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Industrial Environmental
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Cincinnati OH 45268

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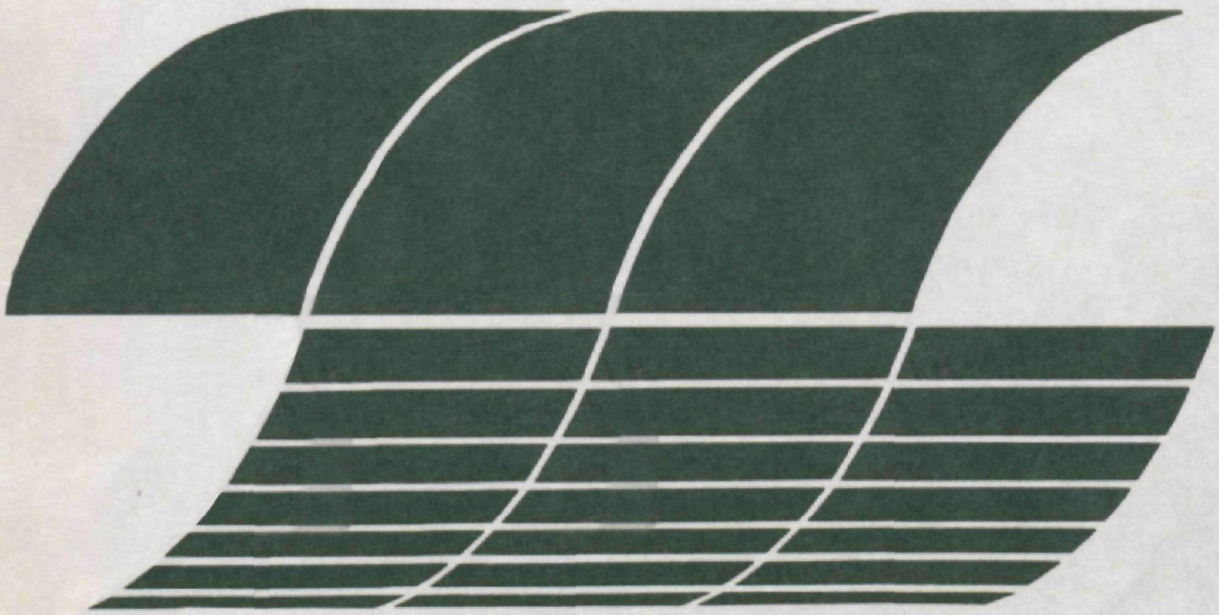
Research and Development

Coal and the Environment Abstract Series

Mine Drainage Bibliography 1929-1980

Interagency Energy/Environmental R&D Program Report



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May 1980

COAL AND THE ENVIRONMENT
ABSTRACT SERIES

Mine Drainage Bibliography
1929-1980

Compiled by

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Grant Number R805336-02

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FOREWORD

When energy and material resources are extracted, processed, converted and used, the related pollutional impacts on our environment and even our health often require that new and increasingly more efficient pollution control methods are used. The Industrial Environmental Research Laboratory - Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet those needs both efficiently and economically.

This publication is the fourth of the "Coal and the Environment Abstract Series." It provides the researcher, scientist, mine executives, and regulators with a timely bibliography. Not only will it provide the research community with a means of readily accessing the literature, but it should provide those persons implementing mine drainage environmental controls with a handy reference to solving their problems. Additional bibliographies are planned for this series.

David G. Stephan
Director
Industrial Environmental Research Laboratory
Cincinnati

PREFACE

Coal is our most plentiful source of energy, and its use is essential to the well-being of the nation. As coal continues to be produced and as mines are opened in areas where mining has not existed previously, opportunities for the occurrence of environmental degradation will increase. However, such degradation need not occur if the existing and evolving pollution control technology is well known and properly applied.

Numerous public and private efforts have contributed to the knowledge concerning coal's environmental problems and to their control. This knowledge is well documented, and the U.S. Environmental Protection Agency (EPA) has been actively involved in compiling and disseminating it. One facet of this activity has been the co-sponsorship of an environmental library at Bituminous Coal Research, Inc. (BCR) for use by the public as well as the coal industry, and the publication of Bibliographies of abstracts based on the collections within the library.

This volume is the fourth to appear in the "Coal and the Environment Abstract Series" and provides additional material to the first volume in the series, "Mine Drainage Bibliography 1910-1976." For this reason the numbering of entries in this volume, for most of the years prior to 1977, does not appear to be consistent. The numbering system for these abstracts is explained in detail in the section on "Format and Use of the Bibliography."

Preparation of this edition was co-sponsored by EPA, Department of Interior's Office of Surface Mining and Enforcement, and BCR. The other volumes in the series are "Bibliography on Mined-Land Reclamation" and "A Bibliography on Disposal of Refuse from Coal Mines and Coal Cleaning Plants." The initial Mine Drainage Bibliography was prepared in 1976 by BCR with co-sponsorship of the Pennsylvania Department of Environmental Resources and EPA. Copies of that Bibliography can be obtained from BCR or from NTIS as PB-265 041/4BE. The Refuse Disposal Bibliography, EPA-600/7-79-076, prepared in 1978 by BCR with support from EPA, can be obtained from EPA, or from NTIS as PB-292 099/9WP. The Reclamation Bibliography, EPA-600/7-79-102, can be obtained from EPA; from Office of Surface Mining in Washington, D. C. and its five regional offices; from BCR; and from NTIS as PB-298 191/8WP. Addresses for each of these organizations are given at the end of the preface.

The Bibliographies in the "Coal and Environment Abstract Series" are intended to complement one another. While each covers one particular subject area, inevitably some documents listed in one are also relevant to one of the other Bibliographies. For example, the Reclamation Bibliography includes information on the effects of mining and reclamation on hydrology and, to some extent, on water quality. However, much of the information on changes in water quality resulting from surface mining and reclamation has been listed in the Mine Drainage Bibliography. Another example of overlap is in the assignment of documents concerned with overburden or spoil. In American usage, these terms are synonymous but in British usage, the term "spoil" includes both overburden and refuse from coal cleaning plants. Documents on "spoils" have been separated into those relating to refuse and to overburden

and put in the proper Bibliography. Since a number of British documents give information on both kinds of spoils, the reader should probably scan both the Reclamation Abstracts and the Refuse Disposal Abstracts. Finally, many documents include material on each of the subject areas covered by the Bibliographies. If one subject area has been emphasized more than the other two, the document is listed only in the bibliography relating to that major area. However, it is so indexed in that Bibliography to show that it also contains information relating to other subjects. If there are major emphases on more than one area, the document is listed in each of the Bibliographies to which it is relevant.

In addition to the abstracts, this volume includes an Author Index and a General Index which are described in the section, "Format and Use of the Bibliography." In the Appendixes are lists of the publications most recently acquired for the "Coal and the Environment Abstract Series." Appendix A gives an update for "Bibliography on Mined-Land Reclamation." Appendix B continues the update for "A Bibliography on Disposal of Refuse from Coal Mines and Coal Cleaning Plants," which was begun in the previous volume of this Series.

Much of the literature listed in the "Coal and the Environment Abstract Series" is available from large libraries, government agencies issuing particular reports, or from the authors. Complete citations have been given so that the reader can obtain material from these sources. Items with NTIS numbers at the end of the citation may be purchased from U.S. Department of Commerce, National Technical Information Service, Springfield, Virginia 22161. For those who have difficulty in obtaining material from these sources, arrangements can be made to use the library of BCR on weekdays between 8:00 a.m. and 4:30 p.m. Limited interlibrary loan service and photocopies of non-copyright material for a nominal fee are also available. Please direct requests to Librarian, Bituminous Coal Research, Inc., 350 Hochberg Road, Monroeville, Pennsylvania 15146.

Searching for and acquisition of mine drainage information is a continuing effort. Although coverage of the early literature is essentially complete, some more recently published material may not have been included. Copies of any publications not listed here, as well as of new publications, should be sent to BCR for inclusion in future issues of the Bibliographies. Any other suggestions, comments, or criticism of this publication are welcomed.

Additional copies of this publication and other bibliographies in the series may be obtained from:

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ABSTRACT

This volume is the fourth to appear in the "Coal and the Environment Abstract Series" and is an update of and companion to "Mine Drainage Bibliography 1910-1976." The other volumes in the series are "Bibliography on Mined-Land Reclamation" and "A Bibliography on Disposal of Refuse from Coal Mines and Coal Cleaning Plants." The three subjects covered by the Bibliographies in the "Coal and Environment Abstract Series" are intended to complement one another. While each covers one particular subject area, inevitably some documents listed in one are also relevant to one of the other Bibliographies. Some of the topics covered in this Bibliography are formation and effects of acid mine drainage; erosion and sedimentation; sediment control technology; the effects of coal mining on ground water quality and on hydrology; and drainage from coal storage piles. In addition to the abstracts, this volume includes an Author Index and a General Index.

This publication has been financed by Bituminous Coal Research, Inc., and by Federal funds from the U.S. Environmental Protection Agency and from the Office of Surface Mining Reclamation and Enforcement, USDI, under grant number R805336-02.

CONTENTS

FORMAT AND USE OF THE BIBLIOGRAPHY

The abstracts are grouped according to the year of publication, with each section being headed by its chronological designation. Within each year the abstracts are arranged alphabetically by the first author, or, if no personal author, by title. Each abstract is numbered sequentially within the year of publication and has its own unique number: for example, M76-42. The letter M indicates the general subject area of effects of coal mining on water quality. The next two digits refer to the year of publication. The number to the right of the hyphen indicates the order in which that abstract is listed within the publication year. These unique numbers are used to reference the abstracts in the indexes. In this publication the sequential numbers of abstracts of documents issued before 1977 do not begin with -1. For example, the first document of the 1976 group has the number M76-25. Abstracts M(D)76-1 through M(D)76-24 are in "Mine Drainage Bibliography 1910-1976." The "D" used with the abstract number in the 1976 Bibliography was dropped in this edition for ease of computer manipulation of the information. At the end of each abstract are either letters, numbers, or various letter-number combinations. These are related to the filing of material in the BCR Library, and will aid the BCR staff in answering questions on the availability of the material.

The Author Index includes the names of all persons who have been listed as authors or editors of any publication. When an organization is shown as the author, it is listed in the General Index. Names beginning with Mc or Mac have been included alphabetically, as spelled, and are not grouped together.

The General Index includes the following categories: names of industry, government, and academic organizations engaged in or sponsoring work related to the effects of coal and coal mining on water quality; geographic features such as names of foreign countries and of states and regions of the United States; and subject areas such as acid mine drainage formation and sediment control. Terminology is as specific as possible and at the same time is controlled to provide consistency both within this volume and in relation to the companion volume, "Mine Drainage Bibliography 1910-1976."

Federal government agencies are listed by name and are not grouped together under United States. As an example, Applachian Regional Commission appears in "A" listings and Old West Regional Commission appears in "O" listings. Both are identified as being part of the United States Government. Subordinate parts of government agencies also are used as main index entries, with cross references from the parent organization. Environmental Protection Agency, U.S. Government, is a main entry which has cross references to Industrial Environmental Research Laboratory, Cincinnati, Ohio, as well as to Crown Mine Drainage Field Site, West Virginia.

State agencies are indexed using the name of the state as the initial word of the agency title. For example, Kentucky Department for Natural Resources and Conservation and Pennsylvania Department of Environmental Resources are used as main index entries.

In all categories, cross references and supplemental words and phrases are used liberally to facilitate information retrieval. All entries in the General Index are intermixed in strictly alphabetical order which follows the word-by-word method, with hyphenated words considered as one word.

The Appendixes are updates of the two other Bibliographies described in the Preface and appear after the indexes. Publications are listed alphabetically by author or title in each category: mined-land reclamation and disposal of coal refuse. No abstracts are included for these items, nor are they indexed. However, abstracts of these publications will be included in the subsequent abstract bibliographies planned for each subject area.

1929

M29-2 WATER PURIFICATION -- AN ACT

The General Assembly of Pennsylvania, File of the Senate, No. 27, Session of 1929, Printer's No. 127, File Folio - 451, Introduced by Mr. Painter, and Referred to the Committee on Public Health and Sanitation, Jan. 22, 1929. 3 pp. Included are a copy of the Act which would require sealing of abandoned bituminous coal mines and brief comments on this requirement. CE354

1931

M31-8 A GENERAL REVEIW OF THE UNITED STATES BUREAU OF MINES STREAM-POLLUTION INVESTIGATION

Leitch, R. D., U.S. Bureau of Mines, RI 3098 (April 1931). 7 pp. This interesting historical paper provides information concerning the first five years' involvement (1925-1930) by the U.S. Bureau of Mines in the mine drainage problem and is essentially a brief state-of-the-art. An insight is given into public attitude at that time toward the problem. Subjects addressed include the interest of water-supply companies in the problem, sources and variations of acid mine water, effects of rock dusting, effects of fish life, non-acid mines, mine sealing, and correction of the acid mine drainage problem in Indian Creek, Fayette County, Pennsylvania, by mine sealing and construction of a rock tunnel and flume diversion system. CE12

1953

M53-14 A LIMNOLOGICAL STUDY OF THE COLLEGE FARM STRIP-MINE LAKE

Burner, C. C. (1) and Leist, C. (2) [(1) Kansas Forestry, Fish, and Game Commission and (2) Kansas State Teachers College], Transactions of the Kansas Academy of Science 56 (1), 78-85 (1953). This introduction to a series of research efforts to improve fish productivity in strip-mine lakes was carried out on a lake located two miles south of Pittsburg, Kansas, and chosen because fish had inhabited it for several years. Both surface and bottom samples taken at five stations by means of a Kemmerer Water Sampler were analyzed for light penetration, pH, dissolved oxygen, free carbon dioxide, and carbonates and bicarbonates. Lake temperature was recorded when sampling was carried out. Biological characteristics studied included aquatic plants, plankton, benthos, and vertebrates, with five species of fish being found. Water quality was favorable for warm water fishes. However, the amounts of benthos and plankton found were considered to be low. In addition, the steep slope of most of the banks was not well suited for the growth of food forms or for breeding purposes. CE31

1954

M54-21 REPORT ON PROGRESS OF FISH MANAGEMENT STUDIES ON STRIP-MINE LAKES

Burner, C. (Kansas Forestry, Fish, and Game Commission), Kansas Fish and Game 11 (3), 5-8 (Jan. 1954). The primary goal of these studies, being carried out

M54-21 (continued)

in cooperation with coal companies, is to develop the best techniques for the improvement of game fishing in the numerous surface mine lakes in Kansas. Physical, chemical, and biological studies are conducted prior to the development of a management program to determine the kind and abundance of fish food, and the growth condition and abundance of fish in the lake. The management program has included combinations of the following techniques: removal and restocking to restore a proper ratio of sunfish (pan species) to bass (desired game species), treatment of shallow water to reduce pan species, and the stocking of strip-mine waters soon after the completion of mining activities. CE30

1960

M60-26 PLANKTON, BENTHOS AND FISH IN THREE STRIP-MINE LAKES WITH VARYING pH VALUES

Stockinger, N. F. and Hays, H. A., Transactions of the Kansas Academy of Science 63 (1), 1-11 (Spring 1960). One acid (pH 3.2-3.6) strip mine lake, one mildly acid (pH 6.2-7.4), and one slightly basic (pH 7.0-7.8) lake were included in this study in southeastern Kansas. In general, the plankton population was reduced in the acid lake as compared to the other two. The benthos comprised a rather diverse group of organisms with the acid lake containing the largest volume of organisms per square foot of bottom. Fish were not present in the acid lake and in the mildly acid lake pronounced stunting of growth was exhibited by bluegills. Growth of bass in the slightly basic lake compared favorably with that of fish in other bodies of water until the third year when stunting also became pronounced. (Adapted from authors' Summary) CE20

1963

M63-29 AN ANNOTATED BIBLIOGRAPHY OF WATER RESOURCE PAPERS PERTAINING TO THE STATE OF WEST VIRGINIA

Tsai, J. C.-H. and Burchinal, J. C., West Virginia University, Department of Civil Engineering, and West Virginia Center for Appalachian Studies and Development, prepared for West Virginia Department of Natural Resources, Division of Water Resources, Oct. 1963. 132 pp. This bibliography contains abstracts of 645 papers of which 26 relate to acid mine drainage. Author and subject indexes are also provided. CE212

1964

M64-17 MICROBIAL FORMATION AND DEGRADATION OF MINERALS

Silverman, M. P. and Ehrlich, H. L., Advances in Applied Microbiology 6, 153-206 (1964). The role of microorganisms in transformations of minerals in nature is discussed with the main emphasis on mineral concentrations of economic importance to the mining industry. Discussed in depth are mechanisms

M64-17 (continued)

of microbial-mineral reactions, sulfur-mineral deposits, and iron and manganese deposits. CE26

1966

M66-52 A QUARTER TO ZERO--SURFACE MINING AND WATER SUPPLIES

Agnew, A. F., Mining Congress Journal 52 (10), 29, 32-34, 38-40 (Oct. 1966). The author discusses the studies of the Indiana University Water Resources Center on the hydrology of Pike County, of the Cypress Creek-Otter Creek-Coles Creek area of Warrick County, and of the Busseron Creek drainage basin of Sullivan County. The preliminary study, begun in the second year of severe drought in southern Indiana showed that the stream gaging stations in unmined areas measured no flow while gaging stations in mined areas showed a low but measurable amount of water yield from the mined areas to the streams. The author also presents a detailed comparison of runoff from mined and unmined land using records of stream gaging stations on the South Fork Patoka River, draining the mined area, and on Flat Creek (east), draining the unmined area, and U.S. Weather Bureau records for one station in Pike County and five stations surrounding it. Data showed that storm runoff from the unmined watershed was greater than from the mined watershed, indicating that the increased water holding capacity of mined land was being recharged. CE29

M66-53 "OPERATION YELLOWBOY" TREATMENT PLAN OF LITTLE SCRUBGRASS CREEK VENANGO - BUTLER COUNTY, PENNSYLVANIA

Dorr-Oliver, Inc. and Gannett Fleming Corddry and Carpenter, Inc., Report to Pennsylvania Coal Research Board, Jan. 1966. 7 pp. The results of a study conducted at Paul Moore's farm located on Little Scrubgrass Creek, Venango County, under the Pennsylvania Coal Research Board's "Operation Yellowboy," are reported. Chemical analyses of the stream showed the iron content to be less than 0.7 ppm and the acidity was 63 ppm. Since solids precipitation was not notable following neutralization, it was concluded that the lime-neutralization aeration-dewatering process under investigation was not applicable to treat this water. CE794

M66-54 ACID MINE WATER REVERSE OSMOSIS TEST AT KITTANNING, PENNSYLVANIA

Riedinger, A., Schultz, J., Di Luzio, F. C., Hunter, J. A., Heintz, J. W., and Seiveka, E. H., General Dynamics, General Atomic Division, Report to U.S. Department of the Interior, Office of Saline Water, Research and Development Progress Report No. 217 (Oct. 1966). 69 pp. NTIS, PB-184 073. The results of tests conducted on a 24-hour-a-day basis for about ten days each at two abandoned mine sites near Kittanning, Pa., are presented. About 75 gallons per hour of high-quality product water were produced from feeds with a pH of 3.0 and lower and containing 100 ppm or more of dissolved iron. The operation could be maintained over periods of several days at recovery rates (product/feed) in excess of 90 percent, even though the solubility limits for some of the constituents were greatly exceeded. The majority of the

M66-54 (continued)

experiments were carried out using the reverse osmosis test unit known as POGO I which has six pressure tubes, each containing six spiral-wound modules, each of which has an active surface area of 6 sq. ft. CE762

1967

M67-74 THE USE OF BIOCIDES AS INHIBITORS OF THE RESPIRATION RATE OF FERROBACILLUS FERROOXIDANS

Charnego, M. R., Indiana University of Pennsylvania, M.Ed. Thesis, 1967. 55 pp. This thesis reports on an investigation to evaluate the capability of certain commercially available biocides in reducing the respiration rate of F. ferrooxidans. Of the fourteen tested, the only biocides found to be effective were quaternary ammonium compounds. These results were based on laboratory studies and the author recognized the need for furthur studies under field conditions and for development of solutions to the engineering problems involved in the application of a biocide. 67-89

1968

M68-101 THE OXYGENATION OF IRON (II) - RELATIONSHIP TO COAL MINE DRAINAGE TREATMENT

Stauffer, T. E. and Lovell, H. L., The Pennsylvania State University, College of Earth and Mineral Science, Report to Pennsylvania Coal Research Board, Special Research Report SR-69 (Nov. 1, 1968). 152 pp. The reaction parameters considered were: pH, temperature, as well as aluminum and iron concentrations. The rate is highly pH dependent, increasing with pH. The rate was shown to have a temperature dependence of eight fold per 10^{o} increase between 5 and 25^{o}C. The presence of aluminum (common in mine drainage waters) results in an overall increase in reaction complexity. Aluminum presence results in an oxygenation rate which is considerably slower after the system reaches a pH near 5.5. However, there is evidence of an earlier distinctly different rate (more rapid) at lower pH values while aluminum hydroxide and hydrous ferrous hydroxide are being precipitated. An increase in initial ferrous concentrations increased the oxygenation rate. The sludge settling rates (from 0.007 to 0.29 inches/minute) responded as the reciprocal of pH and iron-aluminum concentrations. Further data were developed toward establishing a practical process to form a ferromagnetic sludge product. (From Summation of Results) 662.6 P4, CE831

1969

M69-95 WORK PLAN FOR WATERSHED PROTECTION AND FLOOD PREVENTION: CLEAR CREEK WATERSHED, HOPKINS AND WEBSTER COUNTIES, KENTUCKY

Watershed Work Plan Agreement between the Hopkins County Soil and Water Conservation District, Clear Creek Watershed Conservancy District, State of Kentucky, and the U.S. Department of Agriculture, Soil Conservation Service, 1969. 62 pp.+ Included in the plan is a detailed description of the

M69-95 (continued)

watershed, the watershed problems, the improvement works to be installed, the project costs and the benefits to be expected. The identified watershed problem related to coal involves sediments. A minor benefit of the project to coal mining will be that water pumping costs will be reduced by minimizing the areal extent of the land affected by flood waters. CE42

1970

M70-118 THE EFFECTS OF STRIP MINING ON A NATURAL SYSTEM: A WATER QUALITY STUDY OF PIEDMONT LAKE, OHIO

Neely, J. C., III, Case Western Reserve University, Intersession Project, Biology 933, Jan. 1970. 6 pp. This is a college course report paper that presents data on pH, Ca, Mg, Na, and K for grab samples collected at 19 discharge points from surface-mined areas that surround Piedmont Lake, Ohio. R978

1971

M71-99 HISTOCHEMICAL AND CYTOPHOTOMETRIC ASSAY OF ACID STRESS IN FRESHWATER FISH

Anthony, A., Cooper, E. L., Mitchell, R. B., Neff, W. H., and Therrien, C. D., The Pennsylvania State University, Department of Biology, Report to U.S. EPA, Office of Research and Monitoring, Water Pollution Control Research Series 18050 DXJ 05/71 (May 1971). 113 pp. NTIS, PB-227 571. *Longnose dace*, fathead minnows and brook trout were examined in field and laboratory studies for changes in response to acid waters. The target organs, such as the gills, spleen, kidney and liver, were examined for damages from short and prolonged acid exposure. Sublethal levels of acidity were not found to be cumulative. However, it was found that during breeding season when fish have increased oxygen demands, the waters with a pH of 5.0 were hazardous. Streams used in the field studies were Black Moshannon Creek in Centre and Clearfield Counties and Upper Three Runs in Clearfield County. Both of these small tributaries of the West Branch of the Susquehanna River are affected by acid mine drainage. EPA, 71-113

M71-100 LIMESTONE NEUTRALIZATION OF DILUTE ACID WASTE WATERS

Deul, M. and Mihok, E. A. (to United States of America as represented by the Secretary of the Interior), U.S. Pat. 3,617,560 (Nov. 2, 1971). 5 pp. Dilute acid wastes, such as mine drainage waters, are neutralized by reaction with an extremely finely divided limestone slurry after which the neutralized effluent is aerated to strip carbon dioxide and oxidize ferrous iron. After clarification, the product stream is suitable for disposal in surface waters. (Abstract of the disclosure) 71-112

M71-101 BIOCHEMICAL FUNCTION OF EUGLENA MUTABILIS IN ACID MINE DRAINAGE

Lieb, J. A., West Virginia University, Ph.D. Thesis, 1971. 85 pp. University Microfilms, 71-26,662. This dissertation reports on an investigation to determine the role of Euglena mutabilis in iron oxidation in mine waters. Included is a literature review, description of the experimental procedure, and conclusions which indicate that Euglena mutabilis, as an obligate photoautotroph utilizing light energy and producing oxygen, can be utilized to reduce acidity and hasten ferric iron precipitation in mine drainage to alleviate stream pollution. 628.2 L71, 71-111

M71-102 MUDDY RUN MINE DRAINAGE POLLUTION ABATEMENT PROJECT - OPERATION SCARLIFT

Skelly and Loy, Engineers, Consultants, Report to Pennsylvania Department of Environmental Resources, Dec. 1971. 239 pp.+ This report documents a study of the Muddy Run watershed, a tributary of Clearfield Creek, and provides data concerning the extent and severity of mine drainage, a detailed inventory of pollution sources, a determination of the impact of this pollution on Clearfield Creek, recommendations for remedial measures for each pollution source, estimates of the cost of pollution abatement, and recommends an abatement plan for the watershed. Forty-one pollution sources are described and 33 are recommended for abatement, with estimates given for construction costs. The authors conclude that implementation of the abatement plan will result in the return of the 37-square-mile Muddy Run watershed to normal uses and in considerable improvement in water quality of a 36-mile reach of the West Branch Susquehanna River which is downstream from its confluence with Clearfield Creek. 628.2 P41S, 71-114

1972

M72-93 COSTS AND EFFECTS OF A WATER PROGRAM FOR A SMALL STRIPPING COMPANY--SOUTHEASTERN OHIO

Dreese, G. R. (1) and Bryant, H. L. (2) [(1) West Virginia University and (2) Xavier University], Water Resources Bulletin 8 (2), 320-327 (April 1972). A detailed analysis of the financial ability of a small coal company to carry out various water pollution control programs showed that "the added costs would seriously worsen its already precarious financial position." CE579

M72-94 RIFFLE ZOOBENTHOS IN STREAMS RECEIVING ACID MINE DRAINAGE

Koryak, M., Shapiro, M. A., and Sykora, J. L. (University of Pittsburgh, Graduate School of Public Health), Water Research 6 (10), 1239-1247 (1972). Two tributaries of Turtle Creek, itself a tributary of the Monongahela River in Pennsylvania, were qualitatively and quantitatively measured for differences in biomass during the spring and summer of 1968 to compare the physical, chemical, and biological conditions of an acid polluted stream with an organically polluted stream. Haymaker Creek, the organically enriched stream, is located downstream from a sewage treatment plant whereas the headwaters of the acidic stream, Lyons Run, originated in the vicinity of an abandoned strip mine. These two types of pollution had similar effects on the

M72-94 (continued)

ecology and composition of benthic fauna, high numbers of individuals comprised of a few species. Where the acid stream is being neutralized with iron hydroxide deposition, species diversity slightly increases but the biomass is very low. The number of insect groups present increases steadily with progressive neutralization until species which indicate considerable improvement in the water quality appear. The supply of desirable benthic fish food is very high in the parts of the stream where low pH, high acidity, and high ferrous iron concentrations prevent the survival of fish. However, in less acidic zones, the deposition of ferric iron drastically diminishes the total biomass of benthic organisms and severely limits fish populations. CE299

M72-95 MANAGING SURFACE MINE WASTES AND THEIR INFLUENCE ON WATER QUALITY

McCarthy, R. E. (Washington Irrigation and Development Company), in Proceedings, 27th Annual Meeting Soil Conservation Society of America, Portland, Oregon, Aug. 6-9, 1972. pp 123-129. In clarifying turbid water from the mining operation, suspended sediment is flocculated with a polyelectrolyte. The suspension settles out in ponds and clear water overflows into the receiving stream. R160a

M72-96 SIMULTANEOUS POLAROGRAPHIC DETERMINATION OF IRON (II) AND IRON (III) IN COAL MINE WASTE WATER

Tackett, S. L. and Wieserman, L. F. (Indiana University of Pennsylvania), *Analytical Letters* 5 (9), 643-651 (1972). The polarographic method, using a sodium carbonate-oxalic acid supporting electrolyte, is described. The average relative error was 2.2 percent for Fe(II) and 2.1 percent for Fe(III) over a range of 10 to 500 ppm. In actual mine water samples taken near Clymer, Pennsylvania, the Fe(II) content was highest where the mine water emerged. As the water moved down stream from the source of pollution Fe(II) decreased and Fe(III) concentration increased. This was accompanied by a decrease in pH. Further down the stream when Fe(III) started to precipitate its concentration steadily decreased. (Authors' abstract adapted) CE580

1973

M73-84 STRIP MINING AND WATER POLLUTION

Ahmad, M. U. (Ohio University, Athens, Ohio), Ground Water 11 (5), 37-41 (Sept.-Oct. 1973). Discussion of paper and reply, A. F. Agnew, M. U. Ahmad, Ground Water 12 (2), 110-111 (March-April 1974). This paper presents excerpts from the author's 1973 testimony before several congressional committees on the effects of surface mining. Also included is a Discussion of Papers which takes the author to task for overstatements, broad generalizations, and statements which are inaccurate, meaningless or erroneous, and the author's reply to this critcism. R986

M73-85 SOIL AS A MEDIUM FOR THE RENOVATION OF ACID MINE DRAINAGE

Ciolkosz, E. J., Kardos, L. T., and Beers, W. F., The Pennsylvania State University, Institute for Research on Land and Water Resources, Research Project Technical Completion Report, Project A-027-PA, Agreement #14-31-0001-4038, for the U.S. Office of Water Resources Research, Dec. 1973. 135 pp. NTIS, PB-228 868. Equilibration of soil material from three horizons (Ap, B23 and C1) at various ratios (1:1, 1:5 and 1:50) of soil to acid mine drainage water (AMW) indicated that maximum effect on pH, total acidity, conductivity, and iron content of the AMW occurred within five minutes and in the narrowest soil: AMW ratio. Percolation of mine water, which had been collected from the Proctor 2 source at the Pennsylvania State University mine drainage treatment facility at Hollywood, Clearfield County, Pennsylvania, through reconstructed 40-inch profiles of Rayne silt loam and Guernsey silty clay loam at a loading rate of five inches at weekly intervals for 20 weeks increased pH of the AMW from 2.6-2.8 to 4.0 with the Rayne soil and to 8.0 with the calcareous Guernsey soil. Iron was totally removed by both soils. Al was decreased 50 percent by the Rayne soil. The Guernsey soil totally removed Al, An, Cu, and Mn. Twenty one soil samples (horizons) from seven Pennsylvania soils were equilibrated for 32 hours three times in succession in a 1:5 soil: AMW ratio. Multiple linear regression analysis was used to evaluate the effect of certain soil properties on the chemical quality of the equilibrated acid mine water. Most of the variation of pH, total acidity, and iron were accounted for by cation exchange capacity and $CaCO_3$ equivalent. (From authors' abstract) CE3

M73-86 CHLORELLA VULGARIS GROWTH RESPONSE TO ACID MINE WATER STRESS UNDER CONDITIONS OF CONSTANT AND REDUCED LIGHT

Pisapia, R., Kopyta, F., and Keller, E. C., Jr. (West Virginia University, Department of Biology), West Virginia Academy of Science Proceedings, Biology Section 45 (2), 120-127 (1973). Axenic cultures of Chlorella vulgaris (Pratt strain) were grown at ambient temperature using a modified Beijerinck's media and four concentrations of acid mine water (0/32, 1/32, 2/32, 3/32) in a light and a predominantly dark environment. Cell counts were made using an electronic particle counter. From these data, four growth parameters were estimated: the maximum specific growth rate; the maximum population growth rate; the average time for the population to reach the maximum growth rate; and the maximum number of cells obtained. The maximum specific growth rate was shown to differ significantly between the effects of the light conditions and the level of acid mine water (AMW) concentration. Most of the significant variability among the four AMW concentrations for this parameter was attributable to those cultures grown in continuous light. The difference between the light and reduced light conditions had a significant effect on the time measure of the lag phase of growth. For those cultures grown in the reduced light environment, the different concentrations of AMW showed no significant effect on the four growth parameters measured. (Authors' abstract) CE581

M73-87 PHYTOPLANKTON GENERIC DIVERSITY AND BIOMASS ESTIMATES OF A MONONGAHELA RIVER ACID CONFLUENCE

Rankin, D. and Keller, E. C., Jr. (West Virginia University, Department of Biology), Proceedings of the West Virginia Academy of Science 45 (2), 169-177 (1973). Water samples were taken from the confluence of Robinson Run and the Monongahela River in northern West Virginia in order to obtain information on the effect of an acid stream on generic diversity. Samples at each station were examined to determine generic diversity, biomass, density and distribution of phytoplankton in relation to an acid stream. The parameters pH, hot and cold acidity, dissolved oxygen, percent saturation of oxygen, and water temperature were also measured with analyses of variance and correlation performed on the data. The generic diversity and density were found to be significantly decreased in the acid stream with Euglena being the only genus found. Both diversity and density slowly increased down river with increasing distance from the confluence. The highest generic diversities and densities were found upriver from the confluence. Significant differences in the chemical parameters of Robinson Run were also found. High acidity, as measured by hot and cold acidity values, appeared to be a significant factor in determining the diversity and density indices. (Authors' abstract) CE185

M73-88 USE OF OZONE FOR TREATMENT OF MINE DRAINAGE DISCHARGES

Swain, H. A., Jr. and Rozelle, R. B. (Wilkes College), First International Symposium on Ozone for Water and Waste Water Treatment, Washington, D. C., Dec. 2-5, 1973. 13 pp. A brief description is provided of the research activities at Wilkes College on the use of ozone as it affects manganese removal from mine waters. From the research described, it appears that, after the more easily oxidizable ferrous iron is removed, ozone will react with manganese (II) to oxidize it to the +4 oxidation state in which it will precipitate as the manganese (IV) oxide. CE160

1974

M74-90 ADDITIONAL OBSERVATIONS ON THE EFFECTS OF STRIP MINING ON SMALL-STREAM FISHES IN EAST-CENTRAL KENTUCKY

Branson, B. A. and Batch, D. L. (Eastern Kentucky University, Department of Biological Sciences), Transactions of the Kentucky Academy of Science 35 (3-4), 81-83 (Dec. 1974). Observations from November 1971 through December 1972 show that continued siltation from surface mining operations in two tributaries to the North Fork of the Kentucky River has prevented recovery of fish populations in those streams. All species reported from Leatherwood Creek in 1972 have been forced downstream, and six of those species are now absent from that stream. Two other species are now missing from both streams. Populations of Semotilus atromaculatus apparently are on the increase, perhaps because of removal of competing species. (Authors' abstract adapted) CE117

M74-91 A COMPARATIVE STUDY OF CHEMICAL LOADINGS OF ACID AND NON-ACID TRIBUTARIES OF CHEAT LAKE, WEST VIRGINIA

Edens, D. (West Virginia University, Department of Biology), West Virginia

M74-91 (continued)

Academy of Science Proceedings 46 (1), 45-52 (1974). Three acid streams, Canyon Run, Sunnyside Run, and Tower Run, and five non-acid streams, Maple Run, Morgan Run, Cole's Run, Quarry Run, and Rubles Run, were sampled monthly from June 1973 through January 1974. Values were obtained for pH, conductivity, discharge, silicate, sulfate, total iron, total acidity, orthophosphate, total phosphate, nitrate-nitrogen, and for K, Na, Ca, Mg, Zn, Cu, and Mn. Loadings were calculated from concentration and discharge measurements. The acid streams of this study can be distinguished from the non-acid streams on the basis of all parameters studied, except nitrate-nitrogen concentration and loading, silicate loading, and potassium concentration. Maple Run and Quarry Run can be distinguished from the other non-acid streams when concentrations and loadings of selected ions are based upon drainage area. This difference is not apparent when considering concentrations and loadings alone. (Adapted from author's abstract) CE37

M74-92 HYDROLOGY OF THE ABANDONED COAL MINES IN THE WYOMING VALLEY, PENNSYLVANIA

Hollowell, J. R., U.S. Geological Survey, Open-File Report, OFR 74-237 (1974). 47 pp.+ maps This paper reports on a study to determine what modifications of the underground flow system would provide a better quality of mine-water discharge from the mine pools in the Wyoming Valley mine field without causing ground-water flooding or mine subsidence. Maps showing the existing mines, tunnels and discharges are included. Discharge chemical analysis includes trace elements. Recommendations are presented for creating discharge points that would overflow during periods of heavy precipitation. US Geol, CE91

M74-93 POTENTIAL OF MINE AND MILL SPOILS FOR WATER QUALITY DEGRADATION

McWhorter, D. B., Skogerboe, R. K., and Skogerboe, G. V. (Colorado State University), in Water Resources Problems Related to Mining, American Water Resources Association, Proceedings No. 18 (June 1974). pp 123-137. An investigation into the pollution potential and current water quality degradation attributable to mine and mill spoils was conducted in Colorado at the Edna coal mine and at a tailings pond from the production of lead, copper, and zinc. The chemical characteristics of the spoils were determined and correlated with the chemical makeup of water which has passed through and over the spoils. Monthly in-stream water quality measurements were made upstream and downstream of the spoils to determine the degree of water quality degradation. Soluble salts, principally calcium, magnesium, sodium, and sulfate, were found to be the major contaminants at both locations. (Authors' abstract adapted) 628.2 H13, CE25

M74-94 NORTHWEST ALLEGANY COUNTY AND LOWER GEORGES CREEK COMPLEX, ALLEGANY AND GARRETT COUNTIES, MARYLAND: MINE DRAINAGE ABATEMENT INVESTIGATIONS

Green Associates, Inc. and Gannett Fleming Corddry and Carpenter, Inc., Report to Maryland Department of Natural Resources, Nov. 1972. Submitted Dec. 31, 1974. (179 pp.+ 11 plates). Within the 108 square-mile area studied, 360

M74-94 (continued)

mine discharges were identified, 203 of which were considered to be of a pollutional nature. Eleven coal seams in the complex were mined by underground and/or surface mining methods. Three general abatement plans, involving both preventative measures and mine drainage treatment and ranging in cost from $12-28 million are presented. In addition, specific remedial measures and costs are given for each discharge point. 628.2 G79, CE162

M74-95 CHEMICAL KINETICS OF NEUTRALIZATION OF ACIDIC WATER BY CRUSHED LIMESTONE

Pearson, F. H. and McDonnell, A. J. (The Pennsylvania State University, Institute for Research on Land and Water Resources), in Water Resources Problems Related to Mining, American Water Resources Association, Proceedings No. 18 (June 1974). pp 85-98. To provide for the rational design of limestone neutralization processes, the kinetics of the chemical reactions involved were evaluated by experiment, and an analysis made of the chemical and physical boundary conditions that control the extent to which the reactions are completed. The rate limiting reactions are the attack of limestone by hydrogen ions, and the exsolution of carbon dioxide which is thereby generated; the latter reaction has an increasing effect on process efficiency above pH 5. Rate constants for the limiting reactions were evaluated each as a function of temperature, ionic strength, water turbulence, and for the first reaction bicarbonate ion concentration, which catalyzes the attack of limestone by hydrogen ions. A mathematical model of limestone neutralization processes reproduced experimental data. (From authors' abstract) 628.2 H13, CE23

1975

M75-47 GEOCHEMICAL AND SEDIMENTOLOGICAL ANALYSIS OF TYGART LAKE, WEST VIRGINIA

Collin, M. L., West Virginia University, Water Research Institute, Information Report 7, WRI-WVU-75-02, West Virginia University Bulletin, Series 76, No. 3-3 (Sept. 1975). 41 pp. The water of the reservoir was found to be acid with low turbidity and low total solids. The bottom sediment contained 4.1 to 18.3 percent clay. For loss on ignition, cation exchange capacity, clay content, and for the cations nitrogen, phosphorus, calcium, iron, and magnesium, decrease in percentages and in absolute amounts were detected laterally from the dam toward the Tygart Valley River inlet, and increase was observed with depth in the sediment profile. For silicon, aluminum, and potassium cations, the patterns were reversed. Kaolinite, illite, vermiculite, and minor amounts of montmorillonite were present. (Adapted from author's abstract) CE41

M75-48 BIOLOGICAL AND CHEMICAL CATALYSIS OF FERROUS IRON OXIDATION IN ACID MINE DRAINAGE

Curran, L. M. (1) and Svanks, K. (2) [(1) Battelle Columbus Laboratories and (2) The Ohio State University, Chemical Engineering Department], in Proceedings of the 3rd National Conference on Energy and the Environment,

M75-48 (continued)

Hueston Woods State Park, Ohio, Sept. 29-Oct. 1, 1975. pp 70-74. For pH values greater than 4.0, the oxidation rate constants of the chemical reaction system and the biological reaction system were related exponentially to pH. Below pH 4.0, the biological reaction system was found to be independent of pH. During the recycle operation, it was determined that the percent of conversion of ferrous iron increased as the quantity of ferric iron in suspension increased. (From authors' Conclusions) CE249

M75-49 COMPLIANCE WITH NPDES GUIDELINES IN THE COAL INDUSTRY

Drevna, C. T., Advances in Instrumentation 30 (2), 1-2 (1975). The best practicable technology currently available (BPTCA) mandated by the Federal Water Pollution Act of 1972 for acid mine drainage is hydrated lime treatment. A step-by-step description of the process and its safety measures are given. The resultant discharge from the carefully monitored treatment should be in compliance with the National Pollutant Discharge Elimination System (NPDES) guidelines. CE226

M75-50 BACTERIAL ECOLOGY OF STRIP MINE AREAS AND ITS RELATIONSHIP TO THE PRODUCTION OF ACIDIC MINE DRAINAGE

Dugan, P. R. (The Ohio State University, Department of Microbiology), Ohio Journal of Science 75 (6), 266-279 (1975). The activity of acidophilic bacteria as agents involved in the production of sulfuric acid from iron pyrite (FeS_2) found in association with coal mine refuse or spoils was reviewed. Data was presented which demonstrated the inhibitory effect of anionic detergents and certain organic acids on the growth and metabolism of the acidophilic thiobacilli. The influence of acidic mine drainage on the microflora of non-acid polluted streams was considered. Also discussed were the heterotrophic microbes which are indigenous to acid (pH 3.0) streams and acid coal refuse, with a section devoted to the potential for sulfate reducing bacteria as agents for removal of sulfuric acid from the streams. (Author's abstract) R874

M75-51 BACTERIAL ECOLOGY OF STRIP MINE AREAS AND ITS RELATIONSHIP TO THE PRODUCTION OF ACIDIC MINE DRAINAGE

Dugan, P. R. (The Ohio State University, Department of Microbiology), Ohio Journal of Science 75 (6), 266-274 (Nov. 1975). The activity of acidophilic bacteria as agents involved in the production of sulfuric acid from iron pyrite (FeS2) found in association with coal mine refuse or spoils was reviewed. Data was presented which demonstrated the inhibitory effect of anionic detergents and certain organic acids on the growth and metabolism of the acidophilic thiobacilli. The influence of acidic mine drainage on the microflora of non-acid polluted streams was considered. Also discussed were the heterotrophic microbes which are indigenous to acid (pH 3.0) streams and acid coal refuse, with a section devoted to the potential for sulfate reducing bacteria as agents for removal of sulfuric acid from the streams. (Author's abstract) R874

M75-52 GEOCHEMISTRY OF BRINES IN THE COAL MEASURES OF NORTHEAST ENGLAND

Edmunds, W. M. (Institute of Geological Sciences, Hydrogeological Department, London), Institution of Mining and Metallurgy Transactions, Section B 84, B39-B52 (May 1975). Chemical analyses were made of a number of samples of mine waters from throughout the Coal Measures. The majority of brines in Northumberland and Durham comprise calcium chloride brines, characterized by high bromide, but with K, Mg, and Na much lower than in sea water. A smaller group of brines, found mainly in the southeast of the coal field, have higher K and lower bromide compared with the main group and are considered to be derived, in part, from the Permian. The relationship between barium brines (up to 4180 mg/l Ba) and sulfate brines indicates that barite deposition and solution may have occurred in cycles. (From author's Synopsis) CE10

M75-53 ACIDIC AND FERRUGINOUS MINE DRAINAGES

Glover, H. G. (National Coal Board, U.K.), in "The Ecology of Resource Degradation and Renewal," The 15th Symposium of The British Ecological Society, July 10-12, 1973, M. J. Chadwick and G. T. Goodman, Eds., Oxford: Blackwell Scientific Publications, 1975. pp 173-195. The origin and potentially polluting effects of acidic and ferruginous drainages from coal mines, spoil heaps and coal stock-piles are described. Procedures available for the control of contamination at the source and for the treatment of these drainages are reviewed. (Author's Summary) 631 C43

M75-54 GROUND-WATER RESOURCES OF LACKAWANNA COUNTY, PENNSYLVANIA

Hollowell, J. R. and Koester, H. E., Pennsylvania Geological Survey, Water Resource Report 41 (1975). 106 pp.+ This study was made to provide information on the availability, distribution, quality, and use of water for the orderly development of water resources to meet increasing needs for water due mainly to population shifts from urban to suburban and rural parts of the county. The county includes a large extent of the Northern Anthracite Coal Field, and the report also describes the distribution and movement of water in underground mines and also the effect mine-water discharge has upon the Lackawanna River. Tabulated results of water quality analyses include values for a number of trace elements in mine waters. (Adapted from authors' Introduction) 628.2 P34 W41, CE2

M75-55 FOOD HABITS OF ICTALURUS NUBULOSUS IN ACID POLLUTED WATER OF NORTHERN WEST VIRGINIA

Klarberg, D. P. and Benson, A. (West Virginia University, Department of Biology), Transactions of the American Fisheries Society 104 (3), 541-547 (1975). An investigation of the quantity, quality, and preference of food consumed by the brown bullhead in a 3.5 kilometer section of the Monongahela River at Morgantown and in the unpolluted Doe Pond, part of the Tygart River Reservoir, near Grafton, West Virginia, was conducted from June to September 1968. Through stomach analyses the average volume of food per fish by station, month collected, and size were classified as animal, plant, detritus, or sewage material. Animal and plant material were keyed to the taxa of family. In non-acid water, the fish consumed the preferred aquatic insect

M75-55 (continued)

larvae of chironomids, whereas in acid stressed waters, the brown bullhead consumed more oligochaetes than chironomids because of their greater abundance. CE6

M75-56 NEW MEDIUM FOR ISOLATING IRON-OXIDIZING AND HETEROTROPHIC ACIDOPHILIC BACTERIA FROM ACID MINE DRAINAGE

Manning, H. L. (U.S. EPA, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio), Applied Microbiology 30 (6), 1010-1016 (Dec. 1975). The advantages of the new solid medium iron-salts-purified (ISP), are that it is more easily prepared, promotes faster growth of colony types, and allows for better differentiation of iron-oxidizing bacteria than previously developed media. Five acid mine drainage samples, each from a different state, were studied and revealed smooth, smooth with secondary growth sectors, star shaped, radiating lobe and flat-rough colony types on the ISP medium. CE35

M75-57 WATER POLLUTION FROM NONPOINT SOURCES

McElroy, A. D., Chiu, S. Y., Nebgen, J. W., Aleti, A., and Vandegrift, A. E. (Midwest Research Institute), Water Research 9 (7), 675-681 (1975). Drainage from both surface and deep mines is one of the pollution sources discussed in this paper. CE560

M75-58 EVALUATION OF HEAVY METALS MOBILIZATION WITHIN COAL CONTOUR MINING SPOIL BANKS

Minear, R. A., Tschantz, B. A., Turnmire, J. B., and Rose, R. R. (University of Tennessee, Department of Civil Engineering), American Chemical Society, Division of Environmental Chemistry Preprints 15 (1), 170-173 (1975). The continuing project is briefly discussed, no results are given. ACS 51E, CE855c

M75-59 NONAUTOTROPHIC THIOBACILLUS IN ACID MINE WATER

Myers, P. S. and Millar, W. N. (West Virginia University, Division of Plant Sciences), Applied Microbiology 30 (5), 884-886 (Nov. 1975). Also published as West Virginia University Experiment Station Scientific Paper No. 1324. This paper describes the investigation of two Thiobacillus isolates from acid mine water and the characteristics which indicate that they are strains of Thiobacillus perometabolis. CE576

M75-60 A COMPARISON OF BENTHIC OLIGOCHAETE POPULATIONS IN ACID AND NEUTRAL LENTIC ENVIRONMENTS IN SOUTHEASTERN OHIO

Orciari, R. D. and Hummon, W. D. (Ohio University, Department of Zoology and Microbiology), Ohio J. Science 75 (1), 44-49 (Jan. 1975). At monthly intervals during the summer of 1971, faunal, water, and sedimentary samples were collected from comparable coves in Lake Hope, Vinton County, an acid-polluted impoundment, and in Dow Lake, Athens County, a nonpolluted impoundment. The H' species diversity in samples from Lake Hope was

M75-60 (continued)

significantly lower than in those from Dow Lake, although the abundance of individuals in the two sampling areas was similar. Results of a similarity analysis based on shared species diversity indicated that S_H' values were nearly as great among Lake Hope samples as among Dow Lake samples, but that both differed significantly from values between samples from the two lakes. (Adapted from authors' abstract) CE555

M75-61 INFLUENCE OF SPOIL MATERIAL ON GROUND WATER QUALITY

Pagenkopf, G. K. (1), Whitworth, C. (1), and VanVoast, W. (2) [(1) Montana State University and (2) Montana Bureau of Mines], American Chemical Society, Division of Environmental Chemistry Preprints 15 (1), 162-163 (1975). The problem of toxic elements leaching from spoil in the presence of ground water was investigated in the laboratory using samples of water and spoil from the Decker Coal Company Mine, Decker, Montana, and the Western Energy Coal Mine, Colstrip, Montana. Significant amounts of sodium, potassium, calcium, magnesium, bicarbonate, and especially sulfate were analyzed in the leachate. ACS 51E, CE855

M75-62 LIMESTONE BARRIERS TO NEUTRALIZE ACIDIC STREAMS

Pearson, F. H. and McDonnell, A. J. (The Pennsylvania State University, Institute for Research on Land and Water Resources), J. Environmental Engineering Division, ASCE 101 (EE3), 425-440 (June 1975). Proceedings Paper 11382. Water samples were taken for analysis and measurements were made to determine the effect of each installation on water quality at four prototype limestone barriers that had been constructed to neutralize acidic streams. The pH of stream water was increased by up to 3 pH units at low streamflow, to pH 7 or above. This demonstrates that limestone barriers are capable of renovating acidic streams to the point that normal aquatic life can be restored, rendering the stream water suitable for a number of uses that are otherwise precluded. A mathematical model of limestone barriers was constructed, based on hydraulic laws and on the chemical kinetics of the rate limiting reactions between crushed limestone and acidic water. Model predictions matched the observed performance of the barriers. A procedure was developed to determine the design of a barrier of crushed limestone to neutralize a given streamflow. (Authors' abstract) CE8

M75-63 USE OF CRUSHED LIMESTONE TO NEUTRALIZE ACID WASTES

Pearson, F. H. and McDonnell, A. J. (The Pennsylvania State University, Institute for Research on Land and Water Resources), J. Environmental Engineering Division, ASCE 101 (EE1), 139-158 (Feb. 1975). Proceedings Paper 11131. To provide for the rational design of limestone neutralization processes, the kinetics of the chemical reactions involved were evaluated by experiment, and an analysis made of the chemical and physical boundary conditions that control the extent to which the reactions are completed. The rate limiting reactions are the attack of limestone by hydrogen ions, and the exsolution of carbon dioxide which is thereby generated; the latter reaction has an increasing effect on process efficiency above pH 5. Rate constants for

M75-63 (continued)

the limiting reactions were evaluated each as a function of temperature, ionic strength, water turbulence, and for the first reaction bicarbonate ion concentration, which catalyzes the attack of limestone by hydrogen ions. A mathematical model of limestone neutralization processes was simplified to obtain a graphical procedure for the process design for neutralization. These graphs indicate the quantity of crushed limestone of given size that is required to neutralize a specified flow of acid waste from the initial pH to the required final pH. (Authors' abstract) CE9

M75-64 PICKLING LIQUORS, STRIP MINES, AND GROUND-WATER POLLUTION

Pettyjohn, W. A. (The Ohio State University, Department of Geology and Mineralogy), Ground Water 13 (1), 4-10 (Jan./Feb. 1975). The author describes the problems resulting from the use of an abandoned surface-mine area in northeastern Ohio as a dump for neutralized spent pickling liquors. Analyses of samples taken at 23 sites show the effect of the dumped materials on streams, seeps, and ground water in the area. CE270

M75-65 GROUND WATER IN COAL STRIP-MINE SPOILS, POWDER RIVER BASIN

Rahn, P. H. (South Dakota School of Mines and Technology), in Proceedings of the Fort Union Coal Field Symposium, Vol. 3, Reclamation Section, Eastern Montana College, Billings, Montana, by Montana Academy of Sciences, April 25, 26, 1975, W. F. Clark, Ed., 1975. pp 348-361. Available Eastern Montana College Bookstore, Billings, Montana 59101. $8.75 - 5 Vol. set. Preliminary results of a two year research program to study the hydrogeology of coal mine spoil piles are presented. It was observed that spoil permeability is low where the overburden was shale with sandstone, and high where the overburden was mostly alluvium. Permeability also depended on the mechanical equipment used to remove and transport the overburden. The spoil removed by dozer scrapers became more compacted, and therefore less permeable than that moved by dragline excavations. Twenty-one water samples collected from local shallow ground water and from old spoils areas were analyzed for chemical constituents. All samples had greater than 250 ppm sulfate and were also high in calcium, magnesium and total dissolved solids. In addition, it appears that following abandonment aquifers will form as spoils become more saturated. (Adapted from author's Summary) 631 M79, R770

M75-66 LIMNOLOGICAL CHARACTERISTICS OF STRIP MINE PONDS IN NORTHWESTERN COLORADO, U.S.A.

Reed, E. B., Verh. Internat. Verein. Limnol. 19 (2), 856-865 (1975). This report compares Salamander and Camilletti Ponds, both formed from strip-mine operations in Routt County, Colorado. The biological, physical, chemical, and seasonal properties are discussed and the major components of the food web within each system are identified. Camilletti Pond is shown to be able to support trout. CE228

M75-67 SOME GEOCHEMICAL CONSIDERATIONS OF COAL

Renton, J. J. and Hidalgo, R. V., West Virginia Geological and Economic Survey, Coal-Geology Bulletin No. 4 (Aug. 1975). 38 pp.+ The report includes a discussion of the acid producing potential of coal. The results of a study of 26 samples of coal show that the best indicators of acid formation are amounts of sulfate and of total iron in coal leachate. However, it was emphasized that there was no direct correlation between the amount of pyrite in coal and acid production. Rather, amorphous and fine-grained pyrite produces acid very rapidly in comparison with coarse-grained crystalline pyrite. WVa, CE630

M75-68 SOME ASPECTS OF WATER QUALITY AND THEIR RELATIONSHIP TO HYDROLOGY IN SMALL COAL MINED DRAINAGE BASINS IN THE CUMBERLAND MOUNTAINS

Rose, R. R. and Minear, R. A. (University of Tennessee, Department of Civil Engineering), American Chemical Society, Division of Environmental Chemistry Preprints 15 (1), 168-169 (1975). The results of a study of biweekly-samples taken from nineteen stream sites in the New River basin, Tennessee indicate that water quality is affected by mining, related to stream flow, and that certain water quality parameters can be more affected by ground water movement than by surface run-off. (Adapted from text) ACS 51E, CE855b

M75-69 IMPACT OF ACID MINE DRAINAGE ON RECREATIONAL AREA IN SOUTHERN OHIO

Smith, M. J., Haile, D. M., Huntsman, B. E., Warner, B. J., Solch, J. G., and Boller, J. E., American Chemical Society, Division of Environmental Chemistry Preprints 15 (1), 164-167 (1975). Eleven wells located adjacent to streamsites of Lake Hope State Park, Ohio, which receives mine discharge from Sandy Run were monitored twice weekly to assess rapid qualitative and quantitative changes in water. An accurate water budget was established for the area, and stream and lake discharge rates were determined. Water samples were analyzed for 17 separate chemical parameters. No serious water chemistry problem was found, but the data collected from the extensive monitoring will serve as baseline information for the prevention of future problems. ACS 51E, CE855a

M75-70 HYDROLOGIC IMPACTS OF COAL MINE EFFLUENTS AND SPOIL LEACHATES

Van Voast, W. A. (1), Hedges, R. B. (1), and Pagenkopf, G. K. (2) [(1) Montana Bureau of Mines and Geology and (2) Montana State University], in Proceedings of the Fort Union Coal Field Symposium, Vol. 3, Reclamation Section, Eastern Montana College, Billings, Montana, by Montana Academy of Sciences, April 25, 26, 1975, W. F. Clark, Ed., 1975. pp 289-303. Available Eastern Montana College Bookstore, Billings, Montana 59101. $8.75 - 5 Vol. set. Objectives of this report are to describe the current status of research in water-quality effects of mining, to add perspective to current knowledge, and to define the directions of the research program. Research has thus far established that the main hydrologic effects of strip mining of coal will be changes in ground-water flow patterns during mining, and changes in ground-water quality after mining is completed. Alterations of flow patterns during the mining

M75-70 (continued)

operations will occur locally in aquifers peripheral to the mines. Alterations of ground-water quality will occur within and downgradient from mined and reclaimed areas. (From authors' Introduction) 631 M79, R763

M75-71 HYDROGEOLOGIC ASPECTS OF EXISTING AND PROPOSED STRIP COAL MINES NEAR DECKER, SOUTHEASTERN MONTANA

Van Voast, W. A. and Hedges, R. B., Montana Bureau of Mines and Geology, Bulletin 97 (Dec. 1975). 31 pp.+ Coal beds near Decker are important sources of ground water for stock and domestic wells. Tabulated data of the report include basic information on water wells, water level changes in wells, and results of analyses of well, mine, and spoil waters. Water levels in observation wells have declined more than 10 feet within 1 and 1/2 miles west of an active mine. Water-level declines east of the mine have been restricted because of recharge induced from the Tongue River Reservoir. Effluent from the active mine is a mixture of local ground waters. Dissolved-solids concentrations in the effluent have decreased from about 2,000 mg/l in early 1972 to about 1,400 mg/l in early 1975, and sodium-adsorption-ratio values have decreased from about 20 to 10, resulting in the water being usable for irrigation of mine spoils. Predictions are made for the effects on ground water flow and quality of the development of two additional mines in the area. After mining, it is predicted that water levels in affected wells will rise toward premining levels, that ground water flow patterns toward the reservoir will resume, flow rates through the mined areas would not exceed about 3.6 cfs, and average dissolved-solids concentration would be about 2,250 mg/l. (Authors' abstract adapted) 75-47, CE1

M75-72 METHOD OF AND APPARATUS FOR REMOVING CONCENTRATED SOLUTIONS OF IONISABLE COMPOUNDS FROM AQUEOUS SOLUTIONS THEREOF

Wallace, R. A. P., Brit. Pat. 1,410,188 (Oct. 15, 1975). 22 pp. The solution to be desalted flows through an apparatus with semipermiable membranes. Upon application of electric current, ions pass from the water being treated through the membranes and are concentrated in a polymerized silica gel. An experiment run with acid mine drainage is given as one of the examples of the use of the process. Brit Pat, CE98

M75-73 DESIGN OF A SYSTEM FOR MONITORING HYDROLOGIC EFFECTS OF A PROPOSED COAL SURFACE MINE IN SOUTHWEST NORTH DAKOTA

Wright, A. P. (Woodward-Clyde Consultants), AIME-SME Fall Meeting, Salt Lake City, Utah, Sept. 10-12, 1975. 18 pp. Preprint No. 75-F-339. The four major considerations on which the hydrologic monitoring program was designed include the existing hydrologic conditions in the area, the relevant legal criteria, the proposed mining and reclamation plans and methods, and estimates of generalized potential impacts of mining. General information concerning each consideration is given. Surface-water and ground-water flow were monitored and the rationale for selecting sites and designing monitoring stations is presented. AIME, CE76

M75-74 OXIDATION OF FERROUS IONS IN MINE DRAINAGE BY IRON-OXIDIZING BACTERIA

Yabuuchi, E. (1), Imanaga, Y. (2), and Fukuda, K. (1) [(1) Dowa Mining Co., Ltd., Japan, Yanahara Mine and (2) Tohoku Regional Construction Bureau, Japan], The 90th Anniversary and Symposium of The Mining and Metallurgical Institute of Japan, Nov. 23, 1975. Print No. A-7. 3 pp. It is claimed that a commercial oxidizing process, utilizing iron-oxidizing bacteria, has been successfully developed for treating mine drainage. Little descriptive information and data are given concerning the design of the process or the experimentation that led to its development. CE19

1976

M76-25 COAL PILE LEACHATE--QUANTITY AND QUALITY CHARACTERISTICS

Anderson, W. C. and Youngstrom, M. P., American Society of Civil Engineers - Environmental Engineering Journal 102 (EE6), 1239-1253 (Dec. 1976). Discussion by McFall, R. L., ASCE - Environmental Engineering Journal 103 (EE4), 760 (Aug. 1977). Leachate from coal storage piles at Cornell University was monitored to provide information for design of a treatment plant. pH, ferrous iron, total iron, acidity, total dissolved solids, copper, manganese, chromium, and zinc were determined on samples collected both during and after rainfall at the weir used to measure leachate flow. Techniques of collecting and preserving samples, and methods of analysis are described. Data show that the quality and quantity of coal pile leachate depend on the site and precipitation, and that minerals dissolved within the coal pile by retained moisture are flushed out by precipitation. Data were used to develop a method of defining the quality and quantity of leachate from a proposed coal pile after any given conditions of precipitation. McFall criticizes the lack of data on leachate resulting from snowfall and the omission of the chemical analysis of the coal used in the study. CE254

M76-26 DETECTION OF THIOBACILLUS FERROOXIDANS IN ACID MINE ENVIRONMENTS BY INDIRECT FLUORESCENT ANTIBODY STAINING

Apel, W. A., Dugan, P. R., Filppi, J. A., and Rheins, M. S. (The Ohio State University, Department of Microbiology), Applied and Environmental Microbiology 32 (1), 159-165 (July 1976). The specificity of the indirect fluorescent antibody (FA) stain for T. ferrooxidans was demonstrated with both laboratory and environmental samples. Coal refuse examined by scanning electron microscopy exhibited a rough, porous surface, which was characteristically covered by water-soluble crystals. Significant numbers of T. ferrooxidans were detected on the exterior refuse surface by FA staining, whereas none were detected in the refuse pores. A positive correlation between numbers of T. ferrooxidans and acid production in coal refuse in the laboratory was demonstrated with the FA technique. (From authors' abstract) CE176

M76-27 AUTOMATIC SYSTEM NEUTRALIZES ACID WATER

Coal Age 81 (2), 141 (Feb. 1976). The system, built by Mine Safety Appliances Co., Pittsburgh, is controlled by a pH probe. Acid mine water is mixed with

M76-27 (continued)

slaked lime in a flash mixer, transferred to a second reactor where the iron content is oxidized, then discharged to the settling pond. The lime storage and delivery components are sealed to minimize leakage of lime float dust. CE668

M76-28 PRELIMINARY OBSERVATIONS ON RESEARCH INTO THE DEVELOPMENT OF MICROBIOLOGICAL METHODS FOR IDENTIFYING THE SOURCES OF WATER ENCOUNTERED IN BRITISH COAL MINES

Barnes, T. G., and Chamberlain, E. A. C. (National Coal Board, Great Britain), Symposium on Environmental Problems Resulting from Coal Mining Activities, Katowice, Poland, Oct. 18-22, 1976. 16 pp. For the purposes of this investigation, the underground waters encountered in coal mines have been classified as follows: water originating from the water bearing rock strata; water from old mineworkings; and surface water, that is, water entering a coal mine from the surface whether it is through a fault or whether it is pumped from the surface for use in mining activities. Isolations of chemo-heterotrophic bacteria, chemo-autotrophic Thiobacilli, sulphate-reducing bacteria, anaerobic spore-forming bacteria, iron bacteria, actinomycetes and fungi have been attempted from all three types of water. The results obtained from the samples of water so far examined indicate that strata waters are sterile; waters from old mineworkings are characterised by sulphate-reducing bacteria, some species of autotrophic Thiobacilli, anaerobic spore-forming bacteria and small numbers (if any) of chemoheterotrophic bacteria. Surface waters, however, have an abundant and varied microflora therefore enabling a distinction to be made between the three types of water. (From authors' Summary) CE173

M76-29 KINETICS OF LIMESTONE NEUTRALIZATION OF ACID WATERS

Barton, P., and Vatanatham, T. (The Pennsylvania State University), Environmental Science & Technology 10 (3), 262-266 (March 1976). The authors conclude that this laboratory work has shown that the reaction of sulfuric acid with limestone is controlled by hydrogen diffusion in the pH range of 2.5-6. One explanation given is that the hydrogen ion, despite its small size, is the only species that diffuses toward the solid surface, while other ions such as calcium, carbonate, and bicarbonate are all diffusing out. They also note that the apparent rate constant increases from the start to the end of the reaction, indicating that the accumulation of calcium ions is not strongly hindering the diffusion of the hydrogen ions, and that additional modeling work is needed to describe how the presence of iron and aluminum ions slows down the reaction. Jour, CE108

M76-30 STATE ACID-MINE DRAINAGE LAWS: A COMPARISON

Bascle, B. J. and Agnew, A. F., Library of Congress, Congressional Research Service, 76-257S (Dec. 7, 1976). 67 pp. States regulate acid drainage from coal and metal mines either through general water-pollution laws or through mine-reclamation and water-pollution control laws that specifically refer to mine drainage. These laws are summarized for all states except the following

M76-30 (continued)

which do not have active coal- or metal-mining operations: Connecticut, Delaware, Hawaii, Louisiana, Massachusetts, Nebraska, New Hampshire, Rhode Island, South Carolina, and Vermont. CE161

M76-31 INVESTIGATION OF ACID MINE DRAINAGE EFFECTS ON RESERVOIR FISHERY POPULATIONS

Benson, A., West Virginia University, Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, EPA-600/2-76-107 (April 1976). 135 pp. NTIS, PB-252 703. Reissue of a report to U.S. Bureau of Sport Fisheries and Wildlife. See Coal and the Environment Abstract Series: Mine Drainage Bibliography 1910-1976, MD73-9. 73-77

M76-32 COAL AND COAL MINE DRAINAGE (LITERATURE REVIEW)

Boyer, J. F. and Gleason, V. E. (Bituminous Coal Research, Inc.), J. Water Pollution Control Federation 48 (6), 1284-1287 (1976). Thirty articles published in 1975 are included in this annual literature review. Subjects covered include underground mining, surface mining, and mine drainage treatment. Jour, CE67

M76-33 EFFECT OF TEMPERATURE AND FERRIC HYDROXIDE ON THE EMBRYONIC AND PROTEIN DEVELOPMENT OF THE COHO SALMON, ONCORHYNCHUS KISUTCH

Brenner, F. J., Cooper, W. L., and MacHose, C. L. (Grove City College), Proceedings of the Pennsylvania Academy of Science 50, 165-169 (1976). Laboratory studies were carried out at 10 C and at 16 C without ferric hydroxide and in the presence of 3 ppm ferric hydroxide. While both temperature and ferric hydroxide affected protein patterns and rate of development of the embryos, the higher incubation temperature resulted in increased embryonic mortality but ferric hydroxide had no such apparent effect. CE578

M76-34 EFFECT OF FERRIC HYDROXIDE SUSPENSION ON BLOOD CHEMISTRY IN THE COMMON SHINER, NOTROPUS CORNUTUS

Brenner, F. J., Corbett, S., and Shertzer, R. (Grove City College), Transactions of the American Fisheries Society 105 (3), 450-455 (May 1976). Common shiners, Notropus cornutus, were exposed to 3 ppm ferric hydroxide for periods from two to eight weeks. Ferric hyroxide resulted in initial changes in serum protein, glucose, Na and K ions, but these changes did not adversely affect the internal dynamics of the fish. (Authors' abstract) CE573

M76-35 FACTORS AFFECTING WATER QUALITY FROM STRIP-MINED SITES

Connell, J. F., Contractor, D. N., and Shanholtz, V. O., Virginia Polytechnic Institute and State University, Water Resources Research Center, Bulletin 87 (March 1976). 75 pp. Data acquired before and during mining on precipitation, stream flow, and water quality were analyzed to derive linear relationship between a water-quality parameter and such variables as

M76-35 (continued)

temperature, current and antecedent precipitation, and the extent of the area disturbed by mining. Mathematical formulae representing sulfate and calcium concentration, alkalinity, turbidity, conductance, and discharge were used and a correlation analysis was also made among them. A formula for each water-quality parameter was derived for each of three different conditions: (1) before mining; (2) during mining for the disturbed area alone; and (3) during mining for the entire watershed. The findings provide data that can be used for predicting site specific water-quality impacts from strip-mining operations. CE675

M76-36 FUNGI IN AND NEAR STREAMS CARRYING ACID MINE-DRAINAGE

Cooke, W. B., Ohio Journal of Science 76 (5), 231-240 (1976). In 1964 and 1965, the author sampled a number of sites in Ohio and West Virginia for fungi in mine-drainage streams. The results, reported in 1966, gave total numbers of fungi found at various habitats, sampling locations, or dates. This article adds to the information given previously, and tabulates the species found during the study. CE552

M76-37 DEBRIS BASINS FOR CONTROL OF SURFACE MINE SEDIMENTATION

L. Robert Kimball, Consulting Engineers, Report to Kentucky Department for Natural Resources and Conservation and U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-76-108 (June 1976). 48 pp. Dicks Fork and Rhoades Branch watersheds in hilly eastern Kentucky were shown to be acceptable sites for demonstration of the feasibility of debris basins in controlling water pollution. The sites are in areas where very little erosion-causing activity has occurred and where surface mining is to be initiated. Adjacent "virgin" watersheds were also selected for each study site to provide background data on water quality where man's activities have been very limited. Pertinent site information including flow and water quality data were gathered. Cooperation agreements were signed by the various mining companies assuring access and data availability. (Adapted from authors' abstract) EPA, CE28

M76-38 DENT'S RUN CLEAN-UP COMPLETED

Green Lands 6 (1), 6-9 (Winter 1976). The clean-up of the watershed by Consolidation Coal Company, West Virginia Department of Natural Resources, and U.S. EPA is summarized. Land reclamation, mine sealing, and mine drainage treatment were included in the methods used in the project which was carried out over more than four years. Jour, CE1

M76-39 EVALUATION OF SURFACE MINE RECLAMATION TECHNIQUES: CAMPBELL'S RUN WATERSHED, PENNSYLVANIA

Dougherty, M. T. and Holzen, H. H., A. C. Ackenheil & Associates, Inc., Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-76-111 (June 1976). 61 pp. NTIS, PB-255 298/AS. Fifty-two acres (21 hectares) of abandoned

M76-39 (continued)

surface-mined land were regraded and revegetated to reduce infiltration to the spoil zone and to the underlying deep-mine complex. Water quality was monitored prior to, during, and after surface reclamation. The results of sampling Campbell's Run over a three year period indicated that the stream's pH and acidity had improved and that the acid load had decreased 43 percent at its mouth. However, this improvement was attributed more to the construction of residential and commercial establishments, and of U.S. Interstate 79, and to natural fluctuations in mine pool levels and runoff rates than to the reclamation projects. CE71

M76-40 EROSION AND SEDIMENT CONTROL: SURFACE MINING IN THE EASTERN U.S.: VOLUME 1 PLANNING; VOLUME 2 DESIGN

U.S. Environmental Protection Agency, Technology Transfer Seminar Publication EPA-625/3-76-006 (Oct. 1976). Volume 1, 102 pp. Volume 2, 136 pp.+ NTIS, PB-261 343. Volume 1 includes general information on the problem of erosion and sedimentation, description of a number of control techniques, guidance in developing control plans, and a Glossary. Volume 2 presents design and construction considerations for a number of the most commonly used erosion control structures; discussion of products and materials used to aid in erosion control; and a sample control plan. Selected state mining laws and reclamation requirements are also given. EPA, CE113, CE118

M76-41 EFFECTS OF MINE ACID ON THE LONGEVITY AND REPRODUCTIVE RATE OF THE GASTRORICHA LEPIDODERMELLA SQUAMMATA (DUJARDIN)

Faucon, A. S. and Hummon, W. D. (Ohio University, Department of Zoology and Microbiology), Hydrobiologia 50 (3), 265-269 (1976). In laboratory studies, waters from a polluted and an unpolluted stream in Athens County, Ohio were used directly and mixed for tests at pH 8.1, 7.1, 6.4, 5.2, 4.6, and 3.3. Eggs cultured individually at each pH were observed at 12 hour intervals for hatching, daughter egg laying, and death. Data representing 50 animals under each test condition were used in the construction of a series of life tables for calculating maximal life expectancy, net reproductive rate per individual lifetime, and intrinsic rate of natural increase. Associated with the decrease in pH was an increase in total conductivity and a decrease in carbonate alkalinity and hence in carbonate conductivity. It appears that L. squammata is capable of living and reproducing at pH 6.0 to 6.5 under field conditions low in carbonates, providing non-carbonate ions are not abundant, or under field conditions high in non-carbonate ions, providing sufficient carbonates are present. (Adapted from authors' abstract) CE342

M76-42 IRON, AND ITS ROLE IN A RIVER POLLUTED BY MINE EFFLUENTS

Gale, W. F., Jacobsen, T. V., and Smith, K. M. (Ichthyological Associates, Inc.), Proceedings of the Pennsylvania Academy of Science 50 (2), 182-195 (1976). This 1973-74 study of an approximately 74-km stretch of the Susquehanna River covered areas where the water was only slightly polluted as well as areas receiving acid mine drainage and areas downstream from the mine drainage sources. Monitoring of water quality showed iron concentration up to

M76-42 (continued)

38.5 mg/l with a monthly mean of 3.7 mg/l. Laboratory studies confirmed the observation that temperature was a major limiting factor in iron oxidation. In the summer, iron was oxidized to the typical brownish-orange suspension, and through settling, up to 73 percent of the iron was removed within 50 km of the mine effluents. Studies of deposition of iron on the river bottom showed that little iron was deposited in winter and during periods of high flow, more iron was collected on roughened collector plates than on smooth ones, and that plates colonized by aquatic biota collected much more iron than uncolonized plates. In assessing the effects of mine drainage on the ecosystem of the study area, observations of plant life, benthos, and fish are discussed. CE344

M76-43 HARMFUL IMPACTS OF CURRENT SURFACE MINE RECLAMATION ON INFERTILE TROUT STREAMS AND THEIR FUTURE

Gasper, D. C. (West Virginia Department of Natural Resources), Northeast Fish and Wildlife Conference, Hershey, Pennsylvania, April 26-29, 1976. 27 pp. The author is concerned with the possibility of acid seeps being formed when precipitation and/or ground water percolate through acid-forming material buried during reclamation of surface-mined land. He reports examples of the problem from published documents, and reviews his discussions and correspondence on the subject with a number of research workers experienced in acid mine drainage problems. CE13

M76-44 THE TREATMENT OF COAL MINE DRAINAGE WATERS CONTAINING DISSOLVED IRON COMPOUNDS

Glover, H. G. and Chamberlain, E. A. C. (National Coal Board, Great Britain), Symposium on Environmental Problems Resulting from Coal Mining Activities, Katowice, Poland, Oct. 18-22, 1976. 17 pp. Processes used in Great Britain for the treatment of coal mine drainage waters containing dissolved iron compounds are described. Waters are classified chemically as containing permanent or temporary acidity. The former are treated by hydrated lime and sedimentation and the latter by aeration and sedimentation. It is often found preferable to mix alkaline waters from mine workings at intermediate depths with acidic waters so that the cheaper aeration process can be used. In designing mine drainage water treatment plants, the greatest possible use is made of local facilities to obtain the most effective treatment at the least cost. Details are given of the design, construction and operation of one example of each method of treatment. (Authors' Summary) CE172

M76-45 WATER QUALITY SYSTEMS IN COAL MEASURE FORMATIONS IN GREAT BRITAIN

Glover, H. G. and Chamberlain, E. A. C. (National Coal Board, Great Britain), Symposium on Environmental Problems Resulting from Coal Mining Activities, Katowice, Poland, Oct. 18-22, 1976. 18 pp. An understanding of the distribution of water qualities in the undisturbed coal measure strata has been found to be a necessary basis for the prediction of the qualities of waters which will be released during mining and subsequently discharged to surface watercourses. In Great Britain, regular water quality patterns have

M76-45 (continued)

been identified in the coal measure aquifers in most of the coalfields and consistent ionic ratios apparently defined by geochemical constraints have been observed. A relationship has been established between the chloride content of formation waters and the rank and chlorine content of the coals in adjacent seams. An appreciation of the secondary contaminants which are introduced into the formation waters during passage through the mine workings permits the complete prediction of discharged water qualities. (Authors' Summary) CE174

M76-46 SETTLER'S CABIN PARK: MINE DRAINAGE POLLUTION ABATEMENT SURVEY ALLEGHENY COUNTY, PENNSYLVANIA

Gooding, W. E. and Witt, R. C., Ackenheil & Associates Geo Systems, Inc., Report to the Appalachian Regional Commission, GEO Project 75100, Aug. 16, 1976. 49 pp.+ NTIS, PB-261 593/8BE. The condition of the 1,500 acre park was surveyed through field, laboratory, and engineering analyses with recommendations made for mined-land reclamation and pollution-abatement techniques. The recommended plans were formulated as technical and economic objectives to enhance the aesthetic and recreational potential of the park. The technical criteria for water quality were to insure a habitat capable of supporting aquatic life. The recommended abatement plan was divided into five phases and includes strip-mine reclamation, drainage collection, revegetation, excavation of shallow underground mines, and in the final phase, a treatment plant for discharge collected by the Phase I interceptor system. After being judged technically feasible, the plans were economically analyzed. In addition, the reclamation plan was to conform with projected land-use objectives and to minimize adverse impacts upon the terrestrial habitat. CE225

M76-47 UTILIZATION OF ACID MINE DRAINAGE TREATMENT SLUDGE

Grady, W. C. and Akers, D. J., West Virginia University, Coal Research Bureau, Report No. 123, prepared for Proceedings of the Fifth Mineral Waste Utilization Symposium, Chicago, Illinois, sponsored by U.S. Bureau of Mines and IIT Research Institute, April 13-14, 1976. pp 114-121. The report discusses several uses of the low-solids sludge remaining after the neutralization of acid mine drainage. Wet sludge applied to strip mine spoil in greenhouse studies gave somewhat successful results in plant growth and survival. Analyses of spray-dried sludge and of rock dust used for explosion control in coal mining operations were compared. Three of the four samples of sludge prepared for these tests met the requirements of the state of West Virginia for silica content and particle size of rock dust material. Investigations of the use of sludge in structural materials showed that under certain conditions it can be used in briquettes and, in small amounts, can be added to cements. In addition, techniques for recovering metals and minerals from the sludge are discussed. CE250

M76-48 DEMONSTRATION OF COAL MINE HAUL ROAD SEDIMENT CONTROL TECHNIQUES

Grier, W. F., Miller, C. F., and Womack, J. D., Mayes, Sudderth and Etheredge,

M76-48 (continued)

Inc. and Environmental Systems Corporation, Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-76-196 (Aug. 1976). 82 pp. NTIS, PB-258 304. This report presents recommendations for the use of erosion abatement technology in the design, construction, maintenance, and bedding of haul roads through mountainous terrain. Factors such as the length of time the road is to be used, the tonnage to be hauled over it, and the high traffic volume the road must sustain should be considered in the design. The site of the demonstration road will be at the Pevler operations of the Island Creek Coal Company in Martin County, Kentucky. CE168

M76-49 A DUAL FUNCTIONAL SOLID LIQUID SEPARATION PROCESS BASED ON FILTRATION AND SETTLING

Henry, J. D., Jr., Lui, A. P., and Kuo, C. H. (West Virginia University, Department of Chemical Engineering), AIChE Journal 22 (3), 433-441 (May 1976). The dual functional filter combines both the mechanisms of filtration and settling or decantation. The combined mechanisms of separation permit very high degrees of sludge dewatering; for example, slurries containing 0.2 wt. % gelatinous particles have been dewatered to produce a sludge of 35 wt. % particles. A mathematical model was developed which includes both the axial or vertical variation of the pressure driving force and cake compressibility effects. The model which includes both cake compressibility and pressure driving force variation was used to interpret experimental performance data for slurries of neutralized acid mine drainage sludge. (From authors' abstract and Scope) Jour, CE110

M76-50 PREDICTING THE QUALITY OF MINE WATER DISCHARGES

Henton, M. P. (Forth River Purification Board, Scotland), Effluent and Water Treatment J. 16 (11), 568, 572 (Nov. 1976). The Fife coalfields of Scotland have been worked for a number of years and records of quality of water pumped from deep and surface mines and of drainages from old mine entrances are available. The author proposes to combine these data with information on the geology and hydrology of the area to predict the quality of drainages of new mines planned for the coalfields. CE574

M76-51 PREDICTING THE ENVIRONMENTAL IMPACT OF MINE DRAINAGE ON STREAM BIOLOGY

Herricks, E. E. and Shanholtz, V. O., Transactions of the American Society of Agricultural Engineers 19 (2), 271-274, 283 (1976). A hydrologic model based on the Stanford Watershed Model was used to generate data for models of sulfate concentration and sediment movement in a stream. The models were validated with data from a two-year study of Indian Creek, Fayette County, Pennsylvania. In this presentation the author analyzes the similarities of species of macrobenthic organisms found at the sampling stations and relates these results to sulfate loadings as an indicator of acid mine drainage and to variations in the amounts of flow in the watershed. CE39

M76-52 MOBILIZATION, TRANSPORTATION AND SEDIMENTATION OF WEATHERING PRODUCTS FROM ABANDONED BROWN-COAL PITS. (IRON POLLUTION OF THE RIVER SKJERNA AND RINGKØBING FJORD, WESTERN JUTLAND)

Jacobsen, J., Danmarks Geologiske Undersogelse, Arbog, pp 57-74, 1975 (Published 1976). Analyses were made of water samples from a number of lakes formed after coal mining in the area. The two lakes which were found to have the greatest effects on the river system were studied in detail. Effects of drainage from the lakes on the river system were traced by analyses at a number of sampling stations. Amounts of dissolved solids decreased downstream either from being precipitated out or because of dilution. Data collected are considered to be insufficient to show whether suspended iron is carried into the Skjerna and the Ringkøing Fjord. CE571

M76-53 POTENTIAL IMPACT OF THE DEVELOPMENT OF LIGNITE RESERVES ON WATER RESOURCES OF EAST TEXAS

James, W. P., Slowey, J. F., Garrett, R. L., Ortiz, C., Bright, J., and King, T., Texas A&M University, Water Resources Institute, Research Project Completion Report, Project No. B-199-TEX, July 1, 1976-August 31, 1976, Technical Report No. 78 (Aug. 1976). 179 pp. NTIS, PB-263 492. Over a period of one year, sampling was carried out monthly on streams, lakes, and wells near the surface-mined areas at Fairfield and Rockdale and at control stations away from the lignite development area. Studies at the power plant at Fairfield included collection of samples of precipitation under the plume and a limited survey of trace element enrichment of surrounding soils. Studies were also carried out on leachates from several lignites and their overburdens. CE577

M76-54 PURIFICATION OF WATERS FROM STRIP LIGNITE MINES

Janiak, H., Central Research and Design Institute for Opencast Mining, POLTEGOR, Poland, 2nd Interim Report to U.S. EPA, Special Foreign Currency Program Project 05-534-3, July 1976. 177 pp. The main pollution problem in waters from Polish strip pits is suspended solids. Water from three open-pit lignite mines was used in laboratory studies on several methods of removal of suspended particles. Gamma radiation was somewhat effective in settling particles in water with considerable chemical oxygen demand. A number of flocculants were evaluated for settling suspended solids from the mine waters. The most effective was identified as Calgon M-502. Several polyelectrolytes were added directly to sand filter beds. This method was not sucessful in removing a very stable colloidal suspension from one mine water, but clarified other mine waters, particularily with the use of Calgon M-502. Field tests of sediment basins also showed that Calgon M-502 increased the settling rate of suspended solids and decreased the turbidity of mine water. CE65

M76-55 PURIFICATION OF WATERS FROM STRIP MINES

Janiak, H. (POLTEGOR, Poland), Green Lands 6 (2), 42, 44 (Spring 1976). This paper is based on research conducted in Poland and concerns the issues connected with the quality of runoff waters from lignite strip mines and the

M76-55 (continued)

technology employed in their purification. The general classes of stream quality are discussed. Suspended solids are the principal pollutant but the permitted suspended matter level of 20-50 mg/l does not apply to periods of sudden water surges. Hydrocyclones have been used but not widely due to poor reduction of suspended solids. Sedimentation ponds are in wide use and recent studies indicate that a six- to twelve-hour retention time is sufficient to meet the demanded level of purification. Jour, CE64

M76-56 EFFECTIVENESS OF SURFACE MINE SEDIMENTATION PONDS

Kathuria, D. V., Nawrocki, M. A., and Becker, B. C. (Hittman Associates, Inc.), Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-76-117 (Aug. 1976). 109 pp. NTIS, PB-258 917. Nine sedimentation ponds located in Kentucky, Pennsylvania, and West Virginia were sampled during rainfall and baseline conditions. The theoretical and actual efficiencies of removal of suspended solids were computed and compared. The theoretical efficiency was essentially the same as the actual efficiency under baseline conditions. During rainfall, predicted efficiency was higher than actual efficiency in most cases. Generally, the ponds did not exhibit good trap efficiency. Also contributing to the inferior performance were generally improper utilization and mismaintenance of the ponds. Of the various ponds observed, the off channel or dugout-type was found to remove more solids and require less maintenance than ponds built in the main stream channel. Recommendations were made for improvement of the different design and maintenance methods. (Adapted from authors' abstract) EPA, CE111

M76-57 SELECTED HYDROLOGIC DATA, CLARION RIVER AND REDBANK CREEK BASINS, NORTHWESTERN PENNSYLVANIA--AN INTERIM REPORT

Koester, H. E. and Lescinsky, J., U.S. Geological Survey, Open-File Report 76-445, Prepared in cooperation with the Pennsylvania Department of Environmental Resources (July 1976). 164 pp.+ This report summarizes discharge data from 140 stream collection sites, contains tables of about 800 chemical analyses from 164 stream sites, and 107 analyses from 91 abandoned flowing oil and gas wells including concentrations of major ions and trace metals. Tabulated results of collections of microvertebrates at 136 stream sites and seven flow duration curves are presented. (From authors' abstract) CE148

M76-58 PRESERVING THE CROOKED CREEK WATERSHED: THE ERNEST MINE ACID MINE DRAINAGE FACILITY

Kohlbeck, R. A. (L. Robert Kimball, Consulting Engineers), Water Pollution Control Association of Pennsylvania Magazine 9 (5), 4-8 (Sept.-Oct. 1976). When the mine sealing performed under the Operation Scarlift program at the abandoned Ernest Mine near Creekside in Indiana County, Pennsylvania, did not achieve acid mine drainage abatement, the Pennsylvania Department of Environmental Resources contracted for the construction of a lime neutralization plant to improve the water quality. The plant is planned to

M76-58 (continued)

treat 4.5 MGD (18,000 m3/day) of raw mine water. The process includes mixing the pumped mine water with lime slurry, aeration, settling, and discharge of clarified effluent to McKee Run, a tributary of Crooked Creek. Sludge from the neutralization will be discarded in a remote section of the mine to prevent recirculation. CE123

M76-59 HYDROCHEMISTRY OF THE DRAINED SKJERNA DELTA. (IRON POLLUTION OF THE RIVER SKJERNA AND RINGKØBING FJORD, WESTERN JUTLAND)

Kristiansen, H., Danmarks Geologiske Undersogelse, Arbog, pp 45-55, 1975 (Published 1976). A study of the drainage pumped at five stations from low-lying areas in the Skjerna delta shows that water quality differs from station to station. There is also a seasonal cycle with flush-out by autumn and winter rains of oxidation products accumulated in dry weather. Water carrying most iron and other pollutants comes from areas where borings show "occurrences of peaty deposits with a variable content of reduced sulphur components in the upper layers." CE572

M76-60 EFFECTS OF LOW CONCENTRATIONS OF MANGANOUS SULFATE ON EGGS AND FRY OF RAINBOW TROUT

Lewis, M. (Arizona State University, Department of Zoology), The Progressive Fish-Culturist 38 (2), 63-65 (April 1976). Laboratory tests were performed on incubating eggs and two growth stages of fry in four 43 liter tanks containing varying concentrations (0, 1.0, 5.0, and 10.0 mg/1) of manganous sulfate solutions and stock water from an unidentified Pennsylvania stream. An increase in egg mortality corresponded with an increase in the metal concentration. Mortality was most significant during the eye development state and at hatching time. There was no progressive increase in fry mortality at any concentration. In avoidance studies, the fish did not significantly shun the flow of manganous sulfate solutions up to a concentration of 10 mg/1. CE336

M76-61 SURFACE MINING INFLUENCE ON GROUND WATER ENVIRONMENT

Libicki, J. (POLTEGOR, Poland), Green Lands 6 (2), 39-41 (Spring 1976). Addressed are ground water problems in Poland where the majority of surface mining is situated below the stable ground- water table. Problems discussed are the use of pits once the coal has been removed and the influence of the ground-water table drawn down, by surface mining, on the surrounding terrains. Jour, CE63

M76-62 FEASIBILITY OF ELK CREEK ACID MINE DRAINAGE ABATEMENT PROJECT

Loy, L. D., Jr. and Gunnett, J. W., Skelly and Loy, Engineers and Consultants and West Virginia Department of Natural Resources, Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-76-128 (Sept. 1976). 84 pp. NTIS, PB-259 329/1BE. The purpose of this study was to determine the technical and economic feasibility of alkaline regrading, slurry trench construction, and

M76-62 (continued)

mine roof collapse as acid mine drainage abatement techniques. In each technique alkaline spoils or roof materials are manipulated so that they come in contact with mine water and act as a neutralizing agent. Project efforts included: field investigations; soil analysis; water quality and quantity monitoring; bid package preparation and supervision of exploratory backhoe excavation; detailed mapping; and preparation of predesign engineering plans and cost estimates. (Adapted from authors' abstract) 227

M76-63 OPERATION SCARLIFT - MINE DRAINAGE ABATEMENT

McConnell, C. H., Fowler, D. E., and Friedrich, A. E. (Pennsylvania Department of Environmental Resources), American Society of Civil Engineers, Annual Convention and Exposition, Philadelphia, Pennsylvania, Sept. 27 - Oct. 1, 1976. Preprint 2770. 29 pp. Described are the history of mining and mining laws in Pennsylvania, the formation of acid mine drainage, and methods of abatement being used in Operation Scarlift. To date, 2,60 cres of strip-mined land have been restored, ten treatment facilities have been constructed, 32 deep mine complexes have been sealed, and 37 refuse banks have been reclaimed. This has resulted in the cleanup of 48 stream miles and a significant reduction in the pollution of an additional 140 miles. Additional detail is given on projects at the Shaw mine complex to reduce drainage into the Casselman River, Moraine State Park, and Mahantango Creek. CE753

M76-64 THE RAPID ANALYSIS OF ACID MINE DRAINAGE

McMillan, B. G., Akers, D. J., and Colabrese, J. F., West Virginia University, Coal Research Bureau, Report No. 118 (Feb. 1976). 35 pp. Also published in Mining Congress Journal 63 (5), 28-33 (1977). Rapid, accurate analyses of acid mine drainage (AMD) at the site of the treatment plant would allow the operator to adapt the amount of neutralizer used to changing conditions. This study compares the results of analysis for Al, Ca, Cu, Mg, Mn, Fe, Ni, and SO_4 in AMD using a portable field colorimeter, a laboratory spectrophotometer, and an atomic absorption spectrophotometer (AA). The authors discuss testing for each of the species with emphasis on interferences in the various analyses. The portable field colorimeter gave acceptable results for Fe, Mn, Ni, SO_4, and Cu when Fe was present in low amounts. Comparison of titration for Ca and Mg to analysis by AA showed so much greater accuracy by AA that it was concluded that a fast, simple, and accurate procedure was unlikely to be developed for these two ions. Jour, CE241

M76-65 CHRONIC EFFECTS OF REDUCED pH ON BROOK TROUT (SALVELINUS FONTINALIS)

Menendez, R. (West Virginia Department of Natural Resources, Division of Wildlife Resources), J. Fisheries Research Board of Canada 33 (1), 118-123 (1976). Natural conditions of a West Virginia stream were simulated to analyze the effects of continued exposure to low pH levels on all growth stages of the brook trout without the interference of associated factors in the natural environment such as the presence of heavy metals or limited food supplies. The 11 month study was carried out at pH levels of 4.5, 5.0, 5.5, 6.0, 6.5, and the control level, 7.1. The number of viable eggs was reduced

M76-65 (continued)

significantly at pH 5.0 and to a lesser extent at the higher pH levels. Embryo hatchability was significantly less at all pH levels below 6.5. Growth and survival of alevins was reduced at the lower pH levels. These data indicate that continual exposure to pH values below 6.5 will result in significant reductions in egg hatchability and growth. (Adapted from author's abstract) CE186

M76-66 THE EFFECT OF COAL SURFACE MINING ON THE WATER QUALITY OF MOUNTAIN DRAINAGE BASIN STREAMS

Minear, R. A. and Tschantz, B. A. (University of Tennessee), J. Water Pollution Control Federation 48 (11), 2549-2569 (Nov. 1976). The results of first-year observations on six watersheds in the New River Basin of Tennessee are presented and contrasted with case studies of a similar nature conducted in other Appalachian locations. Three of the watersheds in this study were undisturbed by mining activity. These initial observations indicate that the pH, alkalinity, calcium, magnesium, chloride, and solids found in samples taken from the disturbed watersheds are higher than in samples taken from the undisturbed watersheds. Streamflow was continuous in the disturbed watersheds but was interrupted during the dry summer months in the undisturbed watersheds. Jour, CE650

M76-67 TIOGA RIVER MINE DRAINAGE ABATEMENT PROJECT

Miorin, A. F., Klingensmith, R. S., and Heizer, R. E., Gannett Fleming Corddry and Carpenter, Inc., Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-76-106 (June 1976). 71 pp. NTIS, PB-254 418. Because Morris Run, Coal and Bear Creeks, tributaries of the Tioga River, receive drainage from abandoned mines, water in these three streams generally has a pH of about 3.0 with a net acidity ranging from 200 to 1,000 milligrams per litre. The proposed project is recommended to demonstrate effective techniques for mine drainage abatement, to reduce a specific mine drainage problem, and to restore portions of a mined area to their approximate original surface grade. Techniques to be demonstrated include: restoration of strip pits utilizing agricultural limestone and sewage sludge as soil conditioners; burial of acid-forming materials within strip mines that are to be restored; and reconstruction and lining of a stream channel. This project will result in estimated reductions of 8,480 pounds of acid, 550 pounds of iron, and 1.23 million gallons of flow per day under average groundwater conditions at four mine discharges comprising the bulk of the pollutional loadings in the study area. (Adapted from authors' abstract) EPA, CE40

M76-68 SURVIVAL OF MAYFLY LARVAE UNDER MINE ACID CONDITIONS

Napier, S., Jr. and Hummon, W. D. (Ohio University, Department of Zoology and Microbiology), Int. Revue ges. Hydrobiol. 61 (5), 677-682 (1976). Mayfly larvae were abundant and diverse in riffle zones of three control streams in southeastern Ohio. None were found in such zones of Sandy Run, which

M76-68 (continued)

currently receives mine drainage, and of Long Hollow and Minkers Run, which both receive drainage from reclaimed and revegetated mined land. Laboratory studies showed stepwise increases in nonpredatory mortality of mayfly larvae with increased acidity. Dragonfly larvae predation on mayfly larvae was constant at pH 8.1-4.1, but decreased at pH 3.1 despite tolerance of dragonfly larvae to low pH conditions. (Adapted from authors' abstract) CE554

M76-69 TREATMENT OF ACID MINE DRAINAGE BY THE ALUMINA-LIME-SODA PROCESS

Nebgen, J. W., Weatherman, D. F., Valentine, M., and Shea, E. P., Midwest Research Institute, Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-76-206 (Sept. 1976). 105 pp. NTIS, PB-259 930/AS. This chemical desalination process for waters in which the principal sources of salinity are sulfate salts has been field tested at the Commonwealth of Pennsylvania's Acid Mine Drainage Research Facility, Hollywood, Pennsylvania, as a method to recover potable water from acid mine drainage. The process involves two treatment stages. Raw water is reacted with sodium aluminate and lime in the first stage to precipitate dissolved sulfate as calcium sulfoaluminate. In the second stage, the alkaline water (pH = 12.0) recovered from the first stage is carbonated to precipitate excess hardness. Following carbonation, product water meets USPHS specifications for drinking water. Process economics are influenced most by the cost of sodium aluminate. Operating costs for recovering potable water from acid mine drainage having an acidity of 700 mg/litre and a sulfate level of 750 mg/litre have been estimated. The design and costs of constructing a demonstration plant are presented, and operating and maintenance costs are estimated for mine drainage having an acidity of 700 mg/litre and a sulfate level of 750 mg/litre. (Adapted from authors' abstract) EPA, CE155

M76-70 NORTH BRANCH POTOMAC RIVER BASIN MINE DRAINAGE STUDY

Skelly and Loy, Consultants and Engineers, Phase I Task 1 Report to U.S. Army Corps of Engineers, Baltimore District, Feb. 1976. 181 pp.+ A report on the execution of Tasks One and Two of the project to formulate mine drainage abatement plans for the restoration of the study area's water quality is presented. Existing physical, socio-economic and environmental characteristics of the Basin are developed through literature and baseline dat reviews. The scope of the mine drainage problem and data conflicts are identified, compiled and used in updating the data base. An estimate is made of the relative contribution of active and inactive mines to the mine drainage pollution of the basin. In addition, surface mined lands are classified into reclamation categories according to the extent of regrading, degree of revegetation and angle of slope to be attained after mining. An annotated bibliography arranged according to subject area is included. CE120

M76-71 FEASIBILITY OF MINE POLLUTION ABATEMENT PROCEDURES AT GREENE-SULLIVAN STATE FOREST

Oberlies, J. W., Jr. and Polcyn, A. J., M W Inc., Architects-Engineers and

M76-71 (continued)

Ryckman/Edgerley/Tomlinson & Associates, Inc., Report to Indiana Department of Natural Resources and U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Grant No. S-802593, June 1976. 85 pp. This report presents a detailed evaluation of the feasibility of a demonstration project to abate acid mine drainage pollution in and around Reservoir 29 in Greene-Sullivan State Forest, southwestern Indiana. The first step proposed would be to spread and cover the acid producing wastes with a 0.9 meter (3 foot) cover of soil from a nearby borrow area. This would be followed by revegetation to prevent future erosion. The concluding step would be to neutralize the impoundments by the in-place addition of a lime slurry to bring the pH of the lakes from about 3.7 to 7.0. The estimated cost for this project is $1,412,000. Coal drilling, boring, water quality, and precipitation records for the area are included. (From authors' abstract) EPA, CE683

M76-72 ACID MINE DRAINAGE TREATMENT WITH THE ROTATING BIOLOGICAL CONTACTOR

Olem, H. and Unz, R. F., The Pennsylvania State University, Institute for Research on Land and Water Resources, Research Publication 93 (Sept. 1976). 70 pp. Two pilot units were operated intermittently at the Experimental Mine Drainage Treatment Facility, Hollywood, Pennsylvania, from May 1974 to September 1975. The first unit evaluated the oxidation of ferrous iron under varied disc rotation rates and hydraulic loadings, wheras the rotation rate of the second was kept constant for the study of solids formations and microbiology of the process. Under both conditions the half-immersed rotating discs increased aeration of the wastewater and provided surfaces for the growth of iron oxidizing bacteria without the prior innoculation of bacteria or nutritional supplements. The rotating biological contactor (RBC) prepared a mine drainage containing up to 313 mg/l of ferrous iron for limestone neutralization and subsequent solids precipitation. The RBC system has been shown to be dependable, efficient and economically comparable to purely chemical methods of iron oxidation. (Adapted from authors' abstract) CE284

M76-73 PRELIMINARY RESULTS FROM A STUDY OF COAL MINING EFFECTS ON WATER QUALITY OF THE TONGUE RIVER, WYOMING

Olsen, R. D. and Dettmann, E. H. (Argonne National Laboratory, Division of Environmental Impact Studies,) Fifty-Second Annual Meeting, Southwestern and Rocky Mountain Division, American Association for the Advancement of Science, Tucson, Arizona, April 28-May 1, 1976. 10 pp. Results of detailed physical and chemical analyses of mine discharge and ambient water quality of receiving streams suggest that water quality impacts of present mining acitivities in the area examined are small when compared to other apparent land use impacts observed upstream of the mine operated for 20 years by Big Horn Coal Company. A modified dilution equation for predicting the effect of increased drainage from expansion of mining in the area is presented. (Adapted from authors' abstract and text) CE309

M76-74 OPERATING IDEAS: TIP TO WESTERN COAL MINERS--YOU CAN DRINK AND BATHE IN OSMOSIS-TREATED WASTE WATER

Coal Age 81 (8), 128 (August 1976). This short news article references the use of reverse osmosis at the Emery Mine, Utah, for treating 13,000 gpd of mine water containing dissolved solids, bacteria, and organic compounds for use as drinking water and showering. Jour, CE667

M76-75 PHYSIOLOGICAL EFFECTS OF SUBLETHAL LEVELS OF ACID WATER ON FISH

Pegg, W. J. and Jenkins, C. R., West Virginia University, Water Research Institute, Center for Extension and Continuing Education, Bulletin 6, WRI-WVU-76-01, West Virginia University Bulletin, Series 76, No. 11-27 (May 1976). 47 pp. The present study indicates that tolerance for high acidity and low pH was greater for brown bullhead than for either bluegill or pumpkinseed sunfish. The oxygen consumption rate data substantiates information obtained previously in toxicity bioassay tests on the acid tolerance of these fish. In water of pH 3.0 - 4.0 ventilation rates were highly variable and frequently increased to three times the standard resting rate. As an indication of physiological stress, the changes in oxygen-consumption rate in acid waters compared to standard tap water were significant for each fish species. (Adapted from authors' abstract) CE66

M76-76 TOXICITY OF MINE DRAINAGE TO EMBRYONIC AND LARVAL BOREAL TOADS (BUFONIDAE: BUFO BOREAS)

Porter, K. R. and Hakanson, D. E., Copeia, No. 2, 327-331, 1976. Chemical analyses and bioassays of drainage from the inactive Argo mine in Clear Creek County, Colorado, were made to determine if it could be a factor in the absence of amphibians in the area. The concentration of iron, copper, and zinc in the drainage, and its pH, were all individually much greater than the tolerance levels of premetamorphic toads. The drainage had to be diluted approximately one thousand times before larvae could survive in it. (Adapted from authors' abstract) CE561

M76-77 POTENTIAL OF COAL STRIP-MINE SPOILS AS AQUIFERS IN THE POWDER RIVER BASIN

Rahn, P. H., South Dakota School of Mines and Technology, Engineering and Mining Experiment Station, Project Completion Report to Old West Regional Commission, Billings, Montana, Old West Project No. 10470025, June 30, 1976. 108 pp. Plus Appendixes I through VI. Six coal strip mines were studied using field infiltration and laboratory permeability apparatus to determine hydrologic characteristics. Data from 44 sites indicate that the permeability is primarily related to density, which in turn is due to method of emplacement and composition. Spoils emplaced by dragline show higher laboratory permeability than those emplaced by scraper or truck. Areas with large amounts of alluvium or sandstone in the overburden show significantly larger values of laboratory permeability than those where overburden consists chiefly of siltstone or shale. Chemical analyses of 32 water samples show a

M76-77 (continued)

significant difference of the quality of ground water in spoils compared to natural ground water from wells in the Tongue River Formation. Water in spoils contains greater sulfate, calcium, magnesium, and total dissolved solids. However, the mineral content of natural ground water is also sufficiently high to limit its usefulness. (From author's abstract) CE218

M76-78 CORROSIVITY OF UNDERGROUND MINE ATMOSPHERES AND MINE WATERS: A REVIEW AND PRELIMINARY STUDY

Rawat, N. S. (Indian School of Mines, Department of Chemistry, Fuel and Metallurgy), British Corrosion Journal 11 (2), 86-91 (1976). The causes of the corrosivity of mine atmospheres and mine waters are described in detail. The principal factors promoting atmospheric corrosion in underground coal mines are high relative humidity (more than 90%), high temperature (approximately 30 C) and airborne dusts. The characteristics of mine waters are presented and discussed. The causes of the acidity of mine waters have been explained in terms of the decomposition and oxidation of pyrites, the presence of thiobacillus thio-oxydans and thiobacillus ferro-oxydans, etc., and the presence of peaty acids. The acidity of mine water contributes both directly and indirectly to the corrosivity. About twenty mine water samples from Jharia coal mines were selected for preliminary studies. The samples were found to be slightly acidic or neutral and only mildly corrosive. Some mine waters corroded to the same extent whether they had a negative or positive value of the saturation index. This has been attributed to the presence of aggressive ions, i.e., chloride and sulphate, in the mine water. This is further confirmed by the finding that the rate of corrosion in mine water containing chloride ion is of the same order as that in NaCl solution of the same concentration. Similar studies are now in progress on mine atmospheres and mine waters which are highly corrosive. (Author's abstract) CE408

M76-79 FEASIBILITY STUDY: DEER PARK DAYLIGHTING PROJECT

Richardson, A. R. and Dougherty, M. T., Ackenheil & Associates, Inc., Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-76-110 (June 1976). 86 pp. NTIS, PB-257 135. Daylighting of abandoned deep coal mines to abate mine drainage employs common surface mining and backfilling techniques. Data on the present water quality of Lost Run, Garrett County, Maryland were obtained and used for the evaluation of using daylighting as a method to improve water quality. Other criteria were thickness, quality and amount of coal in-place. A mining and reclamation plan developed for the daylighting was based on the acidity of overburden material, the estimated coal in-place, and erosion control methods to reduce siltation. The feasibilitiy study results indicate this demonstration project would be technically and economically feasible and that reclamation would effectively produce usable land and improve water quality. The major obstacle in implementing the project is acquiring rights, easements and methods of awarding contracts. (Adapted from authors' abstract) EPA, CE27

M76-80 DISPOSAL OF COAL-FIRED UTILITY WASTES

Roffman, H. (Westinghouse Environmental Systems Department), Industrial Wastes 22 (5), 36-37 (Sept./Oct. 1976). The potential for water pollution from coal storage pile and coal refuse pile leachate and from wet and dry disposal of bottom and fly ash and of scrubber removal materials is discussed. CE358

M76-81 MODELING OF ACID MINE DRAINAGE AND OTHER POLLUTANTS IN THE MONONGAHELA RIVER BASIN UNDER LOW FLOW CONDITIONS

Sack, W. A., Jenkins, C. R., Chambers, B. R., and Lange, R. W., II, West Virginia University, Department of Civil Engineering, Prepared for West Virginia Department of Natural Resources, Division of Water Resources, June 1976. 159 pp. The QUAL 2 model was used to estimate conservative and non-conservative pollutant concentration in the Monongahela River Basin under low flow conditions. The work was restricted to the West Virginia portion of the basin which has four major sub-basins: Tygart, West Fort, Cheat, and Monongahela. Net acidity, total dissolved solids, dissolved oxygen and ultimate oxygen demand were the parameters modeled. Point sources included over 100 municipalities and almost 2,000 active and abandoned deep mine-related discharges. (From authors' Introduction and Summary) CE317

M76-82 RESOURCES ALLOCATION TO OPTIMIZE MINING POLLUTION CONTROL

Shumate, K. S., Smith, E. E., Ricca, V. T., and Clark, G. M. (The Ohio State University, Research Foundation), Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-76-112 (Nov. 1976). 493 pp. NTIS, PB-264 185. A comprehensive model for mine drainage simulation and optimization of resource allocation to control mine acid pollution in a watershed has been developed. The model is capable of: (a) producing a time trace of acid load and flow from acid drainage sources as a function of climatic conditions; (b) generating continuous receiving stream flow data from precipitation data; (c) predicting acid load and flow from mine drainage sources using precipitation patterns and watershed status typical of "worst case" conditions that might be expected, e.g., once every 10 or 100 years; and (d) predicting optimum resource allocation using alternative methods of treatment and/or abatement for "worst case" conditions during both wet and dry portions of the hydrologic year. Because of the detail incorporated in the model as now constituted, a large amount of field data is required as input. In most cases, the desired field data are not now available. The model has not been fully tested or compared to real systems, nor has sensitivity to input data been determined. Therefore reliability of the model, and the necessity of detailed field data, have not been established. Comparisons with real systems are necessary to determine the level of simplification that can be permitted before the validity or usefulness of the model is impaired. (From authors' abstract) EPA, CE209

M76-83 EARLY DEVELOPMENTAL EFFECTS OF LIME-NEUTRALIZED IRON HYDROXIDE SUSPENSIONS ON BROOK TROUT AND COHO SALMON

Smith, E. J. (1) and Sykora, J. L. (2) [(1) Corps of Engineers, U.S. Department of the Army, Pittsburgh District and (2) University of Pittsburgh, Graduate School of Public Health], Transactions of the American Fisheries Society 105 (2), 308-312 (1976). The study was conducted with a modified proportional diluter. Effects were interpreted from data on hatchability, survival, and growth in five test concentrations and in a control. Growth of 90-day-old coho salmon alevins was reduced in water containing 1.27 mg Fe/liter of lime-neutralized suspended iron, whereas hatchability was unaffected in the highest concentration tested, 10.5 mg Fe/liter. However, the 10.5 mg Fe/liter suspension had no measurable effect on hatchability, survival, and growth of brook trout alevins. (From authors' abstract) CE575

M76-84 REMOVAL OF UNDESIRABLE CATIONS FROM ACID MINE WATER BY A NEW CATION-EXCHANGE MATERIAL

Strohl, J. H. and Hern, J. L., West Virginia University, Water Research Institute, Information Report 9, WRI-WVU-76-04, West Virginia University Bulletin, Series 77, No. 2-2 (Aug. 1976). 14 pp. NTIS, PB-257 092. This study is directed toward the development of materials and methods useful for removing metal-ion pollutants from water. Several modified graphites were prepared that had ion-exchange or chelating properties capable of removing Fe^{+3}, Ni^{+2}, Co^{+2}, Mg^{+2}, and Ca^{+2} from water. The absorption capacities of these modified graphites are too low for economical use in water treatment. They are useful for analytical separations, however. Attempts at producing materials with higher absorption capacities were unsuccessful. Adjustment of pH and removal of some metal ions as the hydroxides by the electrogeneration of base appears to be a practical process for large-scale water treatment. (Authors' abstract) CE171

M76-85 SURFACE MINE POND TO PROVIDE WATER FOR PUBLIC SYSTEM

Green Lands 6 (4), 2-3, 5 (Winter 1976). Briefly described is a twelve acre surface-mine pit pond that will be used as a public water supply for Mt. Storm, Bayard, and Gormania, West Virginia, as well as Gorman, Maryland. Jour, CE134

M76-86 IMPACT OF COAL STRIPMINING ON WATER QUALITY AND HYDROLOGY IN EAST TENNESSEE

Tschantz, B. A. and Minear, R. A., University of Tennessee, Water Resources Research Center, Research Report No. 47 (March 5, 1976). 46 pp. NTIS, PB-251 391/9ST. Six small watersheds within the New River basin of the Northern Tennessee Cumberland Mountains have been monitored for water quality weekly and simultaneously between January and September, 1975. Three watersheds were undisturbed by mining activity and served to establish bench-mark data. The other three watersheds represented varying stages of coal mining activity, ranging from initiation of surface mining in one

M76-86 (continued)

watershed to essentially complete stripping three years previously and current deep mining activity in another. Distinct differences are observed for the variables pH, alkalinity, sulfate, calcium, magnesium, iron, manganese, total solids and suspended solids among the disturbed watersheds. In the undisturbed watersheds, stream constituent concentrations were quite uniform from stream to stream and from sample to sample. Preliminary data on the heavy metals, Cd, Cr, Co, Cu, Pb, Ni, and Zn, indicate increased metal levels in the disturbed streams, principally in particulate form. At least in the short term, the mining activity increased the buffering capacity and the pH of the drainage waters. During the late summer, there was continued streamflow in the disturbed watersheds while the undisturbed watersheds ceased flow. (From authors' abstract and conclusions) CE14

M76-87 AVOIDANCE OF LIME-NEUTRALIZED IRON HYDROXIDE SOLUTIONS BY COHO SALMON IN THE LABORATORY

Updegraff, K. F. and Sykora, J. L. (University of Pittsburgh), Environmental Science & Technology 10 (1), 51-54 (Jan. 1976). Salmon raised in control (unmodified) water and in several different concentrations of iron suspensions showed similar avoidance responses to lime-neutralized iron hydroxide suspension at concentrations of 4.25-6.45 mg Fe/l. Jour, CE107

M76-88 RECENT IRON-RICH SEDIMENTS IN THE SKJERNA RIVER SYSTEM AND IN RINGKØBING FJORD. (IRON POLLUTION OF THE RIVER SKJERNA AND RINGKØBING FJORD, WESTERN JUTLAND)

Villumsen, A., Danmarks Geologiske Undersogelse, Arbog, pp 31-43, 1975 (Published 1976). An increased amount of iron in recent sedimentary deposits is attributed to activity such as open-pit mining of brown coal, drainage of meadows, and straightening of rivers. The geology and geochemistry of the area are described and results of chemical analyses of sediments are discussed. CE570

M76-89 THE EFFECTS OF ACID MINE DRAINAGE ON SPARGANIUM AMERICANUM NUTT.

Walker, B. N. (1) and Medve, R. J. (2) [(1) Cecil Community College, Department of Biology and (2) Slippery Rock State College, Department of Biology], Proceedings of the Pennsylvania Academy of Science 50 (2), 170-172 (1976). In August and September 1969, S. americanum plants were collected from twenty sites in Slippery Rock Creek, Wolf Creek, and Clarion River watersheds, Pennsylvania. These sites had higher concentrations of total acidity, iron, sulfate, and total hardness and a lower pH than did five sites in the same watersheds that were devoid of this species. The production of staminate heads was responsive to changes in total acidity, total alkalinity, iron, and pH. Flowering appeared to be affected by water depth. (From authors' abstract and text) CE558

M76-90 PRELIMINARY RESULTS OF PREIMPOUNDMENT WATER-QUALITY STUDIES IN THE TIOGA RIVER BASIN, PENNSYLVANIA AND NEW YORK

Ward, J. R., U.S. Geological Survey, Water Resources Division, Water Resources Investigations 76-66, USGS/WRD/WRI-76/059, Prepared in cooperation with the U.S. Army Corps of Engineers, Baltimore District, and the Susquehanna River Basin Commission (July 1976). 85 pp. NTIS, ADA029315. The Tioga River and its major tributaries were sampled monthly from September 1973 to May 1975. Mine drainage from both strip- and deep-mined areas enters the stream near Blossburg and is counteracted by alkaline waters of downstream tributaries. All of the streams in the Tioga River basin carry nutrients sufficient for algae blooms. Dissolved solids range from very high to moderately high throughout the basin. The Tioga River has high concentrations of sulfate and heavy metals, particularly iron and manganese. Dissolved oxygen was usually above 80 percent saturation and never dropped below 7.0 milligrams per litre throughout the basin. Relationships between selected water-quality parameters have been developed for the sampling stations throughout the basin. Downstream trends were also examined. (Adapted from author's abstract) CE264

M76-91 SURFACE-WATER QUALITY IN THE YAMPA RIVER BASIN, COLORADO AND WYOMING--AN AREA OF ACCELERATED COAL DEVELOPMENT

Wentz, D. A. and Steele, T. D. (U.S. Geological Survey, Lakewood, Colorado), Conference on Water for Energy Development, Engineering Foundation, Asilomar Conference Grounds, Pacific Grove, California, Dec. 5-10, 1976. 28 pp. Historical data on regional temperature patterns, sediment yields, and relations between specific conductance and concentrations of major inorganic chemical constituents were complimented by a reconnaissance of 82 stream sites in the Yampa River basin during low-flow conditions in August and September 1975. At three sites, trace elements in water and in bottom sediments were found at concentrations higher than ambient levels determined for the basin. Iron and manganese concentrations exceeded U.S. Public Health Service recommended drinking water standards at 40 sites; high concentrations of nitrogen, phosphorous, and organic carbon were found at six sites. Diversity indices for benthic macroinvertebrates provide no concrete evidence for additional anomalous sites in the basin. (Adapted from authors' abstract) CE568

M76-92 pH PROFILES IN A RIVER SYSTEM WITH MULTIPLE ACID LOADS

Yeasted, J. G. and Shane, R., J. Water Pollution Control Federation 48 (1), 91-106 (1976). A model is presented capable of predicting the effects on downstream water quality resulting from a variety of proposed abatement policies. Through the use of basic principles of water chemistry, the foundation of the model was developed in the form of two expressions: an equation which permits a determination of pH when the concentrations of alkalinity and CO_2 acidity are known; and an equation which simulates the change in the hydrogen ion concentration resulting from the gain or the loss of carbon dioxide at the air-water interface. Routines were formulated so that the procedures necessary for the application of these equations could be added to an existing water quality model, Program BASIN. The final product

M76-92 (continued)

was a computer model that could analyze the effect of mine drainage on any branched river system and gives as output the pH of the water at each of a selected number of nodes. A practical application of the complete model to the Kiskiminetas River Basin was made. (From authors' Summary and Conclusions) Jour, CE15

M76-93 TROUGH CREEK LIMESTONE BARRIER INSTALLATION AND EVALUATION

Yocum, S. C., Africa Engineering Associates, Inc., Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-76-114 (May 1976). 101 pp. NTIS, PB-253 766. The project, carried out in south central Pennsylvania, included a stream gaging and sampling program to evaluate the effectiveness of limestone barrier performance under actual stream conditions, and to assess the adequacy of design relationships developed from laboratory research. Limestone barrier performance was excellent during periods of low streamflow, in terms of reducing acidity and raising the pH of the water, but effectiveness was marginal at design or average streamflow. They were ineffective when high runoffs were experienced. Limestone barrier performance deteriorates after the structures are initially constructed and placed in operation because progressive accumulations of sediment clog interstices between the stones, which lessens the hydraulic conductivity of the barriers, and because surfaces of the stones become coated with silt, which causes a reduction in reactivity of the reagent (limestone) with flowing acidic water. The design of limestone barriers should take these factors into account, and the units should be sized sufficiently large to overcome this deficiency. Silted limestone barriers can be restored to porous filtering beds, approximately equal in performance to initial efficiency, by washing and rehandling the crushed limestone materials. (From author's abstract) EPA, CE43

1977

M77-1 ACID MINE DRAINAGE TREATS SEWAGE DUMPED IN STREAMS

Coal Age 82 (11), 23 (Nov. 1977). Raw sewage from lines broken during the July 1977 flood in the Johnstown, Pennsylvania, area flowed into the Conemaugh and Kiskiminetas Rivers, both streams that carry acid mine drainage. Authorities observed that the acid water killed bacteria and prevented a health hazard. Jour, CE156

M77-2 A POLITICAL HISTORY OF ACID MINE DRAINAGE IN WEST VIRGINIA

Alderman, J. K. and Smith, W. M., West Virginia University, Coal Research Bureau, Report No. 139 (Jan. 1977). 10 pp. The authors discuss court cases and legislation of West Virginia and Pennsylvania and Federal regulations relating to acid mine drainage pollution and control. CE361

M77-3 ACID MINE DRAINAGE: THE PROBLEM & THE SOLUTION

Alderman, J. K. and Smith, W. M. (West Virginia University, Coal Research Bureau), Coal Mining & Processing 14 (8), 66-68, 87-88 (1977). The authors review the extent of acid mine drainage in West Virginia and some of the abatement projects carried out over the years. They emphasize the great amount of money required to reclaim watersheds affected by mine drainage, especially from abandoned mines. One recommendation is further research to develop more effective and efficient abatement techniques. A second recommendation is to recover and use minerals and metals in the drainage and in the sludge from treatment plants. Jour, CE295

M77-4 AN AQUATIC BIOLOGY STUDY OF DENTS RUN, MONONGALIA COUNTY, WEST VIRGINIA

Academic Associates, Inc., Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Contract No. CA-6-99-3095-A (undated, issued Nov. 1977). (16 pp.) Sampling was carried out for benthic macroinvertebrate fauna, algal flora, and water quality in June and September 1976 at eight stations on Dents Run and on two stations on adjacent Robinson Run which resembled the pretreatment conditions in Dents Run. Biota found in Dents Run showed that the stream was recovering from acid mine drainage pollution. CE365

M77-5 AN AQUATIC BIOLOGY STUDY OF ROARING CREEK, RANDOLPH COUNTY, WEST VIRGINIA

Academic Associates, Inc., Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Contract No. CA-6-99-3323-A (undated, issued Nov. 1977). (15 pp.) Collections of benthic macroinvertebrates made in a single sampling of selected segments of Roaring Creek were compared to reports of two different collection periods on the stream. Water quality data were also recorded for the sampling stations. The report concluded that "from the available data, the headwaters have greatly deteriorated down to station R5, while below R5 faunal diversity shows less decline and populations have greatly increased since 1970." CE364

M77-6 STOCHASTIC PREDICTION OF SEDIMENT YIELDS FROM STRIP MINE SPOILS OF THE ARID SOUTHWEST

Auernhamer, M. E., Fogel, M. M., Hekman, L. H.,Jr., and Thames, J. L. (University of Arizona, School of Renewable Natural Resources), in "Hydrology and Water Resources in Arizona and the Southwest," Volume 7, Proceedings of the 1977 meetings of the Arizona Section of the American Water Resources

M77-6 (continued)

Association and the Hydrology Section of the Arizona Academy of Science, held in Las Vegas, Nevada, April 15-16, 1977. pp 33-40. Mathematical simulation of the erosion process is accomplished by using a time series of hydrologic parameters as inputs into a modified form of the Universal Soil Loss Equation. A parameter to account for antecedent moisture conditions was found to improve the predictive success of the Universal Soil Loss Equation. The simulation predicts sediment yield resulting from a stochastic sequence of precipitation events on an experimental watershed. This sediment model will be used as a component in a larger, more complex hydrologic simulation model which can be used to determine optimum reclamation practices for the strip mined areas of the arid Southwest. Data from regraded strip mine spoils at the Black Mesa of Arizona are used in calibrating the model. (Authors' abstract) CE678

M77-7 AUTOMATIC WATER-TREATMENT PLANT

Colliery Guardian 225 (10), 794-795 (Oct. 1977). The plant to treat water at the Silverdale Colliery, Newcastle-under-Lyme, Great Britain, is designed to run continuously with an attendant only during the day shift. The water is treated with lime, the sludge thickened with aid of a polyelectrolyte flocculant, and then filtered. The automation of each step in the process is described. Jour, CE406a

M77-8 OUTFLOW IN THE SOUTHERN ANTHRACITE COALFIELD, PENNSYLVANIA

Baskin, L. and Mead, J. (Pennsylvania Department of Environmental Resources), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 124-138. The ground surface recharge area above the Middle Creek Mine Pool in Schuylkill County, Pennsylvania, is about 1,030 acres, 522 of which were strip mined and left unrestored. Reclamation consisted of terrace type backfilling of 400 acres of strip mines, construction of 15,050 linear feet of diversion ditches above the highwall to direct surface runoff away from the restored areas, and construction of 16,050 feet of stream channels. Limited monitoring of the pool outflow since the project has been completed indicates approximate reductions in acidity by 74 percent, in sulphates by 73 percent, in iron by 88 percent, and in the discharge rate by 30 percent. 628.2 C652, CE738

M77-9 COAL AND COAL MINE DRAINAGE (LITERATURE REVIEW)

Boyer, J. F. and Gleason, V. E. (Bituminous Coal Research, Inc.), J. Water Pollution Control Federation 49 (6), 1163-1172 (1977). There are seventy-six references in this review of the literature appearing in 1976. Jour, CE642

M77-10 MEASUREMENT AND MODELING OF STORM WATER RUNOFF FROM COAL STORAGE PILES AND THE IMPACT ON RECEIVING WATERS

Brookman, G. T., Binder, J. J., and Wade, W. A., III (TRC - THE RESEARCH CORPORATION of New England), Coal Mine Drainage Research, Seventh Symposium

M77-10 (continued)

Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 194-222. Presented are the highlights of the coal fired utility storm water measurement program conductd by TRC for EPA to evaluate waterborne fugitive emissions (non-point sources) in relationship to industrial activities. Data are presented from field studies of the Warren and Portland Stations in Pennsylvania. Included is a

description of the Short Storm Water Management Model which was modified for predicting runoff from coal-fired utilities and its application to the sites measured. CE743

M77-11 LONG-TERM ENVIRONMENTAL EFFECTIVENESS OF CLOSE DOWN PROCEDURES - EASTERN UNDERGROUND COAL MINES

Bucek, M. F. and Emel, J. L., HRB-Singer, Inc., Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Interagency Energy-Environment Research and Development Program Report, EPA-600/7-77-083 (Aug. 1977). 152 pp. NTIS, PB-272 373/2BE. The sixty-five mine sites selected for the study represented a cross section of geological and mining frameworks, and covered all the known closure techniques. Available water quality and quantity monitoring records for pre- and post-closure periods and data on physical and mining character of the mines were compiled and complemented by determination of the major chemical pollutants on samples collected at the sites during wet and dry seasons. Overall, the closures were found to reduce acidity and increase alkalinity of mine drainage. Effluents from flooded shaft/slope and drift mines showed generally, although not consistently, better quality than discharges from open, air- or dry-sealed, or partially flooded updip drift mines. The closures for more than half of the sites reversed or reduced trends of increasing pollutants, augmented already decreasing trends, and reduced variations in fluctuations of the water quality. The effect of closures on water quality improvement was found to be determined predominately by the physical and mining framework of the sites and less by the closure technology. (Adapted from authors' abstract) EPA, CE328

M77-12 INTERCONNECTION OF SURFACE AND UNDERGROUND WATER RESOURCES IN SOUTHEAST DURHAM

Cairney, T. and Hamill, L. (Teesside Polytechnic, U.K.), J. Hydrology 33 (1/2), 73-86 (1977). In this study, the River Skerne was shown to be becoming a major source of recharge for the underlying Magnesian Limestone aquifer. The volume of water pumped from Mainsforth Colliery and discharged directly to the river was identified in the data collected to measure river flow. CE485

M77-13 PALEOENVIRONMENT OF COAL AND ITS RELATION TO DRAINAGE QUALITY

Caruccio, F. T., Ferm, J. C., Horne, J., Geidel, G., and Baganz, B., University of South Carolina, Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Interagency Energy-Environment Research

M77-13 (continued)

and Development Program Report, EPA-600/7-77-067 (June 1977). 118 pp. NTIS, PB-270 080/5BE. For the area studied in eastern Kentucky, strata which produce acidic drainages are characterized as having most of the pyrite in the framboidal form and a paucity of a natural water buffering capacity and are associated with lower delta plain-back barrier sequences. On the other hand, strata which produce low to high sulfate-neutral drainages also contain framboidal pyrite but are associated with highly buffered alkaline-water systems in alluvial-upper delta plain sequences. Thus, the distribution of framboidal pyrite, in combination with the concentration of alkalinity of natural waters, determines the quality of drainage from various strata. This study showed that both of these parameters were identified and correlated with the paleo-environment of the coals. It appears, therefore, that mapping coals in the context of their depositional environments provides a tool that can be used to approximate the quality of drainage that can be expected from a mine sited in a particular stratigraphic horizon. (From authors' Results) EPA, CE293

M77-14 PEROXIDE OXIDATION OF IRON IN COAL MINE DRAINAGE

Cole, C. A. (1), Molinski, A. E. (2), Rieg, N. (2), and Backus, F. (3) [(1) The Pennsylvania State University, Middletown Campus, (2) Pennsylvania Department of Environmental Resources and (3) E. E. DuPont DeNemours & Co., Wilmington, Delaware], J. Water Pollution Control Federation 49 (7), 1616-1620 (1977). Alkaline drainage from the closed-down Wildwood Mine in Allegheny County, Pennsylvania, was treated with hydrogen peroxide at an average dosage rate of 6.6 mg/l. Total iron removed averaged 89 percent. Sludge was settled without need for coagulants, although an anionic polyelectrolyte evaluated during a short time was found to be effective in settling the floc. Costs of the procedure are discussed. JOUR, CE318

M77-15 EFFECTS OF COAL MINING ON GROUND AND SURFACE WATER QUALITY, MONONGALIA COUNTY, WEST VIRGINIA

Corbett, R. G. (University of Akron, Department of Geology), The Science of the Total Environment 8 (1), 21-38 (1977). It was found that water in areas disturbed by mining had hardness of the calcium-sulfate or calcium-magnesium-sulfate type, was low in pH, high in iron and aluminum, and contained trace elements at a level of one or more orders of magnitude greater than water from unmined lands. CE420

M77-16 QUALITY AND TREATMENT OF COAL PILE RUNOFF

Cox, D. B., Chu, T.-Y. J., and Ruane, R. J. (TVA, Division of Environmental Planning), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 232-255. TVA has established, at two coal-fired steam plants, programs to provide a characterization of drainage from coal storage piles. Data are given on the hydrology and chemical and physical

M77-16 (continued)

characteristics including acidity, pH, solids, iron, maganese, and trace elements. Studies using ash pond water for neutralization were conducted and it appears that transfer of the coal pile runoff to an ash pond, where neutralization and precipitation occur, will provide adequate treatment. CE745

M77-17 SOME HYDROGEOLOGICAL ASPECTS OF HILLSIDES IN SOUTH WALES

Daughton, G., Noake, J. S., and Siddle, H. J. (Sir William Halcrow and Partners, Mid Glamorgan, Wales), in Proceedings of a Conference on Rock Engineering, organized jointly by the British Geotechnical Society and University of Newcastle upon Tyne, Department of Mining Engineering, held at the University of Newcastle upon Tyne, England, April 4-7, 1977. pp 423-439. Approximately 120 tips and tip complexes in South Wales were investigated. It became apparent that a study of the hydrogeology was a pre-requisite of an accurate assessment of tip security. This paper outlines some of the hydrogeological aspects involved, together with the cost benefit of the investigative techniques used. References to specific examples are given from some of the geologically more interesting sites. A number of diagrams are used to identify many geological elements of the study area. Subsidence patterns, fissure trends, and assessment of aquifer characteristics were an important part of this investigation. (From authors' Introduction) 550. R68, D284

M77-18 WATER QUALITY MANAGEMENT GUIDANCE FOR MINE-RELATED POLLUTION SOURCES (NEW, CURRENT, AND ABANDONED)

Deely, D., U.S. EPA, Water Planning Division, EPA-440/3-77-027 (Dec. 1977). 212 pp. NTIS, PB-280 625. Guidance information and direction is offered to State and local water quality management (WQM) agencies dealing with prevention and control of water pollution from new, current and/or abandoned mine-related pollution sources under the U.S. Environmental Protection Agency's 208 Program. Aspects of mine-related water Quality Management Plan development which are separately explained and discussed include water pollution source identification and assessment, current source control, identification and use of "Best Management Practices", abandoned source abatement, new source planning, and continuing water quality planning and management. Information presented includes mining regulatory control system features needed for effective water pollution prevention control, basic mining water pollution control principles, and distinctions between point sources and nonpoint sources. (Author's abstract) CE692F

M77-19 RECOVERY OF SANITARY-INDICATOR BACTERIA FROM STREAMS CONTAINING ACID MINE WATER

Double, M. L., West Virginia University, M.S. Thesis, 1977. 117 pp. NTIS, PB-288 156/3WP. Improved membrane filtration methods for better recovery of

M77-19 (continued)

sanitary-indicator organisms from aquatic environments containing acid mine water were evaluated. Comparison of the recovery efficiency of various methods used to enumerate coliform bacteria from water indicated that, in general, multiple-tube fermentation techniques gave superior recovery of coliforms than did the membrane filtration procedures. However, the use of resuscitation broth as an enrichment medium greatly improved the recovery efficiency of the membrane filtration technique. A difference was found in the effectiveness of three membrane filter brands studied. Other methods used to improve the membrane filtration efficiency, such as sample pH adjustments with various basic solutions, proved ineffective. Qualitative studies of the Hartman Run drainage area showed that acid mine water may produce a differential inhibitory effect to members of the Enterobacteriaceae. In addition, the use of a two-step enrichment procedure improved the recovery of certain genera, namely, Klebsiella. Thus, it is recommended that enrichment techniques be adopted to aid in assessing the sanitary quality of water. (From author's abstract) CE164F

M77-20 EFFECT OF STRIP MINING ON WATER QUALITY IN SMALL STREAMS IN EASTERN KENTUCKY

Dyer, K. L. and Curtis, W. R., U.S. Department of Agriculture, Northeastern Forest Experiment Station, Forest Service Research Paper NE-372 (1977). 13 pp. Eight years of streamflow data are analyzed to show the effects of strip mining on chemical quality of water in six first-order streams in Breathitt County, Kentucky. All these watersheds were unmined in August, 1967, but five have since been strip mined. The accumulated data from this case history study indicate that strip mining causes large increases in the concentrations of most major dissolved constituents in the runoff waters, the concentration of most of these reaching a maximum some time after mining has ceased, then holding stady for several years. The maximum concentration of dissolved salts occured during the low flow of the dormant season, whereas maximum salt loads occurred during the high flow of the early part of the growing season. (Authors' abstract) CE553

M77-21 THE EFFECTS OF MINE ACID ON THE POND RIVER WATERSHED IN WESTERN KENTUCKY

Dyer, R. (Western Kentucky University), Water Resources Bulletin 13 (5), 1069-1074 (Oct. 1977). Some of the effects of drainage from mines in the watershed are typical orange deposits on stream banks and beds, and the mortality of water-tolerant plants and trees in swampy areas receiving mine waters. CE559

M77-22 ELKINS MINE DRAINAGE POLLUTION CONTROL DEMONSTRATION PROJECT

Edited by PEDCo Environmental, Inc., U.S. EPA, Industrial Environmental Research Laboratory, Resource Extraction and Handling Division, Cincinnati,

M77-22 (continued)

Ohio, Interagency Energy-Environment Research and Development Program Report, EPA-600/7-77-090 (Aug. 1977). 316 pp. NTIS, PB-272 896/2BE. This report describes a project funded in 1964 and carried out jointly by U.S. Bureau of Mines, U.S. Geological Survey, U.S. Sport Fisheries and Wildlife (now U.S. Fish and Wildlife Service), U.S. EPA, and the state of West Virginia. The report includes detailed background information on the mine drainage problem, the legislation and funding, the project site, and project objectives; baseline information on prereclamation conditions at the site; reclamation and revegetation procedures used, with information on costs of equipment and operations; and details of the information gathered in several site assessments conducted since the project ended in 1967. Among the conclusions are that the underground mine in the study area could not be sealed successfully; the success of water diversion could not be evaluated because of the lack of data; reclamation of surface mines in areas where there were no effects from underground mining showed the greatest improvement; acid drainage and pollution loads were highly dependent on precipitation; there were varying degrees of biological recovery in formerly acid streams where water quality was improved. (Adapted from Introduction and Summary and Conclusions of the report) EPA, CE326

M77-23 THE IMPACT OF COAL SURFACE MINING UPON PUBLIC WATER SUPPLIES

Emel, J. L., The Pennsylvania State University, Department of Geography, M.S. Thesis, 1977. 110 pp. Redbank Creek watershed in Clarion County, Pennsylvania, includes seven public water utilities and also represents mining history and conditions in the bituminous coal fields. Data from the seven utilities were obtained from files in the Pennsylvania State Archives and these data were augmented by data from the literature on water quality at other points in the watershed. Results of regression analyses indicated a relationship between the total amount of land disturbed by surface mining and concentration of sulfate, iron, and manganese in both surface and ground water, acidity and total hardness in surface water, and alkalinity in ground water. The report also includes case histories of each of the water utilities, and discussion of legislation and other legal constraints on mining to control water quality. CE383

M77-24 ENVIRONMENTAL ASPECTS OF THE NEW-SOURCE NPDES PERMIT PROGRAM FOR THE WEST VIRGINIA SURFACE COAL MINING INDUSTRY, 1977-1980

Jack McCormick & Associates, Inc., A Subsidiary of WAPORA, Inc., Final Report to U.S. EPA Region III, EPA-903/9-78-002 (March 1977). 219 pp. NTIS PB-277 974. This report (1) describes existing conditions and trends in the surface coal mining industry, (2) identifies known environmentally sensitive resources throughout the State, (3) comments on the probable future flow of applications for new-source NPDES (National Pollutant Discharge Elimination System) permits and on policy alternatives which must be specified by U.S. EPA as the new program is implemented, and (4) presents the conclusions and recommendations of the consultant for implementation of the NPDES program. (From author's abstract) EPA, CE562

M77-25 FEDERAL, STATE AND LOCAL REGULATORY POWERS AFFECTING ENERGY PROCESSING AND RELATED DEVELOPMENT IN THE APPALACHIAN REGION

Hittman Associates, Inc., Report HIT-672 to Appalachian Regional Commission, Report ARC 76-82/CO-4534 (Feb. 1977). EXECUTIVE SUMMARY 40 pp. Vol.I. COMPILATION OF REGULATORY POWERS 392 pp. Vol.II. EVALUATION OF REGULATORY POWERS 400 pp. This study addresses economic and procedural problems related to the multi-level permitting process which must be complied with in developing U.S. energy resources. The study identifies, categorizes, and describes, within a single compilation, all Federal, state and local regulatory powers which affect the energy flow chain within the Appalachian Region. It evaluates the application of selected regulatory powers and identifies areas where bureaucratic bottle-necks exist, and thus determines how the social, economic, environmental and related needs of the Appalacian people are being served by existing powers and institutions. It also makes specific policy recommendations which address the major existing and prospective regulatory problems facing the region. (From Executive Summary, Overview) 311.5 H67

M77-26 TREATMENT OF PRECIPITATION RUNOFF FROM COAL STORAGE PILES

Ferraro, F. A. (American Electric Power Service Corporation, Environmental Engineering Division), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 223-231. Coal pile runoff treatment plants are described for two coal transfer facilities operated by American Electric Power. The Belpre Coal Storage Area involves storage of high sulfur Ohio coals and the runnoff requires lime neutralization and settling. At the Cook Coal Terminal, low sulfur western coals are handled and the runoff treatment system consists of primary settling, addition of a coagulant aid, and final settling. CE744

M77-27 TIME AS A FACTOR IN ACID MINE DRAINAGE POLLUTION

Geidel, G. and Caruccio, F. T. (University of South Carolina, Department of Geology), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 41-50. The chemical reactions that are involved in the disulfide oxidation and the conversion of the weathering products to acidity and the reaction of the calcareous material in the overburden with water to produce alkalinity are discussed. In this discussion it is assumed that the infiltrating waters contact the alkaline producing material before contacting the acid material. The kinetics of both systems are markedly different and the concentrations of acid or alkalinity are time dependent. The authors found the amount of acidity produced by frequent flushings was less than that produced by flushings which were done at longer time intervals. Regardless of the time interval of flushing, the maximum alkalinity produced by calcareous material in the section is rapidly achieved and remains relatively constant. Subsequently, frequent flushings of acidic material prevent the accumulation of oxidation products and produce mildly acidic drainages that can be neutralized by the available alkalinity. On the other

M77-27 (continued)

hand, infrequent flushings solubilize larger concentrations of oxidation products producing strongly acidic solutions which overwhelm the available alkalinity and produce acid mine drainage. 628.2 C652, CE732

M77-28 DIGITAL SIMULATION OF THE YIELD POTENTIAL OF THE ELLIOT PARK-BURGOON AQUIFER IN EASTERN CLEARFIELD AND WESTERN CENTRE COUNTIES, PENNSYLVANIA

Gerhart, J. M. and Parizek, R. R., The Pennsylvania State University, College of Earth and Mineral Sciences, Special Research Report SR-113 (March 1, 1977). 162 pp. In the preliminary evaluation of the aquifer potential of a portion of a thick sandstone sequence underlying the coal-bearing strata in west-central Pennsylvania an estimate of the yield potential of the aquifer was obtained through the use of a finite difference, ground-water flow, digital computer model. In addition, an investigation of the quality of ground water in the aquifer was conducted to determine the effect of acid mine drainage on that water. It indicated the quality of mine waters to be poor, but the ground water quality was not yet adversely affected. (Adapted from authors' Summary of Results) 662.6 P4

M77-29 MICROSCOPIC VARIETIES OF PYRITE IN WEST VIRGINIA COALS

Grady, W. C. (West Virginia University, Coal Research Bureau), Trans. AIME 262 (1), 268-274 (March 1977). Also presented at SME Fall Meeting, Denver, Colorado, Sept. 1976. Preprint 76F315. Petrographic examination of 29 samples from 22 major West Virginia coal seams showed four common modes of microscopic occurrence: massive, patches, framboids, and isolated euhedral crystals. Massive pyrites were the most common type in the coals examined, and were three times more abundant in West Virginia's northern coals than in southern coals, accounting for part of the higher sulfur in the northern coals. Patches were the second most prevalent type found. Quantities of patches, framboids, and isolated crystals were relatively constant throughout the coals examined. (Adapted from author's Summary) Jour, CE646

M77-30 REMOTE SENSING OF EFFECTS OF LAND USE PRACTICES ON WATER QUALITY

Graves, D. H. and Coltharp, G. B., University of Kentucky Research Foundation, Final Report for the period Oct.-May 1977 to U.S. National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Contract No. NAS8-31006, May 31, 1977. (159 pp.) NTIS, N77-26581. Manual photo interpretation techniques were utilized to stratify six watersheds located in the Cumberland Plateau region of eastern Kentucky into vegetative types. Land uses present within the study area were reclaimed surface mining and forestry. Some correlation between densitometric data and some water quality parameters measured in the watersheds existed but ground conditions were not diverse enough to allow meaningful extension of apparent correlations into areas other than the study area. (From authors' abstract) CE672F

M77-31 ONSITE CONTROL OF SEDIMENTATION UTILIZING THE MODIFIED BLOCK- CUT METHOD OF SURFACE MINING

Haan, C. T., University of Kentucky, Kentucky Department of Natural Resources and Environmental Protection, and Watkins and Associates, Inc., Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Interagency Energy-Environment Research and Development Program Report, EPA-600/7-77-068 (July 1977). 101 pp. NTIS, PB-272 244. A detailed survey, including a geologic investigation, was conducted at the project site on Lower Lick Fork, Perry and Letcher Counties, Kentucky. The preliminary plans presented in this report include a description of the method, construction design and schedule, projected mine water quality and quantity, and estimates of capital and operating costs. CE320

M77-32 A GENERIC STUDY OF STRIP MINING IMPACTS ON GROUNDWATER RESOURCES

Hamilton, D. A. and Wilson, J. L., Massachusetts Institute of Technology, Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Report No. 229 (Sept. 1977). 156 pp. NTIS, MIT-EL-77-017. Features of the Northern Great Plains Coal Regions examined are reclaimed mine geometry, relative transmissivity between the reclaimed spoil and the surrounding unmined coal-bed aquifer, anisotrophy, the gravity-sorted rubble layer, coal wedges left between trench cuts, and the position and size of an operational mine in the regional flow system. A finite element computer model was used to simulate the groundwater flow field in relation to local hydrology, interior flow, and regional hydrology. Regional location is found to be the most important factor in the influence of an operational mine on groundwater resources. Relative transmissivity is the most important factor in determining the influence of a reclaimed mine. When present, the rubble layer dominates the flow pattern through the mine spoil. The coal wedges are apparently of little hydrologic consequence. Equidimensional mine shapes are preferred to elongated shapes because they induce the least amount of flow through spoil per unit extracted coal. (From authors' abstract) CE362

M77-33 COAL MINING AND SURFACE WATER QUALITY: CROWSNEST PASS, ALBERTA AND BRITISH COLUMBIA - PRELIMINARY DATA

Harrison, J. E., in Geological Survey of Canada, Report of Activities Part A, Paper 77-1A (1977). pp 319-322. Available, Geological Survey of Canada, 601 Booth Street, Ottawa, K1A 0E8. $7.20 outside of Canada. Sampling was carried out at 14 stations on drainages from abandoned underground mines, 12 ponds in abandoned surface mines, and nine streams originating in surface-mined areas. Seven samples from underground drainages were red from precipitated iron, while water from four ponds and six streams showed varying amounts of suspended sediment. The tabulated data give field observations on color of suspended sediment, pH, and dissolved oxygen, and also laboratory observations on color, turbidity, pH, suspended solids, specific conductance, total alkalinity, total hardness, and concentrations of Fe, Mn, K, Ca, SO_4, Si, Na, and organic and inorganic carbon. The data show that as a result of coal

M77-33 (continued)

mining, total dissolved solids, alkalinity, and hardness, and iron and sulfate are increased in mine waters, and that suspended solids are increased in water from surface mines. 550. C212, CE619

M77-34 EPA SETS WATER POLLUTION LIMITS

Heenan, M. T. (Kilcullen, Smith & Heenan), Coal Age 82 (7), 141 (1977). The Final Effluent Limitation Guidelines, effective July 1, 1977, for coal mine and preparation plant effluents, require permits before discharging water. There is a tabulation of the limitation of total iron, manganese and suspended solids, and pH in discharges under various conditions. Jour, CE280

M77-35 GROUNDWATER RE-ESTABLISHMENT IN CAST OVERBURDEN

Herring, W. C. (AMAX Coal Company), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 71-87. This discussion of ground water re-establishment in surface mined areas in the Illinois Basin is based primarily on existing publications. Some data from new but limited hydrologic studies conducted by AMAX Coal Company is also presented. In most cases the overburden has a neutralization potential exceeding the acid-producing potential and the ground water in the cast overburden will have a somewhat higher dissolved solids content than in adjacent nondisturbed formations. As would be expected the cast overburden aquifers have greater transmissivities, greater recharge, and greater discharge than do aquifers in the unmined overburden. 628.2 C652, CE735

M77-36 HOW MINE WATER IS CLARIFIED AT SILVERDALE COLLIERY

Mine and Quarry 6 (7/8), 6, 8 (July/Aug. 1977). The process includes lime neutralization, sludge thickening with polyelectrolyte, and vacuum filtration of the sludge. Filter cake composition is given and automatic control of the various process steps is described. Jour, CE99

M77-37 FLOWS OF SODIUM POTASSIUM, MAGNESIUM AND CALCIUM IN THE R. CYNON, S. WALES

Hughes, B. D. and Edwards, R. W. (University of Wales, Institute of Science and Technology), Water Research 11, 563-566 (1977). Amounts of Na, K, Mg, and Ca have been determined at 10 sampling stations on the river. The differences in the concentrations of these elements have been attributed to the geology of the drainage area and to the ground water pumped into the river from the marine coal deposits. CE429

M77-38 APPLICATION OF RESIDUALS MANAGEMENT FOR ASSESSING THE IMPACTS OF ALTERNATIVE COAL-DEVELOPMENT PLANS ON REGIONAL WATER RESOURCES

James, I. C., II (1) and STEELE, T. D. (2) [U.S. Geological Survey (1) Reston, Va. and (2) Lakewood, Colo.], Third International Hydrology Symposium,

M77-38 (continued)

Colorado State University, Fort Collins, Colorado, June 27-29, 1977. 23 pp. Results of analyses of samples of the Oak Creek drainage in the Yampa River basin show the effects of mine drainage in higher concentrations of total and dissolved iron and manganese, total cadmium, and dissolved copper and nickel. CE529

M77-39 PROGRESS IN METHODOLOGY OF THE LIGNITE MINE WATERS PURIFICATION

Janiak, H. (Central Research and Design Institute for Opencast Mining, Poland), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bitumnous Coal Research, Inc., Oct. 18-20, 1977. pp 139-149. Data are given on the classes of purity for Polish water courses and reservoirs and on typical water quality of Polish lignite mines. Purification of mine waters in Poland is limited to reducing the excessive concentration of suspended solids. Research on the use of gamma radiation and flocculation to remove suspended solids was conducted in cooperation with U.S. EPA and is described in this paper. 628.2 C652, CE739

M77-40 THE IMPORTANCE OF A LAKE'S LITTORAL ZONE AND ITS RELATIONSHIP TO MINE POND RECLAMATION

Joseph, T. W. (Ecology Consultants, Inc.), in "Reclamation for Wildlife Habitat" Proceedings of Reclamation Workshop II, sponsored by ERT Ecology Consultants, Inc., Fort Collins, Colorado, Sept. 19-20, 1977. pp 50-63. This paper advocates the development of ponds, where water quality permits, on reclaimed land rather than always returning the area to the approximate original contour. As part of the construction, shallow areas should be constructed outward from the shore for support of emergent and submergent aquatic macrophyte production. CE768

M77-41 NEW TRENDS OF RESEARCH IN PROTECTION AGAINST MINE WATER

Kapolyi, L., Publications of the Hungarian Mining Research Institute, No. 20 (1977). pp 39-46. This paper is concerned with procedures for preventing miners and mining equipment from the inrush of ground water in underground mines that are located well within a highly permeable ground water system. It is postulated that by local pumping that follows advance continuously, less water will have to be lifted than by regional dewatering. CE722

M77-42 WATER QUALITY OF SELECTED STREAMS IN THE COAL AREA OF SOUTHEASTERN MONTANA

Knapton, J. R. and McKinley, P. W., U.S. Geological Survey, Water Resources Division, Helena, Montana, USGS/WRD/WRI-77/062, USGS/WRI-77-80 (Sept. 1977). 145 pp. NTIS, PB-273 028. Data collected over a two-year period at 35 sites on Armells, Mizpah, Pumpkin, Rosebud, and Sarpy Creeks and the Tongue River include measurements of major dissolved constituents, plant nutrients, trace elements, water discharge, suspended sediment, and water temperature. Data

M77-42 (continued)

are graphed and tabulated for each sampling station, and conditions in each drainage basin and their relation to water quality are discussed. US Geol, CE177

M77-43 WATER AND RELATED PROBLEMS IN COAL-MINE AREAS OF ALABAMA

Knight, A. L. and Newton, J. G., U.S. Geological Survey, Water Resources Division, USGS/WRI-76-130, USGS/WRD/WRI-77/051 (April 1977). 51 pp. NTIS, PB-271 527. The geology and hydrology of Alabama coal fields are described and surface and underground coal mining methods are outlined. Problems associated with mining of bituminous coal from the Pottsville formation discussed in this report include erosion and sedimentation, flooding, decline in ground water level, diversion of drainage, subsidence, water quality, and vegetation. Both relevant conditions reported in the literature and representative examples of problems of mining reflected in legal action are discussed. CE36

M77-44 MEDIATION OF ACID STRIP MINE POLLUTION BY THE ATTEMPTED INHIBITION OF THE IRON-OXIDIZING AUTOTROPH, THIOBACILLUS FERROOXIDANS

Kugatow, M. A., The Pennsylvania State University, D.Ed. Thesis, 1977. 62 pp. University Microfilms, 78-3339. Counts were made of the numbers of sulfur- and iron-oxidizing bacteria and total heterotrophic microorganisms present in samples taken from three strip-mined areas during the period from the summer of 1973 through the summer and fall of 1974. In untreated soils, those with low soil pH were high in iron-oxidizing autotrophs and vice versa, but no correlations were observed between pH and numbers of sulfur-oxidizing bacteria. With partial neutralization there was usually, but not always, a decrease in iron-oxidizing bacteria, and, in some cases, a stimulation of sulfur-oxidizing bacteria. While the use of an inhibitor which was very effective in the laboratory generally lowered the numbers of iron-oxidizing bacteria in the field, the effect was transitory. Treatments with inhibitors did not affect numbers of sulfur-oxidizing bacteria, nor did they affect either the pH or total acidity of the soil. (Adapted from author's Summary) 628.2 K95, CE638

M77-45 IMPACT OF GOB AND POWER-PLANT ASH DISPOSAL ON GROUND WATER QUALITY AND ITS CONTROL

Libicki, J. (Central Research and Design Institute for Opencast Mining, Poland), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 165-184. Strip-mine pits are receiving wider use for the disposal of mine gob and power-plant ash. Such use incurs the possibility of ground-water pollution with substances leached from the disposed waste material. The objectives of the project described in this paper, which was jointly funded by POLTEGOR (Poland) and U.S. EPA, were to determine the influence of gob and fly ash disposal on ground-water quality, to prepare

M77-45 (continued)

procedures to ameliorate the influence of the storage on ground water and reclamation, and to provide recommendations for investigation and monitoring systems. 628.2 C652, CE741

M77-46 SODA ASH TREATMENT OF NEUTRALIZED MINE DRAINAGE

Long, D. A., Butler, J. L., and Lenkevich, M. J., Gwin, Dobson & Foreman, Inc., Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series, EPA-600/2-77-090 (May 1977). 73 pp. NTIS, PB-272 760/0BE. The objective of this study, which was conducted from August to December, 1974 and for a short time in 1975, was to evaluate the technical and economic feasibility of softening neutralized acid mine drainage waters by means of the cold lime/soda ash process. The study was conducted full-scale at the Altoona Treatment Plant near the Horseshoe Curve area in Pennsylvania. Unit processes employed at the plant consisted of lime neutralization, aeration, settling, soda ash softening, recarbonation, and filtration. The results generally indicated that the desired quality could be achieved. Costs of producing effluents of several different qualities are given in 1975 dollars. CE316

M77-47 LATEST RESULTS OF RESEARCH WORK IN HUNGARY CONCERNING THE PROTECTION OF MINES AGAINST WATER INTRUSION

Martos, F., Publications of the Hungarian Mining Research Institute, No. 20 (1977). pp 20-37. One of the major problems facing the Hungarian mining industry concerns the danger to man and equipment from flooding. This paper describes the problem and presents a simple model for calculating the water yield considering the interrelation between components of a triple system of aquifer, protective layer and mining pit. CE721

M77-48 REMOTE SEALING OF MINE PASSAGES CONTAINING FLOWING WATER

Maser, K. R. (to The United States of America as represented by the Secretary of the Interior), U.S. Pat. 4,000,621 (Jan. 4, 1977). 4 pp. Underground passages having water flowing therein are sealed remotely from the surface by first emplacing an aggregate layer on the passage floor through a borehole to a depth sufficient to allow the flowing water to percolate through the aggregate without overflowing it. Fly ash, either alone or admixed with cement or a swelling clay, is then pneumatically injected into the passage atop the aggregate. Finally, water flow is closed off by injecting a cementitious grout into the aggregate layer. (Abstract of the disclosure) US Pat, CE312

M77-49 REMOTE SEALING OF MINE PASSAGES CONTAINING FLOWING WATER

Maser, K. R. (to The United States of America as represented by the Secretary of the Interior), U.S. Patent 4,000,621 (Jan. 4, 1977). 4 pp. The patent includes as a claim the control of acid water flowing through mines to decrease or prevent pollution of surface water. US Pat, CE312

M77-50 CHEMICAL LIMNOLOGY OF AN ACID MINE DRAINAGE SLUDGE SETTLING IMPOUNDMENT

McDonald, D. G., Sr. (Peabody Coal Company), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 104-123. A stripmine lake in southeastern Illinois was intensely studied from February to August 1972 to (1) characterize chemical and physical stratification; (2) determine the "stability" of stratification and (3) assess the relationship between impoundment stratification and the primary influent source - neutralized acid mine drainage from the Will Scarlet water treatment plant (USEPA - Peabody Coal Company Project No. 14010 DAX). The sludge settling impoundment was characterized as a unique example of an artificially induced crenogenic meromictic (partly-mixing) impoundment. Dichotomized pH stratification and the subsequent accumulation of iron (ferrous) bicarbonates in the lower strata indicated that the origin and maintenance of impoundment meromixis was directly related to the deposition of iron hydroxides from the neutralization process as per the impoundment's intended use. (From author's abstract) 628.2 C652, CE737

M77-51 RAPID ANALYSIS OF ACID MINE DRAINAGE

McMillan, B. G., Akers, D. J., and Colabrese, J. F. (West Virginia University, Coal Research Bureau), Mining Congress Journal 63 (5), 28-33 (May 1977). The portable colorimetric filter photometer which is described provides reasonably accurate results on site and permits following quickly the fluctuations in quality of mine drainage. The on-site photometer was tested for accuracy against a sophisticated laboratory colorimetric photometer and an atomic absorption (AA) spectrophotometer in analysing for constituents of acid mine drainage, Al, Cu, Fe(total), Mg, and Ni. Sulfate could not be determined by the AA. The percent of error for the two photometric methods was similar in most analyses. CE247

M77-52 STRIP MINES AND FLUVIAL SYSTEMS: GEOMORPHIC EFFECTS AND ENVIRONMENTAL IMPACT IN NORTHEASTERN OKLAHOMA

Meleen, N. H., Clark University, Worcester, Massachusetts, Ph.D. Thesis, 1977. 264 pp. The study is carried out in Spencer Creek basin, northeastern Rogers County and examines three categories of changes in fluvial systems produced by strip mining: (1) catchment systems, (2) hydrologic response to rainfall, and (3) sediment movement. Changes in the catchment system are described by examining the key hydrologic variables affected, including infiltration, vegetation, drainage diversions, slope angles and channel gradients, and hydraulic geometry. The hydrologic response is examined both by means of discharge measurements at channel sites and by field observations and analysis of air photos. Sediment data include suspended-sediment samples, channel-geometry measurements, field observations of erosion and deposition within channels, and measurements of dissolved load and acidity. Recommendations are given of ways to reduce the problems and enhance the benefits of strip mining. CE727F

M77-53 TREATABILITY AND TREATMENT OF LEACHATE AND CONTAMINATED RUN-OFF WATERS FROM A COAL TRANSSHIPMENT FACILITY

Metry, A. A. (Roy F. Weston, Inc.), in "Proceedings of the 30th Industrial Waste Conference, May 6, 7 and 8, 1975, Purdue University, Lafayette, Indiana," Ann Arbor, Michigan: Ann Arbor Science Publishers, Inc., 1977. pp 198-206. Laboratory studies to evaluate the quality of leachate and runoff from stockpiles of low-sulfur western coal showed that the only significant pollutant was suspended coal fines. The treatment process recommended in this particular case included gravity settling and polishing with lime and polymer flocculants. 628.2 I323, CE643

M77-54 A MATHEMATICAL MODEL FOR DETERMINING THE OPTIMAL LOCATIONS OF COAL MINE DRAINAGE NEUTRALIZATION PLANTS

Miknis, J. J. and Lovell, H. L. (The Pennsylvania State University, Mine Drainage Research Section), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 150-164. A prescriptive, non-linear mathematical model capable of assisting water quality planners in their efforts to control coal mine drainage pollution is presented. The model is an efficient tool that can be used for the preliminary screening often needed in planning large comprehensive river basin projects. The major aspects that must be evaluated before a prescriptive model can be developed include the types of control measures to be considered, the possible locations of these control measures, the chemical parameters, water quality goals, the areas in which the water quality goals are to be met, and the hydrological-water quality nature of the basin. 628.2 C652, CE740

M77-55 ENVIRONMENTAL ASPECTS OF COAL PRODUCTION IN THE APPALACHIAN REGION

Minear, R. A., Tschantz, B. A., Rule, J. H., Vaughan, G. L., Overton, D. E., and Briggs, G., University of Tennessee Environment Center, Appalachian Resources Project, Progress Report June 1, 1976 - May 31, 1977 to U.S. Energy Research and Development Administration, ORO-4946-2 (undated). 185 pp. This report covers progress on the work being carried out in the New River watershed, Tennessee. Activity is divided into four projects: Task 1. Hydrologic Impact of Strip mining on Small East Tennessee Watersheds; Task 2. Mobilization of Heavy Metals and Other Contaminents from Contour Strip Mine Spoil; Task 3. Distribution of Heavy Metals in Sediment of Strip Mine Watersheds; and Task 4. Biological Impact of Contour Strip Mining in Small Watersheds. CE482

M77-56 CATAWISSA CREEK MINE DRAINAGE ABATEMENT PROJECT

Miorin, A. F., Klingensmith, R. S., Knight, F. J., Heizer, R. E., and Saliunas, J. R., Gannett Fleming Corddry and Carpenter, Inc., Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Interagency Energy-Environment Research and Development Program Report EPA-600/7-77-124 (Nov. 1977). 173 pp. NTIS, PB-276 584/0BE. The study area

M77-56 (continued)

is in the middle anthracite region of Pennsylvania on a creek running into the Susquehanna River. The abatement plan included both mine sealing to inundate acid forming materials, and reconstructing the bed of Catawissa Creek to reduce water entering the mine and thus the amount of discharge. Because of the high cost of constructing the mine seals, only the second part of the project was carried out. Average monthly water-quality data indicate that after streambed reconstruction average acid load was decreased while the iron load was increased slightly. CE382

M77-57 NCB WATER TREATMENT PLANT NEEDS NO LAGOONS

Coal Age 82 (7), 21 (July 1977). The 400 gpm treatment plant at the Silverdale Colliery is described. Mine water is treated with lime and precipitated sludge is mixed with polyelectrolyte flocculant in deep-cone thickening tanks. Clear overflow meets effluent standards of iron content less than 10 ppm, suspended solids less than 50 ppm, and pH between 5 and 9. Inexpensive automatic control is possible because the 250,000-gal balance tank holds the equivalent of ten hours of pumping mine water so that the plant can treat a constant volume of slurry. Jour, CE648

M77-58 NEW PLANT FILTERS 400 GAL/MIN. OF MINE WATER

Filtration & Separation 14 (4), 414 (July/Aug. 1977). The continuously operating water-treatment plant at the Silverdale Colliery, Newcastle under Lyme, near Stoke on Trent, is described. Lime neutralization and polyelectrolyte addition remove iron to levels required for effluents. CE484

M77-59 NORTH BRANCH POTOMAC RIVER BASIN MINE DRAINAGE STUDY: PHASE I BASELINE STUDY

Skelly and Loy, Consultants and Engineers, Final Technical Report to U.S. Army, Corps of Engineers, Baltimore District, May 1977. 282 pp. NTIS, ADA052531 This survey established the extent, magnitude, and effects of coal mine drainage pollution in the basin. Alternative abatement and reclamation solutions were considered. Study included an analysis of socioeconomic and environmental conditions as related to the mine drainage problem. (From abstract of the report) CE120a

M77-60 MODELING AND SIMULATION OF MINE WATER DRAINAGE

Owili-Eger, A. S. and Manula, C. B. (The Pennsylvania State University, Department of Mineral Engineering), in "Application of Computer Methods in the Mineral Industry," Proceedings of the Fourteenth Symposium, Oct. 4-8, 1976, R. V. Ramani, Ed., New York: Society of Mining Engineers of AIME, 1977. pp 526-540. This paper discusses a model for groundwater quantity prediction at operating sections of underground mines. The approach involves the development of a mathematical model for the movement of water through an integrated (unsaturated-saturated) flow domain within a definable watershed. The model is programmed for the IBM 370/168 computer using the method of

M77-60 (continued)

finite difference approximation coupled with a finite element analysis. The conceptual and computational aspects of the model have been validated with both experimental and field data and applied to an active coal mining operation located in central Pennsylvania. (Authors' abstract) 622 A652, CE356

M77-61 EFFECTS OF ACID MINE WASTES ON AQUATIC ECOSYSTEMS

Parsons, J. D. (Southern Illinois University, Carbondale, Department of Botany), Proceedings of the First International Symposium on Acid Precipitation and the Forest Ecosystem, U.S. Department of Agriculture, Forest Service General Technical Report NE-23 (1976). pp 571-595. Also published in Water, Air and Soil Pollution 7, 333-354 (1977). The 1952-1954 studies of surface-mine lakes and effluents from mined lands in the Cedar Creek Basin in Missouri are reviewed. Effects of drainage on aquatic life and the conditions for recovery from mine drainage pollution are related to current problems resulting from acid precipitation. CE292

M77-62 RESEARCH NEEDS RELATED TO ACID MINE WATER: WORKSHOP PROCEEDINGS

Compiled and Edited by M. C. L. Akamatsu, Sponsored by The Northeast Water Institute Directors, Morgantown, West Virginia, Nov. 10-12, 1976. West Virginia University, Water Research Institute, Center for Extension and Continuing Education, 1977. 118 pp. J. F. Martin, of EPA's Industrial Environmental Research Laboratory, Cincinnati, Ohio, opened the meeting with a review of current EPA contracted and in-house research, "Research and development programs for acid mine water," pp 1-7. Presentations were given in five major work areas as follows: Joering, E. A. (Ohio River Basin Commission), "Planning and management aspects of acid mine water," pp 8-13; Menzel, D. C. and Williams, D. G. (West Virginia University), "Research needs related to social, political, and institutional aspects of acid mine drainage," pp 14-26; Crouse, H. L. and Gormley, J. T. (D'Appolonia Consulting Engineers, Inc.), "Research needs related to mining methodology for prevention or reduction of acid mine water," pp 34-45; Smith, E. E. (The Ohio State University), "Research needs related to chemical and physical aspects of acid mine water," pp 52-58; Dugan, P. R. (The Ohio State University, Department of Microbiology and Water Resources Center), "Research needs related to biological aspects of acid mine water," pp 70-82; and Lovell, H. L. (The Pennsylvania State University, Department of Mineral Engineering), "Research needs related to treatment of acid mine water," pp 93-97. The Proceedings also include five work group reports which developed information on definitions of each of the five problem areas addressed, type of research needed, priority level, importance to Northeast Region, specific needs, potential use, and when recommended actions will be needed. CE385

M77-63 ACID GENERATION WITHIN A SPOIL PROFILE: PRELIMINARY EXPERIMENTAL RESULTS

Rogowski, A. S. (U.S. Agricultural Research Service, University Park, Pennsylvania), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 25-40. Two large caissons filled with spoil material from a Kylertown, Pa., surface mine in the lower Kittanning coal seam were used in this study. Preliminary results after initial water application to the two caissons showed a much higher infiltration rate and settling on spoil alone than on spoil covered with soil. Considerable piping and internal erosion tended to transport large amounts of soil material deep into spoil profiles. Temperature profiles reflected water movement, while O2 concentration values decreased when soil covered the spoil surface. Although S contents within a spoil profile undoubtedly were related to acid generation, the highest S content (acid shale, caisson 2) did not seem to generate exceptionally high acid effluent. Apparently adequate topsoil cover (caisson 1) improved the quality of water reaching the water table. Possibly, piping and erosion could have created an internal filter and the results suggest that under controlled field conditions a similar filter may form. Since topsoil cover seemed to reduce substantially oxygen diffusion, less oxidation and acid generation with depth might be expected. The study results showed that organic C and leaching analyses of individual layers might not truly reflect the field situation. Organic C may often be contaminated with coal or organic shale fragments, while a cumulative profile effluent seemed to contain considerably higher concentration of salts than combined leachates from the individual layers. (From author's conclusions) 628.2 C652, CE731

M77-64 MODELING THE IMPACT OF STRIP MINING AND RECLAMATION PROCESSES ON QUALITY AND QUANTITY OF WATER IN MINED AREAS: A REVIEW

Rogowski, A. S., Pionke, H. B., and Broyan, J. G. (Northeast Watershed Research Center, University Park, Pennsylvania), J. Environmental Quality 6 (3), 237-244 (July-Sept. 1977). The authors conclude that modeling techniques available in the current literature can possibly be used to simulate the hydrology of a spoil system. Included in the topics needing more study are temperature distribution in spoil to see if it correlates with acid-producing zones; erosion resulting from the requirement to place relatively fine topsoil on top of coarse rubble material; and the infiltration and redistribution of water in spoil. CE353

M77-65 REGULATION OF THE COAL MINING AND PREPARATION INDUSTRY

Rosenberg, J. I. (1), Campbell, J. M. (2), and Maneval, D. R. (2) [(1) The MITRE Corporation and (2) The Appalachian Regional Commission], Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 5-24. The existing relationship between coal mine and preparation plant operators and the regulators of such facilities at the state and Federal levels is described. By presenting examples of this relationship, drawn from

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a recent study, the paper has attempted to describe how the instruments of regulation (e.g., permits, licenses, and certificates) affect coal industry operators. Although not quantifying, in terms of exact time or dollars, the effect of such instruments upon the industry, it is certainly possible to conclude that the instruments themselves and their required use tend to limit the discretion of the operator. As operators' discretion is limited so is their ability to respond to changes in the market. Thus, existing regulatory procedures which are required of the coal industry entail a certain degree of time delay which translates into additional administrative expense to the operator as well as lost marketing opportunities. (From authors' summary) 628.2 C652, CE730

M77-66 ACID LAKE RENOVATION

Rosso, W. A. (Peabody Coal Company, Kentucky Regional Laboratory), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 61-70. The renovation or reclamation of five acid lakes created by surface mining in Muhlenberg County, Kentucky, is described. The lakes and adjacent watersheds were treated by minimal grading to cover extremely toxic areas, planting with grasses, legumes or trees to stabilize the spoil material, covering problem areas with agricultural limestone, and blowing limestone over the surfaces of four of the lakes. The four lakes treated with limestone recovered in less than six months and the fifth lake became alkaline in 18 months. 628.2 C652, CE734

M77-67 TRACE METAL GEOCHEMISTRY OF A FLUVIAL SYSTEM IN EASTERN TENNESSEE AFFECTED BY COAL MINING

Schrader, E. L., Jr. (1), Rule, J. H. (2), and Furbish, W. J. (1) [(1) Duke University and (2) University of Tennessee], Southeastern Geology 18 (3), 157-172 (1977). Concentrations of Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, and Zn sediments were determined at a number of locations on the New River-Indian Fork stream system. Trace elements were shown to be attached to sediments and also as cations sorbed onto suspended hydrous metal oxides. CE566

M77-68 INVESTIGATION OF ION EXCHANGE TREATMENT OF ACID MINE DRAINAGE

Scott, R. B., Wilmoth, R. C., and Kennedy, J. L. (U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 88-103. Data from research on a 2-resin ion exchange process studied by EPA at the Crown Mine Drainage Control Field Site near Morgantown, West Virginia, are presented. In this system, the first resin is an H+-form, strong-acid cation exchanger and the second resin is a weak-base anion exchanger in the free-base (OH-) form. It was found that the process, as is, will not produce a potable-quality effluent from the Crown acid mine drainage because of its unusual high

M77-68 (continued)

sodium level. If the sodium were not present, the effluent could be post-treated and filtered for residual iron and manganese removal and chlorinated to meet potability standards. 628.2 C652, CE736

M77-69 EVALUATION OF MINE WATER EFFLUENT FROM IOWA COAL PROJECT DEMONSTRATION MINE # 1 AND ENVIRONMENTAL RAMIFICATIONS

Sendlein, L. V. A., Iowa State University, Energy & Mineral Resources Research Institute, Coal Project, Report to Argonne National Laboratory, IS-ICP-36 (Jan. 1977). (58 pp.) This report represents the ongoing data collection program and illustrates that, during the period measured, uncontrolled mining (no sediment control structure) caused the stream to be affected over a short distance (approximately 4,000 feet) whereas effluent from the sediment pond did not negatively affect the stream except during failure of the pond. (From author's Summary) ICP, CE89

M77-70 GROUNDWATER REPORT: IOWA COAL PROJECT DEMONSTRATION MINE NO. 1

Sendlein, L. V. A. and Stangl, D. W., Iowa State University, Energy & Mineral Resources Research Institute, Coal Project, IS-ICP-58 (June 1977). 99 pp.+ A 29-station groundwater monitoring system was installed at the Iowa Coal Project Demonstration Mine Number One located ten miles southwest of Oskaloosa, Iowa, to measure groundwater level fluctuations and to monitor groundwater chemical changes. Water level data was used to indicate the extent of dewatering of surrounding "aquifers" near active mining cuts, and to detect the rate of return of groundwater into the reclaimed portions of the mine. Findings show that water table lowering outside the active mining area is confined to the north hill area in the coals and sands and gravel, no significant acid plume has been generated after a year and one half of mining, and groundwater recharge to reclaimed mine cuts is slow. (From authors' abstract) ICP, CE271

M77-71 ELECTROBIOCHEMICAL NEUTRALIZATION OF ACID MINE WATER

Sisler, F. D., Senftle, F. E., and Skinner, J. (U.S. Geological Survey), J. Water Pollution Control Federation 49 (3), 369-374 (March Part One, 1977). In this process, activity of anaerobic sulfur reducing bacteria is combined with electrochemical activity of a cell with one electrode in anaerobic mud and the other in acid water. Sulfate is reduced to hydrogen sulfide which is then ionized and the sulfide ion oxidized to elemental sulfur at one electrode. At the other electrode, hydroxyl ions are formed and combine with hydrogen ions from the sulfur ionization. Laboratory operation is described and its application to field conditions is discussed. Jour, CE235

M77-72 CHEMICAL TREATMENT OF ACID MINE DRAINAGE WATERS WITH PHOSPHATE MINERALS

Smith, M. J., Haile, D. M., Cox, M. F., and Huntsman, B. E. (Wright State University), American Chemical Society, Division of Environmental Chemistry,

M77-72 (continued)

New Orleans, La., March 20-25, 1977. 4 pp. In laboratory studies of synthetic acid mine water treated with rock phosphate and lime, ferrous iron was effectively removed as a dense, heavily-flocked precipitate. CE184

M77-73 SOLVING DIFFICULT SETTLING PROBLEMS: A SCIENTIFIC APPROACH

Bituminous Coal Research, Inc., Research Report (undated, issued 1977). 2 pp. This leaflet describes the use of zeta potential measurements for determining the amount and type of coagulant to add to a suspension to promote settling. CE267

M77-74 FACTORS INVOLVED IN THE RESISTANCE OF BROOK TROUT (SALVELINUS FONTINALIS) TO SULFURIC ACID SOLUTIONS AND MINE ACID POLLUTED WATERS

Swarts, F. A., The Pennsylvania State University, M.S. Thesis, 1977. 141 pp. NTIS, PB-282 102. Several strains of hatchery-reared brook trout were used in laboratory and field tests and wild trout were also used in field tests. Pronounced strain differences in survival ability were detected among embryonic, juvenile, and adult brook trout in laboratory tests, and among juvenile trout in field tests. Fish had longer resistance times in sulfuric acid solutions or in mine-acid polluted water if they were previously held in, respectively, control laboratory water or in non-acidic field environments. Wild brook trout survived longer at lethal field pH levels than hatchery fish, even if the hatchery fish were held in non-acidic field environments prior to testing. Fish had shorter resistance times in field tests in mine-acid waters than in laboratory tests with sulfuric acid solutions of comparable pH. Larger and older fish tended to survive longer although size was not strongly correlated with resistance times within narrow size categories of equal aged fish. There were no differences between the sexes in survival times at low pH levels. The most important factors in enhancement of acid resistance of a given strain and in the acclimation of fish to stream or laboratory conditions of control pH prior to acid exposure. (Adapted from author's abstract) CE550

M77-75 PRIORITY POLLUTANT EFFLUENT STANDARDS AND THE COAL INDUSTRY

Telliard, W. A. (U.S. EPA, Effluent Guidelines Division), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 1-4. EPA is required to develop effluent limitation guidelines, new source performance standards, and pretreatment rules for 21 industries in response to a law suit filed by several environmental groups. Also established in the court order are criteria and a schedule for the accomplishment of the regulations. The regulations are to be set up industry by industry, rather than pollutant by pollutant, and coal mining is among the industries to be studied. After identifying the priority pollutants, EPA has to prepare an in depth pollutant profile of the consequent ecological and environmental health effects. Additional information will come from EPA's Office of Research and Development, Office of Toxic Substances, and the Office of Pesticide Programs. To keep tract of the multiple activities, regular reports will be given by

M77-75 (continued)

the project officers on their activities. To fufill the obligations of the agreement with the environmental group, EPA will periodically brief the Natural Resource Defense Council of ongoing studies. 628.2 C652, CE729

M77-76 THE IMPLICATIONS OF SURFACE AND SUBSURFACE MINING POLICY FOR GROUNDWATER PROTECTION IN PENNSYLVANIA

Thompson, D. R. (Pennsylvania Department of Environmental Resources, Division of Mine Drainage Control and Reclamation), Water & Sewage Works 124 (12), 70-71 (1977). Pennsylvania policies are based on the Clean Streams Act and the Surface Mining Conservation and Reclamation Act which require drainage and waste-disposal plans with the application for a permit to operate a coal mine. Studies being conducted by the Bureau of Surface Mine Reclamation include determination of the general quality of ground water, coal stratigraphy, types of pyrite present in overburden, and the investigation of the complex hydrology of the Anthracite Coal Fields. CE662

M77-77 TOXIC EFFECTS ON THE AQUATIC BIOTA FROM COAL AND OIL SHALE DEVELOPMENT. PROGRESS REPORT--YEAR 2 (JULY 1976-JUNE 1977)

Thurston, R. V., Skogerboe, R. K., and Russo, R. C., Colorado State University, Natural Resource Ecology Laboratory, Internal Project Report No. 13 (Nov. 1977). 58 pp. Results of studies being carried out at the Edna Mine on Trout Creek, Colorado, and at the Decker Mine near the Tongue River, Montana, are summarized. Preliminary data show that the most significant change resulting from surface mining in the study area is an increase in total dissolved solids, although the ionic compositions of the drainage and receiving waters are quite similar. CE556

M77-78 AQUATIC INSECT DIVERSITY AND BIOMASS IN AN STREAM MARGINALLY POLLUTED BY ACID STRIP MINE DRAINAGE

Tomkiewicz, S. M., Jr. and Dunson, W. A. (The Pennsylvania State University, Department of Biology), Water Research 11, 397-402 (1977). The study site, Upper Three Runs and an acid feeder, is in Clearfield County, Pennsylvania, and is a tributary to the West Branch, Susquehanna River. Biological sampling and pH readings were carried out at five sites approximately weekly from mid-June to mid-July. Diversity and biomass were significantly depressed below the acid feeder stream, but recovered somewhat downstream. pH of the acid stream ranged from 3.00 to 3.35, pH at the control station was greater than 6, and pH increased at downstream stations, but did not recover too much more than pH 5. CE332

M77-79 U.S. COURT UPHOLDS DRAINAGE DECREE

Coal Age 82 (11), 23 (Nov. 1977). The U.S. Supreme Court upheld the ruling of the Pennsylvania Supreme Court that required Barnes & Tucker to continue to control and treat drainage from a mine that had been closed in 1969 in compliance with existing law. The history of the case is summarized. Jour, CE156a

M77-80 UNDERGROUND MINE DRAINAGE CONTROL: SNOWY CREEK-LAUREL RUN, WEST VIRGINIA FEASIBILITY STUDY

Baker-Wibberley & Associates, Inc., Report to U.S. EPA, Industrial Environmental Research Center, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-77-114 (June 1977). 142 pp. The study area, near Terra Alta, West Virginia, on the Maryland border, contributes acid to the Youghiogheny River. The method recommended to reduce the drainage from the Lima and Banner Mines was to increase the size of the mine pools by the use of continuous clay core dams, a mine-pool level-control lake, and moveable wall bulkhead seals. Also included in the report are estimates of capital and operating costs, mine production records, and results of water analyses carried out during the study. CE329

M77-81 UNIQUE AUTOMATIC WATER-TREATMENT PLANT AT SILVERDALE COLLIERY

The Mining Engineer 136 (194), 569-570 (July 1977). The process is described. The water is treated with lime, the sludge thickened with aid of polyelectrolyte, and filtered. The filter cake, whose composition is given, is disposed of on the tip. While the effluent has iron concentration within required limits, the dissolved solids' content is approximately 2,500 ppm. Jour, CE406

M77-82 STRIP MINING AND HYDROLOGIC ENVIRONMENT ON BLACK MESA

Verma, T. R., in "Reclamation and Use of Disturbed Land in the Southwest," J. L. Thames, Ed., Tucson: University of Arizona Press, 1977. pp 161-166. The objective of this paper is to evaluate the results of studies being carried out on the Black Mesa by the School of Renewable Natural Resources, University of Arizona, in cooperation with the Peabody Coal Company. The area has been inventoried for its biological, geological and hydrological characteristics and sparse historical climatic data have been augmented by more detailed meteorological measurements. A 5.5 acre watershed on the regraded mined land and a similar one on a nearby unmined site have been instrumented to study surface runoff, infiltration and water quality. Impacts of strip mining of coal on the hydrologic environment of a semiarid region are different from those in the humid east. Reclamation practices should be aimed at erosion control and on-site conservation of precipitation. There seems to be no permanent impact of strip mining on water quality if the disturbed lands are rehabilitated and effective vegetation cover is established. (From author's introduction and Conclusion) 631 T3, CE391

M77-83 WATER POLLUTION FROM DRAINAGE AND RUNOFF OF WASTEWATER FROM COAL STORAGE AREAS

Wachter, R. A. (Monsanto Research Corporation), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 185-193. A study of the water pollution potential of coal stockpiles maintained outdoors at production and user sites was conducted under EPA Contract No. 68-02-1874 and is briefly described. These storage piles are sources of polluted effluents due to the drainage, and runoff of wastewater which occurs during and after

M77-83 (continued)

precipitation. This study quantified the effluent levels from these sources by examining coals (both freshly mined and aged) from six coal regions of the U.S. Data were obtained by placing these coals beneath a rainfall simulator and collecting grab samples of the drainage. These samples were analyzed for organic and inorganic substances and for water quality indicators. (From author's introduction) 628.2 C652, CE742

M77-84 PHYSICAL, CHEMICAL, AND BIOLOGICAL RELATIONS OF FOUR PONDS IN THE HIDDEN WATER CREEK STRIP-MINE AREA, POWDER RIVER BASIN, WYOMING

Wangsness, D. J., U.S. Geological Survey, Water Resources Division, Cheyenne, Wyoming, USGS/WRD/WRI-77/072 (July 1977). 43 pp. NTIS, PB-273 512. Two ponds near the mined area were compared to two ponds outside the mine boundary. The surface-mine ponds had much lower light penetration and dissolved oxygen concentration, and generally greater dissolved solids and greater population of rooted plants than controls. A listing of the dominant groups of organisms found in the biological study indicated that the surface-mine ponds had better water quality than the controls, but evaluation of the diversity of the organisms in the ponds showed that the control ponds had more diverse and more stable populations indicating better water quality than the surface-mine ponds. US Geol, CE176

M77-85 ENVIRONMENTAL POLLUTION BY TRACE ELEMENTS IN COAL PREPARATION WASTES

Williams, J. M., Wewerka, E. M., Vanderborgh, N. E., Wagner, P., Wanek, P. L., and Olsen, J. D. (Los Alamos Scientific Laboratory), Coal Mine Drainage Research, Seventh Symposium Preprints, Louisville, Ky., by National Coal Association and Bituminous Coal Research, Inc., Oct. 18-20, 1977. pp 51-60. Illinois-Basin coal-preparation wastes containing a multitude of leachable elements were subjected to column and static leaching studies. Data for 18 elements are presented here. Generally these elements occur in the waste leachates at levels related to their occurrence in the waste. Closer inspection reveals, however, that some elements are much more leachable than others. Thus, for Illinois-Basin waste iron is found to be present in waste leachate in high amounts, but this amount represents only a small percentage of the total iron in the waste. Cobalt and nickel, on the other hand, are not very plentiful in the waste, but are highly leachable. Aluminum, a major constituent of clays in the waste, is very poorly leached. Oxygen availability is a prime factor in the production of soluble iron which is readily flushed from the waste. Particle size is less important. Under damp conditions and with plenty of air, pyrite oxides rapidly. This latter situation poses a problem for the plant operator, as coal preparation wastes are discarded damp and remain so via rainstorms for long periods before they are covered. (From authors' summary) 628.2 C652, CE733

M77-86 LIMESTONE AND LIME NEUTRALIZATION OF FERROUS IRON ACID MINE DRAINAGE

Wilmoth, R. C., U.S. EPA, Resource Extraction and Handling Division, Crown Mine Drainage Control Field Site, Rivesville, West Virginia, Report to U.S.

M77-86 (continued)

EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-77-101 (May 1977). 105 pp. In this two-year study, optimization of the limestone process and its feasibility in comparison with hydrated lime treatment were investigated. Operating parameters, design factors, and reagent costs for both processes were determined. Effluent total iron, suspended solids, and turbidity values could be maintained below 3 mg/l, 10 mg/l, and 10 JTU, respectively, by using coagulant addition. The reaction and aeration detention time requirements for the limestone process were two to three times that for the lime process and overshadowed the reagent-usage cost advantage of the limestone process. Therefore, although the limestone process was demonstrated to be technically effective, it was judged not to be feasible for general application for ferrous iron acid mine drainage. (Adapted from author's abstract) CE307

1978

M78-1 SYSTEM TREATS COAL PILE LEACHATE AND MUNICIPAL WASTEWATER-- TOGETHER

Anderson, W. C. (Pickard and Anderson, Auburn, New York), Water & Wastes Engineering 15 (3), 28-31 (March 1978). This paper describes a unique system for treating the leachate from a 12,000 ton coal pile with alkaline boiler blowdown water to produce an acceptable effluent. In the process, the coal pile leachate is collected in an equalization/retention tank and then pumped by precision chemical feed pumps to a mixing tank through which boiler blowdown wastewater flows by gravity. Automatic controls based on pH match the leachate feed rate to the available alkalinity in the boiler blowdown to produce a neutralization effect. CE676

M78-2 PUMPS FOR MINE DRAINAGE

Angles, J. and Bryson, W. (Weir Pumps Ltd.), Pumps 138, 98-103 (March 1978). The features of a horizontal multi-stage pumpset at pit bottom, a vertical multi-stage borehole pumpset, and a fully submersible electric motor-driven pumpset are described. Reference is made to construction materials and operating experience with the emphasis on submersible pumps. CE257

M78-3 THE USE OF GRASS FILTERS FOR SEDIMENT CONTROL IN STRIP MINE DRAINAGE. VOLUME II. PREDICTIONS BASED ON THEORETICAL STUDIES

Barfield, B. J., Hayes, J. C., and Barnhisel, R. I., University of Kentucky, Institute for Mining and Minerals Research, IMMR39-RRR4-78 (Sept. 1978). 15 pp. A steady state model and a non-steady state model are presented for determining the sediment filtration capacity of a grass media and an artificial grass filter respectively, under varying flow rates, sediment loads, particle sizes, flow durations, channel slopes, and media density. Based on laboratory studies, it appears possible to use the models to predict the required media spacing, channel slope, and length of media to give a desired outflow concentration for given flow conditions. CE671

M78-4 QUARTERLY REPORT - EXPERIMENTAL STUDY OF LEACHATE FROM STORED SOLIDS JUNE 1, 1977 TO JANUARY 1, 1978

Boegly, W. J., Jr., Arora, H. S., Davis, E. C., Rao, R. G. S., and Wilson, H. W., Jr., Oak Ridge National Laboratory, Environmental Sciences Division, ORNL/TM-6304 (Jan. 1978). 29 pp. NTIS, ORNL/TM-6304. The basic aim of the program is to determine the environmental acceptability of landfilling solid residues from coal gasification facilities, and also to evaluate potential environmental degradation caused by leachate produced by rainfall on coal storage piles. This report outlines the program plan, discusses waste types to be studied, provides details of the solid-waste leaching studies, describes existing hydrologic models that can be used for predicting contaminant movement, describes results of a literature review of coal pile runoff, and outlines a laboratory and field program to evaluate coal pile leachate. (From authors' abstract) CE673

M78-5 EVALUATION OF FACTORS PROMOTING THE PRESERVATION OF AQUATIC ECOSYSTEMS IN RECLAIMED STRIP MINE AREAS

Brenner, F. J., Grove City College, Report to The Pennsylvania State University, Institute for Research on Land and Water Resources, supported by U.S. Department of the Interior, Office of Water Resources Research, Report No. OWRTA-044-PA(1) (Jan. 1978). 136 pp. NTIS, PB-281 393. An ecological survey was conducted in Mercer County, Pennsylvania, on 82 different strip-mine areas including 132 different aquatic areas located within these lands. A detailed survey of the water chemistry, plankton population, algae biomass and chlorophyll concentration was conducted on 60 mines of various ages. Seasonal changes in these parameters in addition to light and dark bottle productivity and C-14 uptake studies were conducted on three aquatic areas located on the same mine operation. The results of these studies indicate that the seasonal changes in productivity were similar between these mines even though they differed in pH and other chemical parameters. The mathematical relationship between phytoplankton populations, algae biomass, chlorophyll a and C-14 uptake indicate that the productivity of these areas may be predictable within a good degree of confidence. These unique ecosystems should be managed in order to enhance their potential as fish and wildlife habitats. (Author's abstract) CE687

M78-6 COLLIERY SPOIL: THE ACID TEST FAILS

Surveyor 152 (4505), 21 (Oct. 5, 1978). Reported on is the decision to abandon the plan to use colliery reject as fill material for a sand quarry at Godstone, England, because of the potential groundwater pollution that might result. CE717

M78-7 EFFECTS OF SURFACE MINING ON HYDROLOGY, EROSION, AND SEDIMENTATION IN EASTERN KENTUCKY

Curtis, W. R. (Northeastern Forest Experiment Station, Berea, Kentucky), in Proceedings, Fourth Kentucky Coal Refuse Disposal and Utilization Seminar, Pine Mountain State Park, Pineville, Kentucky, by University of Kentucky,

M78-7 (continued)

Pikeville College, and Harland County Coal Operators Association, June 6-7, 1978, J. G. Rose, Ed., Lexington: University of Kentucky, Office of Research and Engineering Services (Dec. 1978). pp 17-19. Forest Service research projects to obtain data on effects of surface mining on water shed hydrology are reviewed. Results indicating increased water retention in spoils, and the success of using impoundment and revegetation to control erosion and sedimentation are discussed. 631 K3 1978, CE844c

M78-8 A REVIEW OF THE LITERATURE ON LEACHATES FROM COAL STORAGE PILES

Davis, E. C. and Boegly, W. J., Jr., Vanderbilt University, Report to U.S. DOE, Oak Ridge National Laboratory, Oak Ridge, Tennessee, ORNL/TM-6186 (Jan. 1978). 36 pp. This report is an assessment of existing information on coal pile leachate. The assessment indicates that few detailed studies have been conducted to date, and these are limited and the results are highly variable. More detailed long-range studies using various types of coal are recommended. These studies should be carried out both in the laboratory and in field-scale experiments. (From authors' abstract) DOE-ORNL, CE677

M78-9 DEPENDABLE SUBMERSIBLE PUMPS DEWATER THREE KAISER MINES

Coal Mining and Processing 15 (2), 74-76 (Feb. 1978). One and a half million gallons of water per day are removed from the working faces of three contiguous mines in Utah. The water is used in the mines for dust suppression and on the surface to supply 95 percent of the preparation plant requirements and to irrigate a golf course and a baseball field. Jour, CE652

M78-10 ASSESSMENT OF WATER QUALITY IMPACTS OF A WESTERN COAL MINE

Dettmann, E. H. and Olsen, R. D. (Argonne National Laboratory), in "Reclamation of Disturbed Arid Lands," R. A. Wright, Ed., Albuquerque: University of New Mexico Press, 1978. pp 53-67. This paper describes the interim results of a study of the effects of surface mining on Goose Creek and the Tongue River in the Powder River basin of Wyoming. The study showed that water quality changes in the vicinity of the Big Horn Mine, which had been in operation for more than 20 years, were within the range of analytical precision and also within the range of background variations. Larger changes were found in water quality upstream from the mining because of the impact of intensive agricultural activity. CE547

M78-11 DEWATERING DRIFTS IN NEW U.K. COAL MINE DEVELOPMENT

Mining Journal 290 (7443), 275 (April 14, 1978). This short article discusses a system of dewatering comprising both verticle wellpoints and deep wells to maintain effective ground-water control while the alluvial section of drifts are driven. CE680

M78-12 RECOVERY OF SANITARY-INDICATOR BACTERIA FROM STREAMS CONTAINING ACID MINE WATER

Double, M. L., Savio, J. A., and Bissonnette, G. K., West Virginia University Bulletin, Series 78, No. 10-7 (April 1978). West Virginia University, Water Research Institute, Information Report 11, WRI-WVU-78-02 (1978). 30 pp. Quantitative and qualitative bacteriological studies were conducted on samples from several points on the Monongahela River and its tributaries in areas where the streams are simultaneously affected by acid mine water and organic waste pollution. Multiple-tube fermentation techniques were found to be preferable to conventional direct membrane filtration in recovering sublethally injured coliforms. The recovery was substantially enhanced by the inclusion of an enrichment step in the procedure. Qualitatively, several members of the Enterobacteriacese were identified, and the differences in the distribution of members of the species at various sampling points suggested that respective members of the species were affected differently by acid mine water. The relative ease of quantitatively detecting fecal streptococci from streams affected by acid mine drainage indicated that this group should be considered for use in assessing bacteriological quality of acid streams. Qualitatively, all members of the fecal streptococcal group were isolated from the streams affected by acid mine water, with the exception of Streptococcus bovis and Streptococcus equinis. "Total" plate counts, performed on several water samples during the summer months, showed that at incubation temperatures of 10, 20, and 35 C there was little difference in quantative detection of bacteria. Prolonged incubation of the "total" bacteria plates gave rise to chromagenic colonies, the numbers of which were found to be correlated with the relative presence of acid mine water in the stream. (Authors' abstract adapted) CE569

M78-13 A WATER-QUALITY ASSESSMENT OF THE BUSSERON CREEK WATERSHED, SULLIVAN, VIGO, GREENE, AND CLAY COUNTIES, INDIANA

Eikenberry, S. E., U.S. Geological Survey, Indianapolis, Indiana, in cooperation with the U.S. Department of Agriculture, Soil Conservation Service, Open-File Report 78-13 (Jan. 1978). 36 pp. In September 1975, field measurements were made at a number of sites of temperature, specific conductance, dissolved oxygen, and pH. Samples collected at representative sites in November 1975 and in February, April, and July 1976 were variously analyzed for chemical constituents, nutrients, bacteria, and phytoplankton. Stream-bed materials were collected at a few sites to determine amounts of chlorinated hydrocarbons and selected trace elements. Drainage from coal mines is evidenced by higher than normal dissolved-solids concentration, and in some areas, increases in iron and manganese concentrations and decrease in pH. Problems from bacteria and phytoplankton result from municipal drainage. CE549

M78-14 COAL MINE WATER POLLUTION LEGAL AND REGULATORY ISSUES: A SURVEY

Fisher, A. B., Illinois Institute of Natural Resources, Document No. 78/33 (Oct. 1978). 43 pp. NTIS, PB-290 918. Colorado, Indiana, Kentucky, Ohio, Pennsylvania, West Virginia, and Wyoming were surveyed to determine the extent

M78-14 (continued)

to which these states are experiencing differences between their effluent standards and their water quality standards and what, if anything, is being done to resolve differences when they occur. Complete information concerning effluent standards and water quality standards are given for each of these states. IINR, CE725

M78-15 THE VARIABLE IRON CONTENT OF MINE FLOOD WATER: IMPLICATIONS FOR SAMPLING AND POLLUTION CONTROL

Frost, R. C., Colliery Guardian International 226 (10), 36-38 (Oct. 1978). The author reviews studies in south Durham which show that the iron content of pumped water is influenced by whether the pumping is intermittent or continuous, degree of flooding, duration of flooding, pumping rate, and probably by seasonal factors. Jour, CE288

M78-16 VARIATIONS IN THE IRON CONTENT OF SOME OUTCROP WATERS IN SOUTH DURHAM

Frost, R. C., Colliery Guardian 226 (5), 233-234 (May 1978). Three effluents from a mine which has been abandoned and flooded for more than fifty years are described. Over a two-year period, two flows were found to contain relatively low and relatively constant amounts of iron and sulfate and the third flow was found to have higher iron and sulfate with definite seasonal peak amounts. The reasons for these differences are discussed.

M78-17 PRELIMINARY EVALUATION OF FINAL CUT LAKES

Gibb, J. P. and Evans, R. L., Illinois State Water Survey, Circular 130, ISWS/CIR-130/78 (1978). 87 pp. Also published as RECONNAISSANCE STUDY OF FINAL CUT IMPOUNDMENTS Illinois Institute for Environmental Quality, IIEQ DOC. No. 78/25 (June 1978). 101 pp. Twelve representative final-cut impoundments in four Illinois counties were studied to determine their volumes and estimated yield potentials. Projections of these estimates to other inventoried final-cut lakes were made and presented as county totals. The potential water supply from final-cut impoundments for the 40 surface mining counties in Illinois range from 0 to 75.66 mgd. For 10 counties the estimated yield potential from final-cut impoundments exceeds the estimated 2020 water demands. Two of the 12 lakes studied have water quality suitable as a source for public water supply, three are suitable for irrigation and all 12 are suitable for livestock watering. (Adapted from authors' abstract) CE664, CE705

M78-18 SELECTED HYDROLOGIC DATA, YAMPA RIVER BASIN AND PARTS OF THE WHITE RIVER BASIN, NORTHWESTERN COLORADO AND SOUTH-CENTRAL WYOMING

Giles, T. F. and Brogden, R. E., U.S. Geological Survey, Water Resources Division, Denver, Colorado, Open-file Report 78-23 (Jan. 1978). 91 pp. This report contains selected hydrologic data from four energy-related projects collected during 1974 and 1975 and parts of 1976 for 129 ground-water sites and 119 surface-water sites. For most samples, major cations, anions, and trace metals were analyzed. For the same time period, field measurements of

M78-18 (continued)

specific conductance, temperature, and pH were made on 252 springs and wells. These sampling sites, as well as the locations of 20 climatological stations, 18 snow-course sites, and 43 surface-water gaging stations, are shown on maps. Geologic units that contain coal deposits or supply much of the water used for stock and domestic purposes in the area also are shown. (From authors' abstract) CE124F

M78-19 ASSESSMENT OF RESEARCH AND DEVELOPMENT NEEDS AND PRIORITIES FOR ACID MINE DRAINAGE ABATEMENT

Gleason, V. E., Price, A., Boyer, J. F., Jr., and Ford, C. T., Bituminous Coal Research, Inc., Report to U.S. Bureau of Mines, Office of the Assistant Director--Mining, BCR-L-822, BuMines-OFR-44-78 (Feb. 1978). 169 pp. NTIS, PB-282 440/7WP. A number of recommendations are made for study and development of methods of mine drainage abatement. The recommendations are based on an in depth study of mine drainage research, laboratory and field studies of methods of preventing or minimizing acid mine drainage formation, and on review of the geological, hydrological, and mineralogical factors involved. There are 772 references. (From authors' abstract) CE166

M78-20 A SURVEY OF THE MACROFAUNA OF A COAL-WASTE POLLUTED LANCASHIRE FLUVIAL SYSTEM

Greenfield, J. P. and Ireland, M. P. (University College of Wales, Department of Zoology, Aberystwyth), Environmental Pollution 16 (2), 105-122 (1978). Ten stations on the Brun, Don and Calder Rivers in the Burnley area were sampled monthly from July 1974 to August 1975 to investigate the effects of runoff from coal mine spoils on the distribution of aquatic organisms. Deposits of iron compounds on the substrate and the presence of clay and suspended solids characterized the condition of the sampling sites which supported the least number of species. The highest number of macroinvertebrate species were identified at the unpolluted stations. CE682

M78-21 RECOVERY OF INDICATOR BACTERIA IN ACID MINE STREAMS

Hackney, C. R. and Bissonnette, G. K. (West Virginia University), J. Water Pollution Control Federation 50 (4), 775-780 (April 1978). Also published as West Virginia University Agricultural Experiment Station, Scientific Paper No. 1455. Pure cultures of three sanitary-indicator bacteria in membrane filter chambers were exposed to the acid waters of small tributaries to the Monongahela River. The two coliforms showed rapid die away, and also were sublethally injured rapidly in acid streams. The recovery ratio, comparing non-selective to selective media counts, was high, indicating that non-selective media would give faulty results. Streptococcus faecalis persisted much longer in the acid streams than did the coliforms and had a much lower recovery ratio, indicating that selective media could be used to quantify fecal streptococci in streams containing acid mine water. Jour, CE656

M78-22 MICROEROSION PROCESSES AND SLOPE EROSION ON SURFACE-MINE DUMPS AT HENRYETTA, OKLAHOMA

Haigh, M. J. (University of Chicago, Department of Geography), Oklahoma Geology Notes 38 (3), 87-96 (1978). Erosion has been monitored on representative slope profiles on two strip-mine dump complexes for a period of 16 months. The major difference between them is that one is nearly 20 years old while the other is nearly 53 years old. The two areas have similar morphologies and are unvegetated. In the last 12 months of observation, erosion was concentrated on the upper sections of the younger slope and was also quite high on the crest and upper convexity of the older slope. Maximum erosion on the older slope, however, occurred on the lower concavity in response to slope-foot channel incision. The younger slope had more erosion than the older one, but the loss converts to an identical loss of 200 tonnes/hectare/year because of the differences in the bulk density of the surface spoil on the two sites. (From author's Conclusion) CE833

M78-23 AQUATIC HABITAT OF COAL AND BENTONITE CLAY STRIP MINE PONDS IN THE NORTHERN GREAT PLAINS

Hawkes, C. L. (Rocky Mountain Forest and Range Experiment Station), in Proceedings of the International Congress on Energy and the Ecosystem, 1978. 5 pp. Twenty-one coal strip-mine ponds were included in this study being carried out to provide the basis for the design and management of strip-mine ponds in the northern Great Plains as high quality aquatic habitats. Habitat conditions which favor rooted aquatic and associated vegetation, aquatic invertebrates, and waterfowl are of primary importance. In many cases efforts will have to be made to reduce the amount of small size particles on the pond bottom and entering the pond from the drainage basin. Dilute brackish water conditions can be expected but should not significantly affect the quality of most impoundments. (Adapted from author's Summary) CE752

M78-24 AN EVALUATION OF THE APPLICATION OF A DUAL-FUNCTIONAL FILTER TO DEWATERING NEUTRALIZED ACID-MINE-WATER SLUDGE

Henry, J. D., Jr. and Kuo, C. H. A., West Virginia University Bulletin, Series 78, No. 10-6 (April 1978). West Virginia University, Water Research Institute, Information Report 10, WRI-WVU-78-01 (1978). 55 pp. The dual-functional filter, constructed from a flexible porous hose, includes a filtration and dump cycle where settling occurs. A design equation developed for the filter facilitated data interpretation and assessment of the feasibility of the process. Alternatives for integrating the dual-functional filter with acid-mine-water-treatment processes were evaluated. Economic evaluation of the costs of a clarifier-filter sequence was used to determine the optimum extent of dewatering prior to filtration. The optimum interstage-slurry concentration between the clarifier and the dual-functional filter for the base case is 0.6 wt. percent. Economic sensitivity analyses illustrate the effect of changes in the fractional redispersion of the filter cake, cycle time and hose life. The labor cost is approximately 70 percent of the total treatment cost for the base case. (Authors' abstract adapted) CE557

M78-25 THE EFFECTS OF LIME NEUTRALIZATION OF ACID MINE DRAINAGE ON STREAM ECOLOGY

Herricks, E. E. (1) and Cairns, J., Jr. (2) [(1) University of Illinois and (2) Virginia Polytechnic Institute and State University], in "Proceedings of the 32nd Industrial Waste Conference, May 10, 11 and 12, 1977, Purdue University, Lafayette, Indiana," Ann Arbor, Michigan: Ann Arbor Science Publishers, Inc., 1978. pp 477-486. In 1965 an automatic lime-neutralization plant was put into operation on Little Scrubgrass Creek, Venango County, Pennsylvania. Effluent from the treatment plant, which was situated downstream from a number of sources of acid mine drainage, carried aluminum hydroxide floc into the stream so that although the acid was neutralized biological recovery was impeded. Summaries of the results of water quality analyses and biological surveys of the stream are given. 628.2 I323, CE640

M78-26 COAL PILE LEACHATE

Hill, G. F. (Gilbert/Commonwealth, Reading, Pennsylvania), Industrial Coal Conference, Lexington, Kentucky, by University of Kentucky, April 26-27, 1978. 6 pp. Leachate from stockpiled coal is characterized and a summary of data from surveys of 11 steam-electric power plants is given. The design and management of the stockpile to reduce the need for chemical and physical treatment of the leachate are described. 662.6 I42k

M78-27 ACID MINE DRAINAGE AND SUBSIDENCE: EFFECTS OF INCREASED COAL UTILIZATION

Hill, R. D. and Bates, E. R., U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series EPA-600/2-78-068 (April 1978). 30 pp. NTIS, PB-281 092/7BE. The increases above 1975 levels for acid mine drainage and subsidence for the years 1985 and 2000 based on projections of current mining trends and the National Energy Plan are presented. No increases are projected for acid mine drainage from surface mines or waste since enforcement under present laws should control this problem. The increase in acid mine drainage from underground mines is projected to be 16 percent by 1985 and 10 percent by 2000. The smaller increase in 2000 over 1985 reflects the impact of the PL 95-87 abandoned mine program. Mine subsidence is projected to increase by 34 and 115 percent respectively for 1985 and 2000. This estimate assumes that subsidence will parallel the rate of underground coal production and that no new subsidence control measures are adopted to mitigate subsidence occurrence. (Authors' abstract) CE565

M78-28 ECONOMIC IMPACT OF DISSOLVED SOLIDS REGULATION UPON THE COAL MINING INDUSTRY (R76-7)

Huff, L. L. and Jarrell, G. A., Illinois Institute of Environmental Quality, Document No. 77/28 (Nov. 1977). 134 pp. NTIS, PB-280 499. Water collected during mining is subject in Illinois to effluent limitations in regard to such parameters as iron, pH, lead, zinc, fluoride, suspended solids, nitrogen and acid. Because enforcement of the dissolved solids regulation results in increased costs of operation, the mining industry is seeking relief from

M78-28 (continued)

compliance. A review of the existing dischargers affected by this regulation and the magnitude of the problem is first presented as background. Then the range of costs incurred by the coal mining industry is examined, and the impact of such costs on the price, output, and employment in the coal industry is described. The benefits are then compared to the costs of regulation associated with a total dissolved solids regulation for the coal mining industry. (From authors' Introduction) R1007aF

M78-29 MEIOFAUNAL ABUNDANCE IN SANDBARS OF ACID MINE POLLUTED, RECLAIMED, AND UNPOLLUTED STREAMS IN SOUTHEASTERN OHIO

Hummon, W. D., Evans, W. A., Hummon, M. R., Doherty, F. G., Wainberg, R. H., and Stanley, W. S. (Ohio University, Department of Zoology and Microbiology), in "Energy and Environmental Stress in Aquatic Systems," J. H. Thorp and J. W. Gibbons, Eds., Selected papers from a symposium held at Augusta, Georgia, Nov. 2-4, 1977, sponsored by Savannah River Ecology Laboratory, University of Georgia, Institute of Ecology, U.S. DOE, Assistant Secretary for Environment, and Savannah River National Environmental Research Park, U.S. DOE, Technical Information Center, CONF-771114 (1978). pp 188-203. In October and November 1976, a collection was made at each of two sites along seven streams in Athens, Vinton, and Hocking counties, Ohio, during a period of stable weather. Streams were chosen to include watersheds with no mining and with varying histories of mining and reclamation. In a dendrogram of S_H' similarity analysis, the unpolluted streams along with several sites with a past history of mining formed an eight- site complex, showing H' taxon diversity values of 1.6 to 2.8 with 40 to 80% in common. The remaining sites, all with a past history of mining, formed two groups. One group of four sites, dominated by rotifers, showed H' values of 1.2 to 1.6 with 36 to 52% in common. The second group of two sites, dominated by nematodes, showed H' values of 1.3 to 1.5 with 46% in common. (From authors' abstract) CE823

M78-30 ABATEMENT OF ACID MINE DRAINAGE BY INHIBITION OF THIOBACILLUS FERROOXIDANS

Kleinmann, R. L. P., Crerar, D. A., and Mohring, E. H. (Princeton University, Department of Geological and Geophysical Sciences), Association of Engineering Geologists, Annual Meeting, Oct. 18, 1978. 10 pp. The role of Thiobacillus ferrooxidans in acid mine drainage formation at three pH levels is explained. Detergents were successfully used as acid-formation inhibitors at sites in Ohio, West Virginia, and Pennsylvania. Since detergents are very soluble, research continues on finding a method for releasing them slowly at the site. CE714

M78-31 REDUCING ACID MINE DRAINAGE THROUGH INHIBITION OF THIOBACILLUS FERROOXIDANS BY CONTROLLED RELEASE OF ANIONIC DETERGENTS

Kleinmann, R. L. P., Crerar, D. A., and Mohring, E. H., Princeton University, Department of Geological and Geophysical Sciences (undated, prepared 1978). (19 pp.) A bacterium, Thiobacillus ferrooxidans, accelerates pyrite oxidation and thereby plays an important role in the problem of acid mine drainage.

M78-31 (continued)

Anionic detergents were tested as a means of inhibiting T. ferrooxidans in laboratory simulations of a coal mine or refuse pile environment. Detergent concentrations greater than 10 ppm decreased acidity and iron values; a minimum concentration of 25 ppm was required to reduce these values to approximately that of sterile controls. Controlled release formulations were tested as a potential method of inexpensively adding detergent to rainfall infiltration over a time period of months or years. Field testing of the method on actual mine sites indicate that significant reductions of acidity are possible at low cost. (Authors' abstract) CE713

M78-32 IMPACT OF MINE DRAINAGE ON A MOUNTAIN STREAM IN PENNSYLVANIA

Letterman, R. D. and Mitsch, W. J. (Illinois Institute of Technology, Pritzker Department of Environmental Engineering), Environmental Pollution 17 (1), 53-73 (1978). Physicochemical parameters and fish and benthic macroinvertebrate community structure were studied in Ben's Creek, located just south of Johnstown. Sampling stations were located upstream and downstream of coal mine drainage in an otherwise unpolluted stream. Due to an alkaline discharge and significant upstream alkalinity the pH below the mine discharges remained between 6.5 and 8. The major factor affecting the benthic community and fish population appeared to be ferric hydroxide deposition. The biomass of macroinvertebrates decreased from approximately 14g wet wt/m^2 above the discharges to 0.1-1.5g wet wt/m^2 within the area of iron deposition. Invertebrate diversity decreased significantly at the discharge but recovered to 75% of upstream values. The low but constant-temperature discharge from the mine may have enhanced the diversity recovery. The standing crop of fish decreased from approximately 228 to 11 kg/ha. Benthic fishes such as sculpin and suckers were the groups most affected. (From authors' abstract) CE834

M78-33 EVALUATION OF THE VOLUMES AND CHARACTERISTICS OF MINE WASTE EFFLUENTS OF THREE STRIP MINE LOCALITIES IN EASTERN KENTUCKY AND THEIR POTENTIAL ENVIRONMENTAL IMPACTS

Leung, S. S. and Hester, N. C., Eastern Kentucky University, Final Report, Covering the Period of Jan. 1, 1976 through June 30, 1977, to Argonne National Laboratory, Research Contract No. 31-109-38-3375, Jan. 1978. (297 pp.) The three study sites in the Hazard Coal-Reserve District are all either on the North Fork of the Kentucky River, or on a tributary to the North Fork. One site is in Breathitt County, one in Perry County, and the third, where the study was of the shortest duration, in Letcher County. The report describes the stratigraphy of the coal beds, the soils, and site characteristics, and gives results of analyses of overburden, coals, and water samples from mine effluents and receiving streams. Only at the site in Perry County, where the relatively high sulfur Hazard #9 coal was being mined, was acid drainage a potential problem. Increases in chemical parameters in mine effluents were reduced as mining ended and the sites were reclaimed. Sediment was judged to be much more of a problem than degradation of the chemical quality of the waters. It was also concluded that using settling ponds to remove sediment was not a satisfactory control method in the hilly terrain of eastern Kentucky. CE546

M78-34 MODEL STATE PROGRAM FOR CONTROL AND PREVENTION OF WATER POLLUTION FROM SURFACE MINES

Ohio River Valley Water Sanitation Commission Ad Hoc Work Group on Mine Drainage Control, Dec. 1978. 15 pp. This second report in a series of model programs developed by ORSANCO is composed of three elements: 1) preplanning to insure proper functioning of new mines, 2) control of active mine operations to assure that the approved plan is followed during the active life of the mine, and 3) post-mining control to provide satisfactory reclamation and maintenance of abandoned mines. The program delineates the extent of legal authority necessary for conducting an effective control program and professional expertise required to implement such a program. (From Summary of the Report) CE686

M78-35 ROTATING-DISC BIOLOGICAL OXIDATION OF FERROUS IRON IN ACID MINE DRAINAGE TREATMENT

Olem, H., The Pennsylvania State University, Ph.D. Thesis, 1978. 168 pp. University Microfilms Int., No. 79-02635. At three coal mining locations, Hawk Run, and Hollywood, Pennsylvania and Crown, West Virginia, treatment of six, heterogeneous mine waters was investigated in experiments with pilot-scale (0.5 m diameter) and prototype (2.0 m) rotating biological contactor (RBC) units. Fe(II) oxidation efficiency was an average 10 percent lower with the 2.0 m than with the 0.5 m RBC under equivalent conditions with homologous mine drainage. In experiments with synthetic mine drainage, Fe(II) oxidation in the bench-scale RBC was improved by supplementation with natural mine drainage. Examination of solids samples removed from disc surfaces of the 0.5 m RBC operating at Hollywood, Pennsylvania revealed the presence of iron-oxidizing and heterotrophic bacteria in a gelatinous, iron-containing matrix. A gelatinous surface covering was not seen on the disc surfaces in field experiments at Hawk Run, Pennsylvania, where Fe(II) oxidation efficiency was 10 to 20 percent less than at other locations. Heterotrophic bacteria recovered from mine water and disc solids may produce the gelatinous film. Neutralization of RBC effluent and separation of precipitated iron solids must be applied in a complete treatment scheme to produce water of a suitable quality for stream-release. (From author's abstract) CE284aF

M78-36 MICROBIAL SULFUR CYCLE ACTIVITY AT A WESTERN COAL STRIP MINE

Olson, G. J. and McFeters, G. A., Montana State University, Montana University Joint Water Resources Research Center, MUJWRRC Report No. 98 (Nov. 1978). 79 pp. NTIS, PB-291 722/7WN. Also submitted by G. J. Olson as "Aspects of Microbial Sulfur Cycle Activity at a Western Coal Strip Mine," Montana State University, Ph.D. Thesis, June 1978. The activity of certain groups of sulfur cycle bacteria associated with waters, sediments, and the coal bearing strata of a coal strip mine at Decker, Montana, was studied. Thiobacillus ferrooxidans, one of the major contributors to acid mine drainage, was consistently detected in the mining environment. Since 1) acidic conditions were never observed at Decker, 2) the isolates died off in mine water environments, and 3) no acid could be formed from coal samples inoculated with a T. ferrooxidans isolate, it was thought that their activity was limited to microzones in the coal bearing strata where they oxidized sulfuric material.

M78-36 (continued)

Sulfate reducing bacteria also were common in the mine waters and sediments. These organisms were particularly active in the settling pond sediments as was evidenced by the rapid rate of conversion of radiolabeled sulfate to sulfide. The hydrogen sulfide produced by these organisms contributed to heavy metal precipitation in the settling pond. (From authors' abstract) CE698

M78-37 SUBMERSIBLE PUMPS FOR MINE DRAINAGE

Orton, D. J. (FLYGT Pumps Ltd.), Pumps 138, 93-95 (March 1978). Although this article focuses on a specific brand of commercially available pumps, a concise discussion is provided of the general problems that may be encountered when pumping mine water and the way the design and construction of the submersible pump helps to overcome them. Some of the pumping arrangements used and the development of the submersible pump are also discussed. R927

M78-38 PRECIPITATION OF IRON RELATED COLOR BODIES

Paul, S. N. (to Chemed Corporation), U.S. Patent 4,071,450 (Jan. 31, 1978). 3 pp. The inventor claims a method of clarifying iron waste waters containing suspended iron-containing particles. The process comprises adding an effective amount of basic dyes such as methylene blue, methyl violet, or malachite green and the like, alone or in combination with organic or inorganic additives, and recovering a clarified correspondingly blue or green tinted water. (Abstract of the disclosure adapted) CE712

M78-39 MINE DRAINAGE PROBLEMS IN NORTH DERBYSHIRE

Peters, T. W., The Mining Engineer 137 (200), 463-473 (March 1978). Removing water from working mines in the area and minimizing infiltration is complicated by numerous pathways for surface water and by connections between mines and from seam to seam where mines have been closed down. The author describes the geohydrology of a number of mines in the area and the performance of pumping stations in dealing with the problems of water handling. Some of the discharges contain iron, sulfate, and acid from pyrite oxidation and must be treated. Jour, CE645

M78-40 SOME RELATIONSHIPS BETWEEN STRIPMINING AND GROUNDWATER

Phelps, L. B. (The Pennsylvania State University), Earth and Mineral Sciences 47 (9), 65-68 (June 1978). Briefly discussed are the potentials for groundwater pollution or depletion that might result from surface mining and the need for knowledge of the groundwater regime during mine preplanning. PSU, CE811

M78-41 A TWO-ELEMENT CERAMIC SENSOR FOR MATRIC POTENTIAL AND SALINITY MEASUREMENTS

Scholl, D. G. (Rocky Mountain Forest and Range Experiment Station, Albuquerque, New Mexico), Soil Science Society of America Journal 42 (3),

M78-41 (continued)

429-432 (May-June 1978). A two-element ceramic sensor was developed to produce optimum electrical response both to soil water matric potential and salinity. A spring-loaded housing was developed for the elements for either drill-hole or pit-face placement. The sensors were calibrated under various matric potential, salinity, and temperature conditions. An initial field test with 72 sensors was conducted under irrigated coal mine spoil conditions. Laboratory and field results indicated reasonable instrument precision over a wide range of matric potential and salinity. The correlation between sensor output and water content in the field was best where the mean of several sensors was used. (Author's abstract) R933

M78-42 REDUCING WATER LEAKAGE INTO UNDERGROUND COAL MINES BY AQUIFER DEWATERING

Schubert, J. P. (Argonne National Laboratory, Energy and Environmental Systems Division), in Proceedings of the International Symposium on Water in Mining and Underground Works, Vol. II, Granada, Spain, Sept. 18-22, 1978. pp 911-931. Based on stratigraphic, structural, hydrogeologic, and mining data collected during a study in central Pennsylvania, a two-dimensional, finite-difference computer model was used to simulate groundwater flow in a sandstone unit (0.3 to 11 m thick) overlying an underground mine, and to evaluate the responses of the flow system and leakage rate into the mine when hypothetical dewatering wells are introduced into the system. Simulation of well dewatering, using 25 wells, showed that negligible reduction in leakage would occur if sandstone permeability was less than 0.30 m/day. When sandstone permeability equalled 3.0 m/day, 25 wells reduced leakage by 2.4 percent. (Author's abstract) CE352

M78-43 SITE SELECTION AND DESIGN FOR MINIMIZING POLLUTION FROM UNDERGROUND COAL MINING OPERATIONS

Shotts, R. Q., Sterett, E., and Simpson, T. A., The University of Alabama, Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Interagency Energy-Environment Research and Development Program Report EPA-600/7-78-006 (Jan. 1978). 98 pp. NTIS, PB-280 180/1WN. This study carried out in the Alabama coal fields was started in September 1974 at two sites where mining could be expected to be started after preliminary data had been collected. However, as plans for mining the areas never developed, the study was transferred to an area where mining was in the early stages. At the third site, the premining environment was assessed by sampling Cedar Creek above the mined area and other streams to the east and west of the site. Analyses of groundwater coming into the mine from "dripper" joints, of water pumped from the mine sump, and of water from Cedar Creek below the mine showed that pollution from the mine was slight even when untreated effluent flowed directly into the creek. Geological and hydrological conditions observed along with the analytical results suggest that water pollution should be minimal during the life of the mine and, if the openings are sealed after mine closure, pollution resulting from mine water should be prevented. It is

M78-43 (continued)

estimated that future subsidence will also be minimal. (Adapted from authors' abstract) CE548

M78-44 BIOELECTRIC NEUTRALIZATION OF ACID WATERS

Sisler, F. D. and Senftle, F. E. (to The United States of America as represented by the Secretary of the Interior), U.S. Pat. 4,072,798 (Feb. 7, 1978). 7 pp. An apparatus to be used in a process for bioelectric neutralization of a body of water having a bottom of anaerobic mud and an acid supernatant liquid, the apparatus comprising a buoy riding on the surface of the water, and upper electrode preferably of carbon suspended from the buoy in the acid supernatant liquid, a lower electrode preferably of iron embedded in the anaerobic mud and a flexible, insulated electrical conductor preferably an insulated copper cable, conductively attached to the upper and lower electrodes. A plurality of sets of apparatus may be used spaced apart from each other in the body of water. (Abstract of the disclosure) US Pat, CE654

M78-45 MÖSSBAUER SPECTROSCOPIC INVESTIGATION OF IRON SPECIES IN COAL

Smith, G. V. (1), Liu, J.-H. (1), Saporoschenko, M. (1), and Shiley, R. (2) [(1) Southern Illinois University and (2) Illinois State Geological Survey], Fuel 57 (1), 41-45 (Jan. 1978). The authors discuss various iron-containing minerals which they identified in a series of samples of Herrin No. 6 coal. The samples included whole coal, autoclaved char, vitrain, and fusain. CE658

M78-46 ASSESSMENT TECHNIQUES FOR MODELING WATER QUALITY IN A RIVER BASIN AFFECTED BY COAL-RESOURCE DEVELOPMENT

Steele, T. D. (U.S. Geological Survey, Lakewood, Colorado), Symposium on Modelling the Water Quality of the Hydrological Cycle, Baden, Austria, by International Association of Hydrological Sciences and International Institute for Applied Systems Analysis, Sept. 11-15, 1978. 16 pp. Modeling techniques were used in five component studies to evaluate direct and indirect impacts of coal-resource development in the Yampa River basin, Colorado and Wyoming. Sediment from surface mining and solute transported into ground water from spoil, pond seepage, and fly ash disposal are some of the factors evaluated by the models. CE551

M78-47 APPLICATION OF MÖSSBAUER SPECTROSCOPY TO MONITOR ACID MINE DRAINAGE POTENTIALS OF COAL SEAMS

Stiller, A. H. (1), Renton, J. J. (1), Montano, P. A. (2), and Russell, P. E. (2) [(1) West Virginia Geological Survey and (2) West Virginia University], Fuel 57 (7), 447-448 (July 1978). Samples of a pyrite lens from a Waynesburg coal seam near Maidsville, West Virginia, were studied with Mössbauer spectroscopy and by x-ray diffraction. The lens was divided into reactive and unreactive portions based on whether the portion was encrusted (reactive) or not encrusted (unreactive). X-ray diffraction showed little difference between the two portions while Mössbauer spectroscopy showed the presence of

M78-47 (continued)

iron sulfate in the portion of the lens assumed to be reactive and only pyrite in the portion considered to be unreactive. Jour, CE659

M78-48 OXYGEN CONSUMPTION AS A FUNCTION OF pH IN THREE SPECIES OF FRESHWATER FISHES

Ultsch, G. R. (University of Alabama, Department of Biology), Copeia (2), 272-279 (1978). Bluegills, goldfish and channel catfish were exposed to acidic water at intervals of 0.5 pH units to reinvestigate the effects of hydrogen ion concentration upon the ability of freshwater fishes to use oxygen from the water for respiration. At a pH of 4.5, only the bluegill was able to survive. Death occurred at 3.5, but not from anoxia. The goldfish could not tolerate acid water with a pH of 4.5 - 4.0 but did not die from lack of oxygen. The channel catfish was the only species to show signs of anoxia at a low pH. The results of this research suggest that the death of fish at low pH may vary among species. CE663

M78-49 HYDROLOGIC CHARACTERISTICS OF COAL-MINE SPOILS, SOUTHEASTERN MONTANA

Van Voast, W. A., Hedges, R. B., and McDermott, J. J., Montana State University, Montana University Joint Water Resources Research Center, MUJWRRC Report No. 94 (June 1978). 34 pp. NTIS, PB-289 223/OWN. The Absaloka, Rosebud, Big Sky, and Decker mines were studied to determine the effects of mining on spoil ground-water quality. Hydraulic conductivities of saturated spoils are more diverse than those of the undisturbed coal beds but have comparable average values. Aquifer development in mine spoils is greatest near the bases of the spoils where coarse rubble and wasted coal accumulate. Median concentrations of dissolved solids (major constituents) and of some trace elements are higher in waters from mine spoils than in waters from coal beds. The potential for increased dissolved solids is considered the most significant. Trace elements, while detectable, were not present in alarmingly high concentrations. CE261

M78-50 SOURCE ASSESSMENT: WATER POLLUTANTS FROM COAL STORAGE AREAS

Wachter, R. A. and Blackwood, T. R., Monsanto Research Corporation, Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, EPA-600/2-78-004m (May 1978). 106 pp. NTIS, PB-285 420. This report quantifies the effluent levels from coal stock piles maintained outdoors at production and usage sites by examining both freshly mined and aged coals from six coal regions of the United States. A representative source is defined to help characterize the wastewater level from the storage areas. Effluent data were obtained by subjecting coals to rainfall beneath a simulation apparatus and collecting grab samples of the wastewater. The samples were analyzed for organic and inorganic substances and water quality parameters. Hydrologic relationships were used to estimate the runoff concentrations. Water quality criteria concentrations are compared with these levels to estimate their potential environmental impact. Applicable and future control techniques are discussed along with the growth and nature of stockpile quantities retained at facilities. (From authors' abstract) EPA, CE614

M78-51 THE STREAM ENVIRONMENT AND MACROINVERTEBRATE COMMUNITIES: CONTRASTING EFFECTS OF MINING IN COLORADO AND THE EASTERN UNITED STATES

Ward, J. V. (1), Canton, S. P. (1), and Gray, L. J. (2) [(1) Colorado State University, Department of Zoology and Entomology and (2) Arizona State University, Department of Zoology], in "Energy and Environmental Stress in Aquatic Systems," J. H. Thorp and J. W. Gibbons, Eds., Selected papers from a symposium held at Augusta, Georgia, Nov. 2-4, 1977, sponsored by Savannah River Ecology Laboratory, University of Georgia, Institute of Ecology, U.S. DOE, Assistant Secretary for Environment, and Savannah River National Environmental Research Park, U.S. DOE, Technical Information Center, CONF-771114 (1978). pp 176-187. Species composition, diversity, and standing crop were examined in studies conducted year-round on Trout Creek, a northwestern Colorado stream that receives drainage from the Edna Mine of Pittsburg & Midway Coal Mining Company. Results are compared with similar studies conducted in eastern states. Generally low values of sulfate and iron, highly-buffered waters, and low levels of toxic substances characterized the Colorado stream and applied, in general, to many streams in the western energy-development region. Moderate inputs of soluble salts increased abundance of macroinvertebrates without significant changes in community structure or other discernible indications of stressed conditions. This is attributed to the relatively soft waters above the mine and the protection afforded by a buffer strip between the mine spoils and the stream. (Adapted from authors' abstract) CE823a

M78-52 UNIQUE AUTOMATIC WATER TREATMENT PLANT AT SILVERDALE COLLIERY

Whitworth, K., World Coal 4 (1), 20-22 (Jan. 1978). The process includes lime neutralization, sludge thickening with polyelectrolyte, and vacuum filtration of the sludge. Filter cake composition is given and automatic control of the various process steps is described. While the effluent has an iron concentration within required limits, its dissolved solids' content is approximately 2,500 ppm. Jour, CE99a

M78-53 COMBINATION LIMESTONE-LIME NEUTRALIZATION OF FERROUS IRON ACID MINE DRAINAGE

Wilmoth, R. C., U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Environmental Protection Technology Series, EPA-600/2-78-002 (Jan. 1978). 52 pp. NTIS, PB-280 169/4WP. Studies were conducted on ferrous-iron acid mine drainage (AMD) treatment by a two-step neutralization process in which rock-dust limestone was mixed with the influent AMD and then hydrated lime was added in a polishing reactor. This combination treatment process resulted in reagent consumption cost reductions as high as 30 percent as compared to those for single-stage hydrated lime treatment of the same AMD. Later data indicated that an equal cost reduction (compared to single-stage lime treatment) could be achieved by a two-stage hydrated lime process in which the AMD and recycled sludge were mixed in the first reaction vessel and hydrated lime was added in the second reactor. No cost advantage for the combination process over straight hydrated lime treatment was felt to exist in situations where sludge recycling was not employed. (Author's abstract) EPA, CE563

M78-54 APPLICATION OF ION EXCHANGE TO ACID MINE DRAINAGE TREATMENT

Wilmoth, R. C. (1), Scott, R. B. (1), and Harris, E. F. (2) [U.S. EPA, (1) Crown Field Site, Rivesville, West Virginia and (2) Industrial Environmental Research Laboratory, Cincinnati, Ohio], in "Proceedings of the 32nd Industrial Waste Conference, May 10, 11, and 12, 1977, Purdue University, Lafayette, Indiana," Ann Arbor, Michigan: Ann Arbor Science Publishers, Inc., 1978. pp 820-829. The authors discuss the Sul-biSul process used at the water treatment plant, Smith Township, Pennsylvania; the modified Desal process used at the Hawk Run plant, Pennsylvania; and the strong-acid/weak-base two-resin process investigated at EPA's Crown Mine Drainage Control Field Site near Morgantown, West Virginia. Some data from the studies at the Crown Site are presented. They show that in treated Crown drainage sodium and sulfate together exceed the 500 mg/l standard for total dissolved solids for potability. 628.2 I323, CE641

1979

M79-1 PLANNING EROSION CONTROL FOR COAL MINING AND RECLAMATION

Anderson, C. E. and Briggs, J. M. (Iowa State University, Department of Agricultural Engineering), Journal of Soil and Water Conservation 34 (5), 234-236 (Sept.-Oct. 1979). A study conducted by the Iowa Coal Project to improve the agricultural production potential of mined land and to minimize erosion is described. The reclamation plan included terracing and diverting the drainage from each terrace to one or two discharge outlets. Although the sediment pond was constructed to approximate federal design standards, effluent standards could not be met. The authors concluded that it is doubtful if any sediment pond design could do so. Sampling during the program indicated that the sediment pond discharge had no effect on water quality in the receiving stream. CE825

M79-2 AREAWIDE ENVIRONMENTAL ASSESSMENT FOR ISSUING NEW SOURCE NPDES PERMITS FOR COAL MINES IN THE MONONGAHELA RIVER BASIN, WEST VIRGINIA

U.S. EPA, Region III, Nov. 1979. 15 pp.+ map. In the EPA areawide approach to the environmental review process for the requirements for the "National Pollutant Discharge Elimination System" (NPDES), baseline information is being compiled on geology and geography, on historic, aesthetic, and recreational sites, on environmentally sensitive areas, and on stream water quality of watersheds affected by coal mining. This description of the information gathered for the lower Monongahela River Basin is accompanied by a map showing the portions designated as Potentially Significant Impact Areas. The results of this environmental information survey, together with the Supplemental Information Form submitted for each application for a mining permit aids in the evaluation of the environmental impact of a New Source coal mine. CE791

M79-3 TVA STRIP MINE ASSESSMENT MODEL: HYDROLOGIC COMPONENT

Bales, J. (Tennessee Valley Authority, Water Systems Development Branch), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for

M79-3 (continued)

Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 265-270. A double triangle unit hydrograph model which has been tested extensively on urban, forested, and agricultural watersheds is currently being modified such that storm events on surface mined watersheds may be analyzed and subsequently simulated. Predictive regionalized equations are developed relating a measure of the runoff intensity to the time of concentration, which is then related to the unit hydrograph parameters. The storm hydrograph model may be used in conjunction with a rainfall generator, a continuous daily streamflow model, a sediment transport model, a background water quality model, and an aquatic biota model component, all of which are now available, to simulate pre- and post-mining streamflow quantity and quality. (Author's abstract) 631 K961, CE852u

M79-4 PREDICTION OF SEDIMENT YIELD FROM SURFACE MINED WATERSHEDS

Barfield, B. J., Moore, I. D., and Williams, R. G. (University of Kentucky, Agricultural Engineering Department), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 83-91. In this paper, a discussion is given of methods for predicting both long term and single storm sediment yield. Particular emphasis is given to methods which use the Universal Soil Loss Equation (USLE) as a base. Attention is directed towards outlining the fundamental basis of the procedures, the complexity, data requirements and availability, and expected accuracy. Very little research has been directed toward predicting the size distribution and time distribution of single storm sediment yield. A discussion is given of this research and preliminary proposals made for using the available information to predict both time and size distribution. (From authors' Introduction) 631 K961, CE852h

M79-5 FILTRATION OF SEDIMENT BY SIMULATED VEGETATION. I. STEADY-STATE FLOW WITH HOMOGENEOUS SEDIMENT

Barfield, B. J., Tollner, E. W., and Hayes, J. C. (University of Kentucky), Transactions of the ASAE 22, 540-548 (1979). Published as University of Kentucky Agricultural Experiment Station Journal Article No. 77-2-128. A steady state model is presented for determining the sediment filtration capacity of a grass media under varying flow rates, sediment loads, particle sizes, flow durations, channel slopes, and media density. Each component of the model was tested in laboratory studies on artificial media. It is possible to use the model to predict the required media spacing, channel slope, and length of media to give a desired outflow concentration for given flow conditions. Based on simulations using the model, it appears that, for a given flow condition, the outflow concentration depends primarily on channel slope and spacing whereas the time required to completely inundate the filter with sediment depends primarily on sediment load. (From authors' Summary and Conclusion) CE724

M79-6 TVA STRIP MINE AQUATIC ASSESSMENT MODEL: BENTHIC INVERTEBRATE MODULE

Barr, W. C. (Tennessee Valley Authority, Fisheries and Aquatic Ecology Branch), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 243-249. Data from several small unmined, recently mined, and older abandoned mine areas were collected, analyzed, and used to develop a simulation model that, given appropriate local information, has the potential to predict the impact of surface mining on stream biota. The model is expressed as a series of ordinary differential equations that when integrated with the initial value of the compartment of interest will show the change in the faunal assemblage with the hydrologic changes through time. The system incorporates temperature changes, sediment transport, and storm event discharges from the hydrologic segments of the model and uses these data to perturb the stream community. (From author's abstract) 631 K961, CE852r

M79-7 OVERVIEW OF TVA STRIP MINE AQUATIC ASSESSMENT MODEL

Betson, R. (Tennessee Valley Authority), American Society of Agricultural Engineers, Winter Meeting, New Orleans, Louisiana, Dec. 11-14, 1979. Paper No. 79-2537. 23 pp. A watershed hydrology model, regionalized so that it can be readily applied using watershed characteristics and climatological information alone, is described. Validation tests using data collected in coal mining areas are used to show how it may be used to predict probable hydrologic consequences of mining on the hydrologic balance. (Author's Summary) ASAE, CE836

M79-8 THE EFFECT OF STRIP MINING ON THE HEADWATER HYDROGRAPH OF EASTERN KENTUCKY

Bryan, B. A. and Hewlett, J. D. (University of Georgia), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 51-55. The Northeastern Forest Experiment Station, Berea, Kentucky, installed 6 weirs and 4 recording raingages on 6 small drainage basins in Breathitt County, Kentucky. Five of the basins were partially stripped over the next 7 years and 1 basin was held as a control. The School of Forest Resources at the University of Georgia and the Forest Service entered a joint study of these basins in 1977. Based on the preliminary results of the study, the authors tentatively conclude that generally surface mining does not greatly alter the flood-producing potential of the Eastern Coal Fields. (Adapted from authors' abstract) 631 K961, CE852d

M79-9 ACID PRECIPITATION: A COMMENT

Bucek, M. F. (HRB-Singer, Inc.), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S.

M79-9 (continued)

B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 33-34. Acid precipitation with pH values about 4.0 has been observed to be a widespread phenomenon in the northeastern United States. Acidification of surface water bodies, increased rates of soil leaching as well as potential water quality problems associated with runoff discharges from regraded mine spoils are some of the resulting environmental problems. (Author's abstract) 631 K961, CE852a

M79-10 SELECTED WATER RESOURCES DATA, CLARION RIVER AND REDBANK CREEK BASINS, NORTHWESTERN PENNSYLVANIA--PART 2

Buckwalter, T. F., Dodge, C. H., and Schiner, G. R., U.S. Geological Survey, Water Resources Division, Water Resources Investigations 79-19, prepared in cooperation with Pennsylvania Department of Environmental Resources, USGS/WRI-79-19 (July 1979). 135 pp. Hydrologic information including data on aquifers, water levels, and yields is presented for 1,304 wells. Records for 51 springs are also given. The report contains 83 chemical analyses of water samples collected from 30 stream sites and 300 analyses of water from 196 wells and 43 springs. Also included are 103 trace-element analyses. Monthly and annual means of ground-water levels for six observation wells are tabulated. Benthic invertebrate data from 136 stream sites are listed. Locations of data-collection sites are shown on 50 page-size reductions of 7 1/2-minute topographic quadrangle maps. (Authors' abstract) US Geol, CE854

M79-11 SEDIMENT CHARACTERISTICS OF THE NEW RIVER TENNESSEE

Carey, W. P. (U.S. Geological Survey, Water Resources Department, Nashville, Tennessee), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 197-202. Results of extensive water quality sampling in the New River basin indicate that a significant characteristic of the water resource is high suspended sediment loads. More than 90 percent of this suspended sediment is silt and clay which imparts a turbid appearance to the water and transports a proportionally large load of sorbed trace metals. Suspended sediment concentration is found to be highly correlated with both suspended and total trace metal concentrations. In contrast to this fine-grained suspended load is an apparently large volume of coal which is transported as bedload during runoff events. Preliminary results of bedload measurements indicate that the coal ranges in size from fine sand to very coarse gravel and frequently accounts for over 50 percent by weight of the material in the sample. (From author's abstract) 631 K961, CE852q

M79-12 THE EFFECT OF ACID MINE DRAINAGE WATER ON TWO PENNSYLVANIA SOILS

Ciolkosz, E. J., Kardos, L. T., and Beers, W. F. (The Pennsylvania State University, Department of Agronomy), Soil Science 127 (2), 102-107 (1979).

M79-12 (continued)

Rayne and Guernsey soil material that had had 525 cm of acid mine water (AMW) passed through it was analyzed. The pH, Ca content, and percent base saturation of the soil material were lowered, and its CEC, acidity, and Fe and Al contents increased. The increase in Al and Fe contents was much greater than was the amount of Al and Fe added by the acid water. Thus, the acid treatments mobilized some native soil Al and Fe in the treated soils. The acid water treatment also created some new CEC sites. Phosphorous data showed a depletion of P in the Rayne and a redistribution of it downward in the Guernsey. Little or no change in particle size distribution and clay mineralogy occurred as a result of the treatment. The various effects of the acid water on the soil were the greatest in the upper parts of the soil. (Authors' abstract) CE402

M79-13 STRIP MINE DRAINAGE--AQUATIC IMPACT ASSESSMENT

Cox, D. B., Betson, R. P., Barr, W. C., Crossman, J. S., and Ruane, R. J., Tennessee Valley Authority, Office of Natural Resources, Interagency Energy-Environment Research and Development Program Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, TVA/ONR-79/11, EPA-600/7-79-036 (Feb. 1979). 93 pp. Preliminary findings of field studies at contour -and area-type mining operations indicate that drainages from mined areas are alkaline rather than acid, and calcium and magnesium concentrations increase as a result of mining in almost every instance. Furthermore, values for iron and sulfate increase in some areas, but not in others, whereas values for trace metals are generally low in all areas. The predominant fish in small Cumberland Plateau streams is the creek chub (Semotilus atromaculatus), and its primary food source is aquatic invertebrates, including midge larvae, springtails, and aquatic mites. Several model components have been developed, including a water quality model for nonpoint sources, a continuous streamflow model, and a storm hydrograph model. Other model components being developed or evaluated include additional small-basin water quality models, water quality and quantity routing models, a low-trophic-level stream-biota model, and a fisheries resource model. (From authors' abstract) EPA, CE849

M79-14 SURFACE MINING AND THE HYDROLOGIC BALANCE

Curtis, W. R. (Northeastern Forest Experiment Station), Mining Congress Journal 65 (7), 35-40 (July 1979). The disturbance of land has created conditions that alter normal infiltration rates, subsurface and overland flows, and help to hasten erosion processes and the consequent movement of sediment. Surface mining has caused such disturbances and has affected water quality and the hydrologic balance by the removal of vegetation and the compaction of soil. Reclamation, erosion, and sediment-yield studies are discussed and the methods of available technology to control the effects of surface mining on the hydrologic balance are described. CE858

M79-15 HYDROGEOLOGY OF A WATERSHED WITH SUBIRRIGATED ALLUVIAL MATERIALS IN CROP PRODUCTION

Dollhopf, D. J., Wendt, G. W., Goering, J. D., and Hedberg, D. W. (Montana State University, Reclamation Research Program), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 311-320. Concern existed that surface mining updip from the cropland area would alter the subirrigation characteristics of the alluvium. A major portion of the ground-water recharge into the alluvium was from an aquifer located stratigraphically below coal seams to be extracted, therefore most of the cropland area is expected to remain subirrigated. However, as mining intercepts secondary sources of recharge to the alluvium, i.e. surface runoff and perched ground-water zones within the overburden and coal seams, some lowering of the water table beneath the cropland is expected. This may result in decreased crop yields. Thirty to forty percent of the cropland area was dependent upon subirrigation for at least one-third of its annual water requirement. Daily water table fluctuations in alluvium during August closely corresponded to daily evapotranspiration patterns, indicating the alfalfa crop was extracting much of its water requirement from ground water. (From authors' abstract) 631 K961, CE852v

M79-16 DEVELOPMENT OF METHODS TO IMPROVE PERFORMANCE OF SURFACE MINE SEDIMENT BASINS

Ettinger, C. E. (Skelly and Loy), American Society of Agricultural Engineers, Winter Meeting, New Orleans, Lousiana, Dec. 11-14, 1979. Paper No. 79-2527. 6 pp. An ongoing EPA sponsored project is described and some initial results are presented. During the first phase of the project, six representative sediment ponds in Appalachia were studied to determine possible improvements in their design and influents to the ponds were subjected to treatability tests to determine the applicability of selected chemical coagulants. ASAE, CE836c

M79-17 WATER DRAINAGE IN COAL MINES

Fernandez-Rubio, R. (University of Granada, Spain), World Coal 5 (12), 16-18 (1979). The importance of hydrogeological factors, such as the speed and direction of water flow, and the connection between the source area and the discharge area, and how to take preventative measures against inrushes of water is described. Pumping, the passive method of protection, is described as being effective once water infiltrates the mine, whereas an active protection system is based on advance and continuous pumping from wells to reduce water pressure. In addition, a method denoted as "instantaneous" controls drainage in the area immediately surrounding the mine to reduce the water pressure. Special precautions are advised and guidelines are given according to mining method for mining under bodies of water. CE859

M79-18 DESIGN OF CHEMICAL TREATMENT SYSTEM FOR REMOVAL OF SUSPENDED SOLIDS FROM SURFACE MINING RUNOFF FROM A 1000-ACRE WATERSHED

Foree, E. G. and Tapp, J. S. (Commonwealth Technology, Inc.), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 189-195. The system, designed to meet EPA and OSM effluent limitations, consists of a polyelectrolyte dosing station and a single relatively large sediment basin located in the main hollow at the most downstream point in the watershed. Material presented includes the detailed hydrologic design of the detention basin; the results of laboratory studies to characterize the expected runoff water, to determine the optimum polyelectrolyte and dosages, and to determine the settling characteristics of the raw and treated water, and the application of results of the laboratory studies to the final design. (Adapted from authors' abstract) 631 K961, CE852p

M79-19 EVALUATION OF THE RATE OF DECREASE IN THE IRON CONTENT OF WATER PUMPED FROM A FLOODED SHAFT MINE IN COUNTY DURHAM, ENGLAND

Frost, R. C., Journal of Hydrology 40 (1-2), 101-111 (1979). An attempt is made to provide a theoretical basis for the evaluation of field data relating to decreasing concentrations of iron in the drainage from flooded coal mines. It is thought that this will aid the formulation and adoption of policies aimed at abating the stream pollution caused by these discharges. The removal of pyrite oxidation products from flooded mine workings is described as a convective mass-transfer process, and equations predicting an exponential decrease in their concentration with time are derived from theoretical considerations. In support of this model, the concentration of Fe, in the water pumped from a flooded shaft mine was found to decrease with time. The half-life of 350 days is compared with a value of 334 days calculated from literature data relating to small self-draining drift mines in the U.S.A. The practical value of the model is illustrated by estimation of the volume of ferric hydroxide sludge that might be formed in a treatment facility. (From author's abstract) CE716a

M79-20 PUMPING RATES AND THE IRON CONTENT OF SHAFT MINE WATER

Frost, R. C., Effluent and Water Treatment Journal 19 (2), 77-80 (Feb. 1979). This paper attempts to determine the mechanism by which pumping rate controls the iron content of water pumped from a deep shaft coal mine. Mine water pumped to the surface is a mixture of ferruginous drainage from the flooded workings with drainage from the non-flooded workings. Model studies indicate that the concentration of iron in the water from flooded workings is independent of the pumping rate. The iron content of the water pumped to the surface is dependent on the relative amounts of the two drainage components and this is controlled by the pumping rate. The implications of these effects for pollution abatement policies are illustrated and discussed. (Author's abstract) CE716

M79-21 HYDROLOGIC AND HYDROGEOCHEMICAL CHARACTERISTICS OF SELECTED STRIP MINE SPOILS IN WESTERN NORTH DAKOTA

Groenewold, G. H. (North Dakota Geological Survey), in "Ecology and Coal Resource Development," M. K. Wali, Ed., New York: Pergamon Press, 1979. pp 770-775. Two research sites instrumented to determine the hydrologic conditions on reclaimed land are at the Indian Head Mine near Zap and at the Center Mine near Center, North Dakota. Results of analyses of water samples show great variation, but indicate that the geochemical processes of dissolution of carbonate minerals, sodium-calcium exchange on sodium-montmorillonitic clays, and oxidation of pyrite control the chemistry of the ground water in these reclaimed areas. Water from the Center site has generally less sodium, sulfate, and bicarbonate content than water from the Indian Head site, reflecting the differences in the characteristics of the overburden at the two mines. CE776

M79-22 GEOLOGY AND GEOHYDROLOGY OF THE KNIFE RIVER BASIN AND ADJACENT AREAS OF WEST-CENTRAL NORTH DAKOTA

Groenewold, G. H., Hemish, L. A., Cherry, J. A., Rehm, B. W., Meyer, G. N., and Winczewski, L. M., North Dakota Geological Survey, Report of Investigation No. 64 (1979). 402 pp.+ 37 Plates. This study has determined the regional stratigraphic framework of the units overlying the Pierre Formation with emphasis on detailed correlation of the Tertiary lignite-bearing strata and has demonstrated that individual lignite beds are traceable for many tens of miles and serve as convenient stratigraphic markers for subdividing the Sentinel Butte and Bullion Creek Formations. The detailed stratigraphic framework, thus defined, has allowed for a specific designation of the intake zone for most of the farm and domestic wells in the study area. This information, in conjunction with previously published groundwater chemical data and additional selective sampling of wells as part of this study, has allowed for a detailed definition of the chemical characteristics of water within the various stratigraphic units. This, in turn, has allowed for the formulation of groundwater geochemical models for the various groundwater systems. The key processes which influence the evolution of groundwater in the Knife River basin are: pyrite oxidation, carbonate dissolution, gypsum precipitation and dissolution, cation exchange, and sulfate reduction. The hydrostratigraphy and hydrochemistry of five proposed and active lignite-mining sites have been discussed in detail. These include the Indian Head, Beulah-Hazen, and Dunn Center sites within the Knife River basin and the Center and Falkirk sites which lie in close proximity to the Knife River basin. The implications of the interpretive groundwater geochemical framework relative to post-mining groundwater quality have been addressed. Of major concern is the generation, in the post-mining landscapes, of waters characterized by adverse sulfate contents generated by pyrite oxidation. In one case the sulfate concentration in a groundwater sample from spoils at the Indian Head site exceeded 9,400 mg/L. Sulfate concentrations in spoil waters commonly exceeded 2,500 mg/L. (From Executive Summary) NDGS, CE827

M79-23 THE EFFECTS OF SURFACE MINING OF COAL ON WATER QUALITY NEAR GRANDE CACHE, ALBERTA

Hackbarth, D. A. (Alberta Research Council), Canadian Journal of Earth Sciences 16 (6), 1242-1253 (1979). Streams and springs in and near surface coal mines located on the eastern slopes of the Canadian Rocky Mountains were sampled between 1972 and 1978. Streams unaffected by mining activity characteristically have calcium, magnesium, and bicarbonate as the dominant ions. Total dissolved solids concentration usually ranges between 125 and 231 mg/L. Sulfate is usually about 20% of the anions and has a concentration less than 75 mg/L. Relative amounts of sodium, potassium, chloride, and nitrate usually are less than 6% of the ions. Values of pH commonly range between 7.6 and 8.2. The effects of mining activity on water quality vary in intensity but follow a consistent pattern. The relative proportion of the various cations does not change; however, their concentrations may rise to four times background values. The concentration of anions also increases and there is a shift in the relative proportions from bicarbonate to sulfate and, at the more strongly affected sites, to nitrate. The distribution of pH values is not significantly different from unaffected sites. (From author's abstract) CE843

M79-24 STREAM BIOLOGICAL SURVEYS - SELF-DEFENSE FOR COAL MINE OPERATORS

Hampton, E. L., Pennington, W. L., Lackey, J. L., North, J. C., and McCoy, V. W. (Resource Consultants, Inc.), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 251-253. Methods of carrying out baseline biological surveys of streams likely to be affected by mining activities, interpretation of results of the surveys and their activities to coal mine operators in making them are discussed. 631 K961, CE852s

M79-25 COAL MINING AND GROUND WATER

Hardaway, J. (U.S. EPA, Region VIII), in "Coal Surface Mining and Power Production in the Face of Environmental Protection Requirements," Proceedings of the Second U.S.-Polish Symposium, Castle Ksiaz, Poland, Sept. 26-28, 1979, Interagency Energy-Environment Research and Development Program Report EPA-600/7-79-159 (Oct. 1979). pp 103-125. Any type of coal mining has the potential to temporarily disrupt the hydrologic balance. In this paper, disruptions have been classified as having either a physical or chemical impact. Research on mining and reclamation effects on ground water quantity and quality are discussed. EPA

M79-26 PRECIPITATION-RUNOFF RELATIONSHIPS FROM EPHEMERAL STREAMS IN THE POWDER RIVER BASIN

Hasfurther, V. R. and Akerberge, M. (University of Wyoming), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation,

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Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 35-42. An experimental watershed established in 1973 on an ephemeral stream in the Eastern Powder River Basin of Wyoming where surface coal mining activity is taking place has been evaluated for pre-mining surface hydrologic conditions. Results of analysis of data are presented on precipitation patterns, surface runoff potential, infiltration rates, and seepage from reservoirs and stock dams. A dimensionless unitgraph is presented which can be used to predict runoff from ungaged ephemeral streams. (Authors' abstract) 631 K961, CE852b

M79-27 EVALUATION OF VEGETAL FILTRATION FOR REDUCING SEDIMENT IN SURFACE MINE RUNOFF

Hayes, J. C. (1), Barfield, B. J. (1), and Barnhisel, R. I. (2) [University of Kentucky (1) Agricultural Engineering Department and (2) Agronomy Department], in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 93-98. A summary of a series of equations developed at the University of Kentucky which can be used to estimate filter performance based on particle size distribution, flowrate, concentration, channel slope, and filter dimension is presented in this report. Extensive data collection using both simulated and real grasses has shown a high correlation between observed and estimated values. Examples of this data will be presented and explained. The theoretical basis for the equations and a graphical solution will be discussed in sufficient detail so that a user can determine if the relationships can be applied to his needs. These procedures should demonstrate the fundamentals of grass filter design and enable relatively inexperienced users to make reasonable estimates. (From authors' abstract) 631 K961, CE852i

M79-28 THE IMPACTS OF COAL MINING ON SURFACE WATER AND CONTROL MEASURES THEREFORE

Hill, R. D. (U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio), in "Coal Surface Mining and Power Production in the Face of Environmental Protection Requirements," Proceedings of the Second U.S.-Polish Symposium, Castle Ksiaz, Poland, Sept. 26-28, 1979, Interagency Energy-Environment Research and Development Program Report EPA-600/7-79-159 (Oct. 1979). pp 143-157. The chemical and physical water problems related to surface and underground coal mining and refuse piles and slurry ponds are described. Mine drainage abatement techniques available for the prevention of pollution at the source and for treatment after mining are reviewed. EPA

M79-29 OVERBURDEN MINERALOGY AS RELATED TO GROUND WATER CHEMICAL CHANGES IN COAL STRIP MINING

Hounslow, A. W. (1), Fitzpatrick, J. (1), Cerrillo, L. A. (2), and Freeland, M. (2) [(1) Colorado School of Mines Research Institute and (2) Engineering

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Enterprises, Inc.], in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 161-168. The predictive methodology was developed from data obtained at eight existing mines in the western United States. Core and cutting samples were obtained from undisturbed overburden and spoil piles, and the mineralogy and bulk chemistry of these rocks were determined. Water samples, both upgradient and downgradient from the spoils, were analyzed to determine the change in water composition. Relationships among and between rock and water variables were established using statistical factor analysis and thermodynamic calculations. Minerals found to have the greatest influence on water chemistry were carbonates, sulfates, clays, and sulfides. Water associated with spoil piles was generally calcium-magnesium-sulfate, high total dissolved solids waters. In geologic environments where ground water is in contact with a representative portion of the overburden, the change in ground water-quality after mining will be minimal unless the overburden contains appreciable amounts of oxidizable minerals such as pyrite. However, where water cannot contact a representative section of the overburden, the change in ground-water quality after mining may be marked. (From authors' abstract) 631 K961, CE852m

M79-30 HOW A DIFFICULT WATER PROBLEM IS HANDLED AT HAYWOOD

Mine and Quarry 8 (11), 4 (Nov. 1979). This is a short description of dewatering of a surface coal-mine site near Forth in Scotland. The mine receives drainage from ground water and from runoff. Jour, CE856

M79-31 THE IMPACT OF LIGNITE MINING ON SURFACE WATER AND MEANS OF ITS CONTRO

Janiak, H. (POLTEGOR, Wroclaw, Poland), in "Coal Surface Mining and Power Production in the Face of Environmental Protection Requirements," Proceedings of the Second U.S.-Polish Symposium, Castle Ksiaz, Poland, Sept. 26-28, 1979, Interagency Energy-Environment Research and Development Program Report EPA-600/7-79-159 (Oct. 1979). pp 159-171. The quantitative and qualitative changes in hydrological balance as affected by mining are described. Basic methods of purification, such as retention basins for the removal of suspended solids, as well as technological achievements using gamma radiation, flocculation, coagulation, filtration through a sandbed and filtration through grass filters are discussed. EPA

M79-32 GROUND WATER MONITORING SYSTEM DESIGN: THE IOWA COAL PROJECT DEMONSTRATION MINE #1, A CASE STUDY

Kipp, J. A. (1), Gulliford, J. B. (2), Stangl, D. W. (1), and Sendlein, L. V. A. (3) [(1) Iowa State University, Iowa Coal Project, (2) Illinois Mining and Mineral Resources Research Institute, and (3) Coal Extraction and Utilization Research Center], in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B.

M79-32 (continued)

Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 145-151. A network of 49 ground water piezometers and sampling tubes has been placed on a 40 acre study site in southeastern Iowa to monitor the ground water quality. Additional hydrogeologic data were obtained from drilling logs of 35 auger holes and 26 coal exploration holes. (Adapted from authors' abstract) 631 K961, CE8521

M79-33 THE BIOGEOCHEMISTRY OF ACID MINE DRAINAGE AND A METHOD TO CONTROL ACID FORMATION

Kleinmann, R. L. P., Princeton University, Ph.D. Thesis, 1979. 104 pp. This study examines the role played by the bacterium, Thiobacillus ferrooxidans, in the oxidation of pyrite and demonstrates that inhibition of the bacterium can be used to reduce the acid drainage problem. Laboratory simulations of coal mine environments were used to establish the activity of T. ferrooxidans under varying hydrologic conditions. By measuring drainage pH in laboratory simulations of a coal refuse pile, it was discovered that T. ferrooxidans accelerated the acidification of freshly-exposed pyritic material but is most significant below pH 4.5 where it also accelerates acidification by the oxidation of Fe^{++}. It was determined that anionic detergents at concentrations greater than 10 ppm inhibit T. ferrooxidans and thereby reduce acid formation; concentrations of at least 25 ppm kill the bacterium. To be effective in reducing acid formation, application of bactericides must be either frequent or persistent. Therefore, a method was developed to release inhibitory concentrations of anionic detergents gradually from a wax or rubber matrix. (From author's abstract) 628.2 K64, CE714a

M79-34 THE LIMNOLOGICAL RESPONSE OF A WEST VIRGINIA MULTIPURPOSE IMPOUNDMENT TO ACID INFLOWS

Koryak, M., Stafford, L. J., and Montgomery, W. H. (U.S. Army Corps of Engineers, Pittsburgh District), Water Resources Research 15 (4), 929-934 (Aug. 1979). Sampling carried out at 14 stations on the Tygart River and impoundment, during the periods of May through October of 1973 and 1974, showed the effects of acid mine drainage on water quality and biota, especially during the low-flow periods of late summer and early autumn. Results of this and later studies lead the authors to conclude that control of drawdown of the lake will affect the mixing pattern of inflow and can aid in mitigating the adverse effects of acid mine drainage. CE839

M79-35 IMPACT OF SURFACE MINING AND CONVERSION OF COAL ON GROUND WATER AND CONTROL MEASURES IN POLAND

Libicki, J. (POLTEGOR, Wrocław, Poland), in "Coal Surface Mining and Power Production in the Face of Environmental Protection Requirements," Proceedings of the Second U.S.-Polish Symposium, Castle Ksiaz, Poland, Sept. 26-28, 1979, Interagency Energy-Environment Research and Development Program Report EPA-600/7-79-159 (Oct. 1979). pp 127-142. Bore holes are used in the

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vicinity of Polish mines to determine the geological structure, location and size of aquifers, infiltration rates and to monitor changes in the water table before, during, and after mining operations. Before approval by local authorities of mine construction plans these preliminary investigations must be completed and submitted. In addition to the quantitive impacts identified by bore-hole investigations, a research program has been prepared to determine the qualitative impact of coal refuse on ground water quality at two waste disposal sites. Suggestions for improvement of storage facilities, and control systems are expected to result from this project. EPA

M79-36 UTILIZATION OF STREAMFLOW RECORDS FOR PERMIT STUDIES

Lichty, J. E. and Rightnour, T. A. (Skelly and Loy Consultants), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979), pp 67-72. A regional streamflow analysis method is presented for preparing hydrologic descriptions of flow conditions for mine permit applications. Based on an index-flood analysis, the method allows generation of regression equations between maximum, minimum and average flow events and drainage area for homogeneous regions. A means of estimating seasonal variations of high and low flows in Appalachia is provided. (Authors' abstract) 631 K961, CE852f

M79-37 CHARACTERIZATION OF THREE ACID STRIP MINE LAKES IN GRUNDY COUNTY, ILLINOIS

Master, W. A., Argonne National Laboratory, Land Reclamation Program, Report to Illinois Institute of Natural Resources, Project No. 80-027, ANL/LRP-TM-15 (Sept. 1979). 65 pp. To identify factors limiting biological productivity, levels of dissolved oxygen, specific conductance, and temperature profiles were determined for three acidic lakes. The lake with the poorest water quality had the least diversity of aquatic vascular plants and benthic invertebrates. (From author's abstract) DOE-ANL

M79-38 HYDROGEOLOGY OF RECLAIMED GULF COAST LIGNITE MINES

Mathewson, C. C., Kennedy, J. L., and Pepper, G. L. (Texas A&M University, Department of Geology), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 321-330. This study has concluded that the hydrogeology of a reclaimed surface mine is controlled by the climate, pre-mine hydrogeology, and the stratigraphy of the mine site, and that the risk of aquifer pollution is minimal in most cases. (From authors' abstract) 631 K961, CE852w

M79-39 ACID COAL MINE DRAINAGE: PAST POLLUTION AND CURRENT REGULATION

McGinley, P. C. and Sweet, T. J. (West Virginia University, College of Law), Duquesne Law Review 17 (1), 67-97 (1978-79). The authors review the legal history of the effects of acid mine drainage on public and private waters. They discuss at length the requirements of recent Federal legislation for mine drainage treatment and control: the 1972 and 1977 Amendments to the Federal Water Pollution Control Act which include requirements for developing the "National Pollutant Discharge Elimination System" (NPDES) and the identification and adoption of "best practicable control technology currently available" (BPT) and "best available technology economically achievable" (BAT); and the Federal Surface Mining and Reclamation Act of 1977. EPA is reproved for not applying these laws to post-mining discharges and the arguments relating to the agency's position are summarized. CE832

M79-40 SIMULATION OF THE EFFECTS OF SURFACE MINING ON GROUNDWATER IN THE POWDER RIVER BASIN

McIntosh, G. E. (U.S. Bureau of Mines, Denver, Colorado), Mining Engineering 31 (4), 385-390 (April 1979). This paper describes an ongoing five-year project designed to assess and predict the impacts which surface coal mining will have on the regional shallow groundwater systems in the Powder River Basin. Discussed are plans for: (1) the design and establishment of a regional network for monitoring shallow groundwater systems; (2) monitoring the direction and rate of flow, water quality, and aquifer characteristics of the shallow groundwater systems; and (3) development of a regional groundwater simulation model, with appurtenant subroutines to determine local effects. (From author's abstract) Jour, CE757

M79-41 TIOGA RIVER MINE DRAINAGE ABATEMENT PROJECT

Miorin, A. F., Klingensmith, R. S., Heizer, R. E., and Saliunas, J. R., Gannett Fleming Corddry and Carpenter, Inc., in cooperation with Pennsylvania Department of Environmental Resources, Report to U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, Interagency Energy-Environment Research and Development Program Report, EPA-600/7-79-035 (Feb. 1979). 87 pp. The Tioga River Demonstration Project in southeastern Tioga County, Pennsylvania, is located in an area essentially defined by an isolated pocket of coal that has been extensively deep and strip mined within the Pennsylvania Bituminous Coal Field. Acid mine drainage from abandoned mines is discharged into Morris Run, and Coal and Bear Creeks before they enter the Tioga River near Blossburg Borough. Water in these three streams generally has a pH of about 3.0 with a net acidity ranging from 200 to 1,000 milligrams per liter. This project demonstrated effective techniques for mine drainage abatement, reduced a specific mine drainage problem, and restored portions of a strip mined area to their approximate original surface grades. Techniques demonstrated included restoration of strip pits utilizing agricultural limestone and wastewater sludge as soil conditioners, burial of acid-forming materials within strip mines that were restored, and reconstruction and lining of a stream channel. Effectiveness of these preventive measures and their costs were determined. Project implementation

M79-41 (continued)

resulted in an estimated acid reduction of 862 kilograms per day under average groundwater conditions from one of the two project sites. Reductions in flows and loadings from the other project site could not be confirmed because of gaps in the monitoring data and the relatively small size of the site when compared to the total mined area contributing to the discharges. However, large volumes of surface water now flow off the restored area to Fall Brook during and following significant rainfalls, rather than continuing to enter the underground mine workings. In addition, 16 and 13 percent reductions in acidity concentrations from the associated mine drainage discharges were documented. (Authors' abstract) EPA

M79-42 HYDROLOGIC IMPACTS OF SURFACE MINING OF COAL IN WESTERN NORTH DAKOTA

Moran, S. R. (1), Cherry, J. A. (2), Rehm, B. (3), and Groenewold, G. H. (4) [(1) Alberta Research Council, Edmonton, Alberta, Canada, (2) University of Waterloo, Waterloo, Ontario, (3) University of North Dakota, Engineering Experiment Station, and (4) North Dakota Geological Survey], in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 57-65. Three potential hydrologic impacts of surface mining in western North Dakota are discussed. They include transient water-level drawdown in wells outside the mining area, development of a post-mining water supply, and impact of mining and reclamation on water quality. Limited observational evidence confirms analytical projections of potential drawdown at two sites, which suggest that transient water-level declines adjacent to mine areas will be minor. Both a major and the several minor aquifers underlying most mineable coal beds as well as hydrologic properites of cast overburden and the rate at which resaturation occurs suggest that adequate rural water supply may be available within some mined areas, at least initially. Although groundwater chemistry in cast overburden at some sites is little different from that prior to mining, calcium sulfate type groundwater, with TDS values as much as 5 times as great as prior to mining, is produced at most sites. On the basis of preliminary analyses it appears that highly saline water in cast overburden can produce a significant deterioration of water quality in surface streams in the vicinity of mine areas. Further work is needed to determine whether this impact will be a long term problem. (Adapted from authors' abstract) 631 K961, CE852e

M79-43 GROUNDWATER MONITORING TO FULFILL U.S. OFFICE OF SURFACE MINING REGULATIONS

Nawrocki, M. A. (Hittman Associates, Inc.), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 139-143. An overview of the

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U.S. Office of Surface Mining's (OSM) Permanent Regulatory Program as related to the requirements for monitoring of groundwater around surface coal mines is presented. Basic requirements for groundwater baseline data are presented and methods for obtaining these data are discussed. Included in the flow measurement discussion are data sources, methods of measuring depth to water, flowing well measurements, and aquifer characteristics determination. The presentation on groundwater quality measurements includes discussions of data sources, methods of sample collection, common field-measured parameters, and sample preservation and storage for laboratory analysis. Modeling of groundwater systems as related to the fulfillment of OSM's regulations is also discussed. Digital and analytical models are summarized as to their applicability. (Author's abstract) 631 K961, CE852k

M79-44 CHEMICAL TREATMENT OF MINE DRAINAGE FOR REMOVAL OF MANGANESE TO PERMISSIBLE LIMITS

Nicholas, G. D. and Foree, E. G. (University of Kentucky), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 181-187. Lime and sodium hydroxide were used to remove manganese from waters collected from three active surface mine sites. These waters were selected to provide a wide range of manganese concentrations and varying percentages of other dissolved metals. The effects of raw water composition, reagent selection, and reagent dosages on manganese removal, settling rate, sludge volumes, specific resistances, and concurrent removal of other dissolved species are reported. The pH values necessary for manganese removal to meet Environmental Protection Agency and Office of Surface Mining monthly average limitations of 2 mg/L were found to vary between 8.4 and 9.25 depending on raw water composition and reagent selection. Lime treatment was found to be particularly advantageous for high sulfate water. Differences in lime and sodium hydroxide treatment became less pronounced at lower pH levels. Chemical requirements and other design considerations such as required sedimentation basin area for a flow of one cfs are also reported for the various waters. (Adapted from authors' abstract) 631 K961, CE852o

M79-45 HYDROLOGIC ASPECTS OF SEDIMENT DAMS IN SERIES

Notary, A. L. and Nesbitt, P. D. (Nesbitt Engineering, Inc.), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 331-346. The proposed final regulations of the Federal Office of Surface Mining (OSM) specifies effluent limitations for water discharged from sediment dams. In addition to these performance specifications, physical design standards for such dams are delineated, along with minimum acceptable detention times. OSM defines theoretical detention time as the time difference between the

M79-45 (continued)

centroids of the inflow and outflow hydrographs. Using runoff hydrographs generated from synthetic rainfall distributions, the implications of this definition for the design of sediment dams in series is investigated, and an equation to calculate the detention time in series dams is proposed. Based on several different dam and spillway configurations for two representative watersheds in Eastern Kentucky, the additional detention time resulting from constructing dams in series is not always large enough to justify the construction of the second dam. (Authors' abstract) 631 K961, CE852x

M79-46 DISCHARGE ESTIMATES IN SURFACE-MINE AREAS USING CHANNEL-GEOMETRY TECHNIQUES

Osterkamp, W. R. and Hedman, E. R. (U.S. Geological Survey, Water Resources Division, Lawrence, Kansas), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 43-49. The method uses the empirical development of simple or multiple power-function equations yielding a discharge value from channel-configuration and channel-material data. The equations have been developed by collecting geometry and sediment data at numerous gaged sites and statistically relating those data to specified discharge characteristics. The principal advantage of the channel-geometry method is that estimates of discharge can be obtained quickly and inexpensively. (From authors' abstract) 631 K961, CE852c

M79-47 MINE SPOIL BANK HYDRAULICS

Pearson, F. H. (University of California, Berkeley, Sanitary Engineering Research Labortory), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 255-263. A method is presented for estimating hydrographs of seepage flow from spoil banks of specified geometry, permeability, and porosity under given time patterns of infiltration at the spoil bank surface. When such hydrographs are combined with estimated total loadings of pollutants leached from the spoil by rain, pollutographs can be developed of the rate of discharge of pollutants such as acidity, sulfate, and metals from the spoil bank. The method for estimating hydrographs is based on finite element analysis, and also shows the rising profile of the water table within a spoil bank during rainfall, and the falling profile after rain. Calculations illustrate the high degree of muting of peak flows from the spoil bank due to temporary storage within the water table in the bank. Diagrams facilitate programming of the method for given field situation. Hydrographs and pollutographs are useful in stream water quality impact studies, and in the design of abatement measures. (From author's abstract) 631 K961, CE852t

M79-48 SCULPTURING RECLAIMED LAND TO DECREASE EROSION

Schaefer, M., Elifrits, D., and Barr, D. J. (University of Missouri-Rolla), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Mineral Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 99-109. A study of three strip mine sites in Boone, Randolph and Macon Counties, Missouri, indicated that reclaimed mine land, even when graded to acceptable specification, is left with an extremely high potential for erosion and sediment yield. Compliance with reclamation law apparently caused grading practices which created convex rounded slopes with long uninterrupted surfaces available for overland flow. Preliminary investigations indicate that a designed drainage system of random patterns with a density calculated from equations relating optimum drainage density, soil erosional shear strength, average hillside slope of concave shape, a surface roughness coefficient, and average runoff intensity can be constructed to minimize high initial erosion of reclaimed land. The proposed procedure is, in effect, a way in which to sculpture the land into a shape that approximates what would be a natural surface in dynamic equilibrium with its environment. (From authors' abstract) 631 K961, CE852j

M79-49 BLACK WATER AND TWO PECULIAR TYPES OF STRATIFICATION IN AN ORGANICALLY LOADED STRIP-MINE LAKE

Stahl, J. B. (Southern Illinois University, Department of Zoology), Water Research 13 (5), 467-471 (1979). During the summer of 1969, weekly water samples were taken from a lake near DeSoto, Jackson County, Illinois, to investigate the cause and distribution of black water. Along with a thermal stratification, two types of chemical stratification, due to the presence of ferrous sulfide, were observed. It was suggested that the one type of chemical stratification, produced by the process of photosynthesis and the reduction of sulfate, be employed to improve the water quality of strip-mine lakes. CE838

M79-50 THE EFFECT OF UNCERTAINTY IN SEDIMENTATION POND DESIGN

Vandivere, W. B., Davis, D. R., and Fogel, M. M. (University of Arizona, School of Renewable Natural Resources and Department of Hydrology and Water Resources), American Society of Agricultural Engineers, Winter Meeting, New Orleans, Louisiana, Dec. 11-14, 1979. Paper No. 79-2523. 7 pp. A hypothetical watershed composed of graded mine spoils was subjected to computer simulation to evaluate the sensitivity of peak flows and sediment yield to Soil Conservation Service curve number selection. A stochastic precipitation model served as the input to a modified Universal Soil Loss Equation (USLE). Results were then compared to those derived from the USLE. (Authors' Summary) ASAE, CE836b

M79-51 SIZING SURFACE MINE SEDIMENT CONTROL RESERVOIRS FOR THEORETICAL DETENTION TIME

Ward, A. D., Barfield, B. J., and Tapp, J. S. (University of Kentucky, Agricultural Engineering Department), in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., University of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 73-82. Unless chemical addition is used to enhance settling, surface- mine sediment-control reservoirs must be designed to have theoretical detention times of 10-24 hours, and must control effluent sediment concentrations to less than 70 mg/l for a 10-year, 24-hour storm event, as required by Public Law 95-87, the Surface Mine Reclamation Act of 1977. Procedures ranging from a complex computer model, DEPOSITS, to simple triangular hydrograph approximations, are described. Recommendations are also presented for methods of designing reservoirs to meet the detention time requirements of the permanent surface mine regulations. (From authors' abstract) 631 K961, CE852g

M79-52 EFFECTS OF FLOW CONTROL STRUCTURES ON SETTLING BASINS

Williams, R. G. and Kao, T. Y. (University of Kentucky), American Society of Agricultural Engineers, Winter Meeting, New Orleans, Louisiana, Dec. 11-14, 1979. Paper No. 79-2525. 14 pp. A hydraulically modeled sediment retention basin was used to evaluate the relative performance of seven inlet and outlet structure combinations. Each structure combination was evaluated for six inflow rates and four inflow concentrations. Data analysis and discussion are presented, and it was shown that inflow and outflow structures have a definitive effect on sediment retention basin performance. (Authors' Summary) ASAE, CE836a

M79-53 EVALUATION OF SEDIMENTATION PERFORMANCE

Wilmoth, R. C. (1), Hill, R. D. (1), and Ettinger, C. E. (2) [(1) U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio and (2) Skelly and Loy], American Society of Agricultural Engineers, Winter Meeting, New Orleans, Louisiana, Dec. 11-14, 1979. Paper No. 79-2526. 33 pp. Provided is an in-depth discussion of the various factors, including storm frequency and particle size distribution, involved in sedimentation pond performance. Also described is a study conducted in West Virginia to evaluate the effects of inlet baffles and outlet structure design on short circuiting. ASAE, CE836d

M79-54 REMOVAL OF TRACE ELEMENTS FROM ACID MINE DRAINAGE

Wilmoth, R. C., Kennedy, J. L., Hall, J. R., and Stuewe, C. W., U.S. EPA, Industrial Environmental Research Laboratory, Cincinnati, Ohio, and Hydroscience, Inc., Interagency Energy-Environment Research and Development Program Report EPA-600/7-79-101 (April 1979). 87 pp. Lime neutralization, reverse osmosis, and ion exchange were studied for their effectiveness in removing mg/l levels of ten specific trace elements from spiked acid mine drainage under typical operating conditions. The specified trace elements

M79-54 (continued)

were arsenic, boron, cadmium, chromium, copper, mercury, nickel, phosphorus, selenium, and zinc. Treatment by lime neutralization was very effective in removing arsenic, cadmium, copper, mercury, nickel, and zinc, and relatively ineffective in removing boron and phosphorus. Reverse osmosis was very effective in rejecting arsenic, cadmium, chromium, copper, nickel, and zinc, and relatively ineffective in rejecting boron. The two-bed (strong acid-weak base) ion exchange system was very effective in removing all of the trace elements except phosphorus and boron. None of the three treatment methods was very effective in removing phosphorus. (From authors' abstract) CE224

M79-55 THREE STAGE APPROACH TO GROUNDWATER CONTROL DESIGN AND EVALUATION FOR STRIP MINES

Wilson, J. L., III (1), Harley, B. M. (1), Schreiber, R. P. (1), and Riordan, P. J. (2) [(1) CDM/Resource Analysis and (2) Consulting Geotechnical Engineer], in Proceedings, Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation, Lexington, Kentucky, by University of Kentucky and Institute for Mining and Minerals Research, Dec. 4-7, 1979, S. B. Carpenter, Ed., Universtity of Kentucky, Office of Engineering Services, UKY BU119 (Dec. 1979). pp 175-180. The first stage consists of simple model studies, based on typical stratigraphy and properties, for the selection and design of a control system. The second stage consists of local calibrated groundwater model studies, used to predict expected time variations of dewatering volumes, uplift pressures, and drawdown during the first years of mine operation. The third stage evaluates the impacts of the control system on neighboring water supplies and stream base flow, using a calibrated regional groundwater model. This approach can be used for a comprehensive study of mine groundwater control or any stage can be used alone when a more limited study is required. (From authors' abstract) 631 K961, CE852n

1980

M80-1 AREAWIDE ENVIRONMENTAL ASSESSMENT FOR ISSUING NEW SOURCE NPDES PERMITS FOR COAL MINES, GAULEY RIVER BASIN, WEST VIRGINIA

U.S. EPA, Region III, Jan. 1980. 15 pp.+ map. In the EPA areawide approach to the environmental review process for the requirements for the "National Pollutant Discharge Elimination System" (NPDES), baseline information is being compiled on geology and geography, on historic, aesthetic, and recreational sites, on endangered species, on environmentally sensitive areas, and on stream water quality of watersheds affected by coal mining. This description of the information gathered from the sparsely populated, relatively undeveloped Gauley River Basin is accompanied by a map showing the portions designated as Potentially Significant Impact Areas. The results of this environmental survey, together with the Supplemental Information Form submitted for each application for a mining permit aids in the evaluation of the environmental impact of a New Source coal mine. CE791a

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APPENDIX A

COAL AND THE ENVIRONMENT ABSTRACT SERIES:
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16. ABSTRACT

This volume is the fourth to appear in the "Coal and the Environment Abstract Series" and is a new edition of "Mine Drainage Bibliography." The other volumes in the series are "Reclamation of Coal-Mined Land" and "A Bibliography on Disposal of Refuse from Coal Mines and Coal Cleaning." The three bibliographies in the series are intended to complement one another. While each covers one particular subject area, inevitably some documents listed in one also are relevant to one of the other bibliographies. In addition to the abstracts, this volume includes an Author Index and a General Index.

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