon and Breach Sci. Publ., New York.

Spoils derived from kaolin-clay mining are characterized. Extreme variation in physical characteristics and in concentration of nutrient elements within small spoil segments were reported. The spoil contains 0 to 100 percent sand or 0 to 85 percent clay. Available P and exchangeable K, Ca, and Mg range from 2 to 160, 4 to 110, 6 to 600, and 2 to 600 ppm respectively. Ca and Mg are low except where lime material is present. P and K are low in all strata. Mn and Fe are most abundant in the upper strata.

U.S.-GA, AL : kaolin : III

372. May, Jack T., C. L. Parks, and H. F. Perkins.
1973. **Establishment of grasses and tree vegetation on spoil from kaolin clay strip-mining.** *In* Ecology and Reclamation of Devastated Land vol. 2: 137-147. Gordon and Breach Sci. Publ., New York.

Concentration of nutrients and the spoil pH are low. By using 908 kg of lime, 13.6 kg of N, 31.8 kg of P and 22.7 kg of K per ha, an excellent ground cover of grasses and lespedezas was established. Best tree species were loblolly pine, Virginia pine, sycamore, sawtooth oak, and black alder. Initial growth was poor, and foliar symptoms of nutrient deficiencies were evident when N and P were not applied at time of planting. High mortality occurred at first year in absence of fertilization.

U.S.-AL : kaolin : VI-B

373. May, Robert F., and William A. Berg.
1967. **Overburden and bank acidity — eastern Kentucky strip mines.** Coal Age 71: 74-75.

The pH of 831 samples of Pennsylvania age strata in the overburden of five coal seams was determined after grinding and then wetting and drying three times to oxidize sulfides. Seventy percent of the rider coal strata were extremely acid, compared with 40 percent of the bone coal, 7 percent of the shale, and 1 percent of the sandstone.

U.S.-KY : coal-B : III-B

374. May, Robert F., and W. David Striffler.
1966. **Watershed aspects of stabilization and restoration of strip-mined areas.** Int. Symp. Forest Hydrol. Proc.: 663-671. Pergamon Press, Oxford and New York.

Strip-mined mountain watersheds with 10 percent of the area disturbed have somewhat higher streamflows than adjacent forested watersheds. Small streams originating in mined areas have a continuous flow whereas before mining they were intermittent. Erosion and sedimentation are attributed to side-cast overburden slides, haul roads, and the mined area itself. Water quality is affected by infiltration and percolation of water through the spoil. Proper spoil placement and adequate drainage control and revegetation are preventing serious erosion and pollution. Herb and tree plantings are effective in spoil stabilization.

U.S.-KY : coal-B : IV-D

375. Medvick, Charles.
1973. **Selecting plant species for revegetating surface coal mined lands in Indiana — a forty-year record.** *In* Ecology and Reclamation of Devastated Land vol. 2: 65-80. Gordon and Breach Sci. Publ., New York.

An analysis of a revegetation program of Indiana mining industries. Over 1 million trees are planted annually. Grass and legume species have also been used. Categories of overburden and recommended revegetation found to be successful are discussed.

U.S.-IL : coal-B : VI-B

376. Merz, Robert W.
1949. **Character and extent of land stripped for coal in Kentucky.** Univ. Ky. Agric. Exp. Stn. Circ. 66. 27 p., illus.

As of 1948, there were 7,267 acres of strip-mined lands in Kentucky. Approximately 80 percent of the stripped area was without vegetation; 46 percent of the area that had been stripped longer than 5 years was fully revegetated; 20 percent of the area stripped before 1942 had adequately stocked forest stands. About 15 percent of stripped lands were toxic to vegetation.

U.S.-KY : coal-B : I-B

377. Merz, Robert W., and Raymond F. Finn.
1951. **Differences in infiltration rates on graded and ungraded strip-mined lands.** USDA For. Serv. Cent. States For. Exp. Stn. Note 65. 2 p. Columbus, Ohio.

Mean infiltration rate on ungraded spoils was more than ten times greater than on graded spoils. Difference in mean volume weight was not significant.

U.S.-OH : coal-B : III-C+IV-A

378. Merz, R. W., and W. T. Plass.
1952. **Natural forestation on a strip-mined area in Ohio.** USDA For. Serv. Cent. States For. Exp. Stn. Note 68. 2 p. Columbus, Ohio.

Observation of natural reproduction on a strip-mined area indicates that natural seeding may satisfactorily reforest some areas near suitable seed sources.

U.S.-OH : coal-B : VI-B

379. Middour, J. C.
1950. **Reclamation of strip mined areas.** Pa. For. and Waters 2 (5): 98-99, 110-111, illus.

Reviews the development of strip-mining for coal in Pennsylvania. Presents some data on land disturbance as of 1950 and discusses some examples of successes and advantages of planting those areas with trees, shrubs, and grasses.

U.S.-PA : coal-B : VI-B

380. Miles, V. C., R. W. Ruble, and R. L. Bond.
1973. **Performance of plants in relation to spoil classification in Pennsylvania.** *In* Ecology and Reclamation of Devastated Land vol. 2: 13-31. Gordon and Breach Sci. Publ., New York.

Since the late 1930s, observations have been made on approximately 190 grasses, 72 legumes, 20 shrubs, 21 trees, and 9 other plants. Results of the performance of the major grass, legume, shrub, and tree species planted by soil and water conservation district cooperators in the Soil Conservation Service's plant-materials program are summarized. Performance of these plants is related to a spoil-classification system considering pH, slope, and stoniness.

U.S.-PA : coal-B : VI-B

381. Mohney, Franklin H.
1965. **The industry and regulatory laws —current and future.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 44-54. University Park.

A summary on development of surface mining and early reclamation programs. Regulatory legislation is compared for this type of mining in Pennsylvania, Illinois, Kentucky, and Ohio. Effect of the law in Pennsylvania, from the viewpoint of industry representatives, is discussed.

U.S.-PA : coal-B : VIII-A

382. Montgomery, Robert K.
1965. **The Kentucky program after one year.** Ky. Dep. Nat. Resour. Strip Mine Reclam. Symp. Proc.: 41-44. Frankfort.

Describes the organization of the Kentucky Department of Natural Resources and assesses reclamation work in the state.

U.S.-KY : coal-B : VIII

383. Moore, Cordell J.
1967. **National strip mine study.** Ky. Dep. Nat. Resour. Strip Mining Symp. 7 p. Frankfort.

Surface mining and its reclamation have become nation-wide problems. Federal guidance and assistance are needed. Apparent weaknesses and deficiencies in the state laws and regulations on surface mining are outlined, and a proposed program is suggested to be financed through federal funds to minimize the damage from past mining.

U.S. : coal : VIII-A

384. Morgan, G. W.
1973. **Crop productivity as affected by depths of topsoil spread for reclaiming bauxite-mined lands in Jamaica** I. Paper presented at the Conference on Soils of the Caribbean and Tropical America, Trinidad. 41 p.

Four soil-depth spreads (6, 12, 18, and 24 inches) used for reclaiming bauxite-mined lands, in combination with two fertilizer treatments and two cultivation treatments, were investigated. Treatments were evaluated by the yields of crops grown on the reclaimed land. Over the period 1969 to 1972 experiments were conducted with grass, maize, yellow yam, and sweet potato. It has been concluded that bauxite lands in Jamaica, which will be used for growing grass, maize, yams, or sweet potato, should be reclaimed with a 12-inch soil-depth spread, that the reclaimed land should not be ripped, and that high application of fertilizers should be profitable except for maize.

Jamaica : bauxite : VI+VII-C

385. Morgan, G. W.
1974. **Crop productivity as affected by depths of topsoil spread for reclaiming bauxite-mined lands in Jamaica.** Trop. Agric. (Trinidad) 51 (2): 332-346.

Depths of soil spread for reclaiming bauxite-mined lands in combination with fertilization and cultivation were investigated. It was concluded that bauxite lands in Jamaica to be used for growing grass, maize, yams, or sweet potatoes should be reclaimed by spreading soil to a depth of 30 cm, that the reclaimed land should not be ripped, and that a high application of fertilizer should be profitable except for maize.

Jamaica : bauxite : VI+VII-C

386. Morgan, Herman, Jr., and W. L. Parks.
1967. **Reclamation of mined phosphate land.** Tenn. Agric. Exp. Stn. Bull. 416. 32 p. Knoxville.

Productive capacity of soil mined for phosphate was evaluated for growing agricultural crops. Responses to lime and fertilizer treatments are given. Physical and chemical properties of mined and unmined areas are discussed.

U.S.-TN : phosphates : VII

387. Morgan, R. L.
1973. **Environmental impact of surface mining: The biologist's viewpoint.** *In* Some environmental aspects of strip mining in North Dakota. N.D. Geol. Surv. Educ. Ser. 5: 61-71.

Surface mining has had little impact on fish and wildlife resources. However, future large-scale operations could prove to be very detrimental to fish and wildlife resources.

U.S.-ND : coal-L : VII-G

388. Morris, Melvin S.
1974. **Coal versus a way of life in Eastern Montana.** Wildlands 1 (1) : 8-14, illus.
The author analyzes coal mining and its effect on the environment and discusses other land uses.

U.S.-MT : coal-L : VIII

389. Moulton, E. Q. [Ed.]
1957. **The acid mine drainage problem in Ohio.** Ohio State Univ. Eng. Exp. Stn. Bull. 166. 158 p.
This report presents the results of the research program in acid mine drainage. The research carried out included (1) mineralogic and geologic considerations, (2) acid formation studies, (3) an impoundment program, (4) the evaluation of the pollution problem on Sundy Run, (5) a mine scaling flooding program, and (6) utilization of gobs for lightweight aggregate. Findings that have the greatest implications pertinent to the acid mine drainage problem are emphasized. More than 500 annotated references on the subject of acid mine drainage are included.

U.S.-OH : coal-B : IV+VII-E

390. Mumford, R. E., and W. C. Bramble.
1973. **Small mammals on surface-mined land in southwestern Indiana.** *In* Ecology and Reclamation of Devastated Land vol. 1: 369-376. Gordon and Breach Sci. Publ., New York.
A study of small mammals on surface-mined land in southwestern Indiana indicated that mice were important factors in the ecosystem. The white-footed mouse was the most abundant. It consumed seeds of important trees as well as other plants on mined land. Five of the nine mouse species trapped comprise a significant segment of the wildlife food chain found on such areas.

U.S.-IN : coal-B : VII-E

391. Munn, Robert F.
1973. **Strip mining; an annotated bibliography.** W. Va. Univ. Library. 110 p. Morgantown.
This bibliography contains 611 citations, many annotated. Citations are listed in an alphabetical order (by authors) and are grouped into 6 chapters: history, government regulations, the controversy over stripping, environmental effects, reclamation, miscellaneous, and addenda.

U.S. : coal : VIII-E

392. Musser, John J.
1963. **Description of physical environment and of strip-mining operations in parts of Beaver Creek Basin, Kentucky.** U.S. Geol. Surv. Prof. Pap. 427-A. 25 p., illus.
Results of an investigation of the effects of strip-mining for coal on the hydrology of a portion of the Beaver Creek Basin, McCreary County, Kentucky. The report describes the topography, drainage geology, soils, climate, hydrologic environment, and forest vegetation of the study area and gives a history and description of the mining. Seven topographic maps are included.

U.S.-KY : coal-B : I+IV

393. Myers, Leroy O.
1950. **Bituminous coal stripping in West Virginia.** W. Va. Acad. Sci. Proc. 22: 98-100.
Brief history of the production of strip-mine coal in West Virginia.

U.S.-WV : coal-B : VIII

394. National Coal Association Bituminous Coal Research, Inc.
1973. **First research and applied technology symposium on mined-land reclamation.** Bitum. Coal Res., Inc. 355 p. Monroeville, Pa.
This volume is a product of the symposium held in March 1973 in Pittsburgh, Pa. It contains 30 papers given by workers well known in the field of reclamation of disturbed areas. The papers are grouped into six topics:

(1) innovative approaches to mining and reclamation, (2) pre-planning and mine operating procedures, (3) characterization and preparation of disturbed materials to enhance plant growth, (4) planting and plant materials, (5) slope stabilization and sediment control, and (6) utilization and management of mined lands.

U.S. : coal : VIII-D

395. National Sand and Gravel Association.
1961. **Case histories; rehabilitation of worked-out sand and gravel deposits.** 32 p. Silver Spring, Md.

Examples of successfully rehabilitated land after sand and gravel deposits have been excavated; pictorial presentation of case histories.

U.S. : sand and gravel : VII

396. Neckers, J. W., and Charles R. Walker.
1952. **Field test for active sulfides in soil.** Soil Sci. 74: 467-470, illus.

Describes a simple field test for sulfides and pyrites that could be used to predict future acidity in coal-mine spoils. The results in general correlate with total sulfur determined by laboratory methods.

U.S. : coal-B : III-B

397. Neumann, G. W.
1969. **Tailings disposal at Brunswick Mining and Smelting.** Can. Min. J. 90 (6): 60-61.

A design for tailing storage and effluent settling ponds. Soluble Zn and Cu are removed by adding lime to increase pH to above 9.5.

Canada : ore waste : VI

398. Neumann, Ulrich.
1973. **Succession of soil fauna in afforested spoil banks of the brown-coal mining district of Cologne.** *In* Ecology and Reclamation of Devastated Land vol. 1: 335-348. Gordon and Breach Sci. Publ., New York.

In the reclaimed areas of the Cologne brown-coal mining district, a succession can be observed from raw spoil banks to approximately 30-year-old afforestations. The progress of succession of carabid beetles, millipedes, and woodlice was investigated. Many pioneer species and numbers of carabids are found on spoil banks. With the development of trees and other vegetation, these fauna are replaced by millipedes and woodlice. Microclimate is one of the most decisive factors in establishment of soil fauna.

Germany : coal-L : VI-B

399. Nielson, Rex F., and H. B. Peterson.
1973. **Establishing vegetation on mine tailings waste.** *In* Ecology and Reclamation of Devastated Land vol. 2: 103-115. Gordon and Breach Sci. Publ., New York.

Most copper tailings in the West are deficient in N and P; some are deficient in K. Uranium tailings are high in N because of ammonium hydroxide used in processing. Salinity is a problem; thus leaching is necessary before vegetation can be established. High acidity occurs in uranium tailings because of the addition of acid in milling. A number of plants have been well adapted to the adverse conditions. Several legumes will develop nodules and fix N if salinity and nutrient deficiencies are corrected.

U.S.-UT : ore waste : III

400. Noble, E. A.
1973. **A geologist's view of strip mining.** *In* Some environmental aspects of strip mining in North Dakota. N.D. Geol. Surv. Educ. Ser. 5: 53-60.

The geologist sees that strip-mining is a unique but relatively minor disturbance of a small portion of the earth's surface. In the context of human experience, the environmental effects of strip-mining have been offensive.

U.S.-ND : coal-L : VIII-B

401. Ohio State University and Ohio Academy of Science.
1964. **A symposium on strip-mine reclamation.** Ohio J. Sci. 64 (2): 65-175.

This volume contains 10 papers presented at the symposium on strip-mine reclamation, held at the Ohio Agricultural Experiment Station in Wooster, in August 1962.

U.S.-OH : coal : VI+VIII-D

402. Olschowy, Gerhard.
1973. **Landscape planning on an ecological basis.** *In* Ecology and Reclamation of Devastated Land vol. 2: 477-484. Gordon and Breach Sci. Publ., New York.

Surface mining interferes with the natural balance of the landscape. Agricultural lands and forests are encroached; water courses, roads, and railroads are shifted; farms and villages are relocated. Reclamation requires finding of facts before and during operations. The landscape diagnosis is prepared to assess damages from mining and the limitation for use after mining. Reclamation can restore lands to productivity and to create diversified spots of forest and lakes for recreation. The brown-coal district could serve as a model for future development in which the need of the economy, agriculture, recreation, and nature preservation are met equally.

Germany : coal-L : VII

403. Onosode, A. T., and J. F. Redhead.
1973. **The reclamation of land devastated by tin mining on the Jos Plateau, Nigeria.** *In* Ecology and Reclamation of Devastated Land vol. 2: 407-416. Gordon and Breach Sci. Publ., New York.

At 4,000 feet elevation, the 2,000-square-mile Jos Plateau of Nigeria is a dry land of seasonal rainfall. Historically, clearing forests, over-farming, and subsequent over-grazing have created severe damage. Surface mining for tin during the past 60 years has superimposed added problems. In the last 20 years the Mineland Reclamation Unit has successfully established eucalyptus plantations on leveled mine dumps. These plantations have improved landscape aesthetics, promoted a biological change in subsoils, and provided poles and firewood for local use.

Nigeria : ore waste : VI

404. Paller, William, and Donald A. Schultz.
1973. **Planning approaches to surface mining on the national forests.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 68-81. Bitum. Coal Res., Inc., Monroeville, Pa.

Phosphate mining in Caribou National Forest, Pocatello, Idaho, is related to the general problems of strip-mining. An administrative study by the Forest Service and four members of the phosphate mining industry considered reclamation of areas already mined and made plans for future mining to minimize effects of disturbing land. Surface mining is also considered in relation to multiple use of an area with nonrenewable resources and its impact on timber production, wildlife needs, water quality, fisheries, and groundwater supplies.

U.S.-ID : phosphates : VI

405. Parks, C. L., H. F. Perkins, and Jack T. May.
1967. **A greenhouse study of P and K requirements for ladino clover establishment on kaolin strip mine spoil.** Ga. Agric. Res. 9 (2): 8-11, illus.

Ladino clover has been grown in kaolin strip-mine spoils in the greenhouse by adding lime, P, and K. Two tons of lime per acre raised the pH from 4.8 to 7.2; 70 pounds of P and 100 pounds of K were needed for good plant growth.

U.S.-GA : kaolin : VI-B

406. Parsons, F. W.
1906. **Coal mining by open stripping in Pennsylvania.** Eng. and Min. J. 81 (26): 1239-1240.

A primitive strip-mining operation in the anthracite coal fields near Hazleton is described. Coal resources and economic considerations are discussed. Mining improvements are suggested.

U.S.-PA : coal-A : II

407. Pennsylvania, Commonwealth of.
1962. **Proceedings of the National Sym-**

posium on Control of Coal Mine Drainage. Pa. Dep. Health Publ. 4. 113 p.
This volume is a product of the symposium held in June 1962 in Pittsburgh. It contains papers on the status of law and legislation, technical aspects of control of drainage from active and abandoned mines, restoration of strip-mined lands, improvement of acid polluted streams, and administration of mine-drainage control programs. The volume includes numerous speeches, reports, and remarks related to the problem.

U.S. : coal : VIII-D

408. Perkins, H. F., and Patricia S. Troth. 1971. **Properties of drastically disturbed surface mined soils.** Rehabil. Drastically Disturbed Surf. Mined Lands Symp. Proc.: 37-41. Ga. Surface Mined Land Use Board. Macon.
A discussion of spoils resulting from strip-mining of kaolin clay. Kaolin overburden and spoil are diverse texturally, structurally, and in ability to hold moisture. They are generally acid and low in nutrients. Deficiencies in toxicities of micronutrients are not indicated. Kaolin spoil is undergoing soil formation as indicated by nutrient recycling.

U.S.-GA : kaolin : III

409. Peters, W. C. [Ed.] 1970. **Mining and ecology in the arid environment.** Univ. Ariz. Coll. Mines Conf. Proc. 229 p. Tucson.
A report on the conference on mining and ecology in the arid environment held in Tucson, Arizona, in March 1970. It contains 21 papers related to the subject. Extensive comments, questions, and answers are included. Some of the subjects and phenomena discussed in this volume are of nationwide importance.

U.S. : ore waste, other : VIII-D

410. Peterson, E. B., and H. M. Etter. 1970. **A background for disturbed land reclamation and research in the Rocky Mountain Region of Alberta.** Can. For. Serv. Dep. Fish. and For. Inf. Rep. A-X-34. 45 p.
The authors review current literature, describe operations and controls, and suggest principles and research objectives for reclamation of land disturbed by coal mining in the Rocky Mountain region of Alberta.

Canada-AB : coal : VIII

411. Peterson, Howard B., and Ralph Monk. 1967. **Vegetation and metal toxicity in relation to mine and mill wastes.** Utah State Univ. Agric. Exp. Stn. Circ. 148. 75 p. Logan.
An annotated bibliography of the literature dealing with the toxic elements found in mine, mill, and smelter wastes, and the toxic effects on vegetation. It lists 167 publications by 220 authors. Subject and author indexes.

U.S. : ore waste : VIII-E

412. Peterson, H. B., and Rex F. Nielson. 1973. **Toxicities and deficiencies in mine tailings.** *In* Ecology and Reclamation of Devastated Land vol. 1: 15-25. Gordon and Breach Sci. Publ., New York.
Various mine and mill wastes differ. Tailings from Cu, Pb, Zn, and U mills have one or more characteristics such as poor physical properties, toxic substances, nutrient deficiency, high acidity, or alkalinity and salinity. The oxidation of sulfides in Cu-wastes lower the pH and increase the solubility of several heavy metals. The problem associated with growing plants on Cu-tailings is related to low pH.

U.S. : ore waste : III-B

413. Peterson, J. R., and J.Gschwind. 1973. **Amelioration of coal mine spoils with digested sewage sludge.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 187-196. Bitum. Coal Res., Inc., Monroeville, Pa.
Acid mine spoils have been successfully reclaimed with digested sewage sludge. Application of 200 to 250 tons per acre resulted in a permanent grass cover, and the sub-

surface water quality was upgraded. Large acreage of calcareous spoils have been upgraded with sludge.

U.S.-IL : coal-B : VI-B

414. Plass, William T.
1966. **Land disturbances from strip-mining in eastern Kentucky. 1. Upper Cumberland Coal Reserve District.** USDA For. Serv. Res. Note NE-52. 7 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.
Results of an airphoto and field survey to determine the extent of land disturbance by coal mining and by coal-haul roads in Upper Cumberland Coal Reserve District. Describes the district's forest cover, physiography and geology, and distribution and physical characteristics of the 11,845 acres disturbed in this 434,000-acre district.

U.S.-KY : coal-B : I-B

415. Plass, William T.
1967. **Land disturbances from strip-mining in eastern Kentucky. 2. Princess Coal Reserve District.** USDA For. Serv. Res. Note NE-55. 8 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.
Results of an airphoto and field survey to determine the extent of land disturbance by coal mining and by coal-haul roads in Princess Coal Reserve District. Describes the district's forest cover, physiology and geology, and distribution and physical characteristics of the 4,761 acres, disturbed in this 855,000-acre district.

U.S.-KY : coal-B : I-B

416. Plass, William T.
1967. **Land disturbances from strip-mining in eastern Kentucky. 3. Licking River Coal Reserve District.** USDA For. Serv. Res. Note NE-68. 6 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.
Results of an airphoto survey to determine the extent of land disturbances by coal mining and by coal-haul roads in Licking River Coal Reserve District. Describes the district, forest cover, physiography and geology, and distribution and physical characteristics of the 1,456 acres disturbed in this 1.1-million-acre district.

U.S.-KY : coal-B : I-B

417. Plass, William T.
1967. **Land disturbances from strip-mining in eastern Kentucky. 4. Big Sandy Coal Reserve District.** USDA For. Serv. Res. Note NE-69. 7 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.
Results of an airphoto survey to determine the extent of land disturbance by coal mining and by coal-haul roads in the Big Sandy Coal Reserve District. Describes the district, forest cover, physiography and geology, and distribution and physical characteristics of the acreage disturbed in this district.

U.S.-KY : coal-B : I-B

418. Plass, William T.
1967. **Land disturbances from strip-mining in eastern Kentucky. 5. Hazard Coal Reserve District.** USDA For. Serv. Res. Note NE-71. 7 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.
Results of an airphoto survey to determine the extent of land disturbance by coal mining and by coal-haul roads in Hazard Coal Reserve District. Describes the district, forest cover, physiography and geology, and distribution and physical characteristics of the acreage disturbed in this district.

U.S.-KY : coal-B : I-B

419. Plass, William T.
1967. **Land disturbances from strip-mining in eastern Kentucky. 6. Southwestern Coal Reserve District.** USDA For. Serv. Res. Note NE-72. 8 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.
Results of an airphoto survey to determine the extent of land disturbance by coal mining and by coal-haul roads in Southwestern Coal Reserve District. Describes the district, forest cover, physiography and geology, and distribution and physical characteristics of the acreage disturbed in this district.

U.S.-KY : coal-B : I-B

420. Plass, William T.
1967. **Survey of eastern Kentucky.** Ky. Dep. Nat. Resour. Strip Mining Symp. 6 p. Frankfort.

A review of the location and status of strip-mining disturbance and data obtained from the survey.

U.S.-KY : coal-B : I-B

421. Plass, William T.
1968. **Tree survival and growth on fescue-covered spoil banks.** USDA For. Serv. Res. Note NE-90. 4 p. Northeast. For. Exp. Stn., Upper Darby, Pa.

A 2-year-old ground cover of tall fescue, K-31, did not affect survival of white pine, loblolly pine, sycamore, and sweetgum seedlings planted on strip-mine spoils in Kentucky, but reduced the height growth of the species as compared with growth on spoils free of cover.

U.S.-KY : coal-B : VI-B

422. Plass, William T.
1969. **Pine seedlings respond to liming of acid strip-mine spoil.** USDA For. Serv. Res. Note NE-103. 8 p. Northeast. For. Exp. Stn., Upper Darby, Pa.

A greenhouse trial was made to determine the effects of liming on the growth of five species of pine seedlings in an extremely acid strip-mine spoil. Liming at the rate of 5 tons per acre-foot significantly increased the growth of four of the species. Tissue analysis indicated that the growth rate may be related to a reduction in the concentration of the metallic ions of Mn, Fe, Cu, and Zn.

U.S.-KY : coal-B : VI-B

423. Plass, William T.
1971. **Highwalls — an environmental nightmare.** W. Va. Univ. Symp. Reveg. and Econ. Use of Surf.-Mined Land and Mine Refuse Proc.: 9-13. Morgantown.

The highwall is the dominant physical feature of most auger and surface mining in mountainous terrain. This is a review of the problems and opportunities for highwall screening based on hypothetical situations. Some obvious problems in highwall screening have been identified. Research priorities can be assigned to these problems, and we have the framework for a research project.

U.S.-WV : coal-B : VI-B

424. Plass, William T.
1972. **Fertilization treatments increase black locust growth on extremely acid surface-mine spoils.** Tree Planters' Notes 23 (4) : 10-12.

Black locust seedlings planted on extremely acid spoils responded to P and N fertilizers during 3 years after planting.

U.S.-KY : coal-B : VI-B

425. Plass, William T.
1973. **Chemical soil stabilizers for surface mine reclamation.** *In* soil erosion: causes and mechanism, prevention and control. Highw. Res. Board Spec. Rep.: 118-122. Washington, D.C.

Successful stabilization of surface-mine spoils and other drastically disturbed areas depends on the establishment of vegetative cover. Mulches and soil stabilizers may be used on these sites to help establish vegetation and reduce erosion. In two cooperative demonstrations in West Virginia vegetation establishment and erosion were compared following 30 mulch and soil-stabilizer treatments. There was no evidence that these treatments were necessary for vegetation establishment. Large variations did occur in erosion losses between treatments.

U.S.-WV : coal-B : VI

426. Plass, William T.
1973. **Genetic variability in survival and growth of Virginia pine planted on acid surface-mine spoil.** *In* Ecology and Reclamation of Devastated Land vol. 1: 493-507. Gordon and Breach Sci. Publ., New York.

Fifty-seven open-pollinated Virginia pine progeny from 10 natural stands widely dispersed throughout Tennessee and Kentucky were evaluated under field conditions. On an extremely acid spoil after two growing seasons, survival, total height, and second-year growth were significantly better for some progeny. Greenhouse growth of 11 progeny did not correlate with growth under field conditions. Tissue analysis of the greenhouse-grown seedlings showed significant differences between progeny in nutrient uptake.

U.S.-WV : coal-B : VI-B

427. Plass, William T.
1974. **Factors affecting the establishment of direct-seeded pine on surface-mine spoils.** USDA For. Serv. Res. Pap. NE-290. 5 p. Northeast. For. Exp. Stn., Upper Darby, Pa.
In a greenhouse study, the emergence, survival, and growth of seven species of pine were related to chemical and textural charactristics of 12 Kentucky spoils. The results were used to identify three factors that may affect the establishment of direct-seeded pine on surface-mine spoils: (1) fine-texturd spoil material may restrict seedling emergence; (2) species vary in their response to chemical and physical characteristics of the spoil material; and (3) the growth of loblolly pine was greatest where the percentage of phosphorus in the whole plant was greatest.

U.S.-KY : coal-B : III+VI-B

428. Plass, William T., and James D. Burton
1967. **Pulpwood production potential on strip-mined land in the South.** J. Soil and water Conserv. 22 (6) : 235-238, illus.
Wherever extensive areas of strip-mined land lie within the procurement area of a pulpmill there is an opportunity for coal and paper companies to cooperatively plan reclamation programs for plupwood production.

U.S.-KY : coal-B : VII-D

429. Plass, William T., and John P. Capp.
1974. **Physical and chemical characteristics of surface mine spoil treated with fly ash.** J. Soil and Water Conserv. 29 (3) : 119-121.
Use of power-plant fly ash for surface-mine reclamation offers an attractive outlet for large amounts of this waste. The authors describe changes that occurred in a spoil following the application of 150 tons of fly ash per acre. The treatment neutralized acidity, added plant-available P, lowered spoil density, and increased subsurface moisture.

U.S.-WV : coal-B : III

430. Plass, William T., and Willis G. Vogel.
1973. **Chemical properties and particle-size distribution of 39 surface-mine spoils in southern West Virginia.** USDA For. Serv. Res. Pap. NE-276. 8 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.
A survey of 39 surface-mine sites in southern West Virginia showed that most of the spoils from current mining operations had a pH of 5.0 or higher. Soil-size material averaged 37 percent of the weight of the spoils sampled. A major problem for the establishment of vegetation was a deficiency of nitrogen and phosphorus. This can be corrected with additions of fertilizer at appropriate rates.

U.S.-WV : coal-B : III-B

431. Paluch, Jan, Ed.
1965. **Materialy Sympozjalne.** Pol. Acad. Sci. Symp. Proc. B. 302 p. Katowice.
This volume contains 44 papers (16 in Russian and 28 in English) presented at the Second International Symposium dealing with the problems of reclamation of industrial lands, held in October 1965 in Katowice, Poland. The papers deal primarily with the ecology and reclamation of disturbed lands in member countries of the Mutual Economic Assistance Committee of Eastern Europe.

Europe : coal : VIII-D

432. Potter, H. Spencer, Sidney Weitzman, and George R. Trimble, Jr.
1951. **Reforestation of strip-mined lands in West Virginia.** USDA For. Serv. Northeast. For. Exp. Stn. Pap. 43. 28 p.
The authors discuss the conditions pertaining to plant growth that prevail in West Virginia; the nature and extent of natural revegetation; condition of existing tree and shrub plantings; and the effects of acidity,

texture, and spoil age on performance of tree species.

U.S.-WV : coal-B : VI-B

433. Pratt, Parker F., Eamor S. Nord, and Francis L. Bair.
1971. **Early growth tolerances of grasses, shrubs, and trees to boron in tunnel spoil.** USDA For. Serv. Res. Note PSW-232. 5 p. Pac. Southwest. For. and Range Exp. Stn., Berkley, Calif.

The effects of B in spoil material on survival and growth of 44 grass, strub, and tree species were tested under greenhouse conditions. The spoil used was from the Angeles Tunnel being built for the California Aqueduct's West Branch. Several species within each plant group apparently can tolerate B, but field tests will be needed before most of them can be recommended for widespread plantings.

U.S.-CA : other : III-B+VI-B

434. Pyles, Hamilton K.
1965. **National forest policy on surface mining.** Ky. Dep. Nat. Resour. Strip Mine Reclam. Symp. Proc.: 36-40. Frankfort.

A report on the "White House Conference on Natural Beauty," emphasizing the work of the panel on "Reclamation of the Landscape."

U.S. : coal : VIII-A

435. Pyles, Hamilton K.
1965. **National implications — the coal regions.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 1-6. University Park.

Discusses the national attention on the restoration of natural beauty in coal regions. The White House Conference on Natural Beauty panel recommendations on rehabilitation of coal-mine spoils and the passage of the Appalachia Regional Development Act are reviewed.

U.S. : coal : VIII-A

436. Rainey, Kenneth D.
1965. **A regional approach to planning and development is necessary to the solution of the problems of the coal regions.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 7-11. University Park.

A need for a regional approach to the solution of the coal regions' problems: highway construction, combating water pollution, and healing the mining scars. The Appalachian Regional Development program is designed to solve some of those problems of the coal region.

U.S. : coal : VIII-A

437. Ramsey, John P.
1970. **Control of acid pollution from coal refuse piles and slurry lagoons.** Coal Mine Drain. Res. Symp. 3 Proc.: 138-144. Bitum. Coal Res., Inc., Monroeville, Pa.

Describes a demonstration project on the control of acid pollution from coal refuse piles and slurry lagoons. Small watersheds were created on a refuse pile and systems for data collection and interpretation of acid formation and water quality were established. To minimize the movement of air and water into the pyrite, by sealing, certain test plots received 40 tons/acre of lime and were seeded to grasses or treated with polyethylene plastic membrane, top soil, or dried sewage sludge. The effectiveness of the restoration on water quality will be studied. An excellent stand of grass was developed on limed and fertilized plots. The lagoons will be restored by planting a vegetative cover.

U.S.-IL : coal-R : VI-B

438. Reilly, James D.
1965. **Planning surface mine reclamation before mining.** Min. Congr. J. 51 (11): 93-96.

A need for a planning of reclamation before mining is stressed. Economics, revegetation, erosion, water conservation, and aesthetics as well as the potential land uses for recreation, forage, timber, and urban development must be considered.

U.S.-OH : coal-B : VII

439. Repp, Gertraud.
1973. **Cytoecological investigations with regard to the mechanism of chemical resistance of plants.** *In* Ecology and Reclamation of Devastated Land vol. 1: 445-466. Gordon and Breach Sci. Publ., New York.

Cell-physiological resistance tests of protoplasm may be of value in the revegetation of chemically adverse sites. When such sites are to be revegetated, these tests can be used as a rapid method for preliminary selection of suitable species. Plasmatic salt-tolerance test results agreed well with the results of field tests. Within the genetic limits of a species, plasmatic resistance is variable that offers possibilities for "hardening" against damaging site factors.

Austria : other : VI-B

440. Research Committee on Coal Mine Spoil Revegetation in Pennsylvania.
1965. **A guide for revegetating bituminous strip-mine spoils in Pennsylvania.** (Rev. 1971). 46 p., illus.

This guide provides a review and summary of knowledge about revegetation of bituminous strip-mine spoils in Pennsylvania, including legislation, characteristics and classification of spoils; and revegetation planning and reclamation for agricultural, wildlife, and recreational uses. Appedixes include a blibliography.

U.S.-PA : coal-B

441. Riley, Charles V.
1957. **Reclamation of coal strip-mined lands with reference to wildlife plantings.** J. Wildl. Manage. 21: 402-413.

The performance of 37 plant species useful to wildlife was evaluated. Bicolor and serecia lespedeza were most successful on various spoils. Korean lespedeza did very well on calcareous materials. Clover proved to be very successful. Alsike clover grew well in moist depressions. Mixed seeding of legumes and grasses did well on spoils with pH from 4.5 to 7.0. Scotch broom and Indigobush made excellent growth. Conifers growing in pure and mixed stands provided good cover. Black locust was superior to all other hardwood species.

U.S.-OH : coal-B : VI-B+VII-E

442. Riley, Charles V.
1965. **Limnology of acid mine water impoundments.** Acid Mine Drain. Res. Symp. 1 Proc.: 175-187. Bitum. Coal Res., Inc., Monroeville, Pa.

A progress report of research on limnological conditions of mine water impoundments. Analyses of watershed spoil material as compared with adjacent undisturbed land and the data on water quality in several ponds are presented. Tolerance of fish to the various chemical and physical components of mine water is also discussed.

U.S.-OH : coal-B : IV-H+V-B+VII-E

443. Riley, Charles V.
1972. **Design criteria of mined land reclamation.** Soc. Mech. Eng. Proc. Oct. 1972. 19 p.

To insure successful reclamation of mixed lands, knowledge and appreciation of the following criteria are essential: geochemistry of the overburden, spoil placement, grading for proper topography and spoil surface, all relative to improved site conditions needed for the successful establishment of vegetation, spoil stabilization, erosion control, and water management. The criteria should be considered as a part of the active mining operation, if the reclamation is to result in environmental improvement.

U.S.-OH : coal-B : III+VI

444. Riley, Charles V.
1973. **Chemical alterations of strip-mine spoil by furrow grading — revegetation success.** *In* Ecology and Reclamation of Devastated Land vol. 2: 315-331. Gordon and Breach Sci. Publ., New York.

A study was made of furrow-graded versus conventional smooth-graded spoils. Analyses revealed extremely high levels of metal ions, sulfates, and soluble salts, and pH values ranging from 3.1 to 4.1. Plant performance was better in the ravines than on the slopes, idges, or smooth-graded spoils. Analyses howed: a higher pH for ravine sites; higher evels of soluble salts in the ridge site; and igher levels of sulfates, Mn, Cu, and Zn in he ridges. Marked site improvement reulted, and reclamation was enhanced by the nodified furrow grading technique.

.S.-OH : coal-B : III-B+VI-A

45. Riley, Charles V.
1973. **Furrow grading—key to successful reclamation.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 159-177. Bitum. Coal Res., Inc., Monroeville, Pa.

he effectiveness of a furrowed spoil surface improving the mined-land's ability to support vegetation was evaluated. Initial spoil nalysis revealed high levels of soluble salts, ulfates, and metal ions, and a pH range of 1 to 4.1. Data from ridge and ravine amples showed a higher pH and lower levels soluble salts for the ravine sites, and gher levels of Mn, Cu, and Zn in the ridge nd smooth surface sites. Ca, Mg and K, O_3, and NH_3 were in greater amounts in dges of smooth surfaces. Furrowing created a surface conducive to water retention, sorption, and infiltration. Site improvement was also reflected by better plant permanence in the ravines than on the ridges or the smooth surfaces.

S.-OH : coal-B : III-B+VI-A

6. Riley, Charles V., and James A. Rinier.
1972. **Reclamation and mine tip drainage in Europe.** Coal Mine Drain. Res. Symp. 4 Proc.: 1-14. Bitum. Coal Res., Inc., Monroeville, Pa.

overview of the study of problems associed with the reclamation of coal and lignite s in western Europe, mainly in Great itain and in West Germany.

rmany : coal-L : VI

7. Roberts, John R.
1971. **Grading and slopes used in reclamation.** Rehabil. of Drastically Disturbed Surf. Mined Lands Symp. Proc.: 47-50. Ga. Surface Mined Land Use Board. Macon.

A fairly comprehensive review of coal strip-mining and reclamation methods and state regulations in Kentucky. The author discusses both contour and area stripping. His description of contour stripping is broken down into different types of cuts and grading methods and final stability of the fills.

U.S.-KY : coal-B : II-B+VI

448. Robinson, Robert C.
1971. **Management of surface waters, erosion control and soil stabilization techniques.** Rehabil. of Drastically Disturbed Surf. Mined Lands Symp. Proc.: 51-53. Ga. Surface Mined Land Use Board. Macon.

The mechanics of erosion are complex. Surface-mined land offers more severe conditions than most other lands, but the problems are the same. By judicious use of vegetation, terraces, diversion channels, outlets and ponds, or sediment basins it should be feasible to adequately control erosion.

U.S.-GA : kaolin : IV-E

449. Rogers, Nelson F.
1949. **The growth and development of black walnut (*Juglans nigra* L.) on coal strip-mined land in southeast Kansas.** Kans. Acad. Sci. Trans. 52 (1): 99-104, illus.

The 12- to 14-year results show that plantations can be established on certain spoils by the planting of seeds. Trees make satisfactory growth, produce seeds, and yield logs and veneer bolts in a reasonable time.

U.S.-KS : coal-B : VI-B

450. Rogers, Nelson F.
1951. **Strip-mined lands of the western interior coal province.** Mo. Agric. Exp. Stn. Res. Bull. 475. 55 p., illus.

A summary of results of the survey on condition of coal strip-mined lands in Arkansas, Oklahoma, Kansas, Missouri, and Iowa. Data on spoil acidities, available nutrients, and organic matter. Area of strip-mined lands, list of tree species found, and other data are presented in an appendix.

U.S. : coal-L : III+VII

451. Roll, William H.
1962. **A short description of Kentucky coals.** Univ. Ky. Eng. Exp. Stn. Bull. 17 (1). 35 p., illus.

A summary description of Kentucky coals, by coal fields and seams. Characteristics of coal are given.

U.S.-KY : coal-B : I-A

452. Roseberry, John L., and W. D. Klimstra.
1964. **Recreational activities on Illinois strip-mined lands.** Soil and Water Conserv. 19 (3) : 107-110.

More than 4,000 acres of land are being excavated annually for open-cut mining in Illinois. A portion of the resulting spoil areas might be developed to meet increasing needs for recreational space. Current use of the more than 108,000 acres of strip-mined land in the state, and the recreational use now being made of it, are described.

U.S.-IL : coal-B : VII-F

453. Rothwell, Frederick M.
1973. **Nodulation by various strains of *Rhizobium* with *Robinia pseudoacacia* seedlings planted in strip-mine spoil.** *In* Ecology and Reclamation of Devastated Land vol. 1: 349-353. Gordon and Breach Sci. Publ., New York.

Sixteen strains of *Rhizobium* were studied for their ability to nodulate black locust seedlings. Three of the bacterial strains were effective in all spoil types, and two strains modulated in three of the four spoil materials where the seedlings were grown under controlled conditions. The use of planting-bullet studies is proposed as an effective technique for studies of rhizosphers as well as symbiotic and mycorrhizal microorganisms of tree species used to revegetate the spoils.

U.S.-KY : coal-B : III-D+VI-B

454. Ruble, Ralph W.
1965. **A review of "A guide for revegetating bituminous strip-mine spoils in Pennsylvania."** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 106-110. University Park.

A review of the material presented in the "Guide for revegetating bituminous strip-mine spoils in Pennsylvania," published in 1965. (The guide was revised in 1971.)

U.S.-PA : coal-B : VI

455. Ruffner, Joseph D.
1962. **New plants for Alleghenies; strip mine spoils and shale soils.** Soil Conserv. 27 (9) : 209-210, illus.

Chemung and Pendleton crownvetch, Garrett County narrowleaf trefoil, Blackwell switchgrass, and Indian grass are new plants suitable for highly erodible mine spoils.

U.S.-WV, MD, PA : coal-B : VI-B

456. Ruffner, Joseph D.
1965. **Adaptation and performance of shrubs in mine spoil reclamation.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 117-123. University Park.

A research summary on shrub-type plants that have been evaluated on coal-mine spoils, with a list of shrubs for spoil reclamation in Illinois, Indiana, Kentucky, Ohio, Pennsylvania, Virginia, and West Virginia. according to spoil-acidity classes.

U.S. : coal-B : VI-B

457. Ruffner, Joseph D.
1966. **An evalution of species planted on coal strip mine spoil in West Virginia for stabilization purposes, 1955 to 1965.** W. Va. Univ. 28 p. Morgantown.

A summary of results from 10 years of species evaluations by the Soil Conservation Service in West Virginia. Grasses, legumes, trees, and shrubs are included.

U.S.-WV : coal-B : VI-B

458. Ruffner, Joseph D.
1973. **Projecting the use of new plant**

materials for special reclamation problems. Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 233-242. Bitum. Coal Res., Inc., Monroeville, Pa.

Knowledge of the site and of the plants to be used are essential for successful revegetation of spoils. The SCS has developed a vegetative species guide based on spoil classification. Spoils are classified by reaction, degree of slope, texture, and stoniness. Selection of grasses, legumes, and tree species depends on the land use intended and on site characteristics. New plant material is evaluated as to its range of adaptability. Exposure, spoil compaction, amount of precipitation, and nutrient requirements should also be considered in revegetation of strip-mined land.

U.S. : coal-B : VI-B

459. Ruffner, Joseph D., and W. W. Steiner. 1973. **Evaluation of plants for use on critical sites.** *In* Ecology and Reclamation of Devastated Land vol. 2: 3-12. Gordon and Breach Sci. Publ., New York.

The authors discuss a program of SCS for developing plants useful for vegetating critical areas. Three major steps are involved: (1) plants are assembled, screened, and repropagated; (2) on-site planting and evaluation for site conditions; (3) evaluation to confirm performance and range adaptation. In the last 10 years more than 15 species and varieties have been confirmed for specific use on critical areas in the Northeast.

U.S. : coal-B : VI-B+VIII-C

460. Sall, George W. 1967. **Reclaiming strip-mined land in Washington.** W. Va. Coal Min. Inst. Proc.: 1-6.

Comments relating to proposed federal surface-mining legislation.

U.S. : coal-B : VIII-A

461. Sandoval, F. M., J. J. Bond, J. F. Power, and W. O. Willis. 1973. **Lignite mine spoils in the northern great plains — characteristics and potential for reclamation.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 117-133. Bitum. Coal Res., Inc., Monroeville, Pa.

Lignite and subbituminous coal spoils were studied to evaluate their potential for reclamation. Results show that the spoil materials provide a very poor environment for plant growth. Materials were extremely fine textured (Montmorillonitic), moderately saline, and highly sodic. Severity of the problems associated with high clay and high adsorbed Na content increase with depth from the original surface. Low organic matter combined with fine texture enhance the Na dispersion effect, which renders the spoil materials unstable, highly impermeable, and erodible. Available P was very low and N varied, depending on spoil age. Fertilization (P) in combination with the use of topsoil and straw mulches showed promise for reclamation. Response to gypsum has been very slow.

U.S. : coal-L : III-B+VI-B

462. Sandoval, F. M., J. J. Bond, J. F. Power, and W. O. Willis. 1973. **Lignite mine spoils in the northern great plains — characteristics and potential for reclamation.** *In* Some environmental aspects of strip mining in North Dakota. ND Geol. Surv. Educ. Ser. 5: 1-24.

Chemical and physical properties of spoils provide a poor environment for vegetative growth. They are often fine textured, moderately saline, and highly sodic. Low organic matter and fine texture enhance the sodium dispersion effect, which renders the spoil unstable, impermeable, and erodible. Available P is very low, and N is variable. P fertilization in combination with topsoil, straw mulches, and gypsum are highly beneficial in reclamation work.

U.S.-ND, MO : coal-L : III

463. Saperstein, Lee W., and Edwin S. Secor. 1973. **Improved reclamation potential with the block method of contour stripping.** Res. and Appl. Tech. Symp. on

Mined-Land Reclam. Proc.: 1-14. Bitum. Coal Res., Inc., Monroeville, Pa.

The block method of mining, which has been used successfully in strip mining on hillsides, is described in detail. Mining is carried out in sections so that overburden from an area being mined can be placed in a mined-out area as mining proceeds. Overburden handling can be planned so that acid-producing soil can be segregated, and buried and topsoil can be reserved for final spreading. A cursory investigation of the economics of the block method indicates that it is no more expensive and may costs less than conventional dragline mining.

U.S. : coal-B : II-B

464. Sargent, Thomas N.
1971. **Protection of streams and lakes and adjacent lands from mining and related industrial waste.** Rehabil. Drastically Disturbed Surf. Mined Lands Symp. Proc.: 59-64. Ga. Surface Mined Land Use Board. Macon.

Mining and related industrial activities are potentially a great source of pollution to streams and lakes. Some of the problems to be solved include solids handling and disposal and the leaching of pollutants from mining activities. The Environmental Protection Agency administers a research program directed toward solving some of these problems.

U.S. : coal, other : VIII

465. Sauer, Elmer L.
1962. **Trends in economics of mined area restoration.** *In* conservation — a key to world progress. Soil Conserv. Soc. Am. Proc. Pap. 108-D: 107-119. Des Moines, Iowa.

A report on the findings of a survey on cost of and possible returns from restoring mined areas. Summaries are presented by states, based on information provided by industry and reclamation associations. Examples of projects developed in several states are given.

U.S. : coal : VI

466. Sawyer, L. E.
1946. **Indiana strip-mine plantings.** J. For. 44: 19-21.

Reforestation of the spoil piles that follow the open-cut mining of coal in Indiana has been under way since 1926. Many species of trees, both softwoods and hardwoods, have been tried. Under a plan approved by the Indiana Coal Producers Association in September 1944, all lands owned by member companies will hereafter be devoted to their highest use.

U.S.-IN : coal-B : VI-B

467. Sawyer, L. E.
1949. **The use of surface mined land.** J. Soil and Water Conserv. 4 (4): 161-165, 170.

The author reviews the development of revegetation programs based on land-use research, starting in the early 1920s. Studies referred to show that survival and growth of trees planted on leveled areas were markedly less than on unleveled areas. The rate of water infiltration on unleveled areas was higher than on leveled areas.

U.S.-IN : coal-B : VI-B

468. Sawyer, L. E.
1962. **Restoration of areas affected by coal mining.** Symp. Control of Coal Mine Drain. Proc. Nat. Pa. Dep. Health Publ. 4: 52-58.

The problems of restoring strip-mined lands are summarized. Discussion includes brief history of early reforestation efforts, research, spoil characteristics and species selection, planting stock and methods, grading effects, and land use for recreation and homesites.

U.S. : coal-B : VI+VII-D

469. Sawyer, L. E.
1962. **Mined area restoration in Indiana.** J. Soil and Water Conserv. 17 (2): 65-67.

An analysis of the problem and a progress report on restoration of coal strip-mine spoils to some form of productive use. Research needs, effects of grading, and tree growth progress in Indiana are discussed.

U.S.-IN : coal-B : VI

470. Scanlon, David H., Carroll Duggan, and S. D. Bean.
1973. **Evaluation of municipal compost for strip mine reclamation.** Compost Sci. 14 (3) : 4-8.

The use of municipal compost in the reclamation of highly acid strip-mine spoils was tested. Heavily composted plots showed a decrease in acidity and developed an organic layer that stabilized the surface. Good herbaceous cover was established without the addition of fertilizers or lime.

U.S.-VA : coal-B : VI-B

471. Schavilje, Joseph P.
1941. **Reclaiming Illinois strip mined coal lands with trees.** J. For. 39: 714-719.

In Illinois about 100 square miles of land have been or eventually will be stripped in mining coal. Although these areas are a small percentage of the total land area of the state, they are ugly scars on the landscape. Largely through the leadership of the Illinois Division of Forestry, the mine operators have undertaken a program of planting stripped areas. This work has been under way for some years, and the results so far obtained are reported here.

U.S.-IL : coal-B : VI-B

472. Schimp, Park E.
1973. **Deep-mine waste reclamation experimentation in the bituminous regions of Pennsylvania.** *In* Ecology and Reclamation of Devastated Land vol. 2: 457-467. Gordon and Breach Sci. Publ., New York.

Trees, perennial grasses, and annuals were seeded to determine germinative capacity. Trees and shrub seedlings were planted to establish utility of various planting procedures and fertilizing methods. It was found that internal heat as a result of burning spots within the bank, erosion, and sulfur gas injury played only minor roles in the high mortality rates experienced in the past. High solar radiation absorption and low moisture combined to desiccate plant tissue during critical periods. Switchgrass, weeping lovegrass, yucca, bristly locust, and Virginia pine demonstrated hardness to the site. Fertilizing and planting with water-soaked vermiculite had no significance in first-year survival.

U.S.-PA : coal-B+R : III+VI-B

473. Schlatzer, Georg.
1973. **Some experiences with various species in Danish reclamation work.** *In* Ecology and Reclamation of Devastated Land. vol. 2: 33-64. Gordon and Breach Sci. Publ., New York.

Plantations on Danish dune areas, heathlands, and strip-mine spoils were established to test native and foreign wood species for use in wildlife plantations, reclamation work, and landscape plantings. The Desert Arboretum plantation covers 20 ha. of strip-mine spoils. It has 460 wood species, of which conifers form but a small fraction. Techniques used, some experiences in amelioration, and examples from the wide range of species planted are discussed.

Denmark : coal, other : VI-B

474. Schmehl, W. R., and B. D. McCaslin.
1973. **Some properties of spent oil-shale significant to plant growth.** *In* Ecology and Reclamation of Devastated Land vol. 1: 27-43. Gordon and Breach Sci. Publ., New York.

Analyses of the spent shale revealed that the material was alkaline, saline, and low in available P and N. There was little growth in wheatgrass and ryegrass in untreated shale. When the shale was mixed with soil, growth of the crop did increase, but on the 50:50 soil-shale mixture it was still less than 10 percent of that on natural soil. When soluble salts were removed from the spent shale by leaching, normal plant growth could be obtained after fertilizing with N and P.

U.S.-CO : other : III-B+VI-B

475. Schmidt, J. W., and K. Conn.
1969. **Abatement of pollution from mine wastewaters.** Can. Min. J. 90 (6): 54-60.
A report on an investigation of generation of acid within the tailings pond system and effluent-receiving stream of a base metal mine. The processes of acid generation and the possible treatment methods of wastes are discussed.

Canada-NB : ore waste : V-B

476. Schramm, J. R.
1966. **Plant colonization studies on black wastes from anthracite mining in Pennsylvania.** Am. Philos. Soc. Trans. (n.s.) 56 (1). 194 p., illus.
A synthesis of findings related to the basic problems in establishment of vegetation on coal-breaker refuse banks and silt basins in the Anthracite Region, based on 24 years of experimentation and observation. Effects of moisture, wind, frost, acidity, surface temperature and the role of mycorrhizal relationships in plant growth are discussed.. Temperature effects, nutrient deficiencies, and the function of micorrhizate deserve special attention.

U.S.-PA : coal-A+R : III+VI-B

477. Seastrom, Paul N.
1965. **New land orchards.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 129-141. University Park.
A story of successful establishment of orchards on stripped lands. The new land can grow high-quality fruit. Prior knowledge of horticulture is essential. Sites should be graded, easily accessible, and located adjacent to a smooth-surfaced road to prevent damage to fruit. Fruit varieties depend on market demands and location.

U.S.-IL : coal-B : VII-C

478. Seidel, Kenneth W.
1961. **Seeded black walnut taller than planted walnut on Kansas spoil banks.** USDA For. Serv. Cent. States For. Exp. Stn. Note 148. 1 p. Columbus, Ohio.
Direct-seeded black walnut trees survived as well as and grew faster than planted trees for 10 years on Kansas spoil banks.

U.S.-KS : coal-B : VI-B

479. Seidel, Kenneth W., and Kenneth A. Brinkman.
1962. **Mixed or pure walnut plantings on strip-mined land in Kansas?** USDA For. Serv. Cent. States For. Exp. Stn. Tech. Pap. 187. 10 p., illus. Columbus, Ohio.
In mixed plantings with black locust, black walnut survival, growth, and form were impaired. When planted with other species (burr oak, sycamore, red cedar, and green ash), however, walnut grew almost as well as in pure stands. Mixed plantings are recommended because they usually result in better trees.

U.S.-KS : coal-B : VI-B

480. Shetron, Stephen G., and Ralph Duffek.
1970. **Establishing vegetation on iron mine tailings.** J. Soil and Water Conserv. 25 (66): 227-230.
Grasses and legumes have been established successfully on fertilized iron mine tailings. Performance of trees was poor. Fine textured layers within the plant rooting zone were beneficial for grass and legume establishment.

U.S.-MI : ore waste : III+VI-B

481. Singer, Philip, C., and Werner Stumm.
1970. **Acidic mine drainage: the rate determining step.** Science 167 (3921): 1121-1123.
Oxidation of ferrous iron is the rate-determining step in the oxidation of iron pyrite and the formation of acidity in streams associated with coal and copper mines. Effective pollution abatement necessitates controlling this reaction.

U.S. : coal, ore waste : V-B

482. Sitterley, J. H.
1964. **Future land use in the Appalachian Plateau and its relation to strip-mine reclamation.** Ohio J. Sci. 64 (2): 106-111.

A projection of land use in the Ohio segment of the Appalachian Plateau for two decades in the future. Land-use in 1980 will be characterized by less land in farms, more strip-mined land, and more land in water reservoirs, highways, parks, and forest. The relationship of land use in 1980 to strip-mine reclamation will be little different from what it is today. The change will arise from the need for watershed protection, pollution control, and recreation.

U.S.-OH : coal-B : VII

483. Smith, Edwin E., Kenesaw S. Shumate, and Karlis Svanks.
1968. **Sulfide to sulfate reaction studies.** Coal Mine Drain. Res. Symp. 2 Proc.: 1-11. Bitum. Coal Res., Inc., Monroeville, Pa.

Investigations designed to point out the physical and chemical parameters related to the kinetics of the sulfide-to-sulfate reaction are described. A mechanism is suggested to explain the observed kinetics.

U.S.-OH : coal-B : IV-G+V-B

484. Smith, Gordon E.
1968. **Swatara Creek watershed abatement project.** Coal Mine Drain. Res. Symp. 2 Proc.: 236-245. Bitum. Coal Res., Inc., Monroeville, Pa.

The author describes steps taken to control water pollution caused by mine drainage flowing into tributary streams of the Swatara Creek watershed. Apparent improvement in the water quality was observed, due to a decrease in sulfate, iron, and acid concentrations.

U.S.-PA : coal-A : VI+IV

485. Smith, H. G., H. H. Morse, G. E. Bernath, L. E. Gillogly, and W. M. Briggs.
1964. **Classification and revegetating of strip-mine spoil banks.** Ohio J. Sci. 64 (2): 168-175.

The authors discuss the classification of strip-mine spoils for purposes of determining suitable land-use planning conditions and planting practices used by the U.S. Soil Conservation Service in strip-mine reclamation.

U.S.-OH : coal-B : III-A+VI-B

486. Smith, John M.
1971. **Spoil placement and use to meet reclamation requirements.** Rehabil. Drastically Disturbed Surf. Mined Lands Symp. Proc.: 42-46. Ga. Surface Mined Land Use Board. Macon.

The author discusses briefly the surface and strip-mining of kaolin in Georgia. He cites requirements for different pieces of equipment, cost of equipment, and economics of overburden removal. He describes different stripping methods and preparation of reclamation sites for their intended end use.

U.S.-GA : kaolin : II

487. Smith, R. M., E. H. Tryon, and E. H. Tyner.
1971. **Soil development on mine spoil.** W. Va. Univ. Agric. Exp. Stn. Bull. 604 T. 47 p., illus. Morgantown.

Physical, chemical, and biological characteristics of iron ore spoils in West Virginia were compared with those of natural soils. Soils were superior in bulk density, porosity, structure, infiltration, N or organic matter, texture, and smoother land surface. Spoils were superior in depth for plant rooting, water-holding capacity, available P, and more gentle slopes. Forest site quality and minerology did not differ greatly. Spoils may be equal or superior for perennial plants and primary legumes, but are likely to be inferior for annual or perennial crops sensitive to N deficiencies.

U.S.-WV : ore waste : III+VI-B

488. Soil Conservation Society of America.
1962. **Conservation — a key to world progress.** Soil Conserv. Soc. Am. Annu. Meet. Proc. 17: 85-119.

Collection of papers dealing with the reclamation of strip-mined lands, presented at the annual meeting of the society.

U.S. : coal : VI

489. Sopper, William E.
1970. **Revegetation of strip mine spoil banks through irrigation with municipal sewage effluent and sludge.** Compost Sci. 11 (6) : 6-11.

Municipal sewage effluent and sludge were applied as amendment to bituminous coal-mine spoils. Beneficial effects on establishment of vegetation are reported.

U.S.-PA : coal-B : VI-B

490. Sopper, William E., and Louis T. Kardos.
1972. **Municipal wastewater aids revegetation of strip-mined spoil banks.** J. For. 70: 612-615.

Municipal wastewater and sludge applied to highly acid coal-mine spoils were effective in establishing a ground cover of grasses and legumes. Performance of forest trees, both conifers and hardwoods, was markedly improved. Chemical characteristics of percolate are given.

U.S.-PA : coal-B : VI-B

491. Stephan, Robert W., and Walter C. Lorenz.
1967. **A review of current research on coal mine drainage in Appalachia.** U.S. Bur. Mines. 26 p. Pittsburgh, Pa.

The status of research on methods for the abatement or control of acid mine drainage. A literature review contains 67 annotated references.

U.S. : coal : V-B

492. Stephan, Robert W., and Walter C. Lorenz.
1968. **Survey of costs on methods for control of acid mine drainage pollution.** U.S. Bur. Mines. 35 p.

A summary of cost data for coal mine reclamation, with emphasis on acid mine drainage control.

U.S. : coal : V-B

493. Striffler, W. David.
1965. **The selection of experimental watersheds and methods in disturbed forest areas.** Budapest Symp. Int. Assoc. Sci. Hydrol. 2: 464-473. Ghentbrugge, Belgium.

Watershed research techniques and their application to problems on mechanically disturbed watersheds are discussed. Some of the methods are being used to evaluate the effects of surface mining on the hydrology of forested watersheds.

U.S.-KY : coal-B : VII-B

494. Striffler, W. David.
1967. **Restoration of open-cast coal sites in Great Britain.** Soil and Water Conserv. 22 (3) : 101-103, illus.

Open-cast mines in Great Britain are physically similar to strip-mines in the United States, but disturbed areas are generally smaller. Restoration of these areas is discussed, along with costs of reclamation.

Great Britain : coal-B : VI

495. Striffler, W. D.
1973. **Surface mining disturbance and water quality in eastern Kentucky.** *In* Ecology and Reclamation of Devastated Land vol. 1: 175-191. Gordon and Breach Sci. Publ., New York.

Surface mining for coal in eastern Kentucky has disturbed thousands of acres of mountain land. Land mined in this manner is frequently considered a major source of acid pollution. A survey of 180 fourth-order and larger watersheds during the summer of 1966 indicated that very little acid pollution occurs in the larger streams; however, acid pollution may be a serious problem on small severely disturbed watersheds.

U.S.-KY : coal-B : V-B+VIII-B

496. Striffler, W. David, and Robert F. May.
1965. **Forest restoration of strip-mined areas.** Proceedings, Soc. Am. For. Proc. 1965: 105-108, illus.

Area and contour-type strip-mining are described. Effects of strip-mining on streamflow, erosion and sedimentation, quantities of dissolved solids, and problems of restoring mined lands to forest are discussed.

U.S.-KY : coal-B : II-B+VII-D

497. Struthers, Paul H.
1960. **Forage seedings help reclaim acres of spoil banks.** Ohio Farm and Home Res. 45 (1): 12-13.
Forage species—legumes and grasses—have been used successfully in revegetation efforts.

U.S.-OH : coal-B : VII-C

498. Struthers, Paul H.
1961. **180,000 stripmine acres: Ohio's largest chemical works.** Ohio Farm and Home Res. 46 (4): 52-53.
A report on the quality and quantity of chemicals leached from strip-mined spoils at various acidity levels, in comparison with natural soils. Salts leached from spoils range from 20 to more than 200 times the amount leached from natural soils.

U.S.-OH : coal-B : III-B

499. Struthers, P. H.
1964. **Chemical weathering of strip-mine spoils.** Ohio J. Sci. 64 (2): 125-131.
Quantitative analytical data on chemical weathering of coal-mine spoils. Intensive weathering began immediately upon exposure to air and water; large quantities of sulfate salts were produced in the top layer; highest salt concentrations occurred in late summer and fall; soluble mineral nutrients were more abundant in spoils than in soils; salt production was not related to spoil pH, and it decreased after the first year. Toxic spoils are characterized by very high acidity, very high salt content, high levels of soluble Al, Fe, and Mn, and by limited amounts of Ca and Mg.

U.S.-OH : coal-B : III-B

500. Struthers, P. H.
1965. **Rapid spoil weathering and soil genesis.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 86-90. University Park.
Man can modify spoil conditions to accelerate the processes of soil formation by grading and planting. A general discussion on spoil modification due to weathering and biological action.

U.S.-OH : coal-B : VI-A

501. Struthers, P. H.
1965. **Influence of weathering on strip mine drainage.** Acid Mine Drain. Res. Symp. 1 Proc.: 161-166. Bitum. Coal Res., Inc., Monroeville, Pa.
Quantitative data about the rate, magnitude, and kinds of changes occurring in strip-mine spoil during physical and chemical weathering. Weathering conditions the spoil for plant growth and accelerates soil formation. The chemistry of strip-mine drainage reflects the chemical changes caused by spoils weathering.

U.S.-OH : coal-B : III-B+IV-F

502. Struthers, Paul H., and J. P. Vimmerstedt.
1965. **Rapid strip mine reclamation.** Ohio Rep. 50 (6): 84-87. Ohio Agric. Res. and Dev. Cent., Wooster.
The amount of drainage and its solute content depend on rain percolation. Salt yields decreased in dry years and the solute concentration increased. The increased drainage is more dilute and flushes out a greater total amount of solute. Weathering processes and biochemical changes are essential in transforming spoil to soil.

U.S.-OH : coal-B : IV-F+VI-A

503. Struthers, P. H., and J. P. Vimmerstedt.
1965. **Advances in strip mine reclamation.** Ohio Rep. 50 (1): 3-5. Ohio Agric. Exp. Stn., Wooster.
Better reclamation can be gained by planting both forages and trees. Terrace grading was beneficial for promoting rain infiltration and leaching, and for controlling erosion.

U.S.-OH : coal-B : IV-A+VI-A

504. Sturgill, William B.
1965. **Strip mine reclamation under the**

1964 act (eastern Kentucky). Ky. Dep. Nat. Resour. Strip Mine Reclam. Symp. Proc.: 4-8. Frankfort.

Discusses the possibility of establishing orchards on strip-mine spoils.

U.S.-KY : coal-B : VII-C

505. Sullivan, G. Don.

1967. **Current research trends in mined-land conservation and utilization.** Min. Eng. 19 (3): 63-67, illus.

A review of the research on mined-land reclamation currently under way. The work is centered in the Eastern States, with some interest and research starting in the Midwest. Areas of interest include revegetation, spoil chemistry, hydrology, and earth movement.

U.S. : coal : VIII-C

506. Sutton, Paul.

1970. **Restoring productivity of coal mine spoil-banks.** Ohio Rep. 55 (4): 62-63. Ohio Agric. Res. and Dev. Cent., Wooster.

A use of soil, limestone, mulch, and subsoiling to loosen the spoils are suggested for reclaiming toxic spoils. The research conducted at the Ohio Research and Development Center is described.

U.S.-OH : coal-B : VI-B+VII-C

507. Sutton, Paul.

1973. **Reclamation of toxic stripmine spoilbanks.** Ohio Rep. 58 (1): 18-20. Ohio Agric. Res. and Dev. Cent., Wooster.

Furrow-grading of toxic spoils did not result in establishing vegetation, but a covering with nontoxic spoil was beneficial in establishing sweet clover and lespedeza.

U.S.-OH : coal-B : III-B+VI-B

508. Sutton, Paul.

1973. **Establishment of vegetation on toxic coal mine spoils.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 153-158. Bitum. Coal Res., Inc., Monroeville, Pa.

Toxic spoils were covered with soil suitable for plant growth, limestone was used to neutralize acidity, organic materials such as sewage sludge and cattle manure were added, and different plant species were used. It seems that toxic coal-mine spoils can be vegetated by these methods. The plant root systems will be confined to the zone of the cover or mixing of the material. The results to date indicate that a period of several years will be required before there will be enough improvement in the untreated portion of the highly pyritic soils to support plant roots.

U.S.-OH : coal-B : VI-B

509. Sutton, P., and J. P. Vimmerstedt.

1973. **Treat stripmine spoils with sewage sludge.** Ohio Rep. 58 (6): 121-123. Ohio Agric. Res. and Dev. Cent., Wooster.

Applications of sewage sludge were highly beneficial in establishing a grass ground cover on acid mine spoils.

U.S.-OH : coal-B : VI-B

510. Sutton, P., and J. P. Vimmerstedt.

1974. **Treat strip mine spoils with sewage sludge.** Compost Sci. 15 (1): 22-23, illus.

Application of sewage sludge proved effective in obtaining plant cover. In addition, the sludge increased P and K levels and increased the infiltration of rainwater, and runoff and erosion of sediment were reduced.

U.S.-OH : coal-B : VI

511. Tennessee Valley Authority.

1963. **An appraisal of coal strip mining.** TN. Val. Auth. 13 p. Knoxville.

Survey findings and an appraisal of the effects of strip-mining and the evaluation of reclamation efforts in the Appalachian and Midwestern coal fields.

U.S. : coal-B : I+VI

512. Tennyson, Gerald R.

1962. **Equipment development for strip mining and reclamation.** *In* Conservation—a key to world progress. Soil Conserv. Soc. Amer. Proc.: 99-105. Des Moines, Iowa.

A review of the current methods of mining and reclamation and the equipment used. The machine of the future is the mine-o-matic, powered by atomic energy and equipped with electronic sensing devices, computers, a T.V. monitoring, and other electronic equipment.

U.S. : coal : II-A

513. Thirgood, J. V.
1952. **The afforestation of colliery spoil heaps.** Coedwigr. 2 (1) : 10-18.
Reclamation of colliery spoil heaps by establishing forest is suggested. Classification and examination of site, treatment, planting methods, selection of species, after-establishment treatment, and economic aspects are discussed.

Great Britain : coal-R : III-A + VII-D

514. Thirgood, J. V.
1969. **Land disturbance and revegetation in Canada.** Can. Min. J. 90 (12) : 33-37, illus.
A review of problems related to land disturbance due to mining for coal, oil, iron, and other minerals as well as to non-mining disturbances. Damages and restoration efforts are discussed.

Canada : coal, other : V

515. Thirgood, J. V.
1969. **Production and reclamation planning, Kaiser Resources Limited.** Proc. 21st Can. Conf. on Coal Proc. 21: 28-36, illus. Calgary.
The author describes the coal-mining operations and reclamation-planning program at the Crowsnest mining operation in British Columbia.

Canada-BC : coal-L : VI

516. Thirgood, J. V.
1970. **Land reclamation in Canada.** Commonw. For. Rev. 49 (3) : 141, 227-234.
Problems related to land disturbance due to mining for coal, oil, iron, and other minerals as well as non-mining disturbances, and damages and restoration efforts are discussed.

Canada : coal, ore waste : V

517. Thirgood, J. V.
1970. **The planned reclamation of mined lands.** W. Miner 43 (6) : 22-25.
A guide to preparation of reclamation plans according to mining laws of British Columbia. Placement of the overburden and revegetation methods are discussed.

Canada-BC : coal : II + VIII

518. Thirgood, J. V.
1971. **The rehabilitation of the mining environment in British Columbia.** Can. Min. and Metal. Bull. August 1971: 1-6.
A review of legislation and its implementation as it relates to coal mining in British Columbia. Technical and organizational problems of reclamation are discussed, and techniques and experiences are described.

Canada-BC : coal : VIII-A

519. Thirgood, J. V.
1971. **Reclamation at Kitsault.** W. Miner 44 (3) : 54-57.
Discusses the mining operation, extent of land disturbance, and actual and planned reclamation of a mining community.

Canada-BC : ore waste : VI

520. Thirgood, J. V.
1973. **Planned Reclamation.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 92-97. Bitum. Coal Res., Inc., Monroeville, Pa.
Reclamation should start with planning the mining operation to minimize dirt handling and assure availability of original topsoil as final cover. Other considerations in a reclamation program are, "the previous and intended use of the mined land and surrounding area, the topography, the potential of the soil for supporting vegetation, the available mining equipment, the regional economy, human settlement and resource use patterns

(current and projected), and the legal requirements."

Canada-BC : coal : VI

521. Thirgood, J. V., and W. F. Gilmore.
1971. **An approach to land reclamation at the Lornex mining project.** W. Miner 1971: 48-51, illus.

Potential land disturbance due to mining of copper and molybdenum ores, and the ways in which the reclamation is being tackled on the Lornex holdings in British Columbia, are described.

Canada-BC : ore waste : VIII

522. Thirgood, J. V., and J. R. Matthews.
1971. **Progress in reclamation research in British Columbia during 1970.** For. Chron. 47 (6) : 1-3.

An overall review of reclamation work in British Columbia.

Canada-BC : coal : VI

523. Thirgood, J. V., and M. D. Meagher.
1972. **Progress in reclamation research by mining companies in British Columbia during 1971.** For. Chron. 48 (6) : 308-311.

This report up-dates the status of reclamation of surface-mined lands in British Columbia. It is based on reports submitted by the industries.

Canada-BC : coal, other : VI

524. Thompson, Donald N., and R. J. Hutnik.
1972. **Environmental characteristics affecting plant growth on deep-mine coal refuse banks.** Pa. State Univ. Sch. For. Res. Briefs 6 (2) : 22-25.

Steep slopes, unstability, coarseness, high surface temperature, and unfavorable chemical characteristics are the common detrimental factors affecting the plant colonization of deep mine coal refuse banks.

U.S.-PA : coal-B+R : III

525. Thor, Eyvind, and James S. Kring.
1964. **Planting and seeding of loblolly pine on steep spoil banks.** J. For. 62 (8): 575-576, illus.

Planted loblolly pine survived better than direct-seeded trees. Both planted and seeded trees grew faster on spoils with southern exposure.

U.S.-TN : coal-B : VI-B

526. Thurn, Edward A.
1952. **The potentialities of revegetating and utilizing agronomic species on strip mined areas in Illinois.** Univ. Ill. Agric. Exp. Stn. and Ill. Coal Strippers Assoc. 6th Yr. Prog. Rep. 48 p., illus.

This report on investigations of the potentialities of revegetating strip-mined lands with agronomic crops covers the first year of a new 3-year project designed to study basic principles of agronomic species on *graded* strip-mined land. Included in this report is a study of some physical and chemical properties of graded spoils, including analyses of highway strata and spoil permeability. Species-adaptation trials on graded spoils include forage crops as well as grain.

U.S.-IL : coal-B : III+VII-C

527. Townsend, W. N., and D. R. Hodgson.
1973. **Edaphological problems associated with deposits of pulverized fuel ash.** *In* Ecology and Reclamation of Devastated Land vol. 1: 45-56. Gordon and Breach Sci. Publ., New York.

Pulverized fuel ash (PFA), resulting from the burning of pulverized coal consists of silica and alumina (ca. 75%), Fe oxides (ca. 10%), alkaline earth elements (ca. 6%), alkali metals (ca. 5%), S (ca. 1%), traces of most other naturally occurring elements, and a small amount of unburned carbon. Physically it is in the coarse silt range and consists mainly of glassy particles. The edaphological problems involve (1) plant nutrients, (2) toxic factors, and (3) its physical nature of ash. The ash has adequate K, is low in P, contains no N, and has adequate micronutrients. High pH, excessive salinity, and water-soluble B result from hydrolysis during weathering. Pozzolanic activity is exhibited during settling, curtailing plant establishment.

Great Britain : fuel ash : III-B

528. Trimble, George R., Jr.
1963. **Hybrid poplar grows poorly on acid spoil banks at high elevations in West Virginia.** USDA For. Serv. Res. Note NE-7. 4 p., illus.

Describes the performance of hybrid poplar on limed and unlimed strip-mine spoils after 3rd and 11th growing season. Lime treatment improved survival and height growth, but overall results were disappointing.

U.S.-WV : coal-B : VI-B

529. Tryon, E. H.
1952. **Pasture cover for spoil banks.** *In* Science Serves Your Farm. W. Va. Univ. Agric. Exp. Stn. Bull. 357 (2): 5, 16.

The productivity of two old iron-ore spoil banks was compared to adjacent fields by counting desirable forage plants and dry-weight yields. Both spoil areas were more productive than the adjacent fields.

U.S.-WV : ore waste : VII-C

530. Tryon, E. H., and Rudolf Marcus.
1953. **Development of vegetation on century-old iron-ore spoil banks.** W. Va. Univ. Agric. Exp. Stn. Bull. 360. 63 p., illus.

Iron ore spoil banks, 72 to 131 years old, were studied to document vegetation, species composition, growth, and density. A comparison was made with adjacent undisturbed land.

U.S.-WV : ore waste : VI-B

531. Turner, William R.
1958. **The effects of acid mine pollution on the fish population of Goose Creek, Clay County, Kentucky.** Prog. Fish-Cult. 20 (1): 45-46.

A ratio in a fish population in an unpolluted creek portion versus the one polluted by acid mine drainage was 12:1 respectively. Economic loss due to fish kill was calculated at $800 per 1 mile of stream.

U.S.-KY : coal-B : V-B+VII-G

532. Tyner, Edward H., and Richard M. Smith.
1945. **The reclamation of the strip-mined coal lands of West Virginia with forage species.** Soil Sci. Soc. Am. Proc. 10: 429-436, illus.

Based on active acidity of the surface layer, the spoils of nothern West Virginia were classified into three types. The properties of spoils are discussed. Factors determining successful plant growth, including use of lime, fertilizers, and manure and the adaptability of various forage species for growth on strip-mine spoils, were reported.

U.S.-WV : coal-B : III-A+VI-B+VII-C

533. Tyner, Edward H., Richard M. Smith, and Sidney L. Galpin.
1948. **Reclamation of strip-mined areas in West Virginia.** J. Am. Soc. Agron. 40: (4), 313-323, illus.

Delaying reclamation 1 and 3 years on pyrite-containing spoils reduced the amount of lime needed. Spoil surface is compacted in regrading to depth of 18 to 24 inches. Tap-rooted legumes, alfalfa, sweetclover, birdsfoot trefoil, and sericea lespedeza penetrate the compacted layers and contributed to breaking up the surface compaction and increasing the permeability of spoil to water, air, and fibrous roots of other species.

U.S.-WV : coal-B : III-B+VI-B

534. U.S. Bureau of Mines.
1973. **Methods and costs of coal refuse disposal and reclamation.** U.S. Dep. Inter. Inf. Circ. 8576. 36 p., illus.

Costs of refuse disposal, spreading, compacting, covering with soil, and planting, as reported by six mining companies and the Commonwealth of Pennsylvania.

U.S.-PA : coal-B+R : VIII-B

535. U.S. Department of Agriculture.
1968. **Restoring surface-mined land.** USDA Misc. Publ. 1082. 18 p., illus.
A summary of extent of land disturbance by strip and surface mining in the United States as of 1965. Broad characteristics and physical conditions of disturbed land are discussed. U.S.D.A. participation in reclamation of surface-mined land, the accomplishments, and the principles for a national surface-mined land conservation effort, are pointed out.

U.S. : coal, other : VI

536. U.S. Department of Interior.
1965. **Proposed outline of report required on strip and surface mining in the United States as authorized under P.L. 89-4, Section 205, Appalachian Region Development Act of 1965.** 55 p.
The report requires the following: nature and extent of strip and surface mining; ownership of real property (surface and/or mineral); the public interest in and public benefits from reclaiming surface-mined lands; role of federal, state, and private interests; objective of total overall costs of reclamation and rehabilitation program in the United States.

U.S. : coal : VIII-A

537. U.S. Department of Interior.
1966. **Study of strip and surface mining in Appalachia.** Interim Report by Secretary of Interior to Appalachian Regional Com. 78 p. Washington.
This report summarizes the findings of the Secretary of Interior on those aspects of strip-mining operations in the Appalachian Region that are urgently in need of attention. The goals are: "to prevent future devastation of the environment while fostering economic growth of the mineral industry and to alleviate damage caused by past strip and surface mining operation." Tables, maps, charts, and appendixes.

U.S. : coal : VIII

538. U.S. Department of Interior.
1967. **Surface mining and our environment.** U.S. Gov. Printing Office, Washington. 124 p.
This volume is a product of a study by a team of experts on surface mining and its effects in the United States, as required by P.L. 89-4. It includes: surface mining, its nature, extent and significance; impact on environment; related problems; yesterday's achievements; tomorrow's goals; the law and surface mining; and recommendations. Appendix includes numerous statistical tables; state strip- and surface-mining laws; and the miscellaneous federal statistics related to mining on federal lands.

U.S. : coal, other : VIII

539. U.S. Environmental Protection Agency.
1971. **Mine spoil potentials for water quality and controlled erosion.** EPA Water Pollut. Control Res. Ser. Proj. 14010 EJE 12/71. 207 p.
This report provides extensive information about geology, soil, chemistry, microbiology, and conservation of present and future coal-mine spoils in West Virginia. It provides a basis for applying those interrelated disciplines to discover and formulate solutions as related to water-quality problems at present and in the future.

U.S.-WV : coal-B : III+IV

540. U.S. Environmental Protection Agency.
1973. **Processes, procedures, and methods to control pollution from mining activities.** EPA-430/9-73-011. 390 p., illus. Washington.
Information about processes, procedures, and methods for controlling pollution resulting from mining. Cost-data estimates for control measures are given. An extensive bibliography is appended.

U.S. : coal, other : V

541. U.S. Forest Service.
1962. **Strip-mine reclamation—a digest.** (Rev. 1964) USDA For. Serv. East. Reg. and Soil Conserv. Soc. Am. 69 p.
The 1962 edition is a digest of literature published through mid-1961. The 1964 edition

includes a review and summary of literature up to 1964. The coverage includes a discussion of spoil characteristics and the effects these have on selection of plant species and planting methods. Potential uses of strip-mined lands and mining methods are discussed. The stringencies and administration of strip-mine reclamation legislation by individual states in eastern United States is reviewed.

U.S. : coal : VI

542. U.S. Soil Conservation Service.
1969. **Kanawha Basin comprehensive study: land stabilization problems area study, Coal River sub-basin and adjacent watersheds.** U.S. Soil Conserv. Serv. 22 p. Princeton, W. Va.

The results of two short-term studies initiated on two watersheds of the Coal River in West Virginia to evaluate soil erosion and sedimentation from surface mining. Treatments and additional studies are proposed for surface-mined areas and refuse piles.

U.S.-WV : coal : IV-E

543. University of Newcastle upon Tyne.
1971-1972. **Landscape reclamation.** Vol. 1, 135 p., and vol. 2, 85 p., illus. IPC Sci. and Tech. Press Ltd., Guildford, Surrey, England.

A two-volume report on reclamation of derelict lands in Great Britain, based on the research conducted by a team of the University of Newcastle. Topics covered are: vol. 1 — landscape reclamation; previous technique; research sites; landform design; earthworks; special problems; soil-forming materials; botanical studies of natural and planted vegetation; practical techniques for establishing vegetation; estimating and cost control and visual assessment of reclaimed landscape; vol. 2 — use, establishment and development of reclaimed landscape; development and maintenance organizations; legal and financial aspects of management; development and management of soil on pit heaps; drainage and erosion control; ground cover; long-term management of grass and tree plantations; the invertebrate fauna; development and appearance of reclaimed sites; and organization and future of research into landscape reclamation.

England : coal, other : VI

544. Usui, Hiroshi, and Heima Suzuki.
1973. **Ecological and revegetational problems of the Ashio devastated area.** *In* Ecology and Reclamation of Devastated Land vol. 2: 395-406. Gordon and Breach Sci. Publ., New York.

An area of 2500 ha in the vicinity of the Ashio copper mine has been damaged by SO_2. The devastation is due to SO_2 damage to the vegetation and to severe soil erosion. For revegetation purposes a "vegetation plate" was devised. It is a pressed plate of soil with fertilizer on which seeds are sown. The plates were arranged horizontally in rows on the eroded slopes. Weeping lovegrass — an exotic and a domestic species *Miscanthus sinensis* — were used. Both grasses thrived well for a few years, but later declined in vigor. *Clethra barbinervis* is the only dominant species of the secondary forest.

Japan : ore waste : VI-B

545. Van Landingham, A. H.
1965. **Mined area restoration today.** J. Soil and Water Conserv. 20 (4) : 185-186.

A digest on strip-mine rehabilitation problems and the factors affecting reclamation.

U.S. : coal : VI

546. Van Lear, David H.
1971. **Effects of spoil texture on growth of K-31 tall fescue.** USDA For. Serv. Res. Note NE-141. 7 p., illus. Northeast. For. Exp. Stn., Upper Darby, Pa.

Growth of K-31 tall fescue was significantly affected by the texture of four spoils from eastern Kentucky. Growth on spoils having no toxic chemical properties was greatest where texture consisted of about equal amounts of soil-size material and a coarser fraction (2.0 to 6.4 mm), probably because moisture and aeration were favorable. On two spoils, adverse chemical properties modified the effect of physical properties associated with texture. Toxic levels of Mn in the smaller size fraction probably reduced yields on one spoil. On another the effect of texture was marked by toxic levels of Al in each of the three particle-size fractions.

U.S.-KY : coal-B : III+VI-B

547. Vimmerstedt, J. P.
1970. **Stripmine reclamation.** Ohio Rep. 55 (4) : 60-61. Ohio Agric. Res. and Dev. Cent. Wooster, Ohio.

A digest of the most important recent research findings.

U.S.-OH : coal-B : VI

548. Vimmerstedt, John P., and James H. Finney.
1973. **Impact of earthworm introduction on litter burial and nutrient distribution in Ohio strip-mine spoil banks.** Soil Sci. Soc. Am. Proc. 37 (3) : 388-391.

Earthworms introduced on acid spoils consumed or buried large quantities of black locust leaf litter and humus. Exchangeable cations and available P in the mineral spoils increased. Earthworm activity did not affect growth of northern red oak seedlings planted in the cores. Introduced on a calcareous spoil revegetated with European alder, the earthworm population increased drastically.

U.S.-OH : coal-B : III-D+VI-A

549. Vimmerstedt, John P., and Paul H. Struthers.
1968. **Influence of time and precipitation on chemical composition of spoil drainage.** Coal Mine Drain. Res. Symp. 2 Proc.: 152-163. Bitum. Coal Res., Inc., Monroeville, Pa.

Eight-year results of chemical characteristics of leachates percolating through the weathering columns of four spoil classes — toxic, marginal, acid and calcareous. Leachate volumes, total soluble salts, sulfate, Ca, Mg, Fe, Al, and Mn were determined. Effects of time and amount of precipitation are discussed.

U.S.-OH : coal-B : III-B

550. Vogel, Willis G.
1970. **Weeping lovegrass for vegetating strip-mine spoils in Appalachia.** First Weeping Lovegrass Symp. Proc.: 152-162. Samuel Roberts Noble Found., Ardmore, Okla.

Weeping lovegrass is more tolerant of extremely acid spoils, dry sites, and summer growing conditions than most of the commonly used cool-season grasses and legumes. It grows well in mixtures with slowly developing long-lived grasses or legumes. It provides quick cover during the first growing season and does not crowd out the companion species. When sown with black locust, it is less competitive with locust seedlings. N and P fertilizers are needed for its establishment on many spoils.

U.S.-KY : coal-B : VI-B

551. Vogel, Willis G.
1971. **Needs in revegetation research on surface-mined lands.** W. Va. Univ. Symp. Revegetation and Economic Use of Surface-Mine Refuse. Proc.: 17-18. Morgantown.

Revegetation research is needed for erosion control and for restoring or developing land uses. Specific needs include studies concerned with quick establishment of cover throughout the growing season, tree-grass competition, soil organisms, spoil amendments and fertilizer, and development of spoil for forest, pasture, wildlife habitat, and other uses. But most urgent is a need for research aimed at preventing problems of extreme acidity and instability.

U.S.-KY : coal-B : VI-B

552. Vogel, Willis G.
1973. **The effect of herbaceous vegetation on survival and growth of trees planted on coal-mine spoils.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 197-207. Bitum. Coal Res., Inc., Monroeville, Pa.

Establishing both trees and herbaceous vegetation is often desirable in the reclamation of strip-mine spoil banks. To study the effect of herbaceous competition with trees, grass alone and grass with legumes were sown concurrently with the planting of four tree species on coal-mine spoils in southeastern Kentucky. After three growing seasons, the herbaceous vegetation, which had produced about 95 percent ground cover, did not significantly affect the survival of trees, but greatly suppressed their growth. However, in the fourth and fifth growing seasons, the growth of trees in the plots dominated by the legume exceeded the growth in plots with grass only and without herbaceous competition. Tree growth was suppressed the most by a cover of grass alone.

U.S.-KY : coal-B : VI-B

553. Vogel, W. G., and W. A. Berg.
1968. **Grasses and legumes for cover on acid strip-mine spoils.** J. Soil and Water Conserv. 23 (3) : 89-91, illus.

A vegetative cover is needed on most strip-mine spoils immediately after mining to reduce erosion and sedimentation. Field and greenhouse studies have shown that fertilized weeping lovegrass provided faster cover on extremely acid spoils (pH 4.0 to 4.5) than any other perennial grass or legume tested. Even the more acid-tolerant legumes grew poorly and did not nodulate in most of the acid spoils with pH below 4.5.

U.S.-KY : coal-B : III-B+VI-B

554. Vogel, Willis G., and William A. Berg.
1973. **Fertilizer and herbaceous cover influence establishment of direct-seeded black locust on coal-mine spoils.** *In* Ecology and Reclamation of Devastated Land vol. 2: 189-198. Gordon and Breach Sci. Publ., New York.

Phosphorous is the limiting element in many spoils for the early growth of direct-seeded black locust. By fertilizing with 49 kg/ha of P, the first year's height of locust was increased fourfold, and higher P rates produced even greater growth. Warm-season herbaceous species seeded with the locust were less competitive with the locust seedlings than were cool-season species.

U.S.-KY : coal-B : VI-B

555. Wagner, Aubrey J.
1965. **Aubrey J. Wagner speaking on Tennessee Valley Authority.** Ky. Dep. Nat. Resour. Strip Mine Reclam. Symp. Proc.: 23-27. Frankfort.

A summary of TVA experiences with strip-mining for coal and other commodities, and land reclamation.

U.S.-TN : coal-B, other : VI

556. Waldbieser, William C.
1968. **Development of equipment for cast overburden reclamation.** Min. Congr. J. 54 (7) : 50-51.

Equipment and methods for the reclamation of strip-mine spoils are reviewed. Larger trenchers, use of booster draglines, and wheel excavators are discussed.

U.S. : coal : II-A

557. Wali, Mohan K., ed.
1973. **Some environmental aspects of strip mining in North Dakota.** N.D. Geol. Surv. Educ. Ser. 5. 121 p.

A product of a symposium held by the North Dakota Academy of Science, containing eight papers dealing with the environmental impact of strip-mining and the viewpoints of individuals in various fields of specialization.

U.S.-ND : coal-L : VIII-D

558. Wali, M. K., and P. G. Freeman.
1973. **Ecology of some mined areas in North Dakota.** *In* Some environmental aspects of strip mining in North Dakota. N.D. Geol. Surv. Educ. Ser. 5: 25-47.

Plant species diversity and an abundance of physical and chemical characteristics of mined and unmined sites were studied. Species diversity was higher at unmined sites. Mined sites showed sparser vegetation with reduced growth and vigor. Mined sites showed higher pH and conductivity, replaceable Mg, Na, total P, and S. The unmined sites were higher in organic matter, replaceable K, and EDTA-extractable Mn. High Mg levels may be an additional problem.

U.S.-ND : coal-L : III+VI-B

559. Walp, Neil M., and Robert M. Gidez. 1965. **Commerce and planning and their relationship to mining.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 24-27. University Park.

States, areas, and communities have suffered greatly from poor mine area planning. We must plan to eliminate the landscape scars and meet the future head-on with effective regulations to ensure the rehabilitation of strip-mined lands that will foster commercial development. Some criteria required by the planner to evalute strip-mine spoils for economic development are discussed.

U.S. : coal : VIII-A

560. Warner, Richard W. 1973. **Acid coal mine drainage effects on aquatic life.** *In* Ecology and Reclamation of Devastated Land vol. 1: 227-237. Gordon and Breach Sci. Publ., New York.

Reaches of Roaring Creek, West Virginia, that were severely polluted by acid drainage (pH 2.8 to 3.8) were inhabited by low diversities of 3 to 12 taxa of benthic invertebrates and 10 to 19 species of algae. Stream reaches with pH values of 4.5 and higher supported communities of 25 or more invertebrates and 33 or more species of attached algae. High concentrations of acidity, total and ferrous iron, sulfate, hardness, calcium, and aluminum produced a complex and varying aquatic environment.

U.S.-WV : coal-B : IV-G

561. Watson, A. E. P. 1969. **Pollution problems associated with base metal mines.** Can. Min. J. 90 (6): 50-54.

A progress report on water-pollution problems associated with base metal mines. Data on pH, conductivity, hardness, Cu, Zn, Fe, and sulfate concentrations in the effluent from tailing ponds sampled daily, and from continuously recording field monitor instruments, are discussed.

Canada-NB : ore waste : V-B

562. Watson, W. Y., and D. H. Richardson. 1972. **Appreciating the potential of a devastated land.** For. Chron. 48 (6): 312-315.

Discussion on the dimension of land and vegetation devastation due to nickel smelting, giving examples of reclamation and suggestions about how implementation of an overall land-use policy might enhance the esthetic value of the damaged area.

Canada-ON : ore waste : VI-B

563. Weigle, Weldon K. 1965. **Designing coal-haul roads for good drainage.** USDA For. Serv. Cent. States For. Exp. Stn. 23 p., illus. Columbus, Ohio.

A guide to help in planning, locating, constructing, and maintaining coal-haul roads on small coal company lands, with special emphasis on drainage.

U.S.-KY : coal-B : II-D+VI-A

564. Weigle, Weldon K. 1965. **Road erosion and spoil-bank stability.** Pa. State Univ. Mine Spoil Reclam. Symp. Proc.: 82-85. University Park.

A discussion of erosion on abandoned haul roads and spoil-bank outslope instability observed on contour-type strip mines in eastern Kentucky. Mining and road-building practices on strip mines are mentioned; problems with erosion and instability are outlined, and some practical solutions to these problems are suggested.

U.S.-KY : coal-B : IV-E

565. Weigle, Weldon K. 1966. **Erosion from abandoned coal-haul roads.** J. Soil and Water Conserv. 21 (3): 42.

Five and 2.6 inches of road surface of clayey silt and sandy silt soil respectively were lost per year due to erosion of abandoned coal-haul roads.

U.S.-KY : coal-B : II-D+IV-E

566. Weigle, Weldon K.
1966. **Spoil bank stability in eastern Kentucky.** Min. Congr. J. 52, (4): 67-73.
The stability of certain spoil-bank slopes was studied, and the respective safety factors were computed. The widths of stable fill-benches depend on percent of original mountain slope.

U.S.-KY : coal-B : VI-A

567. Weigle, Weldon K., and George P. Williams.
1968. **Match additive to soil types for best stabilization.** Rural and Urban Roads June 1968: 24-25.
This article highlights a basic stabilization problem — matching soils to the stabilizing agent. Some soils need different stabilizing treatment than others.

U.S.-KY : coal-B : VI-A

568. Wells, J. Ralph.
1953. **The reclamation of stripmined ears in southeastern Kansas.** Kans. Acad. Sci. Trans. 56 (3): 269-292, illus.
Spoilbanks are favorable for the growth of a variety of plants, both volunteer and planted; leveling is not necessary; allowing spoilbanks to stand for several years is not required for successful seeding and planting; the use of orchards and vineyards offers little success in reclaiming striplands; forest tree plantings are too uncertain to be recommended; conversion to pasture is believed to be the most practical means of reclaiming large acreages of spoil banks; the spoils provide habitats for fish and wildlife, and they are being developed.

U.S.-KS : coal-B : VI+VII

569. Welsh, George W., and R. J. Hutnik.
1973. **Growth of tree seedlings and use of amendments on bituminous refuse.** Pa. State Univ. Sch. For. Res. Briefs 7 (1): 34-37.
Under greenhouse conditions even highly toxic breaker refuse can support plant growth if properly amended. On banks of moderate toxicity, fertilization alone might result in increased growth; otherwise the toxicity has to be minimized before a response to fertilization can be obtained.

U.S.-PA : coal-B+R : III-B+VI-B

570. Wheeler, Wilson H.
1962. **Reclamation of strip mined land in Pennsylvania.** Pa. Dep. Health Nat'l. Symp. on Control of Coal Mine Drain. Proc. Publ. (4): 71-73.
A discussion of strip-mine reclamation in the bituminous coal fields of Pennsylvania in relation to the state's laws and regulations.

U.S.-PA : coal-B : VIII-A

571. Wheeler, Wilson H.
1965. **Progress in reclamation with forest trees.** Pa. State Univ. Coal Mine Spoil Reclam. Symp. Proc.: 111-116. University Park.
A review on performance of forest tree plantations on bituminous coal-mine spoil in Pennsylvania from the point of view of a forester-practitioner. Observations on tree species, planting material, and season, as related to certain spoil characteristics.

U.S.-PA : coal-B : VI-B

572. Williams, E. G., and M. L. Keith.
1963. **Relationship between sulfur in coals and the occurrence of marine roof beds.** Econ. Geol. 58: 720-29.
The hypothesis that regional variation of sulfur in coal beds is related to the influence of penecontemporaneous marine water is tested by stratigraphic and statistical methods. The Lower Kittanning coal exhibits regional variations in sulfur content which are statistically related to the regional changes in overburden, areas of marine overburden being higher in sulfur than continental areas. The Upper Freeport coal, overlain entirely by continental beds, shows no regional sulfur variation. The authors conclude that the presence or absence of mar-

ine waters was one of the factors controlling regional variation of sulfur in coal.

U.S.-PA : coal-B : III-B

573. Williams, George P.
1967. **Roads, slides and check dams.** Ky. Dep. Nat. Resour. Strip Mining Symp. 4 p. Frankfort.

A brief and general discussion of aspects of civil engineering applicable to problems in watershed protection on strip-mined areas. Roads, spoil-bank mass stability, and runoff and erosion control are touched upon.

U.S.-KY : coal-B : VI-A

574. Williams, George P., Jr.
1973. **Changed spoil dump shape increases stability on contour strip mines.** Res. and Appl. Tech. Symp. on Mined Land Reclam. Proc.: 243-249. Bitum. Coal Res., Inc., Monroeville, Pa.

A 1967 survey of strip mines operating under 1966 regulations in eastern Kentucky showed that 94 percent of the outslopes were stable. Of 178 slides that occurred, 50 percent involved spoils dumped in valleys. Slide incidence and terrain steepness were not found to be related. Changes in spoil distribution and spoil dump shape accounted for a 42 percent reduction in disturbance by spoil slides and a 17 percent reduction in total area disturbance.

U.S.-KY : coal-B : VI-A

575. Williams, Roger L.
1971. **Reclamation! How much and when.** Rehabil. Drastically Disturbed Surf. Mined Lands Symp. Proc.: 2-10. Surface Mined Land Use Board. Macon.

The keynote address to the first symposium. A general discussion of all kinds of pollution problems prevalent in the United States today. It includes some statistics and a historical summary of reclamation legislation.

U.S. : coal, other : VIII-A

576. Wilson, H. A.
1951. **Strip mine spoils — they can be reclaimed.** W. Va. Univ. Agric. Exp. Stn. Bull. 349 (1) : 8-9 p., illus. Morgantown.

Beneficial microorganisms, vegetation, and proper soil management are helpful in building up the fertility of spoils.

U.S.-WV : coal-B : III-D

577. Wilson, H. A.
1957. **Effect of vegetation upon aggregation in strip mine spoils.** Soil Sci. Soc. Am. Proc. 21: 637-640.

Aggregation in the coal mine spoils was in the following order: non-vegetated<vegetated<undisturbed. The forested iron-ore spoils are not as well aggregated as the adjacent soils. The type of vegetation is an important factor. Aggregation increased in the following order: non-vegetated<pine<locust<forage grasses and legumes.

U.S.-WV : coal-B : III-C+VI-B

578. Wilson, H. A.
1961. **Rhizosphere bacteria of some stripmine vegetation.** W. Va. Acad. Sci. Proc. 33: 15-20.

Bacteria were isolated from roots, root washings, and the rhizosphere of legumes growing on spoil, and from barren spoil. Medium-size gram-negative rods predominated among the isolates, and most of the isolates required the unidentified substances of yeast extract for maximum growth. Root isolates exhibited more ability to produce a polysaccharide from glucose than the isolates from any other source. The isolates from nonvegetated spoil had the least polysaccharide-producing ability.

U.S.-WV : coal-B : III-D

579. Wilson, H. A.
1965. **The microbiology of strip-mine spoil.** W. Va. Univ. Agric. Exp. Stn. Bull. 506T. 44 p., illus. Morgantown.

Samples from several spoil areas were studied to determine the number of bacteria, fungi, and actinomycetes present. The chemical activities of the spoil microorganisms were documented in related studies.

U.S.-WV : coal-B : III-D

580. Wilson, H. A., and H. G. Hedrick.
1957. **Carbon dioxide evolution from some strip mine spoils.** Appl. Microbiol. 5 (1): 17-21.

Production of CO_2 by microbial populations of nonvegetated and vegetated strip-mine spoils was studied. The addition of N to the spoil, alone or in combination with other elements, had more influence upon the microbial activity than other additions. The addition of $Ca(HO)_2$ was influential in increasing microbial activity, particularly in samples that received an addition of organic matter.

U.S.-WV : coal-B : III-D

581. Wilson, H. A., and H. G. Hedrick.
1957-58. **Some qualitative observations of the microflora in a strip mine spoil.** W. Va. Acad. Sci. Proc. 1959: 35-38, illus.

Bacteria, fungi, and actinomycetes grow and multiplied in strongly acid nonvegetated and vegetated spoils, both with and without the addition of organic matter. The addition of organic matter increased the number and kinds of microorganism and favored closer growth of the microorganisms.

U.S.-WV : coal-B : IV-D

582. Wilson, H. A., and H. G. Hedrick.
1959-1960. **Extractable sulfates and iron in strip mine spoil acid spots.** W. Va. Acad. Sci. Proc. 31-32: 21.

Acid spots on strip-mine spoils snow considerably more soluble sulfates than areas devoid of acid spots.

U.S.-WV : coal-B : III-B

583. Wilson, H. A., and Gwendolyn Stewart.
1955. **Ammonification and nitrification in a strip mine spoil.** W. Va. Univ. Agric. Exp. Stn. Bull. 379T. 16 p., illus. Morgantown.

The study documented the transformation of organic nitrogen to ammonium nitrogen from different materials incorporated into nonvegetated, vegetated, and undisturbed acidic spoils. It also showed that strongly acid spoils must be limed before nitrification takes place.

U.S.-WV : coal-B : III

584. Wiltsee, Herbert L.
1965. **A proposed interstate mining compact.** Ky. Dep. Nat. Resour. Strip Mine Reclam. Symp. Proc.: 31-35. Frankfort.

Presents the provisions of the draft of the proposed "Interstate Mining Compact" initiated by many state governments, and the reasoning behind them.

U.S.-KY : coal-B : VIII-A

585. Wood, R. F., and J. V. Thirgood.
1955. **Tree planting on colliery spoil heaps.** For. Comm. Res. Branch Pap. 17. 18 p. Forestry Commission, London.

Most of the spoil heaps are potentially fertile, can supply sufficient moisture, and thus are capable of supporting tree growth. High slopes, erodibility, heap fires, and vandalism present difficulties in revegetation.

England : coal : VII-D

586. Wood, R. F., and J. V. Thirgood.
1955-56. **Tree planting on colliery spoil heaps.** Colliery Eng. 32: 512-516 and 33: 27-32. London.

The authors discuss the possibilities and difficulties of tree planting on spoil heaps. In the first portion of the article, the authors give information about general environment, physical and chemical characteristics, and special features of burned heaps. In the second portion, the authors present the records of tree growth and discuss site preparation and plantation performance.

England : coal : III+VI-B

587. Young, C. A.
1969. **The use of vegetation to stabilize mine tailings areas at Copper Cliff.** Can. Min. J. 90 (6): 43-46.

The methods used to stabilize and secure vegetative cover on very acid mine tailings are described. Site preparation, seeding, and fertilization are discussed. Grass cover has been established on more than 500 acres.

Canada-ON : ore waste : VI-B

588. Younge, O. R., and J. C. Moomaw. 1960. **Revegetation of stripmined bauxite lands in Hawaii.** Econ. Bot. 14 (4): 316-330 p., illus.

The authors discuss the occurrence, conditions for formation, and commercial potentials of the bauxites, describing vegetation associations of bauxitic areas and reviewing land-use history. Site preparation and revegetation of strip-mined lands, and the beneficial yield effects obtained from lime, N-P-K fertilizer, and mulches are also discussed.

U.S.-HI : bauxite : VI

589. Zande, Richard D. 1973. **Friendship park — one use of reclaimed strip-mine land.** Res. and Appl. Tech. Symp. on Mined-Land Reclam. Proc.: 294-303. Bitum. Coal Res., Inc., Monroeville, Pa.

The plans to turn 1,100 acres of strip-mined land in Jefferson County, Ohio, into park lands are reviewed. The land was donated to the county by Hanna Coal Co., Cadiz, Ohio, a division of Consolidation Coal Co. An 85-acre lake for fishing and boating is being formed by construction of an earth-fill dam. An airport, picnic areas with shelters, and hiking trails are also included in the nearly completed phase I of the project.

U.S.-OH : coal-B : VII-A

590. Zarger, T. G., G. W. Bengtson, J. C. Allen, and D. A. Mays. 1973. **Use of fertilizers to speed pine establishment on reclaimed coal-mine spoil in Northeastern Alabama.** II. Field experiments. *In* Ecology and Reclamation of Devastated Land vol. 2: 227-236. Gordon and Breach Sci. Publ., New York.

N and P are the main elements limiting growth of loblolly pine on coal mine spoils in Alabama. Early results showed a significant increase in seedling height when P was added at 100 pounds per acre. Additional growth and improvement in color and vigor resulted when N was applied with P at rates of 25 to 100 pounds. Seeded pines also responded to NP fertilizer applied at rates 100 pounds per acre of each element. Few seedlings were killed by frost heaving when the spoil was fertilized.

U.S.-AL : coal-B : VI-B

591. Zarger, T. G., J. A. Curry, and J. C. Allen. 1973. **Seeding of pine on coal spoil banks in the Tennessee Valley.** *In* Ecology and Reclamation of Devastated Land vol. 1: 509-523. Gordon and Breach Sci. Publ., New York.

Tree seeding tests were established on graded and ungraded spoils to evaluate time, rates, and treatments. Loblolly, shortleaf, Virginia and white pine were tested. Two-year results show that the March to mid-April seedlings gave satisfactory seedling stands. Stratified and repellant-treated loblolly pine seeded at 1.0 and 1.5 pounds per acre or Virginia pine at 1.0 pound per acre produced stands of 1,500 seedlings. White pine stratified for 60 days and seeded at 1.5 pounds produced 1,300 seedlings. Shortleaf pine produced poorer results.

U.S.-AL, TN, VA : coal-B : VI-B

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