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Wetlands and Coal Surface Mining: A Management Handbook

Digital Object Identifier: https://doi.org/10.13023/kwrri.rr.154

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RESEARCH REPORT NO. 154

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WITH PARTICULAR REFERENCE TO THE ILLINOIS BASIN OF THE EASTERN INTERIOR COAL REGION

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1984

UNIVERSITY OF KENTUCKY

WATER RESOURCES RESEARCH INSTITUTE

LEXINGTON, KENTUCKY

United States Department of the Interior

Agreement Number: G-844-23 (FY 1983)

P.L. 95-467

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With Particular Reference to the Illinois Basin of the Eastern Interior Coal Region

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Project Number: A-096-KY (Completion Report)

Agreement Numbers: G-844-23 (FY 1983)

Period of Project: September, 1983 - September, 1984

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The research on which this report is based was financed in part by the U.S. Department of the Interior, as authorized by the Water Research and Development Act of 1978 (P.L. 95-467).

September, 1984

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ABSTRACT

As the third phase of a three-year project, this report outlines management options for protecting wetlands during the surface mining of coal, particularly for the portion of the Eastern Interior Coal Region that is found in Kentucky, Indiana, and Illinois. It is presented in manual form for use by coal mine operators, regulatory agencies and research institutions.

The previous phases of the project produced an atlas of the most heavily-mined areas of the western Kentucky coal field, which classified and identified wetlands in these areas, and discussed some specific impacts of mining on these wetlands. The need to present information that will lead to action by coal operations and regulatory agencies to protect wetland areas, is the incentive for this report.

The main issues addressed in this the manual include: basic information for identifying wetlands; wetland values, and methods used for values assessment; how coal surface mining can affect wetlands; a method for addressing wetland protection needs and some prevention and mitigation actions; reclamation alternatives, including wetland restoration and the creation of wetlands as alternative ecosystems on mined areas; and general legal and regulatory information concerning wetland protection and surface mining of coal.

Information was gathered through a search of current literature and by contact with state and federal agencies, some coal mining operations, and other concerned organizations. A detailed listing of places to go for more information is included as an appendix.

Descriptors: Wetlands*; Coal Surface Mining; Ecosystems

Identifiers: Illinois Coal Basin; Surface Mine Reclamation; Wetland Management

ACKNOWLEDGEMENTS

Much information for this report was either directly or indirectly provided through personal contact with many persons from federal and state agencies, coal companies and coal associations, environmentally concerned organizations, and other research institutions. In the Commonwealth of Kentucky, the Department of Surface Mining and Reclamation provided much assistance, with special acknowledgements to Sara Sanders of the Division of Permits and Pete Croswell in the Lands Unsuitable for Mining Program. David Rosenbaum, Division of Abandoned Lands and Richard Shogren, Division of Water were helpful with regulatory concerns. Special acknowledgements to Sarah Lynn Cunningham, Division of Water for her assistance and information on best management practices. John Brame, Charles Menser, Department of Surface Mining and Reclamation and Laney Scott, Division of Abandoned Lands of the Madisonville Field Office graciously provided an in depth field tour of mining conditions in the western Kentucky coalfield. Mike Morton, Kentucky Fish and Wildlife Resources was most helpful in discussing wetlands in western Kentucky and current habitat management practices. Both Richard Hannan, Kentucky Nature Preserves Commission, and Hugh Archer of the Nature Conservancy generously gave of their time to discuss wetland protection concerns. Bill Caylor, Kentucky Coal Association and David Short, Mineral Law Center, University of Kentucky were most helpful in presenting mining operation concerns.

In the State of Illinois, Walt Zyznieuski, Department of Energy and Natural Resources; Kathleen Andrews, Marvin Hubbell, and David Klinedinst, Department of Conservation provided information on Illinois wetlands/surface mining conditions.

Several persons of the Indiana Department of Natural Resources provided information on Indiana's concerns including: David Turner, Division of Fish and Wildlife; John Hall, Division of Water; Joan Hardesty of the Jasonville Field Office; and Ed Theroff, Division of Reclamation.

Persons in several federal agencies were helpful in answering questions on federal regulations and policies and in providing direction towards needed information. These people included: William Christman, Louisville District of the Army Corps of Engineers; Roger Calhoun, the regional office of the U.S Office of Surface Mining; Dean Hunt, U.S. Office of Surface Mining, Washington, D.C.; Don Eagleston, U.S. Department of Agriculture-Forest Service; William Mason, U.S. Fish and Wildlife Service; and Jay Benforado, U.S. Environmental Protection Agency.

Contact with Pat Wiram, AMAX Coal Company and Bill Kirk, North American Coal Company was appreciated for their views on mining interests in wetland restoration/reclamation projects.

Other current research information was generously provided by: Mark Brown, Center for Wetlands, University of Florida; Jack Nawrot, Cooperative Wildlife Research Laboratory, Southern Illinois University; Ben Pasevento, private consultant, Emlenton, Pennsylvania; Ardell Bjugstad, South Dakota School of Mines; Eugene Doll, Northern Great Plains Research Center, North Dakota; Douglas Scott, Institute of Natural Resources, Montana State University; and Richard Kleinman and Patricia Erickson, Bureau of Mines, U.S. Department of Interior, Pittsburgh, Pennsylvania.

Support for this project was provided through the Kentucky Water Resources Institute by the U.S. Department of the Interior and by the University of Louisville. The staff of the Systems Science Institute, University of Louisville have been graciously patient and have offered assistance even in the busiest of times. Michelle Ising prepared the grahics and artwork.

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PREFACE - A GUIDE TO THE USE OF THIS MANUAL

Before diving into the information contained in this manual it is suggested that the following be read to give the reader a brief glimpse of the content and usefulness of this manual. This document is intended to primarily assist coal mine operators and their representatives, to encourage wetlands protection policies of regulatory agencies, and to act as a resource for further study by research institutions and others.

1. IS MY PROPOSED MINING SITE IN OR NEAR WETLANDS? AND WHY SHOULD I CARE?

Section 816.97(f) of the regulations promulgated by the U.S. Office of Surface Mining in response to the Surface Mining and Control Reclamation Act of 1977 requires that wetlands are to be protected during the surface mining of coal. CHAPTER I - INTRODUCTION and CHAPTER V - LEGAL AND REGULATORY CONSIDERATIONS discuss the laws and regulations concerning wetlands in more detail.

2. HOW DO I KNOW A WETLAND WHEN I SEE ONE?

Some wetlands are easy to spot like swamps and marshes. Other wetlands do not always have standing water in them and need to be identified through other clues, such as plant types and wildlife that might be seen. CHAPTER II - WETLANDS, includes a step by step method for spotting a wetland and gives some typical wetland charateristics.

3. SHOULD I BE CONCERNED ABOUT THESE WETLANDS?

The answer is yes. Wetlands are significant resources that have been destroyed by various means, including surface mining. They are diminishing rapidly, and it is important that protection and restoration of wetlands be given immediate attention. CHAPTER III - IMPACTS OF MINING ON WETLANDS, discusses the extent of the problem and the ways that surface mining affects wetlands.

4. HOW DO I FIND OUT MORE ABOUT THESE WETLANDS?

Many State and federal agencies, universities, and environmentally concerned organizations have information on wetlands and their uses. Refer to CHAPTER V - LEGAL AND REGULATORY CONSIDERATIONS of this report for a discussion of regulatory agency concerns and APPENDIX A for a listing of sources for further information.

5. IS THE WETLAND THAT IS IN OR NEAR MY PROPOSED MINING SITE A VALUABLE RESOURCE?

The most significant function of wetlands is their use by fish and wildlife for breeding, shelter and food. Many of the nation's endangered and rare species depend on wetland areas for these functions. Wetlands are also useful resources in that they act as flood storage facilities, groundwater recharge areas, recreational (hunting and fishing) facilities, and interface systems that reduce sediments and waste loadings on downstream waters; and they have been recently managed as waste treatment systems. All wetlands do not perform all of these functions.

In general, the law requires that wetlands are to be protected rather than destroyed. There is always the need to interpret the law and regulations to meet the many and complex conditions of the real world. There are wetlands that are highly sensitive and should not be mined, and should be protected from mining impacts. There are others that are clearly of little value (already severely degraded) and would not pose a significant loss of habitat. And thirdly, there is a range of wetlands in between these two ends that are in need of a detailed method of evaluation. Refer to CHAPTER II - WETLANDS for more information on wetland functions and for a discussion of how wetlands can be evaluated.

6. WHAT PROTECTION METHODS ARE AVAILABLE FOR MINING IN OR NEAR WETLANDS?

By careful premining analysis, hydrogeochemical studies, and thorough planning, impacts on wetlands can be prevented. There are other methods for mitigating impacts through the improvement of mining techniques, acid mine drainage control and treatment, and sediment collection. A meaningful and potentially powerful method for reducing impacts on wetlands is simply applying quality control systems on existing environmental protection methods. Is what you planned to do actually what is being done? See CHAPTER IV - ACTION FOR PROTECTION OF WETLANDS IN COAL MINING REGIONS, for a discussion on prevention and mitigation measures, and on reclamation management alternatives that may be helpful no matter what stage of mining you are in.

7. WHAT CAN WETLANDS DO FOR ME?

Wetlands are being shown to be potential systems for use in the treatment of acid mine drainage, the collection of sediments, and as significant interface systems that help protect downstream waters. Every wetland could not and should not be designated as a treatment system. However, research in these areas are beginning to show that a wetland can be useful to you if properly managed and designed (in the case of a wetland specifically created for these purposes). See CHAPTER IV - ACTION FOR PROTECTION OF WETLANDS IN COAL MINING REGIONS for information concerning the creation and management of wetlands.

By developing a system to restore or enhance a wildlife habitat within your mining area, you may be eligible for consideration under Section 711 of the Surface Mining Act, Experimental Practices. Refer to CHAPTER V - LEGAL AND REGULATORY CONSIDERATIONS for more discussion on this section of the law.

CHAPTER I - INTRODUCTION

Inland wetlands are found throughout the United States. It has been estimated that 30 to 50% of the nation's original wetlands have been drained, destroyed or eliminated to make way for agricultural needs, residential and industrial development, heavy construction including mining and highway building, and drainage control (OTA, 1984). The loss of these fish and wildlife habitats, natural flood control systems, and areas of recreation and aesthetic beauty is significant; immediate action is necessary to save the remaining wetlands and restore some of the destroyed wetlands to their original conditions.

Surface mining has become the major method for removing the much needed coal from the ground in many coal producing regions of the United States, including the Eastern Interior Coal Region. The methods of mining, the quality and characteristics of the coal, the environmental impacts, and the techniques used for reclamation vary to some degree for each coal region.

The relationship of wetlands and coal has a very fundamental beginning. During the coal-forming period, trees and other vegetation grew abundantly in shallow swamp areas where the dead and fallen organic matter was prevented from total decay by the stagnant, slightly acid water of the swamps. It is that partially decayed organic matter that became coal as we find it.

REGION OF STUDY

There are many wetlands within western Kentucky, southern Indiana, and southern Illinois, including marshes, bottomland hardwood forests, and bald cypress swamps. Some of these wetlands provide major habitats for fish and wildlife within the Mississippi Flyway for migrating waterfowl. Maybe not so coincidentally, many of these wetlands lie within the Eastern Interior Coal Region, and specifically within the Illinois Coal Basin. The major portion of the Basin extends from western Kentucky, northwest through the western-most parts of Indiana and north through Illinois. The Basin lies within the Interior Low Plateaus with an underlying strata of sandstone, limestone and shale. The topography of the Basin ranges from the low relief and rolling hills characteristic of the western Kentucky section, to the flatlands of deep glacial tills of the upper Illnois section. The flat to rolling topography lends itself to many lowland areas containing significant wetlands. Figure I-1 illustrates the extent of surface mining and some of the larger wetland areas in the currently mined sections of the region of study. In the western Kentucky portion of the Basin, over 177 square miles of wetlands exist, comprising approximately 12% of the western coal field in this state.

Phases I and II of our project summarized environmental data, and delineated wetland areas and surface mining activities on USGS Quadrangle maps for a specific 3960 square kilometers region in western Kentucky. An "Atlas of Wetlands in the Principal Coal Surface Mining Region of Western Kentucky" (citation: Mitsch et al., 1983) was a major product of those studies and illustrates the intimate relationship that exists between coal mining and wetlands in western Kentucky, a representative area of the Eastern Interior Coal Region. In this Phase III report, the intent is to provide a working manual to aid decision makers in employing management and mitigating methods that will protect wetland areas during the surface mining of coal. The discussion of the wetlands/surface mining interface is directed to the portion of the Eastern Interior Coal Region found in Kentucky, Indiana, and

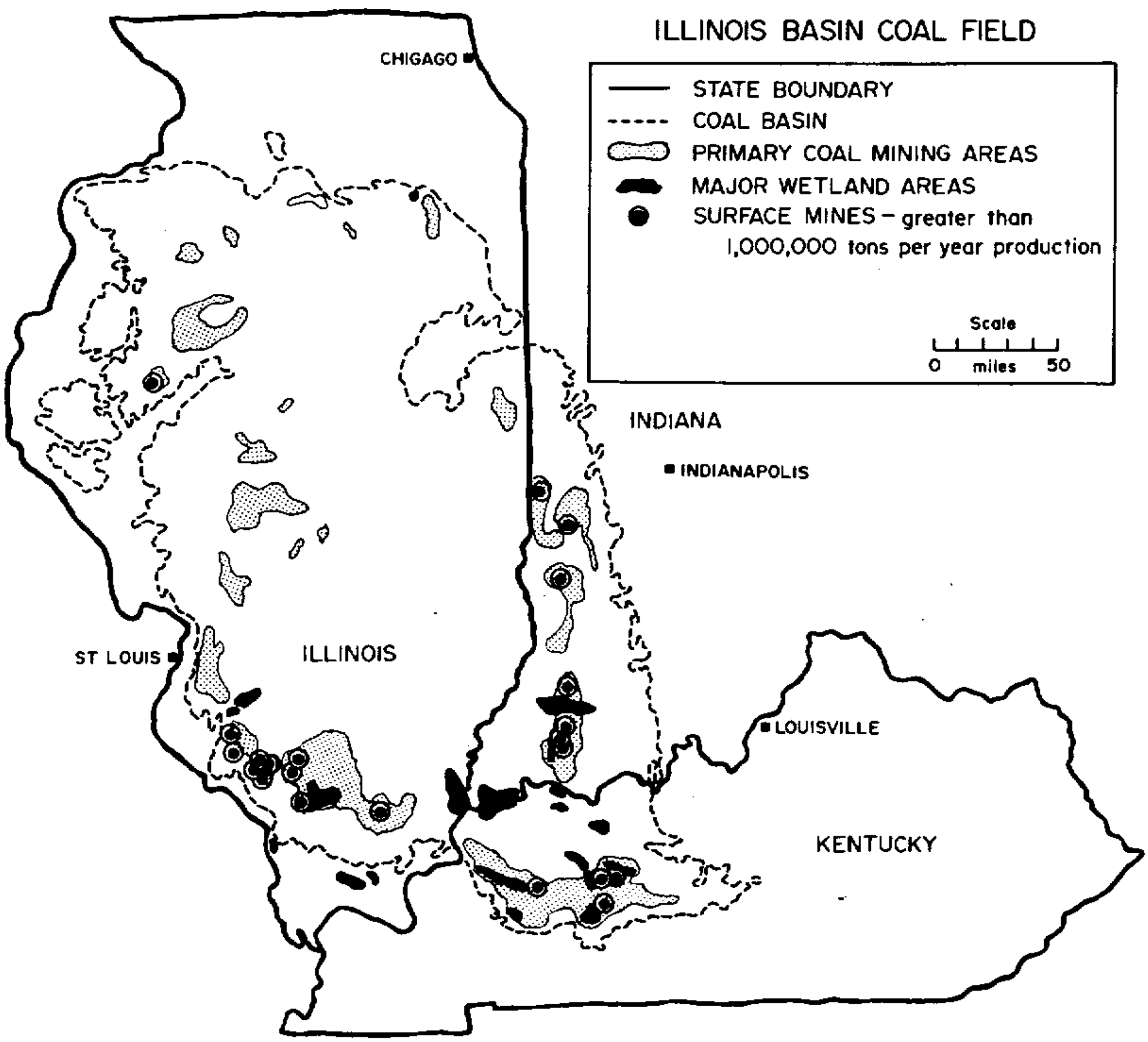


Figure I-1: Illinois Coal Basin - Major Surface Mining and Wetland Areas

Illinois. However, many aspects of this interface may be applicable to other areas where wetlands and coal mining meet, such as the perched wetlands in the heavily-mined West Virginia mountains.

EXTENT OF THE PROBLEM

The topographic and geologic conditions of the region prescribe the potential environmental impacts of surface mining. These impacts generally include acid mine drainage and its precipitate "yellow boy", increased sediment loads, and the disruption of runoff patterns, aquifers and other hydrologic conditions.

Surface mining activity within the Basin has increased significantly since the early 1960s. There is an estimated total of 20,600 million tons of coal reserves yet to be mined through surface mining techniques within western Kentucky, Indiana, and Illinois; and it is being mined at an approximate rate of 90 million tons per year (Lin, 1977). One of the of results mining has been environmental damage to many wetland areas throughout the region. The remaining wetlands in the region are in need of consideration prior to the mining of lands near wetlands or containing wetland areas. Technological developments in coal mining equipment have allowed the mining of saturated lands and consequently, have threatened even more rapid destruction of wetlands.

Prior to regulations, lands that were surfaced mined were left unreclaimed. The spoil that was replaced within the trenches was not graded and was left in sharp jagged mounds that were easily eroded. In addition topsoil was not removed prior to mining and was mixed in with the spoil, along with other possible toxic soils. Many lands within the study region remain unreclaimed (abandoned mined lands), with unvegetated spoil piles that continue to erode, tailing ponds, and gob piles that may all contribute acid mine drainage and high sediment loads to the waterways in the surrounding environment. Table I-1 lists the estimated area of abandoned mined lands within the study region.

TABLE I-1
Estimated Area of Abandoned Mined Lands in
Western Kentucky, Indiana, and Illinois, 1980 (in acres)

State	US OSM 1980 (1)	SCS 1979 (1)	Other	Highest Estimate
Illinois	118,400	118,711	-	118,711
Indiana	55,500	25,882	-	55,500
Western Kentucky	-	20,777	75,000 (2)	75,000
Totals	173,900	165,370	75,000	249,211

(1) Klimstra, 1980
(2) Division of Abandoned Mine Lands, KCNREP

The problem of reclaiming abandoned mined lands is a large one. Acid seeps and continued sedimentation from abandoned mined lands are major sources of wetland degradation. Abandoned mined lands have also created wetlands (ponds, swamps, acid impoundments, coal tailing basins, and final pit impoundments) that may be undesirable due to their acid nature and/or their lack of diverse vegetation.

SPECIFIC REGULATIONS ON COAL MINING AND WETLANDS

Following the 1977 Surface Mining Control and Reclamation Act (SMCRA), the promulgated regulations were developed to specifically state that:

> The operator conducting surface mining activities shall avoid disturbances to, enhance where practicable, restore, or replace wetlands, and riparian vegetation along rivers and streams and bordering ponds and lakes - 30 CFR Section 816.97(f)

In response to these regulations each coal mining state has developed regulations to reflect the intent of the federal law. These regulations

Reference should be made to existing wetland classification information as has been developed by the U.S. Fish and Wildlife Service in "Classification of Wetlands and Deepwater Habitats of the United States" (Cowardin et al., 1979) for detailed descriptions of specific types of wetlands and the "Status and Trends of Wetlands and Deepwater Habitats" (Frayer et al., 1983) for information on wetlands within the United States. Palustrine wetland types are most common in our region of study. Figure II-1 illustrates these wetlands, and typical water conditions and vegetation. However, for those who need a beginning understanding of wetlands we include here a brief primer on identifying these commonly found wetlands.

FIVE STEPS TO SPOT A WETLAND

Identifying wetlands is not always an easy task. Obvious wetlands, such as cattail marshes or cypress swamps, are easy to spot; but are not the only types of wetlands found in the western Kentucky, Illinois and Indiana coal fields. Many wetlands are dry during part of the year and must be identified by using other characteristics. The illustrations in Figures II-2 and II-3 are examples of some typical wetlands. The following steps can aid an observer in identifying wetland ecosystems:

1. MANY WETLANDS MAY BE IDENTIFIED FROM 7.5 MINUTE USGS TOPOGRAPHIC MAPS.

Topographic maps often have symbols marking wetlands. The marked wetlands will probably be the most obvious wetlands, such as swamps and marshes. Other likely wetland areas may also be selected from map examination. Forested areas on topographic maps are often colored green. Low-lying green areas adjacent to streams may be periodically flooded and be considered bottomland hardwood forest wetlands. Natural oxbows and cut-off meanders of channelized streams are usually prime wetland habitats. Figure II-4 illustrates some of these map identifications. Maps are not a

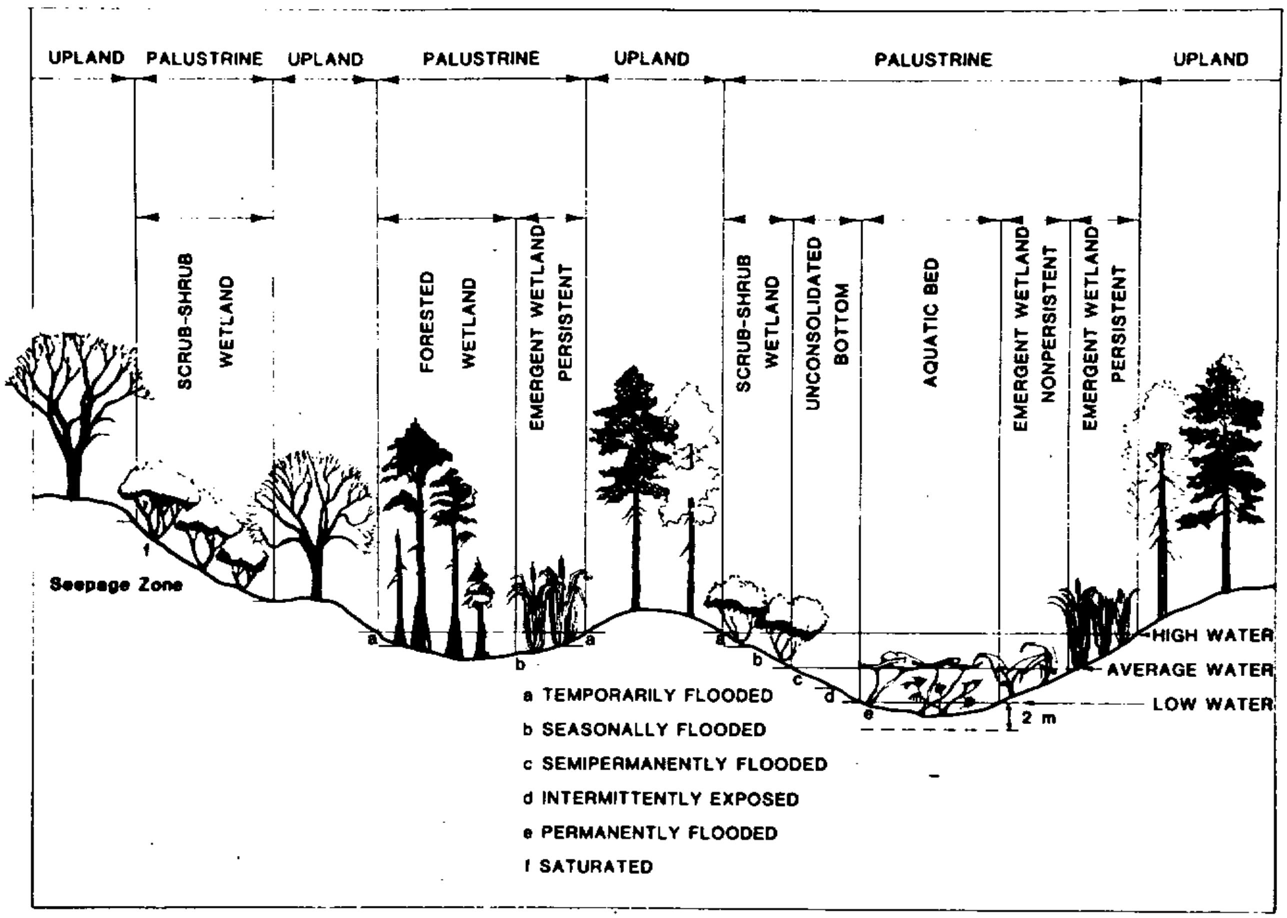
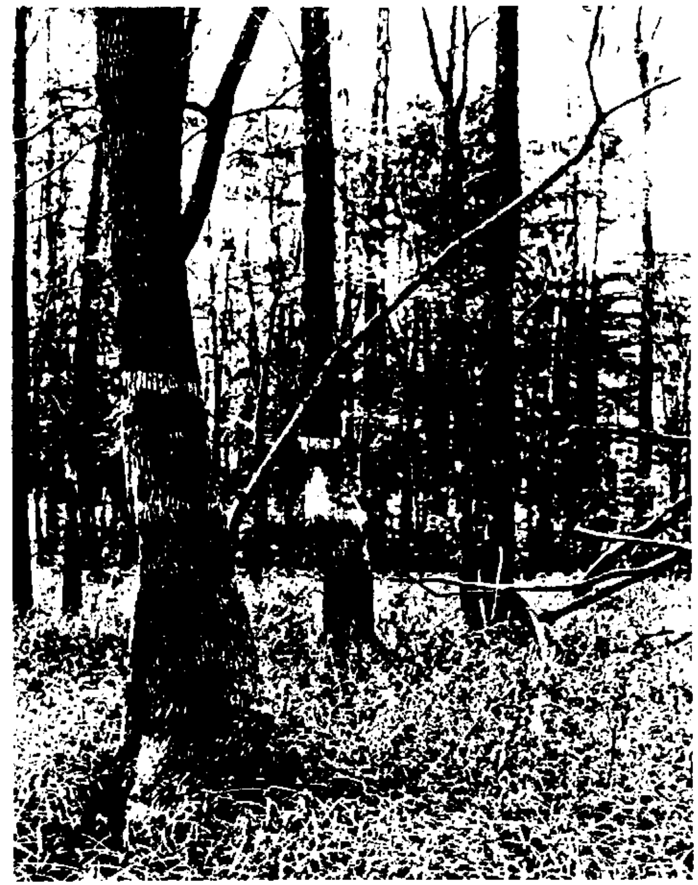


Figure II-1: Typical Features of Palustrine (Wetland) Systems (from Cowardin et al., 1979)

Emergent Wetland (Typha Marsh)



Bottomland Hardwood Forested Wetland

Figure II-2: Typical Wetlands of the Eastern Interior Coal Region

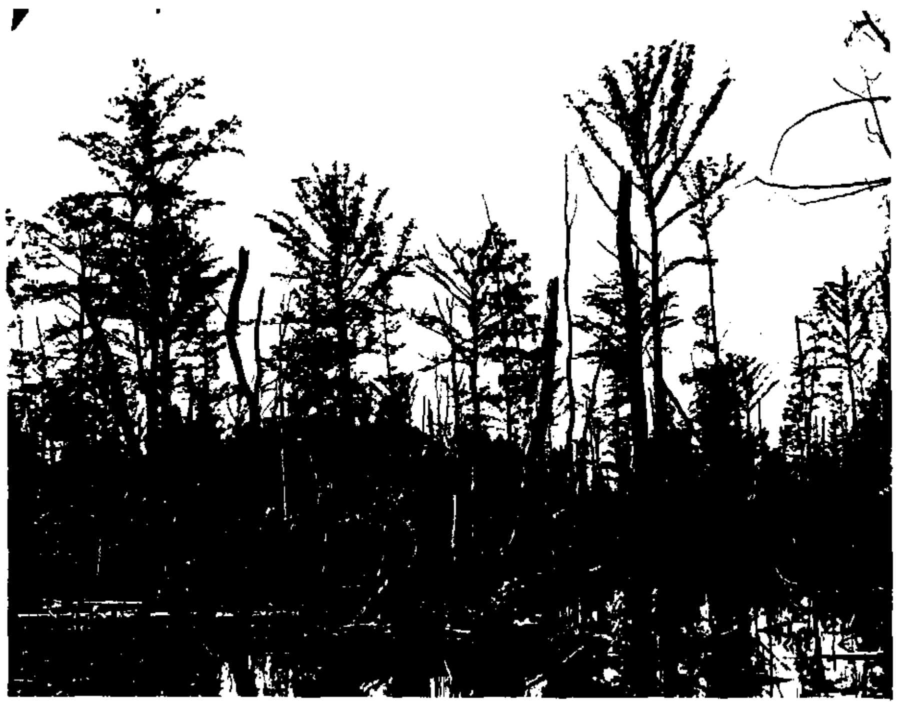


Figure II-3: Typical Cypress Wetland

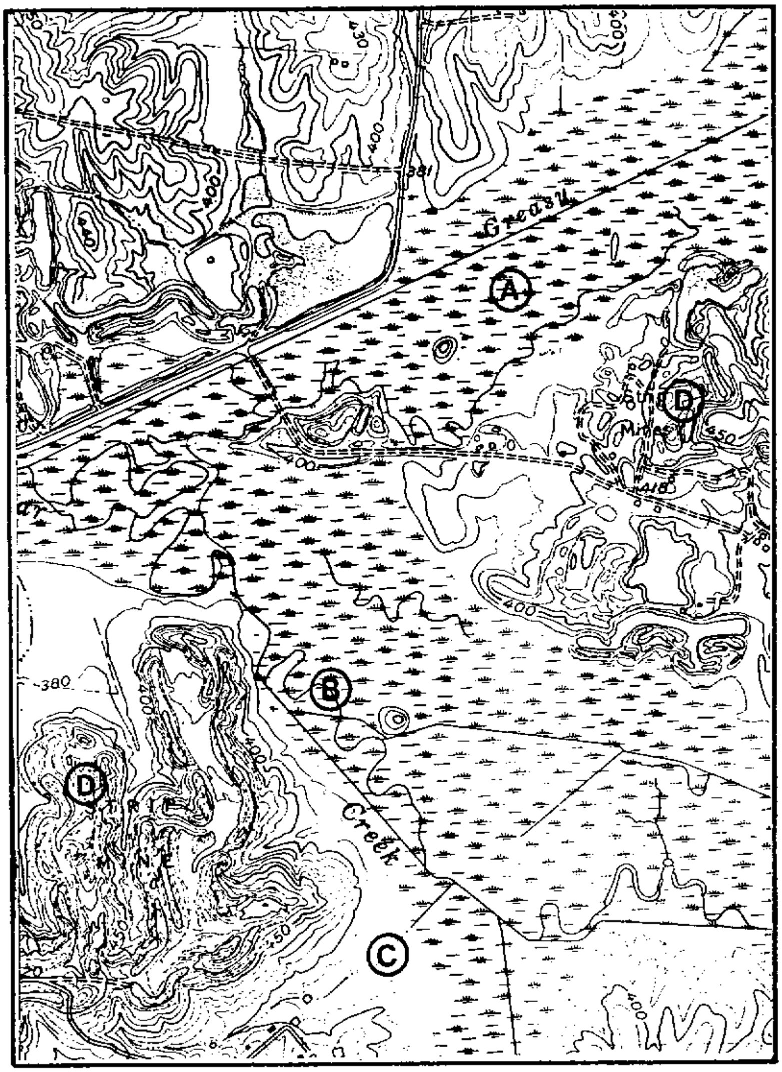


Figure II-4: U.S.G.S. Topographic Map Symbols

A Wetland Symbol
B Cutoff Meanders
C Intermittent Stream
D Strip Mines

replacement for on-site inspection, but can be very helpful in screening regions to increase the efficiency of time spent in the field.

2. WETLANDS HAVE STANDING WATER AT LEAST PART OF THE YEAR AND SIGNS OF FLOODING DURING DRY PERIODS.

If your observations take place during the dry season, how can you decide if the area is flooded at other times? There are several indicators which can be used for this purpose. When a forest is flooded repeatedly to the same approximate depth, some trees exhibit scars on the bark. If many trees have scars at about the same height, a wetland ecosystem is indicated. The trees in Figure II- 2 show scars caused by repeated flooding. Flooding in winter may also produce recognizable ice damage to trees. Foreign objects, whether plant material or human litter, in the branches of trees and shrubs are also good indicators of flooding. Forest floors usually have a thick carpet of decomposing organic material. In contrast, streamside forests with a sparse or absent decaying organic layer show the flushing effects of frequent flooding. Also, an area where the water level is at, or just below the ground surface is most probably a wetland.

3. HYDROPHYTIC AND WATER TOLERANT PLANTS ARE GOOD WETLAND INDICATORS.

Many plants grow only in wet areas while others tolerate prolonged flooding. Some herbaceous plants which are common in wetlands include: cattails, sedges, rushes, bulrushes, reeds, arrowhead, lizard tail, water lilies, duckweeds, pondweeds, knotweeds, and rice cutgrass. There are many others which can be identified from several readily-available books. There are very few trees and shrubs that will grow <u>only</u> in wetlands. However, there are many woody plants which are found most frequently in swamps and bottomland hardwood forests. The most indicative swamp species are bald cypress and buttonbush. Common species of forested wetlands include:

willows, green ash, river birch, silver and red maple, sycamore, swamp cottonwood, swamp white oak, willow oak, swamp privet, and many others. In western Kentucky, southwestern Indiana, and southern Illinois, no conifers except bald cypress will be found in wetlands; pines and other evergreens in this region are inhabitants of drier areas.

4. MANY ANIMALS ARE CLOSELY ASSOCIATED WITH WETLANDS.

A place used by ducks and other waterfowl as a nesting or staging area is clearly a candidate for wetland status. Other birds associated with wetlands include: herons, egrets, bitterns, cranes, sandpipers, red-winged blackbirds, swalllows, eagles, and ospreys. Figure II-5 shows some typical animals found in wetland areas. Gnawed trees or lodges indicate the presence of beavers, inhabitants of wet areas. Crayfish exoskeletons and "chimneys" on a forest floor are good indicators of flooding. Parts of aquatic organisms in animal droppings may also indicate wetlands. Insects which spend part of their life cycle in water may be common in and around wetlands. These include dragonflies, midges, and mosquitoes among others. Observation of these and other creatures common to wet places can be an important tipoff to wetland habitats.

5. LOCAL RESIDENTS ARE OFTEN FAMILIAR WITH WETLANDS.

Any area which is called a wetland by people who fish and hunt and other local people is worth investigating. These people are usually very familiar with the lands nearby, especially if the lands are either known for good fishing and hunting or for mosquitos and snakes. Terms used to identify wetlands are variable. They may include: swamp, marsh, bog, fen, bottom, mire, oxbow, slough or something like "that swampy area over there."

There are many more features which can be observed and measured to

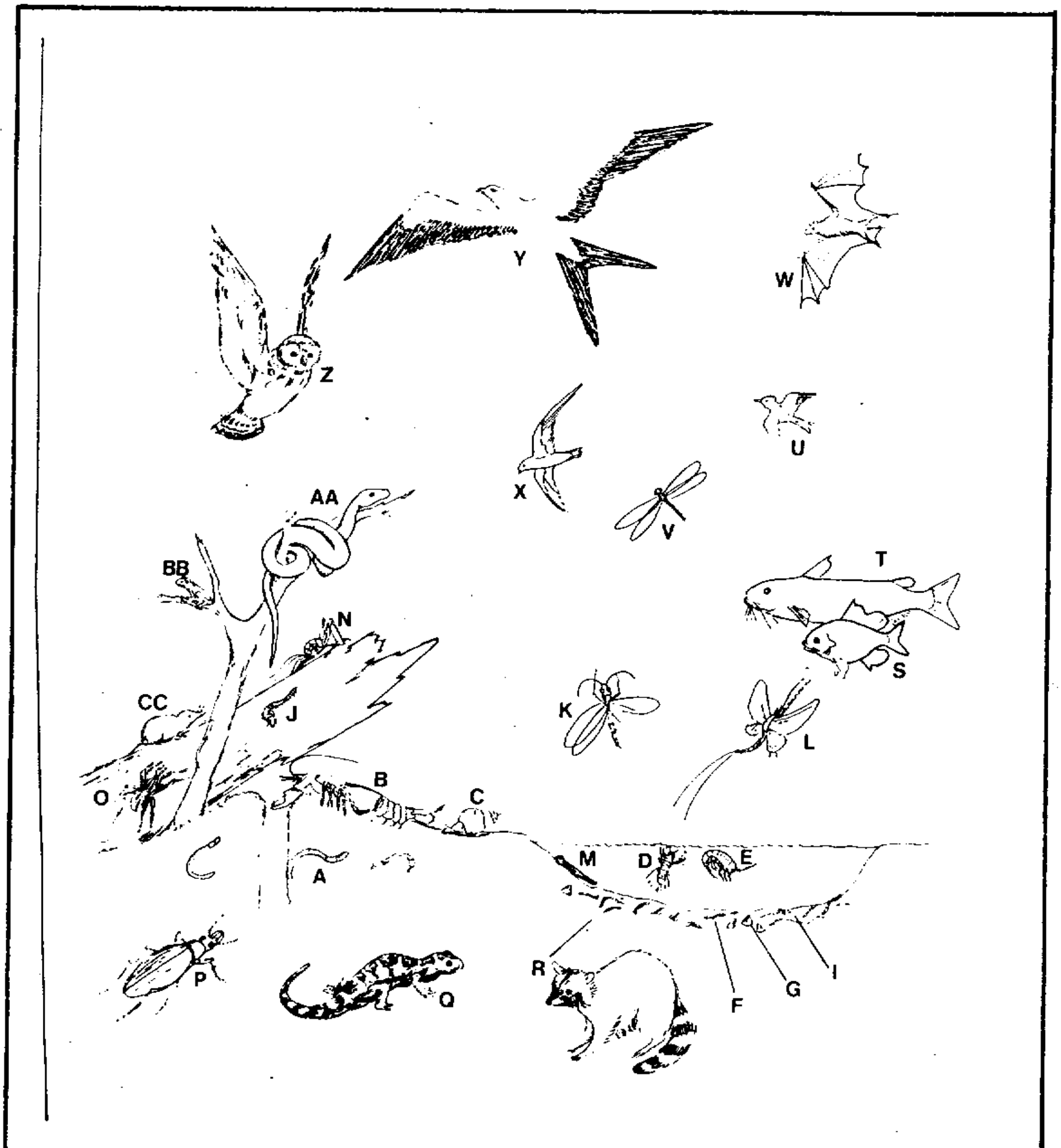


Figure II-5: Typical Wetland Wildlife.

Detritivores: A earthworms, B crawfish, C snail, D isopod crustacean, E amphipod crustacean, F enchytraid worms, G sphaerid clams, I midge fly larvae, J millipede, K stonefly, L mayfly, M flatworm, N camel cricket. Predators: O wolf spider, P carabid beetle, Q marbled salamander, R raccoon, S sunfish (during inundation), T catfish (during inundation), U acadien flycatcher, V dragonfly, W bat, X chimney swift, Y swallowtail kite, Z barred owl, AA rat snake, BB bird-voiced tree frog, CC shrew. Primary consumers (deer, ducks, rabbits, mice, turkey, robins, and others) are not shown (as taken from Wharton et al., 1981).

pinpoint wetlands, but these can become complicated and time consuming. By using the five steps discussed above, most wetlands can be identified relatively quickly. A stray heron flying overhead may not be enough to designate a wetland. However, if that sighting is combined with one or more of the other characteristics, then, generally, a good case can be made for wetland status.

If you think your mine is in a wetland or there are wetlands downstream within the watershed, you should contact the closest U.S. Fish and Wildlife Service, or other agencies as listed in Appendix A of this report, for more information. These agencies may be able to tell you if these wetlands are protected or if they should be further scrutinized for protection.

WETLAND INVENTORIES

In an effort to gain a data base for protecting wetlands, a first step is finding out where wetlands are, of what type they are, and what their uses might be. The U.S. Fish and Wildlife Service has developed a program to inventory the nation's wetlands. This National Wetlands Inventory (NWI) program is underway with approximately 25% percent of the wetlands of the lower 48 states inventoried. It is expected that by 1988, 55% will be inventoried and will cover the top priority areas (Tiner, 1984). Illinois, the southwestern areas of Indiana, and some parts of western Kentucky are included in the top priority areas.

Illinois has recently initiated a program to both inventory and evaluate wetlands within the State. Indiana has participated in the NWI program with concentration in the upper three tiers of counties where most of their wetlands are located, expecting to then move to the southwestern wetland regions. The wetlands atlas (Mitsch et al., 1983) is an inventory of wetlands within the most heavily-mined regions of the western Kentucky coalfield. Reference should made to Appendix A for those agencies involved in wetland inventories.

WETLAND VALUES (1)

Most people would guess that wetlands are only useful for breeding snakes, wildlife, and mosquitoes. They are indeed vital breeding and nursery grounds for reptiles, amphibians, fish, waterfowl, and other wildlife, as well as food and shelter areas for many other kinds of animals. However, wetlands provide other functions, many of which are not understandable without looking at the overall system of rivers and streams that make up the watershed of which the wetland is a part and the terrestial and human ecosystems that directly or indirectly interact with wetlands.

Fish and Wildlife Habitat

Habitat value for fish and wildlife depends on the diversity and arrangement of vegetation, the amount of open water, the arrangement of vegetation relative to the water, the relationship of the wetland to topographic features, such as lakes, streams, and other wetlands, the size of the wetland and surrounding habitat, water chemistry, and wetland permanence (Kusler, 1983). Animals such as deer, muskrats, raccoons, and beaver depend on wetland environments for food and shelter. The rich storehouse of plants and animal life provide an ongoing gene pool that maintains species diversity and a natural balance of life and activity. Some animals depend on the natural cycle of wet and dry seasons in floodplain wetlands; for example, certain species of fish spawn and feed on the floodplain during the flood season. Many fish in more permanent bodies of water depend on food chains that are built on the organic contributions of leaves and fallen debris from adjacent wetlands. The diversity and varied arrangements of wetland

(1) Much of the information for this section from: Mitsch et al., 1979.

vegetation provide cover areas needed by wildlife for breeding and predator escape.

Although wetlands cover only a small portion of the land area of the nation (approximately 5%), close to 35% of all rare and endangered animal species are dependent on wetland habitats (Kusler, 1983). In Kentucky there are several wetland-dependent animals considered endangered, threatened, or rare, including the river otter, the bald eagle, and the sandhill crane (EPA, 1983).

Water Quality Control

Wetlands have been shown to act as pollution sinks, retaining nutrients such as nitrogen and phosphorus, which can be detrimental to lakes and streams if present in abundant quantitites. Wetlands act to reduce nutrient loadings on adjacent streams and water bodies in two ways. Inorganic nutrients are absorbed during the growing season by wetland vegetation and sediments, and released to the streams in small doses, in organic forms, that are less polluting. Secondly, some nutrients are lost to the atmosphere through processes that are unique to the swamp-like environment.

Wetlands also act as buffer areas between agricultural and urban areas and the streams and lakes that drain them. The wetlands filter runoff water from urban runoff and agricultural fertilizers. The runoff contains organic wastes, as well as toxins such as pesticides, herbicides and other exotic man-made chemicals that would otherwise contaminate downstream bodies of water. Microorganisms within the wetland system break down many of these substances into less harmful compounds. Also, trace metals can be bound by other chemicals in the wetlands forming insoluble compounds that settle into the bottom sediments. In this way wetlands can act as long term storage facilities for many of these toxins. Wetlands have been shown to be effective systems for domestic wastewater treatment in experiments in Florida, Michigan and elsewhere. More recently, wetlands have been tested for their potential use as acid mine drainage treatment systems, because of their high quality filtering capabilities.

Flood and Drought Control

Working as water storage facilities, wetlands provide the functions of conserving water in the upstream areas of a river basin and releasing that stored water to downstream areas in a gradual manner so as to create more stable river flows during dry periods. Downstream users might receive water of poorer quality during low flow periods without upstream wetlands. Wetlands help to lessen the impacts of flooding on downstream areas by collecting and storing runoff. Peak storm flows in streams have been shown to be lowered in areas where floodplain wetlands are intact. The elimination of wetlands by draining, filling, construction, levee building, or mining could result in major flooding of downstream areas. Often it has been necessary to build expensive flood control structures to attempt to carry out the functions of lost wetlands.

Sediment Removal

During flooding and high flow periods, river channels overflow into wetland areas and deposit sediments made up of clay, sand, and silt. These materials are often rich in nutrients and contribute to the productivity of floodplain vegetation. The wetland acts as a sediment collector and, at the same time, benefits from these deposits by receiving nutrient-rich sediments.

Riparian vegetation (plants that grow on the floodplain) act as effective bank stabilizers, preventing erosion and silt/sand build up in downstream channels. The removal of riparian vegetation along streams that have been channelized can cause erosion and collapse of the stream embankments. Streams and rivers usually have high quanitities of suspended material during floods. Wetlands can reduce the variation of suspended materials in the rivers by their action as flood storage and buffering systems during high water times.

Groundwater Recharge and Storage

In many regions, wetlands provide a vital function of groundwater recharge and storage. Wetlands that are located at far upstream reaches of the watershed are more likely to function as groundwater recharge systems. The interconnections of wetlands and groundwater aquifers are not easily identified or traced, except for the wetland areas immediately adjacent to river banks. Here water can be stored as groundwater during high water periods, and be slowly released during low flow times.

Recreation, Education, Historic, and Aesthetic Values

Sportsminded people who enjoy fishing and hunting are dependent on wetlands that act as fish and wildlife breeding areas. The natural beauty of many wetlands also provide an ideal setting for those who choose to observe waterfowl, wildlife, and plantlife for recreational pleasure. Millions of people participate in these recreational activities nationwide.

The educational significance of wetlands is growing as more and more people come to understand the importance of these lands to the overall environmental system. Several universities use wetlands for tools of study and research. They are unique ecosystems that lend themselves to detailed study and to developing an understanding of the inter-relatedness of all the parts of an ecological system. Also, many wetlands are sites of old Indian settlements and could provide historical and archaeological information.

Global Values

Wetlands can provide significant functional values in the maintenance of larger than regional ecosystems. Worldwide air quality may be affected by the cycling of nitrogen, sulfur, methane, and carbon dioxide in which wetlands play an important role. For example, carbon dioxide levels may be increasing not only from the burning of fossil fuels, but from the clearcutting of tropical wetland forests that use large quantities of carbon dioxide in their growth process.

IS THIS WETLAND WORTH PROTECTING?

Many methodologies have been developed to attempt to evaluate the significance of a wetland. Indeed, the method and style of evaluation is a critical issue in determining which course of action should be followed for wetland protection and appropriate use of this valuable resource.

IT SHOULD BE UNDERSTOOD THAT IMPACTS FROM ONE ACTIVITY OR ANOTHER CAN BE AMPLIFIED WHEN ACTING IN RELATIONSHIP WITH OTHER DISTURBANCES TO THE ECOSYSTEM. Recognition of wetlands as part of a larger ecosystem, subject to many and varied disturbances, is a key in the development of an evaluation methodology. A wetland cannot be evaluated based on how one potential disturbance will affect one of its uses or characteristics; however, indicators are often used, based on the theory that impacts on the indicators mean the entire wetland ecosystem is being affected.

Mining impacts are only one of many effects on wetland ecosystems. Figure II-6 illustrates these various sources of disturbance. The Kentucky Nature Preserves Commission suggests that the primary impact to western Kentucky wetlands is mineral extraction and the secondary impact is logging (Harker et al., 1980). In the Illinois and Indiana portion of the coal basin, a major wetland disturbance is agricultural use; however in regions of these states where mining is heavy, mining impacts on wetlands are also of

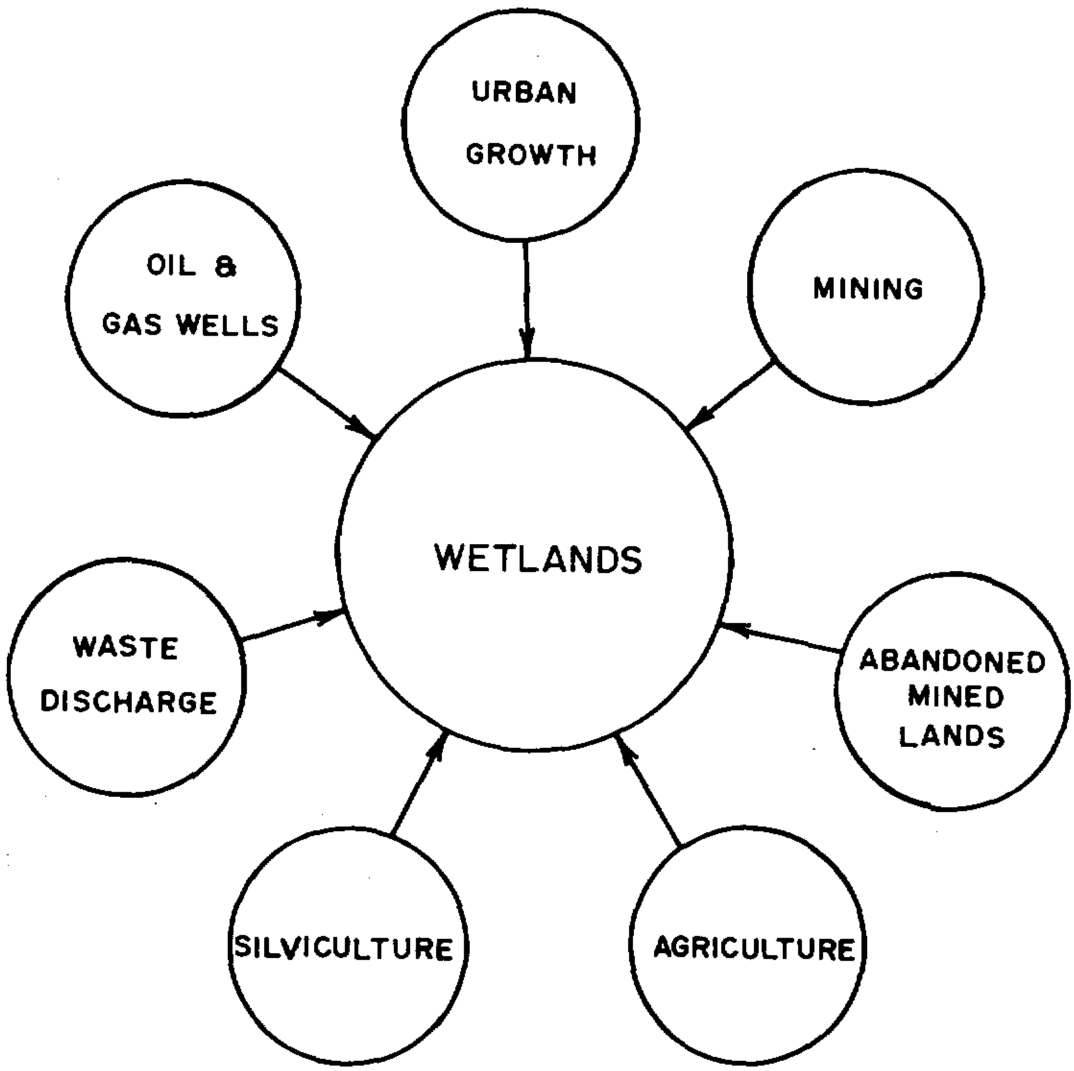


Figure II-6: Sources of Wetland Disturbances grave concern.

CONTACT SHOULD BE MADE WITH LOCAL AGENCIES FOR CURRENT INFORMATION ON WETLAND EVALUATIONS. Evaluating a wetland or any other resource is a complex problem that can not be easily accomplished. Considering the range of knowledge needed to fully evaluate a system in all of its parts and functions, it appears to require a team of experts to make proper evaluations. The current surface mining regulations do not require the mining company to collect data other than that which has already been generated. This leaves the burden of wetland evaluation on regulatory agencies and other related agencies, such as Fish and Wildlife offices, Nature Preserves Commission, Universities, and private organizations. In Kentucky, the Nature Preserves Commission has identified significant water resources and has suggested a methodology and plan for evaluating Kentucky's aquatic resources; however, actual evaluation has not been completed and is limited to specific resource areas. In Illinois, the Department of Conservation is beginning a wetland evaluation program which should prove most useful to anyone involved in wetlands management.

There are some wetlands that have already been identified as significant resource areas by local, state or federal agencies. In these cases the wetland should be considered of high value and any proposed disturbance (surface mining) should be avoided by alternative siting (if proposed on-site) or by taking highly protective and mitigative measures (if wetland is off-site).

Wetland Evaluation Procedures

WETLAND EVALUATION HAS BECOME A SIGNIFICANT CONCERN BOTH TO PROTECT VALUABLE WETLANDS AND TO ALLOW OTHER NEEDED ACTIVITIES TO CONTINUE WHILE ACCOUNTING FOR, UNDERSTANDING, AND MITIGATING THEIR IMPACTS ON WETLANDS. One could assume that all wetlands are of high value and eliminate the need to go through an evaluation procedure. If one has this point of view, the consequences include limiting all activity within or near wetlands that might destroy or disturb it beyond its resiliency level. This point of view is sometimes felt in the hearts of those who have deep interest in wildlife and natural environments.

Current methods for evaluation depend in part on the judgment and intuition of the evaluator. Therefore, the point of view of the evaluator plays a significant role in the evaluation procedure and outcome. The methods of evaluating and the procedure followed should respond to the specific wetlands of concern and the proposed disturbance. Also, the evaluator should continuously raise questions of suitability, objectivity, and, lacking sufficient data, the limits of truth of the evaluation.

There has been no consensus on a methodology for wetland evaluation because of the complexity of wetland ecosystems, the difficulties in quanitifying the many functions and inherent values, and the lack of agreement on how to compare wetland values with the values of the proposed construction or mining activity. Several approaches are available and the best method should be chosen to suit the conditions of the wetlands in question and the proposed activities. Some of the methods available include:

Scaling and Weighting - These methods use a comparative analysis of the wetlands in question with a "first-class" wetland, by assigning a numerical index value to each wetland for each value it may provide. For example, the carrying capacity of a first class wetland may be 200 ducks per acre, and the wetland under evaluation has been estimated to carry 100 ducks per acre. This wetland would receive an index for that specific use of 0.5. These index values can be used to compare various wetlands in question.

Common Denominator - Wetlands are evaluated by attempting to reduce wetland values and the value of the proposed activities to a common means of measurement. Most often this common unit is money. Wetland values are converted to costs based on specific marketable contributions, such as recreational fishing and hunting, furs, and fish production. In some situations this methodology could be helpful to decision makers. One of the problems with this method is not accounting for such values as aesthetic quality, good nesting areas, or the significant life-support function that wetlands play in the food chain for wildlife. Another common denominator approach has been developed that reduces wetland systems to the amount of energy flow through the system as defined by "embodied energy", the total energy required to produce the system or commodity (Costanza, 1980). In this way the embodied energy of a wetland ecosystem, in terms of productivity and the functional uses of the wetland, in terms of energy needed to provide that function, can be summed and compared with the embodied energy requirements of the proposed construction. Dollar values could also be given to these energy index units.

Replacement Value - These methods rely on monetary equivalency of replacing the function played by the wetland if it were lost. For example, if a wetland is controlling downstream flooding, its replacement value would be the cost of constructing flood control facilities if the wetland were to be destroyed. This method depends solely on the functional values of wetlands, and would tend to result in high cost figures since most mechanical facilities or human constructions are expensive. Consequently, it is likely that if the function were lost, it would not be replaced and the resulting problems would be transferred "downstream" for someone else to handle. The replacement cost method should be considered in some situations where a wetland has been identified as playing a significant human concerns function.

A METHOD FOR WETLAND EVALUATION IS NEEDED WHICH SPECIFICALLY CONCERNS ITSELF WITH THE EFFECTS OF MAJOR DISTURBANCES, AS IN THE MINING OF WETLAND AREAS, AND CAN EVALUATE A SINGLE WETLAND AREA INDEPENDENTLY OF OTHERS FOR ITS OWN INTRINSIC WORTH, BE IT AS HABITAT OR OTHER FUNCTIONAL VALUE. The protective actions offered in this manual in CHAPTER IV - ACTIONS FOR PROTECTION OF WETLANDS IN COAL MINING REGIONS, are predicated on wetland evaluation. No single procedure has been developed that can meet the needs of every mining/wetland interaction; however, habitat or functional use analysis could provide a basis for determining site-specific wetland value decisions. Parts of both the Habitat Evaluation Procedure and the Federal Highway Administration methods offer the possibility of single wetland value assessment. They are summarized in Table II-I and are discussed in more detail below.

TABLE II-I
Evaluation Methodologies and Their Applicability

Method	Applicability	Reference
Habitat Evaluation Procedure (HEP)	Fish and wildlife habitats	U.S. Fish and Wildlife Service, 1980
Federal Highway Administration (FHWA)	All wetlands	Adamus and Stockwell, 1983

Habitat Evaluation Procedure (HEP)

The U.S. Fish and Wildlife Service has been developing a method for evaluating areas in terms of availability of the habitat for wildlife use. Evaluation species are used in this procedure as indicators. This method is applicable to any type of wildlife area, including wetlands. When habitat value is determined by HEP, it can be used to develop mitigating policy. Guidelines for recommending mitigation are based on four resource categories. These are described in Table II-2. The HEP procedure has three phases, all of which may not be applicable to the conditions under study:

<u>Habitat Assessments</u> - The quality and quantity of available habitat for selected wildlife species is used as a means of evaluation for 1) comparing different wetland areas for the relative availability of habitat, and 2) comparing the availability of habitat of a specific area with the same area in the future, with or without the proposed disturbance. The baseline assessment of the study area includes: defining study limits, delineating cover types, selecting evaluation species, and characterizing the study area in terms of Habitat Units (HU).

The method involves establishing a Habitat Suitability Index (HSI) through mathematical or word models to describe the relationship of the study area habitat condition to the optimum habitat conditions. For example, an HSI is equivalent to the ratio of population density estimates of the white-tailed deer to the maximum observed population density (this is a weighting and scaling technique). This relationship is expressed numerically. The HSI is then multiplied by the total area (in acres) of available habitat to produce Habitat Unit values which are numbers that can be compared among various wetlands or at various points in time for one wetland.

<u>Trade-off Analysis</u> - In comparing alternative actions, resource planners must often use value judgments. This trade-off analysis attempts to document value judgments by developing Relative Value Indices (RVI). This is a weights and scaling procedure that sets up relative values for each

TABLE II-2

U.S. Fish and Wildlife Guidelines on Wetland Value Designation as Applied to HEP for Determining Mitigation Policy (1)

Value Category	Mitigation Policy Guideline
1. HIGH VALUE UNIQUE WETLAND Wetland is of high value for evaluation species and is unique (one-of-a-kind) and irreplaceable on a national basis or in the ecoregion.	No loss of existing habitat value will be allowed.
2. HIGH VALUE SCARCE WETLAND Wetland is of high value for evaluation species and and is scarce or becoming scarce on a national or ecoregion basis.	No loss of existing habitat value will be allowed, unless compensated for by replacement with the same type of wetland having at least the same habitat value.
3. HIGH TO MEDIUM VALUE WETLAND Wetland is of high to medium value for evaluation species and is relatively abundant on a national basis.	No loss of existing habitat value will be allowed, unless compensated for by replacement with wetland of comparable habitat value (not necessarily same type) and every effort is made to reduce loss to wetlands of the same type.
4. MEDIUM TO LOW VALUE WETLAND Wetland is of medium to low value to evaluation species (regardless of scarcity).	If losses cannot be minimized compensation with replacement or enhanced habitat may be recommended, depending on the significance of the potential loss.

(1) Adamus and Stockwell, 1983 as taken from Federal Register, Jan. 23, 1981

evaluation species; in this way socio-ecomonic criteria and complex ecological criteria are accounted for and quantified.

Compensation Analysis - A compensation analysis would be used to evaluate the means to offset unavoidable habitat losses through replacement methods. A listing is made of evaluation species for which compensation is desired, and the Habitat Units are developed for each. This method can be used for three possible compensation goals: in-kind replacement (no trade-offs), equal replacement through an equal gain in Habitat Units lost, and relative replacement by trading off a gain in a desirable species HU with the loss of an evaluation species HU.

Federal Highway Administration (FHWA) Method

The FHWA method for evaluation is specifically designed to be used for wetland evaluation in connection with highway construction, although with little modification could be applied to any proposed wetland disturbance. The method addresses wetland functional uses and employs predictors (indicators) to estimate functional value. Wetland value involves the opportunity it may have to fulfill a particular function, the level of effectiveness in fulfilling that function, based on probabilities, and the significance given to the performed function in terms of its value to society. It is intended to act as a rapid assessment method to screen alternative locations or to determine the need and range of more detailed study (Adamus and Stockwell, 1983). There are three separate procedures:

Procedure I - Threshold Analysis - The results of this analysis are estimates of the relative value of the wetland in question in terms of high, moderate, or low value. The procedure requires collection of data on-site, and includes information on vegetation, land forms, wildlife, cover types, and much more. These data are collected in reference to various functions that may be provided by the wetland. Interpretation of the data is carried out based on interpretation keys prepared by the method authors that address effectiveness, opportunity, and actual site conditions that must be present for carrying out the specific function. Interpretation keys are available for each wetland function that exists. Functional Ratings result and when evaluated with significance ratings, an overall Functional Significance Rating in the form of high, moderate and low is reached.

Procedure II - Comparative Analysis - This procedure was developed to analyze two or more wetland areas whose functional significance ratings are identical, and more refined discrimination of value differences is necessary.

Procedure III - Mitigative Analysis - Mitigation costs and wetland functional significance are used to compare alternative locations for any proposed construction. This procedure may not be applicable to surface mining conditions, unless there appears to be a choice of where to mine, and at the same time, a choice of wetlands that may be impacted. The procedure could be analyzed for its adaptibility for use in comparing mitigating costs with alternative siting costs.

CHAPTER III - IMPACTS OF MINING ON WETLANDS

Strip mining is an intense method of extracting coal. All the earth is removed from above the coal seam and deposited in only a slightly different location. That action can produce major upsets in soils, water ways, plant and animal life, and in human communities located nearby or even those far from the mine site. Understanding and developing the means for minimizing these impacts on the environment and still getting the coal out within economic reason, is a difficult task. Sensitivity to wetlands and to the valuable role they play as part of this region's ecosystem is necessary to permit the continued activity of coal mining and at the same time protect and hopefully enhance a significant natural resource.

Within the Eastern Interior Coal Region the typical method of mining is area mining, box-cut method. Figure III-1 illustrates this method of mining and at the same time shows the various relationships mining might have with wetlands. The natural wetland may act as a buffer area and wildlife refuge between the mining site and downstream resources. Damaged wetlands can result from inadequate protection activities in mining areas. Wetlands can be useful reclamation projects that function as fish and wildlife habitats, as well as possible treatment systems.

The affects of mining on wetlands results from several conditions acting together. In order to understand these conditions, one must know WHERE they might occur (on-site or off-site); WHEN in the mining process impacts could result; WHAT the impacts are on water resources, land resources, vegetation, wildlife, and recreational and aesthetic aspects; WHY mining activities

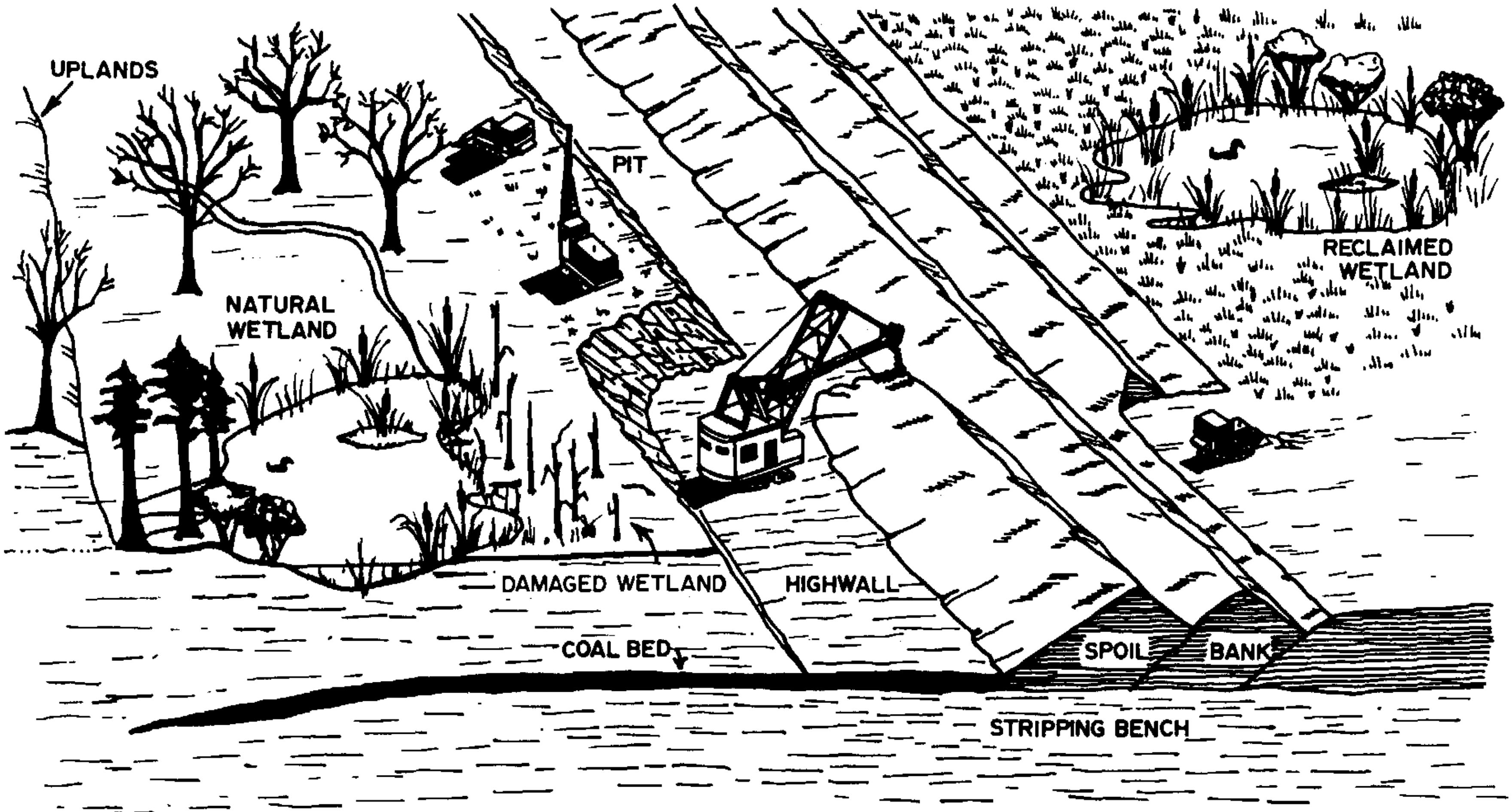


Figure III-1: Wetlands and Surface Mining might cause these impacts; and those conditions which control just HOW MUCH of an impact results from the mining activities. Table III-1 provides a summary of these what, where, when, why, and how much questions discussed below.

WHERE AND WHEN MINING MAY IMPACT WETLANDS

Mining affects wetlands either on-site, where wetlands are included in the mining area, and/or off-site, where mining may affect wetlands downstream from the site. The significant impacts for each of these conditions are noted in Table III-1(b) and are summarized here:

1. ON-SITE: Mining in wetlands will cause hydroperiod disruption, fish and wildlife habitat destruction, water quality degradation (pH, sediments and toxics), aquifer disruption, flood control and storage loss, and general alteration of land use.

2. OFF-SITE: Mining near wetlands can cause off-site sedimentation, acid mine drainage and toxic waste impacts, water quality degradation, flood control and storage loss for off-site users, aquifer disruption which may affect the hydroperiod of downstream wetlands, and disruption of fish and wildlife habitats.

3. ABANDONED MINED LANDS: The impacts from abandoned mined land may be either of those above, since the abandoned mined land may have been a wetland or may be affecting an off-site wetland.

It can be expected that if a wetland is in or near the mining site, consideration for possible effects on the wetland must be accounted for at each mining stage. The general stages of surface mining are: exploration, clearing, draining, drilling, blasting, overburden removal, haulage, soil storage, maintenance, reclamation, and post-operation (Ramani and Clar, 1978). The mining activities at each of these stages should be reviewed for

TABLE III-I

IMPACTS OF MINING ON WETLANDS: WHAT, WHERE, WHEN, WHY, AND HOW MUCH

a) WHAT IMPACTS ON WETLANDS [1]	b) WHERE MINING ON-SITE	 OFF-SITE	c) WHEN MINING STAGES [2] THAT AFFECT WETLANDS	d) WHY REASONS FOR IMPACTS [3]	e) HOW MUCH LEVEL OF INTENSITY [4] CONTROLS
WATER			EXPLORATION	CHEMICAL	MINING RELATED FACTORS
Quality degradation	X	X		Addition of large amounts of chemical	Mining Methods and
Aquifer disruption	X	X	AREA DEWATERING AND	elements.	timing.
Flood control disruption			DIVERSION	Addition of large amounts of chemically	
and storage loss	X	X		reduced materials, esp. sulfides.	Quality Control
Alteration of seasonal			CLEARING	Addition of metallic oxides and hydroxides.	
flow patterns	X	X		Addition of large quantities of sulfuric acid.	Reclamation methods
			TOPSOIL REMOVAL	Drastic lowering of pH.	and timing
LAND				Reduction and elimination of carbonates.	
Erosion	X	X	BLASTING	Placing of heavy metals into solution.	SITE CONDITIONS
Alteration of land use	X	X		Reduction of free oxygen.	Spatial Response
Soil redistribution	X		OVERBURDEN REMOVAL	Contamination of groundwaters that feed	
Alteration of soil				wetland areas.	Time-related response
productivity	X		SPOIL REPLACEMENT		
Alteration of soil				PHYSICAL	WETLAND SENSITIVITY
stability	X		HAULAGE	Drainage of wetlands.	Resiliency
				Filling of wetlands with spoil and tailings.	
VEGETATION			SOIL STORAGE	Alteration of stream courses by channeliz-	Inertia
Vegetation removal	X			ation, diversion, and impoundment.	
Alteration of species			MAINTENANCE	Widening of stream beds.	Elasticity
composition	X	X		Covering of wetland bottoms with spoil and	
Reduction of vegetative			RECLAMATION	tailings.	EXTENT OF RECLAMATION
diversity	X	X		Increased silt loads.	
			POST-OPERATION	Increased turbidity.	
WILDLIFE				Decreased light penetration.	
Habitat destruction	X	X		Reduction of habitat diversity.	
Wildlife displacement	X	X			
Creation of wildlife				TOPOGRAPHIC	
barriers	X			Removal of natural cover.	
				Removal and burial of topsoil.	
OTHER				Exposure of vast bare rock surfaces.	
Alteration of recreational				Creation of long highwalls which may seep.	
use	X	X		Creation of open pits, quarries, spoil	
Alteration of asthetic				depressions which may fill up with seepage.	
value	X	X		Creation of vast areas of spoil piles which	
Alteration of scientific/				seep, erode, and are unstable.	
educational/historical/				Acceleration of surface runoff.	
archaeological value	X	X		Increased erosion.	
				Watercourse modification from spoil and	
				tailing impoundments.	
				Groundwater lowering.	
				Inadequate buffer zones or refugia.	

[1] Carpenter and Farmer, 1981; [2] Ramani and Clar, 1978; [3] Darnell, 1977; [4] Adamus and Stockwell, 1983

ways that impact wetlands and for possible protective measures.

THE MAJOR IMPACTS OF SURFACE MINING AND WHY

The impacts of surface mining on wetlands can be categorized under impacts on water, land, plant and animal life, and impairment of other uses of wetlands. See Table III-I(a). The WHAT and WHYS of environmental impacts cannot be discussed separately; they are intimately tied to each other through the dynamic interactive system of mining and the environment in which it occurs.

Impacts can be acute, as in the immediate destruction of habitat resulting from the removal of cover vegetation, or they can be the result of chronic stress. Over time, the alteration of seasonal flow patterns and the elimination of peak flows can deteriorate the biological communities that thrive in wetland environments. Also, chemical factors such as leaching spoil piles and other sources of mine drainage can cause chronic distress on the wetland system (Darnell,1977).

One of the most significant impacts of mining activity on wetland environments is habitat loss. This can occur via direct removal or be caused by increased sediment loads, acid mine drainage, or alteration of stream and water flow patterns that are critical in maintaining plant life and the reproductive environments needed by fish and wildlife.

The results of mining that lead to detrimental impacts have been determined by Darnell (1977) as falling into three categories: chemical, physical, and topographic. See Table III-l(d). Additions of large quantitites of potentially toxic chemicals, increased silt loads, and removal of natural cover, for example, can interact to produce impacts on the environmental system.

Coal contains many elements that may be considered as potential pollutants, both in the coal burning and coal mining processes. The major polluting elements that appear in the surface mining of coal are pyrite and its oxide forming compounds. In the Eastern Interior Coal region the extent of pyrite is high, possibly due to the sulfur-producing bacteria that was present during the coal formation time. If the pH of the coal-forming swamp was not too low, sulfur producing bacteria would grow. In the swamp areas that may have been near limestone deposits, the acidity of the swamp water would have been tempered enough to allow the growth of more sulfur-producing bacteria. The results of this phenomenon are coals with higher sulfur content (Caruccio and Ferm, 1977). Other trace elements that may be found in coal soils are: beryllium, fluorine, arsenic, selenium, cadmium, mercury, and lead (Magee et al., 1973). The appearance of these elements depends on the surrounding geological formations.

Heavy metals are relatively insoluble in water, and therefore tend to accumulate in the bottom sediments downstream from their point of entry. If the pH is reduced, they tend to become more soluble, and enter the free flowing water from the sediments. It has been determined that the toxicity of metals to fish increases as the carbonate content of the water decreases (Darnell,1977). As mining activities introduce heavy metals into the aquatic environment and at the same time, introduce acid drainage reducing the carbonate level, heavy metals become increasingly more toxic. The implication here is that wetlands downstream from mining operations can be critically impacted in that they act as sediment collectors and also maintain a reduced pH. The naturally lowered pH condition of wetlands is dependent on surrounding geology; however, it can be magnified by mine drainages and, when combined with increased metals loading, can result in a severely degraded fish and wildlife habitat.

HOW MUCH OF AN IMPACT

In any situation where a wetland and surface mine interact, the environmental impacts that have been discussed can occur in varying degrees. The level of intensity of the impact would depend on; 1) mining related factors, 2) the site conditions, and 3) the sensitivity of the wetland. These items are shown on Table III-1(e) and are discussed below.

Mining Related Factors

The impacts of mining are dependent on the development and level of effectiveness in the following:

1. Mining plan (methods and timing)
2. Quality control
3. Reclamation plan (methods and timing)

These three items are inter-related and any degree of change or failure in one can cause an enhancement of or problem for the other (Figure III-2). For example, if the mining plan is not adhered to closely, the revegetation planned during reclamation may be thrown off schedule causing a delay until the next planting season and allowing for continued environmental impact from sediment runoff.

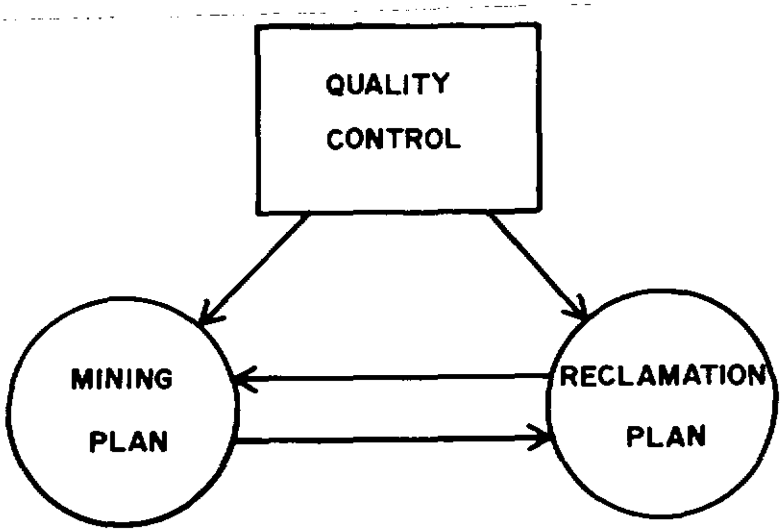


Figure III-2: Mining Factors Affecting Impacts on Wetlands

The level of quality control is an important issue in evaluating the impact of surface mining on wetlands. If the mining plan and reclamation plans have not been properly developed and/or are not carried out as planned, the impacts of the mining on wetlands would be significantly increased.

Site Conditions

Environmental impacts can vary in degree depending on location, most likely in direct proportion to the proximity of the mining operation to the wetland; this means that if mining occurs within the wetland the impacts are clearly most severe. In terms of spatial response, a two-stage response might be expected on downstream and adjacent wetlands. This is shown in Figure III-3. Upstream wetlands could also be impacted by mining activities, as in the case of stream channelization causing a change in water levels upstream, thereby destroying or altering the wetland ecosystem. In terms of time-related response, one or a combination of three patterns of response would be applicable for varying mining/wetland systems. Figure III-4 shows these patterns and conditions under which they might apply. Graph A illustrates how an abandoned mined land (AML) could affect a wetland area either on-site or off-site. Over time some recovery might take place through natural reclamation; however, the level of recovery is dependent on the level of reclamation. Most often chronic effects on downstream wetlands are likely to occur until the AML is properly reclaimed.

Reclamation efforts can be either inadequately performed at the time of reclamation, or are not properly designed to anticipate long term, maybe, unanticipated problems. In either case, there is a lag time between reclamation efforts and the time when wetlands begin to be adversely affected

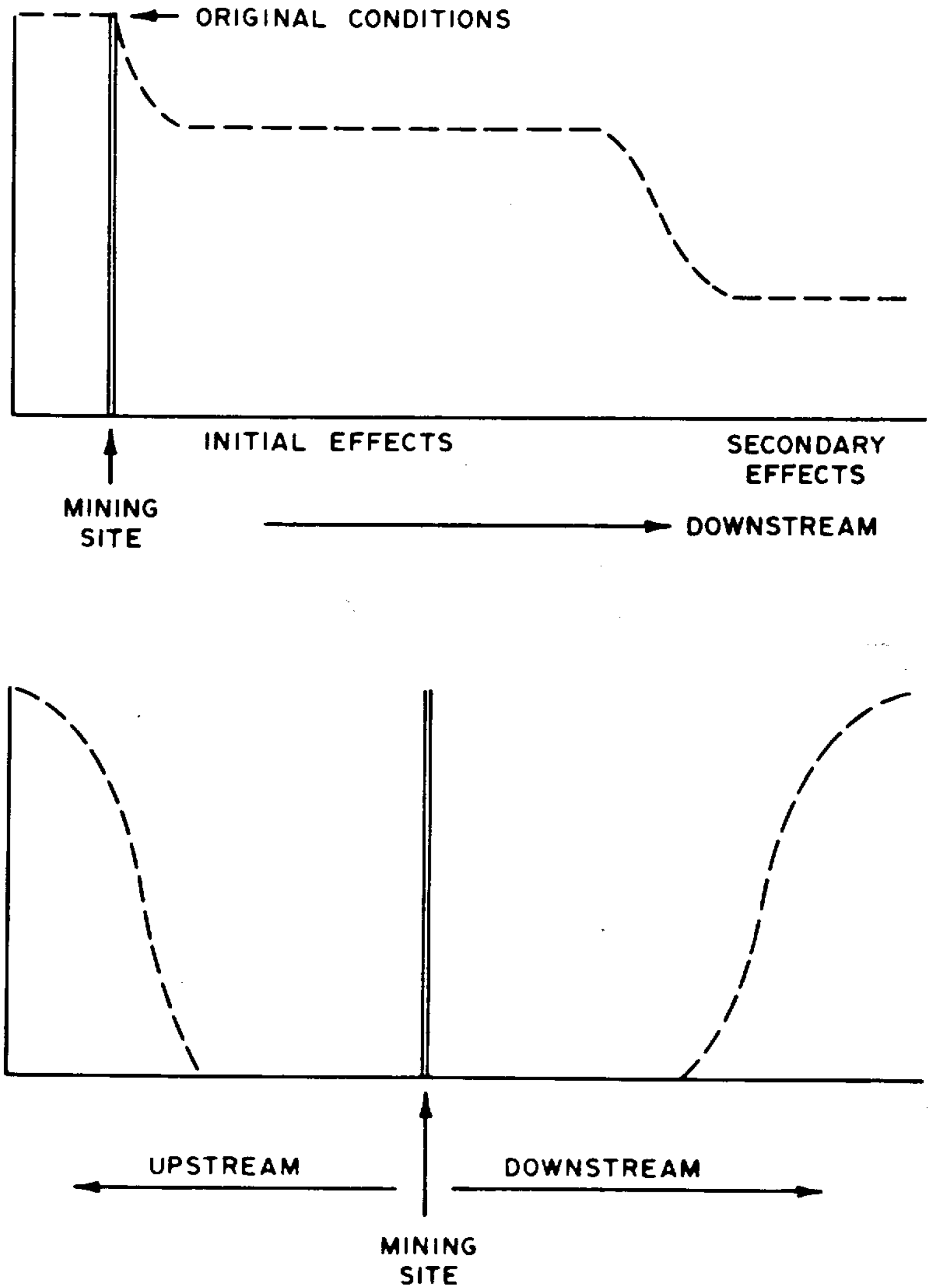


Figure III-3: Spatial Response Patterns of Off-site Wetlands (adapted from Darnell, 1977)

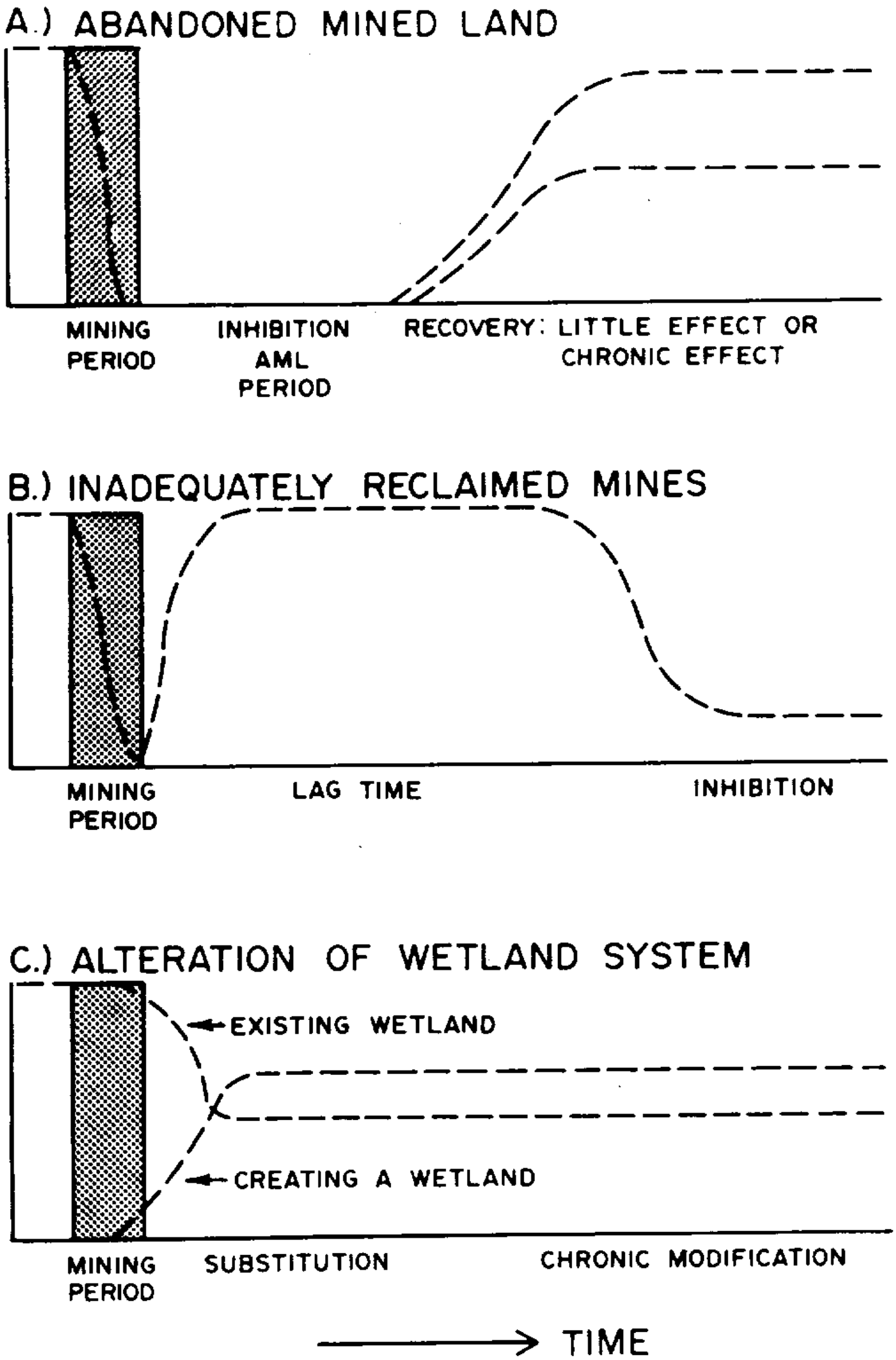


Figure III-4: Time Related Patterns of Wetland Response to Mining (adapted from Darnell, 1977)

A) Recovery is dependent on the extent of natural reclamation.
B) Mining affects on-site or off-site wetlands when reclamation efforts fail.
C) Chemical or hydrologic alteration causes a change in the type of wetland.

(see graph B, Figure III-4). Many lands reclaimed before 1977, with some reclamation but not under current reclamation standards, would be prime candidates for this pattern of response.

Graph C of Figure III-4 describes how existing wetlands can be chronically modified by effects of chemical introducion or hydrologic disruption; these may not destroy the wetland, but convert it to a different type of lesser diversity. Also, some mining activities have created wetlands; these swampy areas, acid ponds, and tailing basins are certainly saturated lands, but with little or no diverse vegetation. Understanding the pattern of response of wetland systems will provide a basis for understanding, designing and implementing protection measures.

Wetland Sensitivity

Each wetland has a different ability to adapt and recover, or to be overwhelmed by the effects of mining. These items are measurable through an analysis of these wetland characteristics (Adamus and Stockwell, 1983, Harker et al., 1980, Cairns et al., 1978):

1. INERTIA - The sensitivity of the vegetation, or the ability to resist displacement of functional and structural characterisitics can be used as a measure of wetland health. Inertia is determined by the existence of vegetation that is accustomed to variable conditions, redundancy in land forms and functional factors, mixing or flushing capacity, chemical characteristics of water, how much disturbance has already occurred and how closely this has drawn the system to an ecological threshold, and management capabilities of the region.

2. ELASTICITY - The ability of the wetland to adapt is determined by existence of seed bank areas to repropagate the disturbed wetland, the dispersal ability of the seed types, habitat condition, toxin levels, and

management capabilities for control of damaged areas.

3. RESILIENCY - The recovery capacity of a wetland is not well understood, although it is assumed that there is a limited number of times that a system can recover from disturbances, before it is critically damaged.

Extent of Reclamation

The degree of reclamation that has been attained either by natural means or by attempts at reclamation will have an affect on the intensity of environmental impacts. Some abandoned mined lands have reclaimed themselves to a certain degree over time through a process of reducing toxins in the topsoils by leaching and erosion to allow for the growth of whatever volunteer seeds came their way. These lands may or may not be impacting wetlands. Other lands have been reclaimed under previous laws that did not require the replacement of topsoils; the success of reclamation on these lands must be measured individually.

Those lands mined since 1977, and currently being mined must also be evaluated for reclamation success. Often even meeting the requirements of the law does not establish successful reclamation. Wetland ecosystems may be impacted from lands that are considered successfully reclaimed. If a significant wetland lies within the impact range of a proposed or currently active mine, it is important to begin an analysis and monitoring program for affects on that wetland. If a significant wetland has been identified within the impact range of a mining operation that is still under bond, the impacts on that wetland should be monitored and mitigated.

It should be emphasized that understanding the impacts of surface mining on wetland systems means understanding that the conditions that produce an impact are many and varied. Specific events or conditions can appear to have little impact if perceived as acting alone, but most often these act in combination and their impacts could be magnified into a highly degrading system.

CHAPTER IV - ACTION FOR PROTECTION OF WETLANDS IN COAL MINING AREAS

Protection of wetlands during and after the surface mining of coal depends on actions that are planned for and carried out in each phase of the mining process. Methods and types of protective actions are presented here, to be applied in various mining-wetland interactions.

TERMINOLOGY

In consideration of how wetlands can be protected during the surface mining of coal, the concepts of prevention, mitigation, and reclamation should be understood. These protection concepts are illustrated in Figure IV-1 and are defined in the following discussion:

1. PREVENTION: There are two categories of prevention. The first is total avoidance of wetland disturbance by simply not mining in or near the wetland. The second category is prevention of impacts on wetlands through careful consideration during the planning and premining stages. Designing the method and system of mining the land, determining the postmining use, and developing a corresponding mining and reclamation procedure should be carried out in conjunction with a careful analysis of the potential impacts on wetlands.

2. MITIGATION: The activities of the mining operation can be developed to minimize or mitigate the impacts on wetlands. These activities would include altering mining techniques, improving sedimentation controls and acid mine drainage control and treatment facilities, and maintaining quality control measures. This mitigative concept of protection is different than prevention, in that mitigating measures would be applied to currently

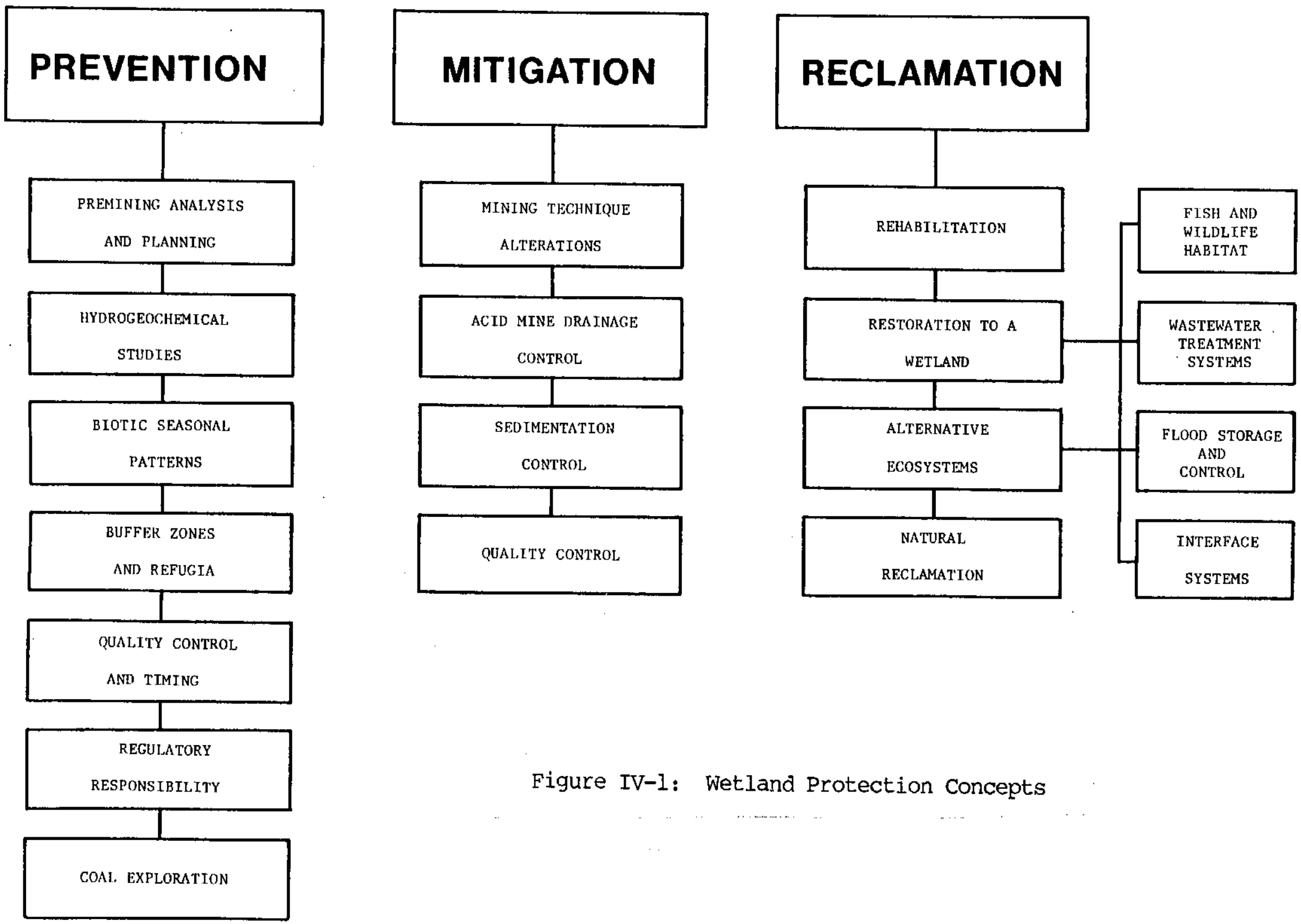


Figure IV-1: Wetland Protection Concepts mined operations and abandoned mined land conditions.

3. MANAGEMENT TECHNIQUES FOR RECLAMATION: In the premining, ongoing mining and post mining stages, the reclamation program is of major significance in protection of wetlands. The management options that are available include (Cairns, 1983):

a. REHABILITATION - reclaiming the mined land to inhibit further disturbance to biotic and abiotic systems. This method of reclamation is the most common form that is practiced today. Rehabilitation techniques could be applied in all mining conditions (premining, currently being mined, post-operative, and abandoned mined lands).

b. RESTORATION - returning the mined land to its original ecosystem. This management option may be applied in all mining conditions.

c. ALTERNATIVE ECOSYSTEMS - creating a new ecosystem that will provide some useful function for the area, such as a fish and wildlife habitat, flood storage and control system, waste treatment system, or interface system.

d. NATURAL RECLAMATION - allowing previously unreclaimed land to continue its natural process of succession with vegetative systems that have voluntarily established over long periods of time. Natural reclamation is not an option for any new or ongoing mining operation.

4. REPLACEMENT: Compensating for a loss by replacing or providing substitute resources or environments, is an indirect method of protection and is not recommended. If such a method is considered, many concerns must be addressed, including: a) the impacted wetland is lost and irretrievable, and there is no guarantee that the replacement wetland will remain undamaged by other pressures in the future; b) it may not be possible to find a comparable wetland with an owner willing to sell; c) agreement must be

reached on a basis for establishing comparable value; d) agreement must be reached on a value exchange ratio (Adamus and Stockwell, 1983).

PREVENTION

Premining Analysis and Planning

To assure that wetland concerns are addressed in the premining analysis, a procedure for action is presented. Figure IV-2 presents a flow chart of action alternatives that should be investigated at the premining stage. Action is considered for proposed mining sites that are located near wetland areas (off-site) and for proposed mining sites that may be located within or contain a wetland area (on-site).

AS PART OF THE ENVIRONMENTAL INFORMATION GATHERING PROCEDURE, A DETERMINATION SHOULD BE MADE OF THE LOCATION AND EXTENT OF WETLANDS WITHIN THE IMPACT RANGE OF THE MINING SITE. The range of impact would be dependent upon the hydrologic and geological conditions in the area. All wetlands in the same watershed should be located, including those upstream of the proposed mining activities. Even wetlands of a small size (one hectare or less) should be noted in that they may be a special habitat or serve a unique function in the area. CHAPTER II offers a brief procedure for identifying wetlands, entitled FIVE STEPS TO SPOT A WETLAND. For more information and assistance, reference should be made to existing wetland inventories, and contact should be made with local sources of information as described in CHAPTER V of this report.

UPON DETERMINATION OF POTENTIALLY EFFECTED WETLANDS, AN EVALUATION OF THE WETLANDS SHOULD THEN TAKE PLACE. This evalution is intended to determine the overall value of the wetlands and, thereby, help establish the degree to which the wetlands need to be protected. If the wetlands have already been evaluated and identified this information should be noted. If the wetlands

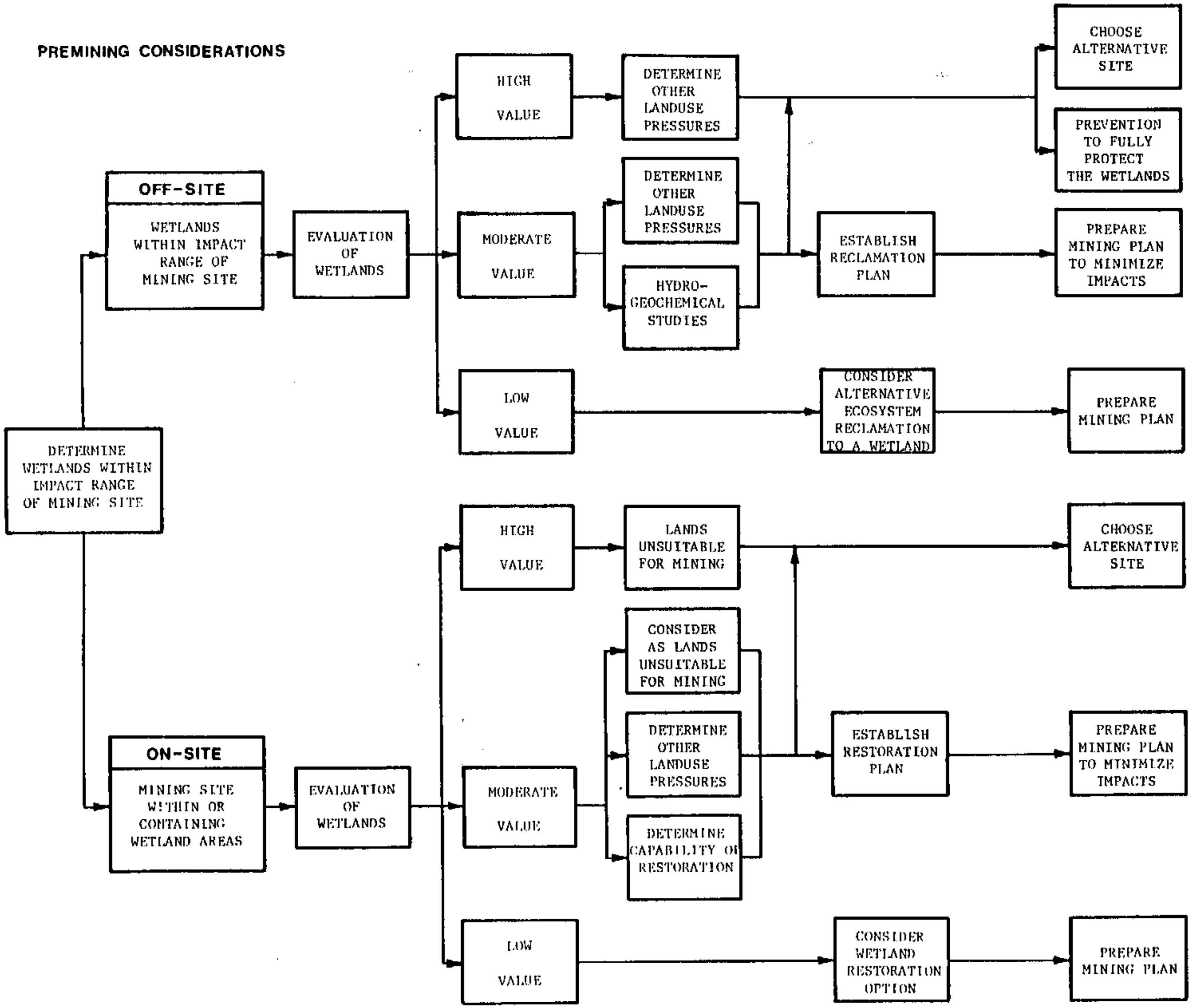


Figure IV-2: A Flow Chart for Determining Course of Action for Wetland Protection.

have not, then an evaluation should be carried out according to the methods discussed in CHAPTER II of this report.

Three categories of wetlands are used in this analysis; wetlands of high value, wetlands of moderate value, and wetlands of low value. Preliminary contact with local wetland-concerned agencies may quickly identify wetlands of high value and those of low or insignificant value. It is the broad range of wetlands that lie in between that will require close scrutiny and further data gathering.

A wetland of high value should be given special attention at this premining stage, it may be clear that the area is of such a high value, that it should be considered as "Lands Unsuitable for Mining". Section 522, of the Surface Mining Act of 1977, states that

> areas...are designated to be unsuitable for mining if reclamation ...is not technologically feasible or economical,...or if the mining would affect fragile natural systems, or...affect renewable resource lands in which mining could result in reduction of long-range productivity of water supply, including aquifers and aquifer recharge areas, or...affect natural hazard lands in which mining could endanger life and property, including lands subject to frequent flooding.

DETERMINE OTHER LAND USE PRESSURES ON THE IDENTIFIED WETLANDS. In watersheds where mined lands are abandoned or not yet reclaimed, or where the wetlands are being stressed by agriculture or logging, further mining might cause added impairments that would damage or destroy the wetlands beyond their recovery levels. Avoiding areas where other land use pressures on wetlands are increasing, or establishing a land use schedule to lessen the intensity of stresses over time should be considered (Harker et al., 1980).

<u>Hydrogeochemical Studies</u>

IF THE PREMINING ANALYSIS CONCLUDES THAT THE AREA IS TO BE MINED, FURTHER GEOCHEMICAL AND HYDROLOGICAL STUDIES NEED TO BE CARRIED OUT.

Geochemical Studies - The level of toxicity that is contained in the overburden must be identified to prevent water and soils contamination. According to EPA (1978) methods for examining overburdens and minesoils, the following three steps are recommended:

1. A geological and soils inventory of soil types and characteristics should be carried out to establish a soils removal plan which will: a) assist in locating areas to be avoided; b) maximize the reclamation efficiency of the site by proper storage and placement of nutrient rich soils; and c) locate toxic soils and determine methods for proper handling and burial.

2. Data should be collected on the regional physical and chemical properties of soil profiles and rock units.

3. Detailed physical and chemical analyses of appropriate samples should be carried out to determine the characteristics of soils and rocks on proposed sites.

Determination should be made of where framboidal pyrites are most prevalent, such as in the far southwestern edge of the coal field in western Kentucky. In these areas of framboidal pyrite, a severe acid mine drainage problem will result from mining in these coal soils. Preventive measures should be taken by either not mining these areas or preparing to contain and treat the acid waters properly before they are released into the ecosystem (Caruccio and Ferm, 1974). Treatment facilities increase reclamation costs. It may be beneficial to the mining operator to place relatively fewers funds into premining geological surveys and avoid mining the areas of highest pyritic content than to pay the much higher costs of acid seepage treatment later.

The acid-base account is a method for evaluating overburdens to predict the potential acid drainage problem and thereby assist in locating and developing new mine sites. The acid-base account method defines any rock or soils as acid-toxic if they contain enough acid producing pyrites to require 5.0 tons or more of calcium carbonate equivalent per 1000 tons of material to neutralize the acid (EPA, 1978).

Hydrologic System - Understanding the hydrology of the area prior to mining aids in: a) better operation of the mine by reducing water related problems; b) proper analysis and construction of sedimentation controls; and c) the development of appropriate grading and reclamation procedures to restore the system to its premining state. The extent of the hydrologic study, according to Wiram (1977), should include:

1. Surface water drainage patterns, flow volumes, and water quality monitoring.

2. Groundwater conditions including aquifer characteristics, water quality, and ongoing groundwater observation systems.

3. In addition, hydroperiod identification and monitoring is necessary, in the case of a wetland intended to be mined.

The situation where wetland mining is proposed is of particular concern, because only great efforts will restore the land to proper hydrologic conditions for wetlands.

If a wetland is mined and it is intended to restore the mined land to a wetland, it is important to know the hydrological conditions of the wetland and its function within the larger watershed. The hydroperiod of the wetland should be monitored and identified. Hydroperiod means the seasonal pattern of water levels within the wetland throughout the year. Some typical hydroperiods for wetlands are shown in Figure IV-3. Knowing the natural hydroperiod, will help to design the necessary water storage and surface

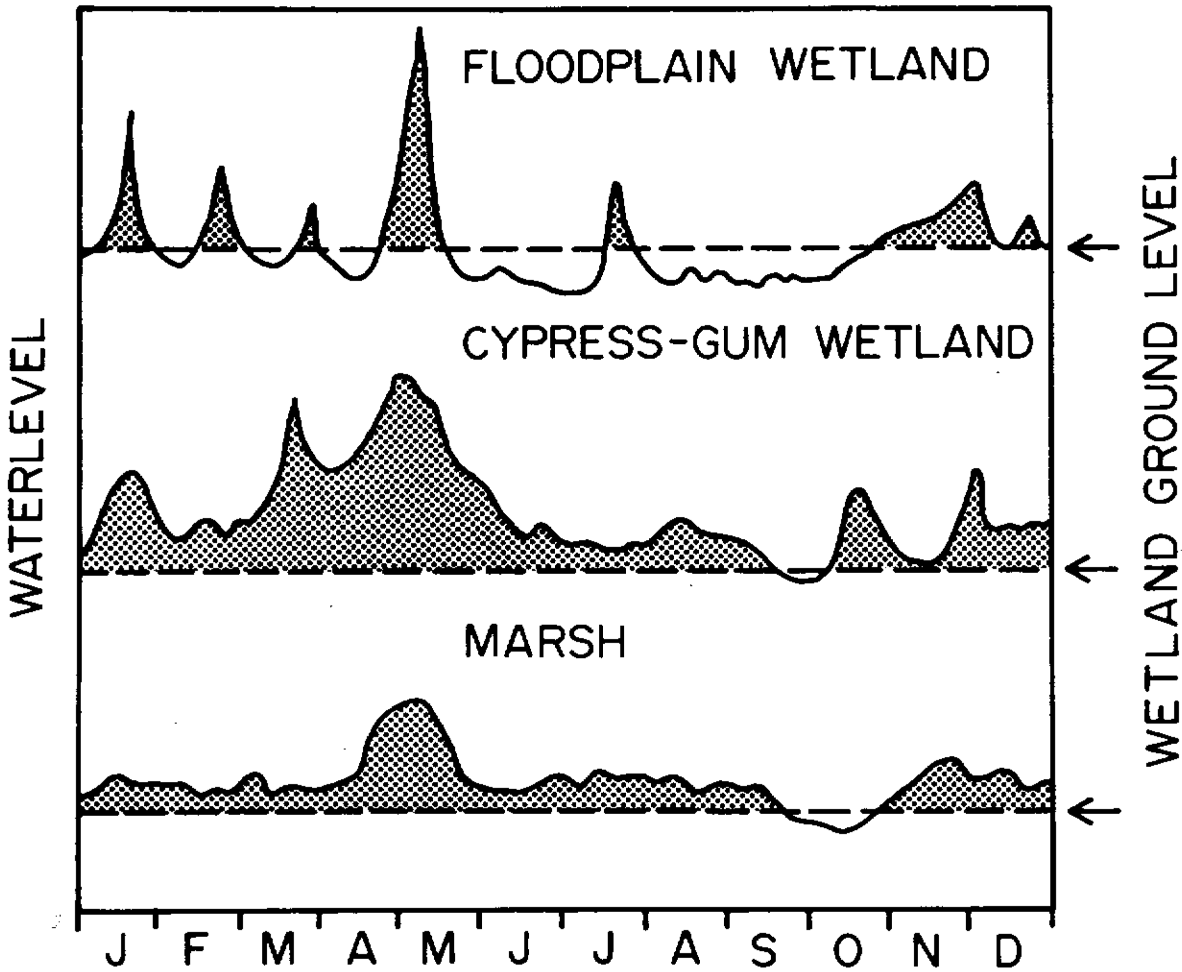


Figure IV-3: Typical Hyrdroperiods for Various Wetland Types features of a restored wetland.

The flood storage capability of a wetland should be investigated before its hydrologic patterns are disturbed. Many of the larger wetland systems in the region provide significant storage capacity during wet seasons and prevent or buffer the effects of flooding on downstream communities. If a wetland is within the mining impact range and it does act as a significant flood control facility, the wetland should not be disturbed or equivalent flood control facilities should be developed.

Groundwater flows and recharge areas should be identified in the analysis of an area to be mined. The impact of mining on wetlands that provide this function must be determined to develop mitigating action or to choose an alternative site. Also, mining may interrupt groundwater flows to downstream wetlands severely interrupting their hydroperiods.

Impacts on off-site wetlands can be minimized by proper design of postmining runoff patterns, which depend on premining hydrologic conditions. Surface water control is a critical part of the mining plan for wetlands protection. The alteration of flow patterns (hydroperiod) is considered one of the most significant deleterious impacts on wetland habitats.

Premining water quality and groundwater monitoring systems should be established. Proper water quality monitoring of both ground and surface waters that leave the mining site is necessary to assure the effectiveness of preventive and mitigative measures developed to protect off-site wetlands.

Biotic Seasonal Patterns

DETERMINE THE SEASONAL ECOLOGICAL PATTERNS OF THE FLORA AND FAUNA WITHIN THE AREA TO BE MINED OR IN THOSE WETLAND AREAS IMPACTED BY MINING ACTIVITY. This information should be considered in planning of the mining schedule so that habitat disturbance is minimized during breeding and nursery periods

(Darnell,1977). Contact should be made with local fish and wildlife offices (such as listed in Appendix A) for more information on local biotic seasonal patterns. On-site mining clearly disturbs habitat, but blasting can be damaging to wildlife on off-site areas, as well.

Buffer Zones and Refugia

THE DEVELOPMENT OF THE MINING PLAN SHOULD INVOLVE SETTING ASIDE LANDS AS BUFFER ZONES AND AREAS OF REFUGE (REFUGIA) FOR WILDLIFE AND VEGETATION. Allowing areas of uninterrupted habitat to remain within the mining site will aid in restoration and reclamation practices. The ability to leave untouched areas is dependent on the extent of land to be mined and the mining arrangement. Allowing for refugia will provide a retreat for wildlife during the habitat disturbance, will act as a cover for wildlife movement across mined areas, and will enhance the reclamation of the land by acting as seed banks. The need for seed banks has been identified in quickening the development of diverse vegetation in wetland reclamation (Adamus and Stockwell, 1983).

Buffer zones surrounding the wetland provide buffering functions as sediment and seepage collectors that protect on-site streams and downstream waters, as well as act as wildlife refuges and seed banks. Wetland vegetation can be particularly suited to this type of buffering. Buffer zones should be untouched and protected by proper sedimentation and acid mine drainage controls. Current buffer zone requirements are 100 feet from a perennial stream or an intermittent stream (30 CFR Part 816.57 1(a), 1983). The riparian wetlands that border these streams can act as valuable resources for the mining operation and for reclamation purposes.

Quality Control and Timing

THE MINING PLAN SHOULD INCLUDE A MEANS OF MONITORING QUALITY CONTROL

FROM THE DESIGN PHASE THROUGH THE RECLAMATION PHASE. Poor engineering, sloppy mining practices and inadequate reclamation work can result in major damages from heavy sediment loads and increased mine drainage, which essentially counteract all of the good intent of the "planned" measures for environmental protection. A quality control monitoring program should include a checking system and an adaptive function.

A quality control program can be easily one of the most beneficial programs to the mining company and for wetlands. The development of a checking system can reduce the cost of reclamation not only by proper planning but by assuring that the varied activities of the mining system are functioning responsively and responsibly; so that intended activities are actually done well and at the right time. Timing is a critical aspect of mining. Coordinated actions that are completed correctly can only improve the overall effectiveness of the mining operation and of the resulting reclamation and environmental protection efforts.

Unexpected events are a common experience in any planned system. The development of a mining plan that is adaptive in nature can allow for unexpected changes, and can maximize intended mining goals and environmental protection efforts. The nature of an adaptive plan implies a methodology for monitoring, so that changes are quickly observed and responses occur with minimal delay.

Regulatory Responsibility

In conjunction with a quality control program built into the mining plan, THE REGULATORY AGENCIES MUST MEET THEIR RESPONSIBILITIES BY PROVIDING ADEQUATE INSPECTION AND ENFORCEMENT OF THE REGULATIONS.

Most environmental protection efforts are carried out by the mining company in direct response to the Surface Mining Control and Reclamation Act

(SMCRA) which requires reclamation. Most mining companies operate at low profit margins and it is their intention to meet the requirements of the law with the minimum of cost and effort. What this means then is a dependency on the regulatory agencies to interpret the law and to define what meets the requirements of the law and what does not. Often these decisions must be made in the field. The regulatory agency must recognize its reponsibility to provide adequately trained and properly supervised field personnel. It is not the purpose of this report to discuss the needs of regulatory agencies; however, it is obvious that efficiency and work quality at the industry level can be assisted by efficiency and work quality at the regulatory level.

Coal Exploration

DURING THE EXPLORATION FOR COAL, AVOID DISTURBING AREAS OF UNIQUE HABITAT AND SCHEDULE TO AVOID BREEDING AND NURSERY PERIODS. The SMCRA regulations specify that persons holding a coal exploration permit must avoid disturbing habitats of unique value to fish, wildlife and other environmental systems, along with several other requirements to avoid harmful effects to the natural condition of the land under exploration (30CFR 815.5). Consideration of habitat disturbance is critical in wetland areas or near to wetland areas. The time of exploration should be chosen to avoid the breeding and nursery periods for the majority of the fish and wildlife. Habitats of endangered or threatened species should be totally avoided.

Mining and Reclamation Plans

THE MINING AND RECLAMATION PLANS SHOULD REFLECT CONSIDERATION OF WETLAND AREAS. All the items previously discussed should be considered in the development of the mining plan. The reclamation plan and the mining plan should be coordinated to assure that protective actions are adequately planned, prepared and carried through. Table IV - 1 lists surface mining

TABLE IV-I

WETLAND PREVENTIVE AND MITIGATIVE ACTIONS FOR EACH MINING STAGE [1]

MINING STAGES	ON-SITE WETLANDS	OFF-SITE WETLANDS
EXPLORATION	-Schedule during off-season for breeding and nursery times.	
	-Restore lands to prevent erosion.	-Same
AREA DEWATERING AND DIVERSION	-Install adequate surface water controls.	-Same
	-Construct on-site impoundments for habitat use.	
CLEARING	-Vegetation removal in phases to minimize exposed area.	-Same
	-Maintain adequate buffer zones and refugia.	-Same
	-Stockpile vegetation for wildlife cover and restoration use.	
TOPSOIL REMOVAL	-Remove in phases as area is mined.	-Same
	-Remove as much topsoil as possible for restoration and reclamation use.	
	-Stockpile seed bank soils for restoration use.	
BLASTING	-Schedule to avoid critical breeding and nursery periods.	-Same
OVERBURDEN REMOVAL	-Avoid mining areas of high toxicity.	-Same
	-Use mining method and pattern to maximize compaction for wetland restoration.	
SPOIL REPLACEMENT	-Bury toxic soils appropriately.	-Same
	-Grade soils and rip surfaces to reduce runoff.	-Same
	-Collect and treat acid mine drainage.	-Same
	-Immediately revegetate and stabilize soils.	-Same
HAULAGE	-Limit tree cutting and filling area to immediate roadways.	-Same
	-Provide proper drainage and and sediment controls.	-Same
SOIL STORAGE	-Grade and stabilize stored soils.	-Same
	-Stockpile on upland areas.	
	-Minimize duration of topsoil stockpiling to maximize seed bank potency.	
RECLAMATION	- Assure proper long term reclamation with revegetation/ soil stabilization.	-Same
	-Restore to wetland.	-Use created wetlands for long term sediment and acid mine drainage control.
POST-OPERATION	-Dismantle haul roads and other facilities.	-Same
	-Provide continued sediment and acid mine drainage control.	-Same
	-Continue revegetation management systems.	-Same
	-Continue monitoring systems.	-Same

[1] Information taken from Carpenter and Farmer, 1981; Dunn and Best, 1983; and Kusler, 1983.

stages and special preventive and mitigative actions that should be addressed in the mining and reclamation plans to protect on-site and off-site wetlands. Many of the items presented are discussed further in the following sections.

MITIGATION

The major methods of mitigating surface mining impacts on wetlands include mining technique alterations, acid mine drainage control, sedimentation control, hydroperiod maintenance, and improvement of quality control systems. The use of best management practices (BMP) for sediment control and acid mine drainage control and treatment is necessary to minimize downstream impacts by applying the latest technology. Contact should be made with state environmental protection departments for current BMP information. Specific methods for developing mined lands for fish and wildlife needs are included in a U.S. Fish and Wildlife Service publication entitled "Best Current Practices for Fish and Wildlife on Coal Surface Mined Lands in the Eastern Interior Coal Region" (citation: Herricks et al., 1982).

If a wetland is being mined, there may be some mitigative actions that will minimize the total destruction of the wetland or will aid in enhancing the final reclamation methods; these actions would emphasize habitat sensitivity and hydrological controls.

Mining Technique Alterations

Alteration of mining patterns, equipment usage and schedules can be used to mitigate impacts. A successful monitoring system will provide information on changes and unexpected problems encountered during the mining process. The quality of the response to problems is dependent on the quality of information available and the proper interpretation of tests and observations.

Acid Mine Drainage Control

APPLY STATE OF THE ART TREATMENT SYSTEMS FOR ACID MINE DRAINAGE CONTROL, both in wetland areas that are to be mined and mining areas that are affecting off-site wetlands. Acid mine drainage control involves: 1) proper handling of overburden and placement of spoil to reduce the exposure of pyrites to the air thereby reducing the production of acid mine drainage; and 2) applying appropriate acid mine drainage treatment systems.

Overburden Handling - Previous discussion on geochemical studies described the necessary testing to be done prior to mining to identify toxic soils. However, during mining, the variation in geology should be followed as mining progresses. Field identification and testing methods should be utilized to determine changes and thereby, alter mining operations to assure proper handling of toxic materials. Using segregation of materials, blending, or a combination should be determined in response to the strata exposed (Sturm et al., 1979). The acid-base account tests previously discussed should help to identify areas where blending would be appropriate. If overburden is properly handled post-operative acid mine drainage problems can be minimized.

Acid Mine Drainage Treatment - In cases where waters leaving the mine site are in need of acid mine drainage treatment to meet water quality standards, some options include:

1. Neutralization with lime in the form of quicklime or calcium hydroxide. Lime has been used extensively either by spraying with a slurry, hand or drip feeding into ponds or channels for batch neutralization, or by constructing treatment plants. Lime treatment systems can be expensive and require a source of electricity.

2. Recent usage of flow through treatment plants utilizing sodium

hydroxide or soda ash as the neutralizing agents has met with success. Sodium hydroxide is more expensive than lime, but is 100% reactive and the system does not require electricity, which may mean overall savings.

3. On refuse piles and other raw areas the use of bactericidal treatment has been recently tested (Kleinman & Erickson, 1982). Sodium Laurel Sulfate (SLS) is a detergent that is effective in inhibiting the growth of iron-oxidizing bacteria. It is this type of bacteria that contributes to pyrite oxidation and acid mine drainage problems. Application rates and conditions are dependent on soil adsorption capacity, the location of the pyrite materials, the compaction levels in the overburdens, and dry weather. This method is still experimental and needs further testing before use, especially in mined areas near wetlands, to check SLS runoff affects on wetlands.

4. The use of wetlands as treatment systems is discussed later in this chapter, under Alternative Ecosystems.

Sedimentation Control

APPLY STATE OF THE ART METHODS FOR SEDIMENT CONTROL. Erosion and soil loss cause downstream sediment problems. Control of sediments is dependent on stormwater runoff control and proper sediment entrapment.

Stormwater Runoff Control - Runoff control can be achieved through vegetative and structural practices, construction measures that control the location, volume, and velocity of runoff, and the scheduling of mining operations to minimize seasonal storm fluctuation problems (EPA, 1976).

Reduction of runoff water can be achieved by minimizing the expanse of area exposed to surface runoff. Proper scheduling of clearing, grading, and revegetation is necessary to reduce the quantity of exposed surface area at any time during the mining process.

Detention of runoff water is aided by grading and shaping of the soil surface. Minimizing the grade at the base of slopes will reduce erosion and trap sediments from upper portions of the slope. This technique may mean that returning to approximate original contour is not appropriate in cases of originally steep slopes. Soil surfaces can be shaped by chiseling, ripping, gouging, or furrowing; each done along the contour of the graded surface. Studies done in western Kentucky showed that minesoil surfaces which had been ripped, greatly increased the surface ability to detain runoff and also improved revegetation (Barnhisel, 1977).

Interception and diversion of stormwater is necessary to isolate runoff from on-site critical areas, such as raw spoils, access roads, steep or log slopes, and highwalls. Diversion ditches around these areas can be effective in intercepting and directing runoff to an area or structure where it can be adequately handled.

Soil stablization achieved through vegetative and non-vegetative means can prevent soil erosion. Vegetative stabilization involves the planting of grasses, legumes, shrubs, and trees depending on the soil and moisture conditions, climate, and the post-mining land use. By preserving areas of natural vegetation in the buffer zones, runoff will be slowed and some sediment trapped. Non-vegetative coverings include mulches, gravel, riprap, jute netting and chemical emulsions. Usually a combination of vegetative and non-vegetative stabilizers are used to accomodate both short term and long term needs.

Sediment Collection - Sedimentation ponds and traps should be used to collect sediments before water leaves mining areas. The use of sedimentation ponds have had varying degrees of success. The critical concerns for proper functioning include: 1) adequate sizing; 2) timely and adequate maintenance; and 3) the utilization of improved sediment trap technology, including the use of baffles, inlet flow devices and outlet controls (Ettinger, 1980). A key to maintenance and cleaning of ponds is a high quality and strictly followed monitoring system.

Haul Roads - Haul roads can be major sources of sediments into nearby waterways. Haul roads should be constructed on upland areas with a minimum distance of a 100 feet filter strip between the road and streams or wetlands. Several routes should be evaluated to determine the best possible locations with minimal impacts. The filter strip acts as a vegetative buffer area. Soils that have been overcast should be seeded for stabilization, or sediment catch basins constructed. Surfacing materials should not contain any toxic soils. Drainage structures should be properly designed. Maintenance includes regrading the surface to keep its original shape and slopes, and maintaining drainage systems. Haul roads should be properly dismantled after mining is completed by regrading and ripping road surfaces, and establishing a vegetative cover (Grim and Hill, 1974).

MANAGEMENT TECHNIQUES FOR RECLAMATION

Two conditions exist in mining reclamation: 1) that of abandoned mined lands (AML, those that were mined and inadequately reclaimed prior to 1977); and 2) that of lands mined since 1977. In the case of AML, the responsibility for reclamation currently lies with the State/Federal commitment to utilize those monies from the SMCRA created Reclamation Fund. This fund is being built from a fee paid by the coal industry on every ton of coal mined for a fifteen year period (through 1992). It is then the federal government and the individual State agencies assigned to carry out the AML program who must review each AML reclamation plan and apply the methods discussed here for wetland protection and enhancement.

In the case of lands that have been mined since 1977, many of these lands have been successfully reclaimed within the guidelines established by the law and regulations. Others have not. Mined lands that have not been reclaimed successfully remain under bond until reclamation requirements are met. It is suggested that the following conditions may contribute to improper reclamation:

1. Low profit margin for coal mining operation. Money making or losing is a strong motivator for action or inaction.

2. Unexpected changes of events, such as, a turn in the market value of coal, unanticipated site problems, a worker's strike.

3. Inadequate regulatory staffing/materials to meet enforcement demands.

4. The perception that the value of coal is higher than the value of the environment or vice versa.

The first three items can be dealt with from the manipulation of materials/money and supply/personnel. But none of these problems can be solved without squarely facing the fourth reason - one of values. The solution is not easy. Some would say that this little bit of hurt in the coalfields of western Kentucky, Illinois and Indiana is not significant compared to the good that comes to a broader population through the service of energy/electricity. Others would say that the loss of the quality of life for those living within and near the coalfields is the result of insensitivity and can not be tolerated. The reality is that one cannot be valued over the other; both a healthy environment and the mining of coal play a meaningful role in the overall functioning of the natural, political, social and economic systems. Consequently, our perception of the roles of coal and environment must change to how they can function cooperatively to benefit the greater system; and from this new perception, produce actions within the first three concerns discussed above to meet those needs.

The reclamation management options available to AML and lands mined since 1977 include:

<u>Rehabilitation</u>

This method of reclamation involves the most common form that is practiced today. Spoils piles are regraded, highwalls are reduced, topsoil is replaced, and the area is revegetated to meet the needs of the predetermined postmining land use. Essentially, rehabilitation returns the mined land to a state that is intended to prevent further disturbance to the biotic and abiotic systems. Usually, the land is left in an "old field" environment, with the intention that natural succession processes will eventually takeover.

State of the art methods for rehabilitation should be followed to protect downstream wetland areas from continued acid mine drainage and sediment problems. In addition, revegetation methods are a vital part of successful long term rehabilitation of mined lands. The types and methods of vegetative cover vary according to minesoil characteristics, post-mining land use, climactic conditions, and long term management plans.

<u>Revegetation</u> - Off-site impacts of mined areas can be reduced by prompt and stabilizing revegetation practices. Many references are available on methods for choosing plant types and establishing planting schedules to minimize exposed areas.

Where significant wetlands are being mined, the wetland vegetation should be restored, as discussed below. Where wetlands are near the mining site, revegetating to meet fish and wildlife needs should be considered. In planning to meet fish and wildlife needs, a good interspersion of vegetative types helps establish more "edge" systems. Edge environments provide food, nesting sites, and cover for travel or escape routes, and are created by a combination of strip, border and clump plantings in and around open areas. Contact should be made with local and U.S. Fish and Wildlife Service people for more information on revegetation types and methods.

If a wetland is to be mined it would be preferable to restore it to a wetland; however, if it has been evaluated as not significant, a possible postmining land use would be as a prime agricultural area. In this case the quantity of topsoil removed should be increased to save as much of these rich soils of the wetlands as can be physically stored within the mining property.

Restoration to a Wetland

After mining is completed, the original ecosystem of the mined land is restored to its premining condition. In our region of study this method may find some applicability. The restoration of a mined wetland means that the following parameters must be considered in the reclamation plan: controlled hydroperiod, pH balance, sediment control, an adequate revegetation plan that includes management needs over the long term, and sufficient seed and wildlife sources for the eventual restoration to a wetland.

Wetland restoration technology is in its infancy. Several areas of the country are attempting to restore wetlands; in the phosphate-mined floodplains of Florida, the lignite-mined potholes of the plains states, and in the riparian lands adjacent to relocated stream channels in coal-mined areas of Illinois and Indiana. The greatest commmon problem in these projects is the hydrologic considerations. A wetland must have just the right amount of water to maintain the plant and animal species that are specific to that type of wetland; for example, if there is too much water, the floodplain wetland habitat changes over to that of a swamp; or if there is too little water there is no wetland at all.

Proper premining analysis and planning is necessary to address the hydologic and revegetation concerns of wetland restoration. The need for further reseach and experimentation in wetland restoration is great. The existing information provides some ideas that may lead to successful restoration including (Carpenter and Farmer, 1981; Dunn and Best, 1983; Hey, 1982; Ruesch, 1983; and others):

1. In an attempt to restore the flooding elevation of bottomland wetlands, the method and patterns of mining and the type of equipment used should be considered to help replace and compact the spoil to close to original elevations. The use of the modified block-cut area mining method may contribute to better a compaction rate in areas where the coal seam is within 40 to 50 feet of the surface.

2. The plan for removal, storage, and redistribution of subsoils is an important key in rebuilding a wetland.

3. Vegetation removed from the wetland should be stockpiled for use as wildlife cover during mining activity and for use as structural building material for wetland restoration.

4. It is important to store the bottom soils of the wetland as seed banks and the substrate soils for restructuring the water bearing capacity of the wetland.

5. Topsoils should not be removed until it is necessary. Elimination of lengthy periods of stockpiling of topsoil helps to improve the survival of seeds that are naturally occurring. Seed banks in the top soils of wetlands are invaluable sources of plant life, which can increase the rate and diversity of revegetation.

6. Revegetation should include a mixture of wetland types, including scrub-shrub, woodlands, and emergent types. Long term revegetation plans may

be necessary to give proper direction to the intended wetland vegetative system.

Figure IV - 4 shows a hypothetical wetland in its premining, mined, and restored states. The information provided in this figure is not to be taken as the way to restore a wetland, as it has not been tested. It is offered as a means of explaining some techniques that may help in developing the technology of wetland restoration. Further information on restoring wetlands can be drawn from the discussion on creating wetlands as alternative ecosystems as presented below.

Alternative Ecosystems

Recent investigations into management options for reclamation of mined lands has included the possibility of developing a specific ecosystem that is not a restoration of the original ecosystem, but involves the development of a different type of system that may provide a useful purpose or fit some need of the community.

In developing an alternative ecosystem the SMCRA regulations require that the following be met (30 CFR 817.133):

...There must be a reasonable likelihood of completing the proposed use.
...The use must not present any hazard to public health or safety, or threaten the quality or quantity of the water supply.
...The proposed use must be practical and reasonable, consistent with applicable land use policies and plans, capable of being implemented without unreasonable delay, and consistent with the Federal, State, and local law.

Creating Wetlands - The building of a wetland as an alternative ecosystem in the region of study should be considered as a viable management option. This option includes developing an existing degraded wetland. Wetlands should be constructed for one or more specific functions to meet

SURFACE MINED WETLAND RESTORATION

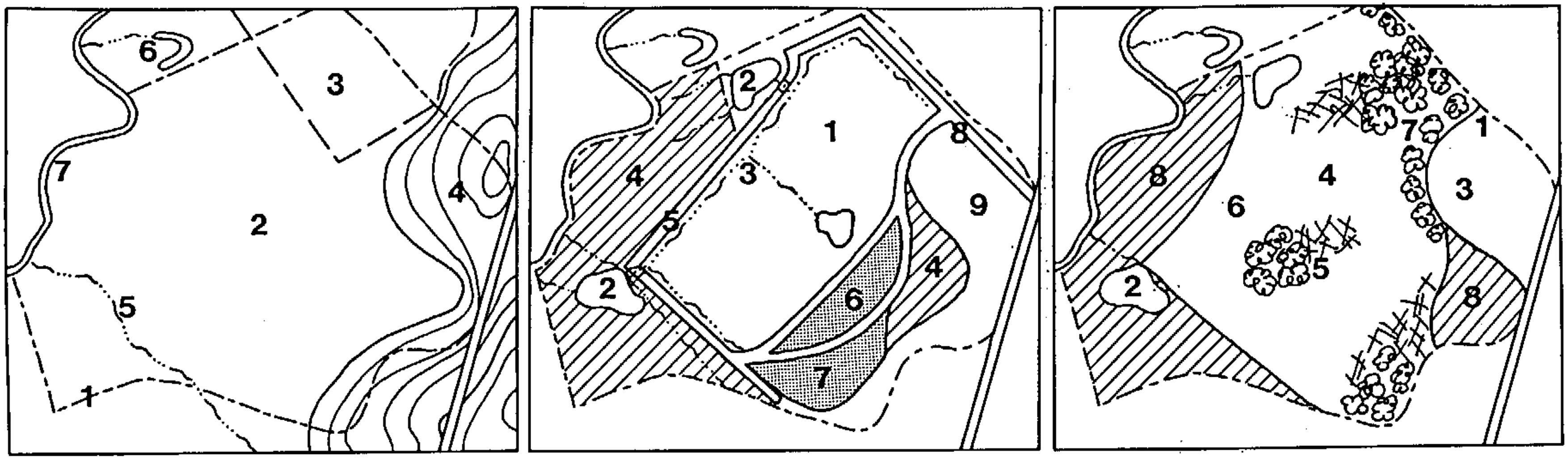


Figure IV-4: Hypothetical Wetland Restoration: Premined, Mined, Restored

Premined

1 Mine Area Boundary
2 Forested wetland
3 Farmed Area
4 Uplands
5 Intermittent Stream
6 Natural Oxbow
7 Perennial Stream

Mined

1 Active Mining Area
2 Sedimentation Ponds
3 Wetland Drainage System
4 Buffer Zones and Refugia
5 Embankments and Roads
6 Spoil Storage
7 Topsoil Storage and Seed Bank
8 Haul Roads
9 Ancillary Facilities

Restored

1 Dismantled Haul Roads
2 Sediment Ponds Converted to Wildlife Open Water Areas
3 Reclaimed Uplands Used to Place Extra Spoil
4 Regraded to Original Elevations or Hydrologic Controls Built to Create Saturated Conditions
5 Construction of Varied Landforms with Previously Cleared Vegetation
6 Replaced Topsoils and Seed Banks
7 Revegetated with Trees, Shrubs, and Typical Wetland Vegetation
8 Natural Areas Maintained

reclamation needs and could, at the same time, provide for possible area needs such as:

...Fish and wildlife habitats. It has been well known that some of the best fish producing waters in western Kentucky are the old, thirty years or more, mining pits (Morton,1983).

...Wastewater treatment systems for small communities or industries that need more advanced treatment systems, but cannot afford expensive mechanical systems.

...Flood storage and control.

...Interface systems that may help to mitigate the impacts of surface mining on downstream aquatic systems.

...Abandoned mined land reclamation

If one were to create a wetland to be used for any of these purposes the major parameters that must be addressed include, controlling hydroperiod, balancing pH, establishing vegetation, and developing a long term management plan. Some specific activities include (Carpenter and Farmer, 1981; Hey, 1982; Rosso and Walcott, 1977; and others):

1. Create a flooded environment through the construction of dams or levees, with flexible water levels. Also, on some mined lands, seeps may be collected and carried to a lowlying area to establish a continuously water fed region. Some acid mine drainage treatment may be necessary to increase the pH; however, the created wetland itself may become the acid mine drainage treatment system. Further discussion of wetlands as interface systems is presented below.

2. The creation of smaller systems of wetlands may be more attractive to wildlife use as cover and nurseries, than larger systems.

3. Regrade surface to uneven contours and construct scattered

islands with previously cleared vegetation to increase spatial and habitat diversity.

4. Create shallow water margins to encourage emergent vegetation.

5. Revegetate with selected plantings of locally adapted wetland species. Some success on establishing wetland species has resulted from placing bottomland soils removed from other wetland regions to act as seed banks.

6. Establish a monitoring program to follow water quality, water table levels, groundwater flow, wildlife utilization, and affects on vegetation.

WETLANDS CREATED OR ENHANCED THROUGH MINE RECLAMATION CAN PROVIDE SIGNIFICANT FISH AND WILDLIFE HABITATS. Water, food and cover are the essential ingredients to meet the needs of aquatic and terrestial animal life.

A wetland habitat for fish and wildlife is a diverse system of open water, emergent zone habitat and bottomland forests. Open water is necessary as habitat for waterfowl and fish. Sedimentation ponds and other water bodies inside the mined area, after mining is complete, can continue to trap sediment and also can be developed to encourage usage by wildlife, along with other uses. Converting ponds for wildlife use after mining includes creating gently sloping shorelines for emergent vegetation, using logs, rocks, or hay bales in open water for preening and sunning areas, some fencing off to protect areas from grazing of larger animals, and vegetating surrounding areas with food species. Peabody Coal Company and others have established several wetland option areas on reclaimed lands in western Kentucky by converting water bodies and revegetating with food species (Rosso and Walcott, 1977).

Restoring riparian areas along relocated or damaged stream channels not only stabilizes the stream banks, but provides wildlife cover, breeding habitats for fish, and food. Regrading to shallow slopes and planting typical vegetation are the techniques employed. Contact should be made with the Soil Conservation Service for information on stabilizing stream banks with vegetation. The Illinois Soil Conservation Service has established guidelines for "retaining, creating, or managing wetland habitat for wildlife", as part of program to restore shallow water areas that have been lost through siltation from agricultural use (SCS-IL, 1982).

WETLANDS CAN BE USED TO RECEIVE AND FILTER EFFLUENT FROM WASTEWATER TREATMENT FACILITIES. In reclaiming mined areas the construction of wetlands for use in wastewater treatment could prove to be beneficial to nearby communities who are in need of improved wastewater treatment systems and who can not afford the mechanical models. Wetlands have been used for additional treatment and as effluent receivers where there is no stream or where the stream is protected from discharges. In Florida, Michigan, New York, California, and other areas wetlands have proven to be effective treatment and filtering systems. Short and long term impacts have been investigated by EPA These wetlands can be designed with specific vegetation such as cattails, or with diverse vegetation to attract fish and wildlife usage (Dinges, 1982).

WETLANDS CAN BE USED TO STORE FLOOD WATERS TO PROTECT DOWNSTREAM AREAS. Although it is unlikely that a wetland would be constructed for the sole purpose of flood protection, it is a valuable secondary use, and has been applied as a main reason to keep a wetland rather than destroy it. The U.S. Army Corps of Engineers purchased a system of wetlands to continue their function of flood control on the Charles River in the Boston, Massachusetts area in lieu of constructing expensive flood control structures (U.S. Army

Corps of Engineers, 1972).

The necessary measures for constructing a wetland for flood control is to determine the needed volume of water storage, and design the size of the wetland to hold flood waters. Wetlands function in such a manner that shallow, wide areas that are heavily vegetated with diverse wetland types slow water flow and store water during heavy seaonal flooding periods, then acts as surface and groundwater recharge systems during drought periods. Developing wetlands to act as flood control is in need of study to determine actual design criteria.

WETLANDS CAN ACT AS INTERFACE SYSTEMS TO REDUCE THE IMPACT OF SEDIMENTS AND ACID MINE DRAINAGE ON DOWNSTREAM ENVIRONMENTS. The control of sediments and toxic runoff from mined areas through wetland systems can be effective as long term solutions to problems in active mine areas as well as in abandoned mined areas. Often an existing wetland, created accidentally in the mining process, may already be functioning as an interface system; and with proper monitoring and management can be improved and act as an acceptable means of lessening the impacts of mining.

Sediment containment in a wetland depends on its flushing capacity. The grades, contiguity, wind exposure, surface area and depth contribute to the determination of flushing capacity. If sediments remain only a brief time within the wetland, there is less chance that increased sediment loads will affect the plant and animal life in the wetland. However, sediments can remain in a wetland without negative impacts if the load volume is small compared to that of the wetland. It is important to know the existing suspended sediment condition in the standing water of the wetland to determine its capacity to hold sediments without negative impacts. A careful analysis of the use of wetlands for these purposes is necessary to assure that a wetland is actually functioning in such a manner rather than simply delaying the transporting of sediments to downstream areas without decreasing the load.

Recent investigations into the use of wetlands for acid mine drainage treatment have taken place in the West Virginia and Pennsylvania coal mining regions. Spaghnum moss and bog type wetlands, which are themselves slightly acidic in nature, have shown the capability of reducing sulfates in acid mine runoff and seepages. The wetland acts as a biomass filter, and it is believed that the sulfate reducing bacteria naturally present in the wetland are the active workers (Wieder and Lang, 1982; Kleinman et al., 1983). Further research is needed to determine the use of wetlands for acid mine drainage treatment in the wetland types commonly found within our region of study. Typha (cattail) marshes show adaptability to acid conditions and may prove to be useful as treatment systems.

WETLANDS COULD BE USED TO AID THE RECLAMATION OF ABANDONED MINED LANDS. Past and current mining practices have resulted in the creation of undesirable swamps with pH of 3.0 or lower. Also, on relatively flat and poorly drained areas large strip mines and sediment blocked channels can create swamp-like conditions upstream (KCNREP/DAL, 1981). Current regulations require that stripped areas be properly reclaimed; however, the condition of acid mine drainage and increased sediment loads to downstream channels continues from both abandoned mined lands and from some of those currently being mined. It has been estimated that in Kentucky approximately 30,000 acres of land has been effected by swamping from mining operations and that this continues at a rate of 500 to 1000 acres per year (KCNREP/DAL, 1981). These swamps are considered undesirable because of their acid conditions which limits species diversity and consequently their potential use as wildlife habitats or for any other purpose.

In reclaiming abandoned mined lands that have or are creating swamps, a system of converting these swamps to desirable wetlands with diverse species should be considered. Some experimentation with converting tailing ponds to wetlands has begun. The work done in Illinois (Nawrot and Yaich, 1982) have used naturally occurring vegetation (reedgrass) to establish cover and reduce toxicity of inoperative slurry ponds. This method precludes the need to cover tailing ponds with topsoil as is presently required by SMCRA regulations, and ordinarily could not be used as an acceptable reclamation practice. A current research project is underway which hopes to develop a more diverse wetland on a slurry pond using the "experimental practices" section of the act. Using wetland development for abandoned mined land reclamation has the potential to save millions of dollars in reclamation costs. The successful results of current and needed research must be matched with adaptibility in the laws and regulations.

Natural Reclamation

Observations of mined lands that were not reclaimed after mining was completed, have revealed that over the long term (thirty to forty years) the land has established a vegetative cover and may be better left alone to continue along the natural succession process; although there may be some management methods that can improve this very slow rate of succession. The natural reclamation process is most likely to occur on spoil piles where the acid and toxic conditions have been neutralized overtime through erosion and by the leaching of toxics into the soil substrates, thereby giving the surface soils a chance to grow whatever seeds happen to come their way. In examining abandoned mined lands that may have been wetlands or are impacting wetlands, this option should be investigated, since it is possible that major rehabilitation work on naturally reclaimed lands may cause the negative impacts to worsen.

A study done on a 43-year old naturally reclaimed site suggests various actions: 1) to improve succession rate by some management of vegetative species, namely by creating some open areas in dense shrub and herbaceous growth that inhibit tree growth and by planting trees in those openings; 2) to allow the suppressed rate of natural selection to continue without interference, since the site may already be supporting wildlife (Haynes, 1983). The lack of hardwood seed sources at the appropriate times in the succession process may have limited the establishment of these needed trees to carry the land into a higher rate of natural succession. This means that it is important to leave buffer zones and some lands with the natural vegetation in the area to aid in long term reclamation of mined sites.

A study done in North Dakota (Wali, 1983) recommends that the hardy weed species that can endure stressed environments of unreclaimed lands should not be destroyed to make way for seeded vegetation in the process of reclamation, but should be allowed to remain since these species act as a good "nurse crop" and eventually diminish as the soils improve and allow for other species to grow. There is need of a similar study of the naturally reclaimed areas in the Illinois Coal Basin to determine what management options are available that can aid in natural succession. Specifically, one can notice that on the pond edges and in the swamps of abandoned mined sites the first species to take hold is *Typha.* They may well be acting as a nurse crop and as a buffering system for downstream water quality; if properly monitored and managed can lead the way to developing a more diverse and useful wetland ecosystem.

ACTIONS FOR EACH MINING CONDITION

As a means of summarizing protection methods, a brief discussion of actions that can be initiated at any point in the mining process is presented below.

Permitting and Premining Period - This period of the mining process is critical in protecting wetlands. Identifying and evaluating significant wetlands within the range of impact of the proposed mine is a necessary step towards the development of adequate wetland protection methods. Premining studies to determine location of toxic soils, surface and groundwater flows, and seasonal patterns of plant and animal life and more, are needed to establish a sound mining and reclamation plan. Quality control measures should be developed in this phase to assure that actions are carried out as planned and to provide a means for quick response to unexpected events.

Active Mining Period - Determination of significant wetland areas within the range of impact of the mine should be made, if such a determination was not made during the premining period. The methods of water and sediment control employed in a currently active mine should be investigated as possible sources of wetland degradation. Also, the method of mining as it relates to acid spoil placement, sediment control and runoff control should be reviewed. The mining plan should be reviewed to minimize habitat disruption from blasting and earth moving during critical wildlife breeding and nursery periods.

Reclamation Period - Reclamation is best performed concurrently with mining. The concerns during the reclamation phase would include timing to promote rapid establishment of cover, the style and type of revegetation planned, and the long range methods for sediment and acid mine drainage control.

If a wetland is being mined, complete or partial restoration should be considered to lessen the rate of wetland loss in the region. Also, creating wetlands on other mined sites, especially those that have been abandoned, can be a means of developing wildlife habitats, interface systems for acid mine drainage treatment and sediment collection, flood control systems, or wastewater treatment systems.

Post-operative Period - Often the post-operative period can be the most detrimental. Proper dismantling of haul roads, continued sedimentation controls, continued surface and groundwater monitoring of sediment and acid mine drainage should be carried out for proper wetland protection.

Abandoned Mined Land Condition - The problem of reclaiming abandoned mined lands is a large one. Those state agencies and contracted consulting engineers should identify the wetlands that are being impacted from an abandoned mine land. Acid seeps and continued sedimentation from abandoned mined lands are major sources of wetland degradation. Many abandoned lands have acid impoundments, coal tailing basins, and final pit impoundments that are essentially created wetlands. Most of these are of poor quality. Application of what is currently known about wetland ecology to improve and develop these created wetlands into useful balanced ecosystems, should be considered. Also, wetlands are beginning to be used as treatment/interface systems to buffer the effects of acid drainage and sedimentation on downstream waters.

CHAPTER V - LEGAL AND REGULATORY CONSIDERATIONS

FEDERAL GOVERNMENT POLICIES AND LAWS

Some of the significant activities in the Federal Government that led to a consistent inland wetland protection policy have included presidential orders on wetland protection and floodplain management, implementation of a dredge and fill permit system to protect wetlands, and separate initiatives and regulations by various agencies. A summary of the primary wetland protection mechanisms in the Federal government is given in Table V-1.

Presidential Executive Orders

President Jimmy Carter issued two executive orders in May 1977 that established the protection of wetlands and riparian systems as an official policy of the Federal government.

Executive Order 11990, Protection of Wetlands - This order requires all Federal agencies to consider wetland protection as an important part of their policies:

> Each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for (1) acquiring, managing, and disposing of Federal lands and facilities; and (2) providing federally undertaken, financed, or assisted construction and improvement; and (3) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

Executive Order 11988, Floodplain Management - A similar Federal policy for the protection of floodplains is established by this order, requiring agencies to avoid activity in the floodplain wherever practicable. Agencies

TABLE V-1

Federal Laws, Directives, and Regulations that Have Been Used for the Management and Protection of Wetlands (1)

DIRECTIVE OR STATUTE	DATE	RESPONSIBLE AGENCY
Executive Order 11990 Protection of Wetlands	May, 1977	All agencies
Executive Order 11988 Floodplain Management	May, 1977	All agencies
Federal Water Pollution Control Act, as amended	1977	
Section 404 - Dredge and Fill Permit Program		Army Corps of Engineers in cooperation with Environmental Protection Agency and U.S. Fish and Wildlife Service
Section 208 - Area-wide Water Quality Planning		Environmental Protection Agency
Section 303 - Water Quality Standards		Enviromental Protection Agency
Section 402 - National Pollution Discharge Elimination System		Environmental Protection Agency (or state agencies)
Surface Mining Control and Reclamation Act	1977	Office of Surface Mining (or state agencies)
Flood Disaster Protection Act	1973 and 1977	Federal Emergency Management Agency
Land and Water Conservation Fund Act	1968	Fish and Wildlife Service, Bureau of Land Management, Forest Service, National Park Service
Federal Aid to Wildlife Restoration Act	1974	Fish and Wildlife Service

(1) taken from Mitsch and Gosselink, 1984 (under preparation)

are directed to revise their procedures to consider the impact that their activities might have on flooding and to avoid direct or indirect support of floodplain development when other alternatives are available.

Clean Water Act: The 404 Program

Section 404 of the Federal Water Pollution Control Act (FWPCA) Amendments of 1972 (PL 92-500) and the 1977 Amendments (also known as the Clean Water Act) set into motion a broad-ranging program that has become the Federal government's primary tool for protecting wetlands. Section 404 of FWPCA gives authority to the Corps of Engineers to establish a permit system to regulate the dredging and filling of materials in "waters of the United States." The definition of waters of the United States was, at first, interpreted to mean only navigable waters, but was expanded in a 1975 court decision Natural Resources Defense Council v. Calloway to include wetlands. This court interpretation, along with the Executive Order 11990 on Protection of Wetlands, has placed the major responsibility for wetland protection on the Corps of Engineers.

The 1982 revised regulations issued by the Corps for the 404 Program, specifically requires consideration of the effects on wetlands during the review of permit applications. The general policy of the Corps states that:

> (1) Some wetlands are vital areas that constitute a productive and valuable public resource, the unnecessary alteration or destruction of which should be discouraged as contrary to the public interest.
> (4) No permit will be granted which involves the alteration of wetlands identified as important...unless the district engineer concludes on the basis of...analysis, that the benefits of the proposed alteration outweigh the damage to the wetlands resource (33 CFR Part 320.4 (b), Federal Register, July 22, 1982).

The definition of freshwater wetlands as developed by the Corps has been included in CHAPTER I - INTRODUCTION of this manual. Also, these regulations give information on what constitutes an important wetland based on their functional use. Wetland evaluation is discussed in detail in CHAPTER II - WETLANDS. Currently the Corps is undecided on the approach they will use to determine wetland value; however, they are most interested in the method developed for the Federal Highway Administration, which is also discussed in CHAPTER II.

These regulations are currently under review. Contact should be made with local Corps of Engineer District offices for the latest information on wetland protection.

Surface Mining Control and Reclamation Act

The Surface Mining Control and Reclamation Act (SMCRA) was passed in 1977 in direct response to the need for a comprehensive act that would require the proper and quick reclamation of surface mined lands. All lands mined before the act are not subject to the reclamation requirements established by the act. Those lands that were not adequately reclaimed and mined before the 1977 act are considered to be abandoned mined lands. Reclamation of these abandoned lands are specifically addressed in the act, as will be discussed further. Several sections of the act (SMCRA) are relevant to wetland protection and development.

Fish and Wildlife Protection: Section 515(b)(24) - Under environmental concerns the act states that:

> to the extent possible using the best technology currently available, minimize disturbances and adverse impacts of the (mining) operation on fish, wildlife, and related environmental values, and achieve enhancement of such resources where practicable.

The regulations promulgated by the act describe fish and wildlife protection through the protection of their habitats, namely, wetlands. The most recently revised regulations, 30 CFR Parts 816 and 817, include statements on stream buffer zones and the protection of fish and wildlife habitats and related environmental values. Specifically Section 816.97(f) states that

> The operator conducting surface mining activities shall avoid disturbances to, enhance where practicable, restore, or replace, wetlands, and riparian vegetation along rivers and streams and bordering ponds and lakes. Surface mining activities shall avoid distrubances to, enhance where practicable, or restore, habitats of unusually high value for fish and wildlife (Federal Register, June 30, 1983).

Wetlands are defined in these regulations in accordance with the existing definition developed by EPA and the Corps of Engineers for the Section 404 program.

Endangered and threatened species, bald and golden eagles, and their habitats are also protected under Section 816.97(b,c,d). Often these habitats are located within wetland areas. Within the region of study, bald eagles are registered as endangered species.

Title V of the act generally deals with control of environmental impacts of surface mining, as well as its concerns for fish and wildlife habitats. Also, included in this part of the act are application requirements; the most significant of these include: identification of adjacent land uses, coal and overburden characteristics, a full description of on and off-site hydrologic affects of mining including water quality of ground and surface waters, maps showing surface and subsurface features, and the mining operation plan for the entire life of the mine. The act does not require the applicant to assess the probable cumulative impacts of mining on environmental concerns; this is considered regulatory responsibility (Harvey, 1978).

<u>Lands Unsuitable for Mining Clause: Section 522 (a)(2 and 3)</u> - If a land area can not be reclaimed within technological and economical feasibility then the regulatory agency can determine this land to be

unsuitable for mining. Other criteria include: incompatibility with State and local land use plans, affecting lands where there would be significant damage to important historic, cultural, scientific, and esthetic values and natural systems, affecting substantial losses in renewable resource lands such as aquifers and aquifer recharge areas, and affecting natural hazard lands such as areas subject to frequent flooding.

Some wetland areas within the region of study should be considered probable candidates for lands unsuitable for mining. Contact should be made with Fish and Wildlife agencies, local conservation groups, and others of concern as listed in Appendix A, for information concerning those lands that may be considered as unsuitable for mining.

Abandoned Mined Lands: Title IV - This section of SMCRA addresses the concerns of reclaiming abandoned mined lands. Although wetland protection is not mentioned in this section, it is through the reclamation of abandoned lands that wetlands will be protected.

The main purpose of this section of the act is to set up a reclamation fund to provide the resources needed to reclaim abandoned mined lands. These funds are accumulated by assessing a reclamation fee on every ton of coal extracted from the earth from both surface and deep mining operations. The resulting Reclamation Fund is appropriated back to those states that have approved abandoned mined land reclamation programs. Up to 50% of the fees paid out of each state is to be returned through this program. From the inception of the act in 1977, fees will be collected until 1992. It has been estimated that over $3 billion dollars will be collected over the fifteen year life of the reclamation fund. However, the total cost of correcting the damage associated with past mining has been estimated to be up to $30 billion dollars (OSM, 1983).

Experimental Practices: Section 711 - This section of the act allows for departures from the regulations to allow for experimental projects.

> To encourage advances in mining and reclamation practices or to allow post-mining land use for industrial, commercial, residential, or public use (including recreational facilities), the regulatory authority may authorize departures in individual cases on an experimental basis from environmental protection performance standards promulgated under sections 515 and 516.

These departures would be authorized with several conditions that require continued protection of the environment and the health and safety of the public. An area that is a good candidate for application of this section of the act is the restoration or enhancement of wildlife habitats (Cooper, 1983). If a wetland is to be created with the post-mining use as a wildlife habitat, interface system, treatment system, flood control system or any combination of these, this section of the act should be investigated. Application of methods using wetlands that are created on mined areas could reduce costs of reclamation and long term management, and at the same time make significant headway in new technologies, as long as proposed activities are well planned, monitored and documented. Contact should be made with the state regulatory authority early in the process of application to inform them of the intention to apply for the use of the experimental practices provision.

Other Federal Activity

The Clean Water Act of 1977, in addition to supporting the 404 Program, authorized $6 million to the Fish and Wildlife Service to complete their inventory of wetlands of the United States. The National Wetland Inventory project is being carried out according to priorities based on the rate of loss of wetland areas. The State of Illinois is among the several states in the Mississippi Flyway identified as having lost significant quantities of wetlands (Frayer et al., 1983), and is participating in the wetlands inventory program. The Commonwealth of Kentucky is losing an estimated 3600 acres per year of wetlands along the Ohio and Mississippi Rivers (Tiner, 1984), yet presently ranks low on the priority list.

STATE POLICIES AND REGULATION

Wetland protection within the states Kentucky, Indiana and Illinois is indirect through the cooperative state/federal programs; none having comprehensive legislation that would directly protect wetlands. Illinois has attempted to pass a comprehensive bill and is beginning to work out the conflicts between agriculture and conservation. Indiana and Illinois have some protection of riparian wetlands. Without comprehensive legislation, the major regulation for wetland protection lies with the 404 program as administered by the Army Corps of Engineers. States can obtain primacy over enforcement of federal legislation, but must pass their own regulations that are required to meet the minimum requirements as established by the federal law.

Kentucky

Water Quality - In the Commonwealth of Kentucky's water quality program through the Kentucky Cabinet of Natural Resources and Environmental Protection (KCNREP), Department of Natural Resources, Division of Water, wetlands are treated as "waters of the Commonwealth" and are not distinguished from other waters. A specific wetlands policy has not been formulated; this means that wetlands are indirectly protected from degradation by regulations controlling wastewater discharge. Kentucky has not permitted any discharges into wetland areas to date. Kentucky holds primacy over the discharge elimination permitting system (KPDES), but does not hold primacy over the 404 program.

Surface Mine Reclamation - The surface mining regulations of the

Commonwealth of Kentucky require that coal operators:

> (e) Restore, enhance where practicable or maintain natural riparian vegetation on the banks of streams, lakes, and other wetland areas. Wetlands shall be preserved or created, rather than drained or otherwise permanently abolished (405 KAR 16:180E).

The Kentucky Department of Surface Mining has primacy and is charge with the enforcement of these reguations. No departmental policy on wetlands protection has been developed to assure that these regulations are enforced. Surface mining permit applications require identification of wetlands adjacent to and within the mining area under the listing of existing land uses, and on the environmental resources map.

Permitting regulations do not require that new environmental information be generated; only existing data needs to be gathered. The burden then lies on the regulatory and affiliated agencies to produce the needed information, such as wetland inventories and assessments, as the first step towards wetlands protection. The Wetlands Atlas developed in Phase II of our project provides wetland identification and classification in the most heavily mined regions of the western Kentucky coalfield; and the Kentucky Nature Preserves Commission has begun to identify significant water resources, some of which are wetlands. Other wetland inventories are discussed in CHAPTER II.

The Kentucky Fish and Wildlife Service has field knowledge of significant fish and wildlife wetlands. They manage some protected wetland areas and have worked with coal companies to develop wildlife areas on mined lands.

Indiana

Water Quantity - In Indiana, some wetlands are indirectly protected through the state law governing construction in the floodway. A proposed project in the floodway (that land lying within the 100 year storm frequency contour) must answer to the affects the project might have on fish and wildlife habitats (IC 13-2-22). The Department of Natural Resources, Division of Water has jurisdiction over water quantity concerns in Indiana.

Water Quality - The Indiana Stream Pollution Control Board administers the National Pollution Discharge Elimination System for permitting discharges into the waters of the State. The Indiana Stream Pollution Control Law does not specifically address wetlands, but the definition of "waters of the state" can be easily interpreted to include wetlands. Indiana does have a 1968 wetland policy developed by the State Natural Resources Commission which specifically calls for the preservation of wetlands contiguous to natural lakes. This policy is most applicable to the wetlands in the northern regions of Indiana which are outside of the mining regions.

Surface Mine Reclamation - Indiana holds primacy of surface mining control and reclamation through the Division of Reclamation. Wetlands are indirectly protected through the requirement that fish and wildlife habitats be restored. There is no overall or specific wetland protection policy, some riparian wetlands are protected through stream channel diversion regulations. Riparian vegetation is required to be replaced or restored on perennial streams and on intermittent streams with a drainage area of greater then one square mile (IC 310 - Art. 12-5-19). Special permission is needed to divert stream channels, otherwise mining is not to occur within 100 feet of any perennial stream. The Division of Fish and Wildlife works closely with the Division of Reclamation to enhance mined areas for devlopment of habitat, and has begun to encourage the use of wetland interface systems in reclamation of both active mines and abandoned mined lands.

Illinois

Surface Mine Reclamation - Illinois holds primacy over the surface mining control and reclamation program. Mining permit applications are reviewed through an interagency agreement. The Department of Mines and Minerals, the administrative and enforcing agency, receives permit applications; then routes the applications through to the Department of Agriculture, Department of Conservation, Illinois Environmental Protection Agency, Department of Transportation, and the Commerce and Community Affairs Department. The Department of Conservation is concerned with fish and wildlife protection and comments on endangered species that may be affected by proposed mining. The current State regulations are in the process of being revised to meet the latest changes in the federal regulations. Presently no mention of wetlands or fish and wildlife habitat protection is included in the state regulations; although some wetlands are protected indirectly through requirements for replacement of riparian vegetation after stream channel diversions. The Department of Conservation works with mining companies to encourage reclamation that would provide fish and wildlife habitats.

INFORMATION SOURCES

In order to assist mine operators and their representatives in gaining more information on the subjects discussed in this manual, a listing of appropriate regulatory agencies, research institutions, and other related groups is included here as Appendix A.

REFERENCES

Adamus, P. R. & L.T. Stockwell. 1983. A Method for Wetland Functional Assessment: Vol. I, Critical Review and Evaluation Concepts; Vol. II, FHWA Assessment Method. U.S. Dept. of Transportation, Federal Highway Administration, FHWA-IP-82-23 & FHWA-IP-82-24. Washington, DC.

Barnhisel, R.I. 1977. Reclamation of Surface Mined Coal Spoils. Agricultural Experiment Station. EPA No 600/7-77-093. Cincinnati, OH.

Bell, Howard E., III. 1981. Illinois Wetlands: Their Value and Management State of Illinois. Institute of Natural Resources. Doc. No 81/33. Chicago. 133p.

Cairns, John Jr. 1980. The Recovery Process in Damaged Ecosystems. Ann Arbor Science, Ann Arbor. 164p.

Cairns, John Jr. 1983. Management Options for Rehabilitation and Enhancement of Surfaced Mined Ecosystems. Minerals & the Environment, Vol 5, p.32.

Cairns. J., Jr., J.R. Stauffer, Jr., and C.H. Holcutt. 1978. Opportunities for Maintenance and Rehabilitation of Riparian Habitats: Eastern United States. In Strategies for Protection and Management of Floodplain Wetlands and Other Riparian Ecosystems (R.R. Johnson and J.F. McCormick, tech. coord.). Proceedings of the Symposium, December 11-13, 1978, Callaway Gardens, Georgia. Forest Service, United States Department of Agriculture. General Technical Report WO-12. Washington, DC. pp. 304-317.

Carpenter, J. M. & G. T. Farmer. 1981. Peat Mining: An Initial Assessment of Wetland Impacts & Measures to Mitigate Adverse Impacts. Env. Protection Agency. PB 82-130766. Washington, DC. 61 p.

Caruccio, F.T. and J. C. Ferm. 1974. Paleoenvironment-Predictor of Acid Mine Drainage Problems. In papers presented before the Fifth Symposium on Coal Mine Drainage Research. Louisville, KY. pp.5-9.

Chironis, N.P., Editor. 1978. Coal Age Operating Handbook of Coal Surface Mining and Reclamation, Vol. 2. McGraw-Hill, Inc. NY, NY.

Cooper, R.V. 1983. 'Experimental Practices' Opportunities Under the Federal Surface Mining Control and Reclamation Act of 1977. In 1983 Symposium on Surface Mining, Hydrology, Sedimentology and Reclamation, Univ. of KY., Lexington, KY, Nov. 27-Dec. 1. 3p.

Costanza, R. 1980. Embodied Energy and Economic Valuation. Science 210:1219-1224.

Cowardin, L. M., V. Carter, F.C. Golet & E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. Fish & Wildlife Service, U.S. Dept. of Interior. Washington, DC. 103p.

Darnell, R. 1976. Impacts of Construction Activities in Wetlands of the United States. US Env. Protection Agency. EPA-600/3-76-045. Corvallis, OR. 393 p.

Dinges, R. 1982. Natural Systems for Water Pollution Control. Van Nostrand Reinhold Co., NY. 244p.

Dunn, W.J. & G.R. Best. 1983. Enhancing Ecological Succession: 5. Seed Bank Survey of Some Florida Marshes & Role of Seed Banks in Marsh Reclamation. In Proceedings, 1983 Symposium Surface Mining, Hydrology, Sedimentology and Reclamation. Lexington, KY, Nov 27-Dec 2. pp365-370.

Ettinger, C. E. 1980. Development of Methods to Improve Performance of Surface Mine Sediment Basins, Phase I. US Env. Protection Agency. EPA 600/7-80-072. Cinncinati, OH.

Fowler, D.K. & L.J. Turner. 1981. Surface Mine Reclamation for Wildlife. US Fish and Wildlife Service. FSW/OBS-81/09. Kearneysville, WV. 28p.

Frayer, W.E., T.J. Monahan, D.C. Banden, & F.A. Graybill. 1983. Status & Trends of Wetlands and Deepwater Habitats in the Conterminous United States, 1950's to 1970's. National Wetlands Inventory Project, US Fish and Wildlife Service. Washington, DC. 31p.

Goodwin, R. H. & W.A. Niering. 1975. Inland Wetlands of the United States. Evaluated as Potential Registered Natural Landmarks. Natural Park Service. Natural History Theme Studies, No. 2. Conn. College. New London, CT. 550p.

Grim, E.C. & R.D. Hill. 1974. Environmental Protection in Surface Mining of Coal Mining Pollution Control Branch. US Env. Protection Agency. EPA 670/2-74-093. Cincinnati, OH. 277p.

Harker, D.F., Jr., G.M. Gigante and R.R. Cicerello. 1981. Evaluation of Fish & Wildlife Habitats: A Selected Bibliography. KY Nature Preserves Commission. Frankfort, KY. 105p.

Harker, D.F., Jr., R.F. Hannan, M.L. Warren, Jr., L.R. Phillippe, K.E. Camburn, R.S. Caldwell, S.M. Call, G.J. Fallo and D. VanNorman. 1980. Introduction and Ecology and Ecological Features of the Western Kentucky Coalfield, Vol. I, Part II. Ky Nature Preserves Commission, Frankfort, KY. 584pp.

Herricks, E.E., A.J. Krzysik, R.E. Szafoni, & D.J. Tazik. 1982. Best Current Practices for Fish and Wildlife on Coal Surface Mined Lands in the Eastern Interior Coal Region. U.S. Fish & Wildlife Service FWS/OBS-80/68, Kearneysville, WV.

Harvey, M.D. 1978. Paradise Regained? Surface Mining Control & Reclamation Act of 1977. In Houston Law Review, Vol. 15, p. 1147-1174.

Haynes, R.J. 1983. Natural Vegetation Development on a 43 Year Old Surface-Mined site in Perry County, Illinois. In Proceedings of 1983 Symposium on Surface Mining, Hydrology, Sedimentology and Reclamation. Univ. of KY. Lexington, KY, Nov. 27-Dec 2, pp 457-466.

Hey, D.L., J.M. Stockdale, D. Kropp, and G. Wilhelim. 1982. Creation of Wetland Habitats in Northeastern Illinois. Illinois Department of Energy and Natural Resources. DOC. No. 82/09. Springfield, IL. 117 p.

KCNREP/DAL. 1981. Abandoned Mine Land Reclamation Plan. Ky Cabinet of Natural Resources & Environmental Protection, Div. of Abandoned Lands. Frankfort, KY.

Kleinman, R. & P.E. Erickson. 1982. Full-Scale Field Trials of a Bactericidal Treatment to Control Acid Mine Drainage. In 1982 Symposium on Surface Mining, Hydrology, Sedimentology and Reclamation. Univ. of KY. Lexington, KY, Dec. 5-10, pp 241-245.

Kleinman, R.L.P., T.O. Tiernan, J.S. Solch, and R.L. Harris. 1983. A Low-Cost, Low-Maintenance Treatment System for Acid Mine Drainage Using Sphagnum Moss and Limestone. 1983 Symposium on Surface Mining, Hydrology, Sedimentology and Reclamation, Univ. of Ky. Lexington, KY, Nov. 27-Dec. 2. p 241-245.

Klimstra, W.D. 1980. Methods for Enhancement of Fish and Wildlife on Abandoned Mine Lands in Eastern United States. US Fish & Wildlife Service. FWS/OBS 80-40. Kearneysville, WV.

Kusler, J.A. 1983. Our National Wetland Heritage, A Protection Guidebook. Environmental Law Institute. Washington, DC. 167 p.

KCNREP. Surface Mining and the Natural Environment. Ky. Bureau of Surface Mining, Reclamation & Enforcement. Frankfort, KY.

Larson, J.S. 1976. Models for Evaluation of Freshwater Wetlands. U. of Massachusetts, Amherst. 91p.

Leedy, D.L. & T.L. Franklin. 1981. Coal Surface Mining Reclamation and Fish & Wildlife Relationships in the Eastern United States. Vol I & II. Fish & Wildlife Service. US Dept. of the Interior. FWS/OBS-80/24. Washington, DC.

Leuthart, C.A. 1975. Reclamation of Orphan Strip Mined Land in Southern Illinois and Western Kentucky. Doctoral Dissertation. University of Louisville, Louisville, KY.

Library of Congress. 1982. Wetland Management. Congressional Research. Service, USGPO Serial No. 97-11. Washington, DC. 149p.

Lin, K. 1977. Coal Data 1977. National Coal Association. Washington, DC.

Magee, E.M., H.J. Hall & G.M. Varga, Jr. 1973. Potential Pollutants in Fossil Fuels. U. S. Environmental Protection Agency. EPA-R2-73-249. Washington, DC.

Mason, W.T., Jr. 1979. A Rapid Procedure for Assessment of Surface Mining Impacts to Aquatic Life. In Coal Conference and Expo V. Louisville, KY, October 23-25. U.S. GPO 867-110. 11p.

Mitsch, W.J., J.R. Taylor, K.B. Benson, & P.L. Hill, Jr. Atlas of Wetlands in the Principal Coal Surface Mining Region of Western Kentucky. U.S. Fish and Wildlife Service. FWS/OBS-82-72. Washington, DC. 134 p.

Mitsch, W.J. M.D. Hutchison, & G.A. Paulson. 1979. The Momence Wetlands of the Kankakee River in Illinois - An Assessment of Their Value. State of Illinois, Institute of Natural Resources. Doc No. 79/17. Chicago. 55p.

Morton, Mike, 1983. Wildlife Biologist. KY Fish & Wildlife Service. Personal Interview, Nov. 11, 1983.

Nawrot, J.R. & S.C. Yaich. 1982. Wetland Development Potential of Coal Mine Mine Tailing Basins. In Wetlands Volume 2. Society of Wetland Scientists, Wrightsville Beach, NC. pp 179-180.

Office of Surface Mining, US Dept. of Interior. The Surface Mine Operator's Manuel-A Guide to the Regulatory Program & Compliance Standards. Washington, DC.

Office of Technology Assessment. 1984. Wetlands: Their Use and Regulation. OTA-O-206. Washington, DC. 207p.

Olson, R.A. 1981. Wetland Vegetation, Environmental Factors and Their Interaction in Strip Mine Ponds, Stockdams, and Natural Wetlands. U.S.D.A. Forest Service. Gen. Tech Report RM-80. Ft. Collins, CO. 19p.

Powell, J.L., R.I. Barnhisel, G.W. Akin, & M.W. Ebelhar. 1977. The State of the Art of Reclaming Land Surface-Mined for Coal in One Western Kentucky Coal Field. In Proc. 5th Symposium on Surface Mining & Reclamation, NCA/BCR. Louisville, KY pp255-273.

Ramani, R.V. & M.L. Clar. 1978. User's Manual for Premining Planning of Eastern Surface Coal Mining, Vol I: Executive Summary. EPA-600/7-78-180. Cincinnati, OH. 71p.

Rosso, W.A. 1979. Water: Resource or Liability in Surface Mining. In Coal Conference & Expo V. October 23-25. Louisville, KY

Rosso, W.A. & B.H. Walcott, Jr. 1977. Wildlife Option in Kentucky. In Fifth Symposium on Surface Mining and Reclamation. National Coal Association/ Bitumous Coal Research, Inc. October 18-20. Louisville, KY. pp20-23.

Ruesch, K.J. 1983. A Survey of Wetland Reclamation Projects in the Florida Phosphate Industry. Florida Institute of Phosphate Research. Publ. No. 03-019-011. Bartow, FL. 39p.

Soil Conservation Service-Illinois. 1982. Wildlife Wetland Habitat Management 644. Unpublished Soil Conservation Service Specifications. Springfield, IL. 6p.

Sturm, J.W. et al. 1979. Suggested Guidelines for Method of Operation in Surface Mining of Areas with Potentially Acid-Producing Materials. In Symposium on Surface Coal Mining & Reclamation. Coal Conference & Expo V. October 23-25. Louisville, KY. pp.177-189.

Surface Mining Control and Reclamation Act of 1977. 30 USC 1201.

Tiner, R. W., Jr. 1984. Wetlands of the United States: Current Status and Recent Trends. U.S. Fish and Wildlife Service. Sup. of Doc. U.S. Gov. Printing Office. Washington, DC. 59p.

U.S. Army Corps of Engineers. 1972. Charles River Watershed, Massachusetts. New England Div., Waltham, MA. 65p.

U.S. Environmental Protection Agency. 1976. Erosion and Sediment Control Surface Mining in Eastern US: Volumes 1 & 2. EPA-625/3-76-006. Washington, DC.

U.S. Environmental Protection Agency. 1978. Field and Laboratory Methods Applicable to Overburdens and Minesoils. Industrial Env. Research Lab. EPA-600/2-78-054. Cincinnati, OH. 204p.

U.S. Environmental Protection Agency. 1983. Freshwater Wetlands for Wastewater Management. Region IV. EPA 904/9-83-107, Atlanta, GA. 380p.

U.S. Environmental Protection Agency. 1983. The Effects of Wastewater Treatment Facilities on Wetlands in the Midwest. Region V. EPA/905/3-83-002. Chicago, IL.

U.S. Fish and Wildlife Service. 1980. Habitat Evaluation Procedures (HEP). ESM 102. Washington, DC.

Vogel, W.G. 1981. A Guide for Revegetating Coal Mine Soils in the Eastern United States. USDA, Forest Service, Northeastern Forest Experiment Station. General Technical Report NE-68. 190p.

Wali, Mohan K. 1983. Succession on Mined Lands. In Can Mined Land be Made Better than Before Mining? North Dakota Energy Development Impact Office, Bismarck, ND. pp.23-32.

Wharton, C.H., V.W. Lambour, J. Newson, P.U. Winger, L.L. Gaddy & R. Mancke. 1981. The Fauna of Bottomland Hardwoods in Southeastern United States. In Wetlands of Bottomland Hardwood Forests, Proceedings of a Workshop on Bottomland Hardwood Forest Wetlands of The Southeastern United States, Lake Lanier, Georgia, June 1-5, 1980. Elsevier Scientific Publishing Company. NY pp. 71-87.

Wieder. R.K. & G.E. Lang. 1982. Modification of Acid Mine Drainage in a Freshwater Wetland. In Symposium on Wetlands of the Unglaciated Appalachian Region, WVU, Morgantown, WV . May 26-28. pp.43-53.

Wiram, V.P. 1977. Keeping Things Clean with Soap and Water. In Proc. 5th Symposium on Surface Mining & Reclamation, NCA/BCR. Louisville, Ky. pp41-53.

APPENDIX A - SOURCES FOR FURTHER INFORMATION

Organization	Topic of Concern
FEDERAL AGENCIES Environmental Protection Agency Region IV 345 Courtland Street, NE Atlanta, Georgia 30365 (404) 881-3004	Water quality concerns, wetlands as wastewater treatment systems.
Region V Water Division 230 South Dearborn Street Chicago, Illinois 60604 (312) 353-2157	
U.S. Army Corps of Engineers U.S. Army Engineer Division, North Central 536 South Clark Street Chicago, Illinois 60605 (312) 353-6310	Dredge and Fill (404) Permit Program, values assessment. Note: Contact Division Office for the appropriate local District Office address.
U.S. Army Engineer Division, Lower Mississippi Valley P.O. Box 80 Vicksburg, Mississippi 39180 (601) 634-5750	
U.S. Army Engineer Division, Ohio River P.O. Box 1159 Cincinnati, Ohio 45201 (513) 684-3002	
Office of Surface Mining, U.S. Department of the Interior Kentucky: 340 Legion Drive, Suite 28 Lexington, Kentucky 40504 (606) 233-7327	SMCRA administration, abandoned mined lands. Note: Contact state regulatory offices FIRST.
Indiana: 46 East Ohio Street Indianapolis, Indiana 46204 (317) 269-2600	
Illinois: 600 East Monroe Street, Room 20 Springfield, Illinois 62701 (217) 492-4486	

U.S. Fish and Wildlife Service

Fish and wildlife protection information, best current practices for reclaiming to meet fish and wildlife needs, wetland inventories, and values assessment.

Note: Contact Regional office for address of nearest field office.

Region 3
Federal Building
Ft. Snelling
Twin Cities, Minnesota 55111
(612) 725-3510
Field Office for Indiana: Bloomington
Field Office for Illinois: Rock Island

Region 4
Richard B. Russell Federal Bldg.
75 Spring Street SW
Suite 1276
Atlanta, Georgia 30303
(404) 221-6343
Field Office for Kentucky: Cookville, Tennessee

Division of Biological Services
Research and Development
U.S. Fish and Wildlife Service
Washington, D.C. 20240
(202) 653-8738

Eastern Energy and Land Use Team
Route 3 Box 44
Kearneysville, West Virginia 25430
(304) 725-2061

Office of Information Transfer
U.S. Fish and Wildlife Service
Drake Creekside 2
2629 Redwing Road
Ft. Collins, Colorado 80526-2899
(303) 226-9430

Soil Conservation Service

Soils information, Rural Area Mining Program (RAMP), reclamation information.

Note: Contact State office for the nearest SCS field office address.

Kentucky State Office:
333 Waller Avenue
Lexington, Kentucky 40504
(606) 233-2749

Indiana State Office:
Corporate Square West
5610 Crawfordville Road
Indianapolis, Indiana 46224
(317) 248-4350

Illinois State Office:
Springer Federal Building
Champaign, Illinois 61820
(217) 398-5267

U.S. Department of Agriculture
Forest Service
Kentucky/Indiana/Illinois
NE State and Private Forestry
Route 2, Highway 21 East
Berea, Kentucky 40403
(606) 986-8431

Mining reclamation and revegetation

STATE REGULATORY AGENCIES

Kentucky

Kentucky Cabinet for Natural Resources and Environmental Protection
Department of Natural Resources

Division of Water
Fort Boone Plaza
18 Reilly Road
Frankfort, Kentucky 40601
(502) 564- 3410

Water Quality, Best Management Practices for environmental protection.

Division of Abandoned Lands
618 Teton Trail
Frankfort, Kentucky 40601
(502) 564-2141

Abandoned mined lands program.

Department of Surface Mining Reclamation and Enforcement

Division of Permits
Capital Plaza Tower, Third Floor
Frankfort, Kentucky 40601
(502) 564-2377

SMCRA administration.

Madisonville Field Office
Old TB Facility
Laffoon Street
Madisonville, Kentucky 42431
(502) 821-4954

Lands Unsuitable for Mining Program
Capital Plaza Tower, 14th Floor
Frankfort, Kentucky 40601
(502) 564-5174

Kentucky Natural Resource Information System (KNRIS) online data base.

Department of Fish and Wildlife Resources
Headquarters
592 East Main Street
Frankfort, Kentucky 40601
(502) 564-5448

Wetland information.

Henderson Field Office
Route 2, Box 29-D
Henderson, Kentucky 42420
(502) 827-2673

Kentucky Nature Preserves Commission 407 Broadway Frankfort, Kentucky 40601 (502) 564-2886	Identification of some significant wetlands, rare plant and animal types in Kentucky.
<u>Indiana</u>	
Indiana Department of Natural Resources Division of Water 2475 Directors Row Indianapolis, Illinois 46241 (317) 232-4160	Construction in floodway permits.
Division of Fish and Wildlife State Office Building, Room 607 Indianapolis, Indiana 46204 (317) 232-4080	Wetland inventories and information.
Division of Reclamation Jasonville Field Office P.O. Box 147 Jasonville, Indiana 47438 (817) 665-2207	Mining Permits, abandoned mined lands program, reclaiming for fish and wildlife use.

Note: The Jasonville office contains the significant personnel for mining concerns, including permits, abandoned mined lands, and enforcement. Also, there is a wildlife biologist from the Division of Fish and Wildlife located in this office.

Indiana Stream Pollution Control Board 1330 West Michigan Street Indianapolis, Indiana 46206 (317) 633-0700	NPDES and water quality concerns.
<u>Illinois</u>	
Department of Mines and Minerals Division of Land Reclamation 227 South Seventh Street, Room 204 Springfield, Illinois 62706 (217) 782-4970	
Department of Conservation Division of Planning Mining Program 524 South Second Street Springfield, Illinois 62706 (217) 782-4543	Reviews mining permits for affects on endangered species, coordinates with Corp of Engineers and U.S. Fish and Wildlife, experimental practices, wetland inventories.
Department of Energy and Natural Resources 325 West Adams Street, Room 300 Springfield, Illinois 62706 (217) 785-2800	Lands Unsuitable for Mining program.

Illinois Environmental Protection Agency 2200 Churchill Road Springfield, Illinois 62706 (217) 785-0748	Water quality, sediment control structures.
Department of Transportation Division of Water Resources DOT Administration Bldg., Room 339 Springfield, Illinois 62764 (217) 782-3862	Stream channel diversions, floodplain construction.
Abandoned Mined Lands Reclamation Council Alvina Building, First Floor 100 North First Street Springfield, Illinois 62701 (217) 782-0588	Abandoned mined lands program.

RESEARCH AGENCIES AND INSTITUTIONS

Kentucky

Center for Environmental Sciences and Management
Systems Science Institute
University of Louisville
Louisville, Kentucky 40292
(502) 588-6482

Kentucky Water Resources Research Institute
161 Anderson Hall
University of Kentucky
Lexington, Kentucky 40506
(606) 257-4856

Institute for Mining and Minerals Research
University of Kentucky
Iron Works Pike, Box 13015
Lexington, Kentucky 40583
(606) 252-5535

Mineral Law Center
College of Law
University of Kentucky
Lexington, Kentucky 40506
(606) 257-1161

Murray State University
Department of Biological Sciences
Murray, Kentucky 42071
(502) 762-2786

Illinois

Cooperative Wildlife Research Laboratory
Southern Illinois University at Carbondale
Carbondale, Illinois 62901
(618) 536-7766

Coal Extraction and Utilization Research Center
Southern Illinois University at Carbondale
Carbondale, Illinois 62901
(618) 536-5568

Illinois Natural History Survey
Natural Resources Building
607 East Peabody Drive
Champaign, Illinois 61820
(217) 333-6889

Illinois Water Resources Research Center
2535 Hydrosystems Lab
University of Illinois
Urbana, Illinois 61801
(217) 333-0536

Coal Extraction and Reclamation Project
Energy and Environmental Systems Division
Argonne National Laboratory
Argonne, Illinois 60439

Indiana

Indiana Water Resources Center
Purdue University

School of Public and Environmental Affairs
Indiana University
Bloomington, Indiana

Holcomb Research Institute
Butler University
Indianapolis, Indiana 46208
(317) 283-9421

OTHER AGENCIES

Kentucky Coal Association
340 South Broadway
Lexington, Kentucky 40508
(606) 233-4743

Illinois Coal Association
212 South Second Street
Springfield, Illinois 62701
(217) 528-2092

Indiana Coal Association
P.O. Box 210
632 Cherry Street
Terra Haute, Indiana 47808
(812) 232-2008

Indiana Coal Council
143 West Market Street
Suite 701
Indianapolis, Indiana 46204
(317) 638-6997

The Nature Conservancy
Kentucky Chapter
P.O. Box 2125
Covington, Kentucky 41012
(606) 291-8585