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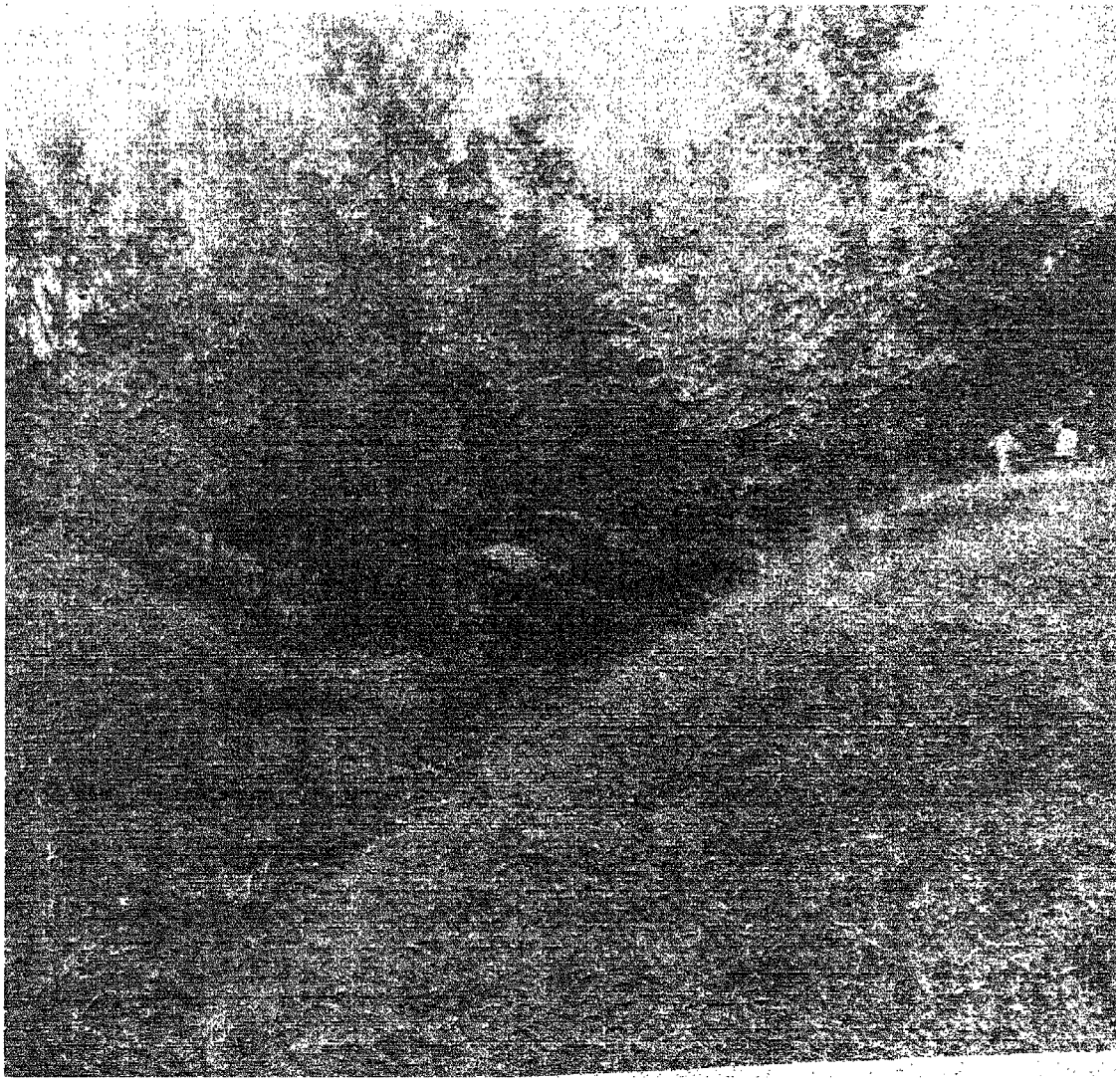
A Guide for Revegetating Coal Minesoils in the Eastern United States

by Willis G. Vogel



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ABSTRACT

This report provides information, recommendations, and guidelines for revegetating land in the Eastern United States that has been disturbed by coal mining. Included are brief descriptions of major coal mining regions in the East, and a discussion of minesoil properties and procedures for sampling, testing, and amending minesoils. Plant species that have been used for revegetating surface-mined lands are identified and described. Selection criteria for plant species and methods and requirements for seeding and planting are explained. Some of the data on tree species used in reforestation were obtained from recent surveys of 30-year-old experimental plantings in several Eastern States.

FOREWORD

The mining of coal, especially surface mining, often is dangerous to environmental resources. Existing vegetation is destroyed, ecosystems are altered, and unreclaimed areas are visually displeasing. One of the adverse effects of mining and vegetation removal is the degradation and pollution of water resources. Erosion on raw exposed minesoils can contribute large quantities of sediment to streams. Where the overburden contains acid-bearing rocks, streams also are polluted with toxic chemical substances.

The revegetation of land disturbed by coal mining is necessary primarily for controlling runoff, erosion, and sedimentation. Simultaneously, the establishment of vegetation improves the visual quality of mined areas and aids in or contributes directly to restoring mined land to productive uses.

The principles and guidelines in this report are applicable primarily to past and current surface-mining operations; they may also apply to surface disturbances caused by underground mining. This report is not directed to the establishment of agricultural crops on areas designated as "prime farmland," though many of the revegetation principles and practices will apply.

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COAL MINING REGIONS

The eastern half of the United States includes three major bituminous coal regions--the Appalachian, the Eastern Interior, and the Western Interior. Anthracite coal is found in the northern end of the Appalachian Region and mineable lignite is found in Arkansas, Louisiana, and eastern Texas (Figure 1). The bituminous coal regions lie mostly within a zone that has an average annual precipitation of about 35 inches or more (Figure 2), and a mean annual temperature that ranges from about 50° to 65°F.* The topography of the Eastern United States ranges from nearly level in portions of Illinois and eastern Kansas to mountainous in the Appalachian States. In general, revegetation problems and practices are similar in all the coal regions; however, local geologic, topographic, and climatic environments create unique problems in each that must be dealt with accordingly.

APPALACHIAN COAL REGION

Geology

The Appalachian coal fields cover approximately 72,000 square miles in parts of nine States, extending from Pennsylvania to Alabama. The coals of Appalachia are of Pennsylvanian Age, and are essentially coextensive with the Appalachian Plateau physiographic province. The most abundant coal-bearing rock types in Appalachia are the fine-grained siltstones and shales. Although less abundant, sandstones and conglomerates are conspicuous because of their resistant nature, frequently forming bold outcroppings and capping mountains. Limestone is prevalent in western Pennsylvania and Ohio, but in the rest of Appalachia, where present at all, lime is found mostly in calcareous shales or as a cementing agent in sandstones and siltstones. The coal beds are distributed throughout the sequence of Pennsylvanian rocks.

Many of the coal-bearing strata contain varying amounts of the mineral pyrite, which is of considerable importance because of its potential for producing acid spoil and acid-mine drainage. However, with local exceptions, the patterns of acid-mine drainage affecting major stream systems indicate that this problem is most prevalent in Pennsylvania, portions of eastern Ohio, a

*English units are used in deference to the majority of the readers for whom this guide is intended. An English to metric conversion table is on page x.

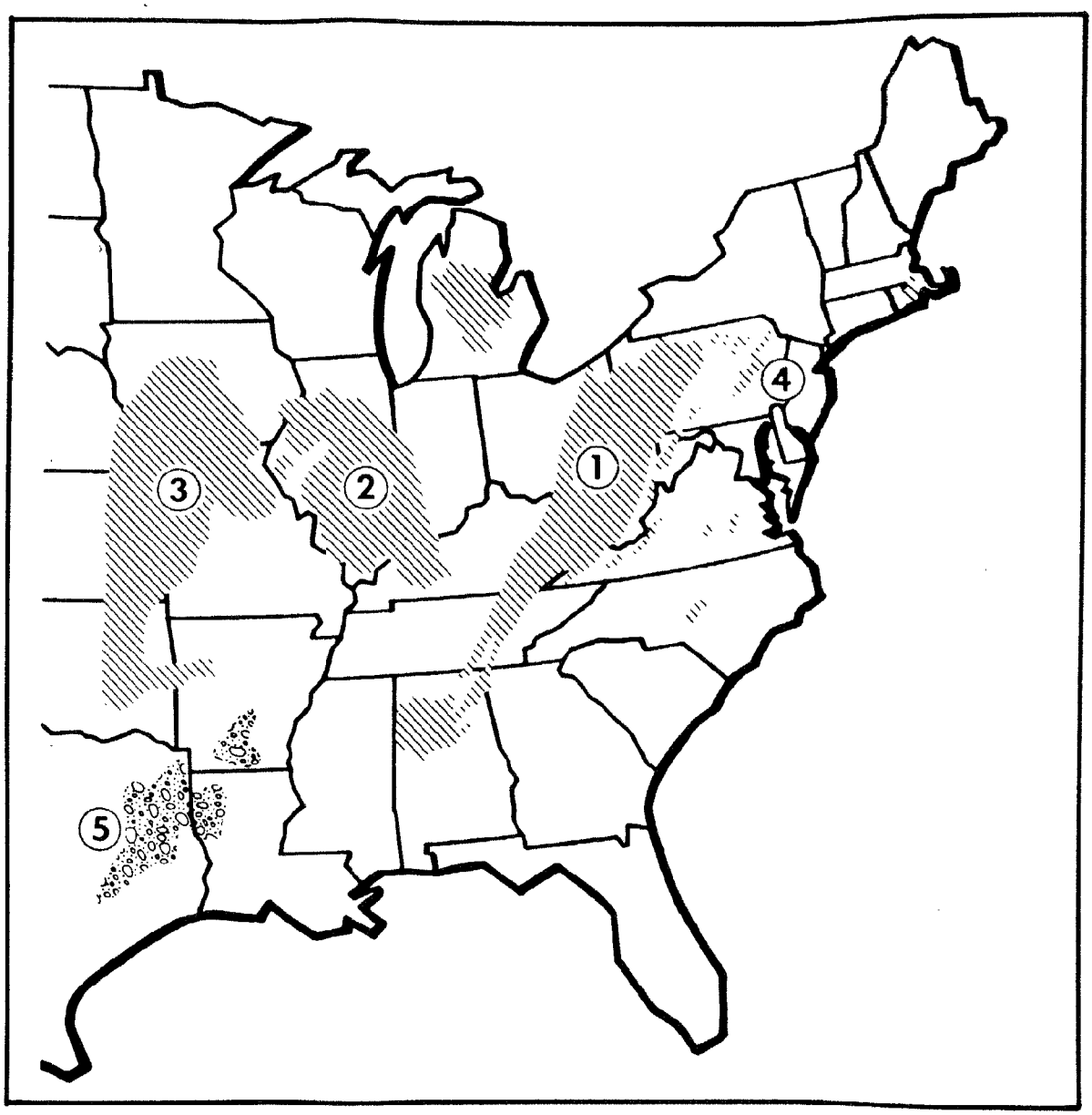

Figure 1. Coal regions of the Eastern United States: (1) Appalachian; (2) Eastern Interior; (3) Western Interior; (4) Anthracite; (5) Lignite.

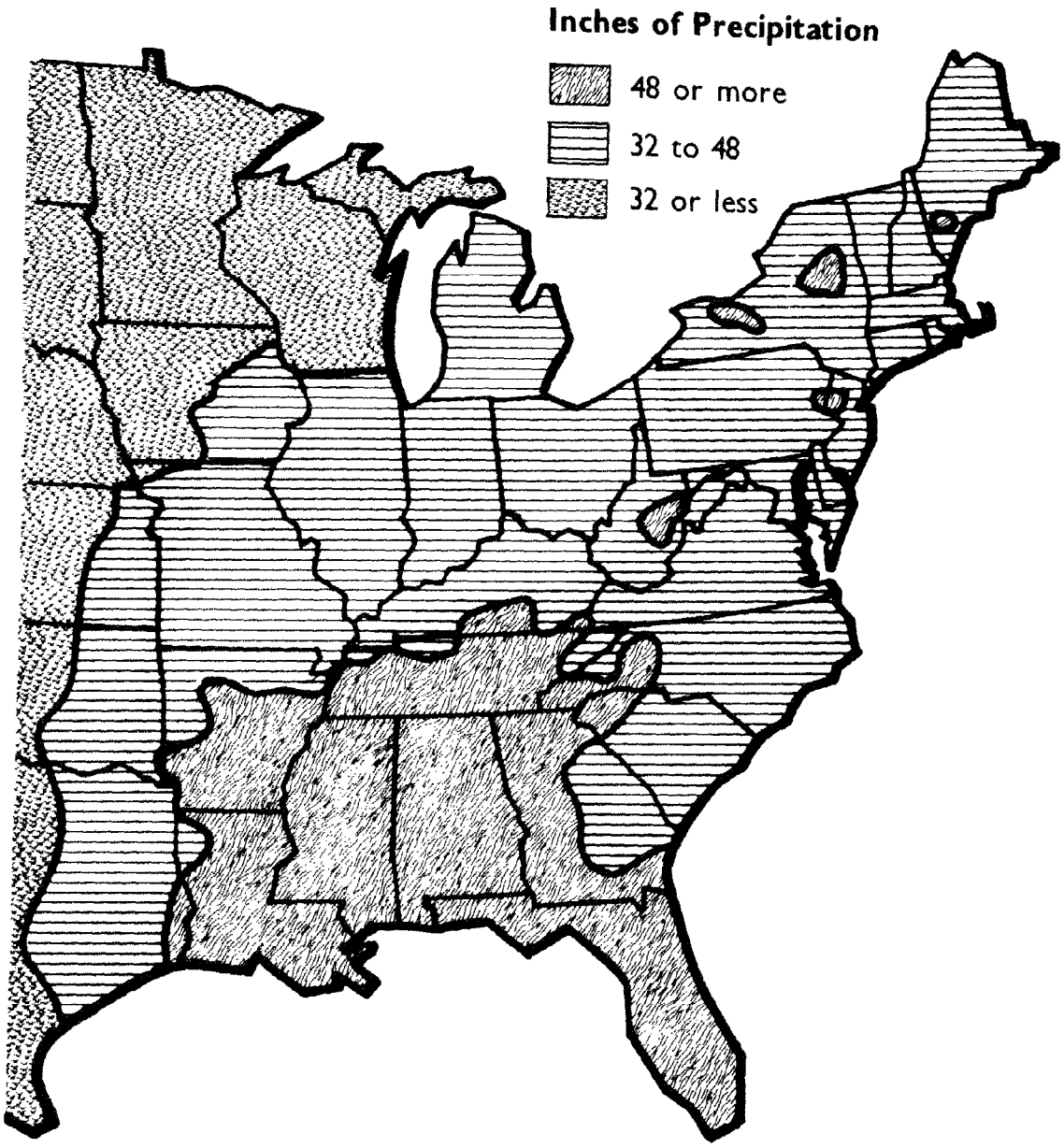

Figure 2. Average annual precipitation for the precipitation zones of the Eastern United States.

band along the boundary of Kentucky with West Virginia and Virginia, and an area in north-central Tennessee. Coal-bearing strata that, chemically, are strongly alkaline are found in a few areas, but are of minor consequence to the region.

Physiography

The Appalachian Coal Region occupies a high plateau that in most parts has been deeply incised by a dendritic stream pattern, giving rise to a rugged mountainous terrain. Altitudes range from 900 to 4,800 feet, with relief in the mountainous areas ranging from 500 to 1,500 feet. Slopes exceeding 30° are common throughout much of the region, with steeper slopes and vertical cliffs along major rivers. Terrain of this nature has necessitated contour and mountain-top-removal mining methods and has created severe erosion and stream sedimentation. In addition, transportation is hampered by the difficulty and expense of building and maintaining roads and railways.

Climate

Precipitation over all of Appalachia averages 47 inches annually. It ranges from 35 inches in Pennsylvania and progressively increases southward to a high of 55 inches in Alabama. The precipitation is fairly well distributed throughout the year. Approximately one-half is lost through evaporation and transpiration. Short periods of dry weather occur infrequently, usually in mid to late summer.

Average annual temperature ranges from about 50°F in Pennsylvania to a little over 60°F in Alabama. Average maximum temperature ranges from about 90° to 100°F, while average minimums range from around -10° to 10°F. Seasonal temperature variations as well as rainfall are strongly influenced by local topographic extremes. Some mountain tops and adjacent valleys experience nearly as much climatic variation as occurs between Pennsylvania and Alabama.

Vegetation

Mixed hardwood forest is the predominant natural vegetation type in most of the Appalachian Region. On the average, forest vegetation still occupies about 85 percent of the land area that is being mined. Nonforested lands are mainly those where the topography has allowed the development of agricultural land uses, primarily pasture.

Cutting of merchantable timber without regard to forest management principles has been a continual process on much of the forested land since original settlement. Today, much of the private forest land is poorly managed or unmanaged and is stocked primarily with low-quality trees, both in species and in form.

EASTERN INTERIOR COAL REGION

Geology

As with the Appalachian Region, the coals of the Interior Regions are of Pennsylvanian age and the coal-bearing strata are predominantly shales, siltstones, and sandstones. However, in the Interior Regions a repeating marine influence is more strongly seen; hence, limestones are more common than in Appalachia.

The marine influence is also seen in the more abundant highly pyritic black shales, especially in southern Illinois and western Kentucky. This shale causes problems with acid spoils and acid-mine drainage. In some areas, shallow underground mines, worked out in the past, have been broken into by subsequent surface mining. This has released copious flows of extremely acid water that has damaged streams and nearby agricultural and forest lands subject to flooding. In other situations, surface mining has sealed or eliminated old underground mines and reduced the flow of acid water.

Physiography

The Eastern Interior Coal Region lies almost entirely within Illinois, Indiana, and the western part of Kentucky, with very minor extensions into Iowa and Missouri (Figure 1). Most of the area in Illinois and Indiana lies within the Central Lowlands physiographic province, while the portion in Kentucky and extreme southern Illinois and Indiana is in the Interior Low Plateaus. The boundary between these two physiographic provinces marks the southern limit of glaciation.

The Central Lowlands, in the vicinity of the coal fields, consists of broad level uplands between steep-sided valleys with broad floodplains. This area is covered with glacial till and loess deposits that, toward the Mississippi River, reach 30 feet in thickness.

The Interior Low Plateaus consist of a slightly westward sloping plateau that is deeply entrenched with meandering rivers. This area has more relief than that to the north, but is still gently rolling. The low, gently rolling topography of the Eastern Interior Coal Region has allowed extensive area-type surface mining and an easily developed road, rail, and river barge transportation system.

Climate

Precipitation in this coal region averages 40 to 50 inches annually, and normally is most abundant during the growing season. Occasionally, there are extended dry periods that jeopardize the establishment of newly seeded and planted vegetation. The spring and summer rains often occur as severe thunderstorms, sometimes with damaging winds, hail, and flooding. Temperature ranges are extreme, with average minimums of -10°F and average maximums of above 100°F. The annual average temperature is about 55°F.

Vegetation

Mixed hardwood forest originally covered much of the Eastern Interior Coal Region, primarily the eastern and southern portions; and tall grass prairie occupied much of the northwestern part of the region. Today, much of the land in this region is used for agriculture. It includes some of the most productive cropland in the nation, especially in the Central Lowlands. Forests occupy most of the land that has not been developed for agriculture and urbanization. In Illinois, about 30 percent of the surface mining is on forested land. This percentage is higher in Indiana and western Kentucky.

WESTERN INTERIOR COAL REGION

Geology

The coals and coal-bearing strata in the Western Interior Coal Region are of Pennsylvanian age and similar to those in the Eastern Interior Region. However, problems with acid drainage from worked-out underground mines and with flooding of adjacent lands are less severe than in portions of the Eastern Interior Region. Minesoil toxicity resulting from acid-bearing strata is relatively minor for the region as a whole, but is serious in some localities. The rock strata dip to the west-northwest; thus, the coal outcrops are on the eastern edge of the region.

Physiography

The Western Interior Coal Region lies within Iowa, Nebraska, Kansas, Missouri, Oklahoma, and Arkansas (Figure 1). The northern portion of this coal region is in the Dissected Till Plain section of the Central Lowland physiographic province. The southern part, lying in Kansas and Oklahoma, is in the Osage Plains and the small area extending into Arkansas falls within the Ozark Plateaus.

The Dissected Till Plain has been glaciated and, hence, is of low relief that ranges from 100 to 300 feet. The glacial till of this area is covered in the more eastern parts with up to 30 feet of loess.

The Osage Plains lies south of the glacial limit so it is of greater relief than the glaciated area of the Central Lowlands to the north. Most of the Osage area consists of upland plains with deeply entrenched rivers, some with valleys a few hundred feet deep.

The Ozark Plateaus resemble the Appalachian Province, but altitudes and relief average lower than in the Appalachians. A maximum altitude of 2,000 feet is reached in the southern part of this province.

Climate

The climate of the Western Interior Coal Field is essentially like that of the Eastern Interior Coal Field, but less humid. Average annual precipitation ranges from about 30 to 40 inches, and is most abundant during the grow-

ing season. However, there can be extended periods of drought. Temperatures are extreme and range from -20°F to over 100°F. This area is even more prone than the other regions to severe spring and summer storms, often with damaging winds, hail, and tornados.

Vegetation

The natural vegetation in much of this region was an intermingling of hardwood forest and tall grass prairie. The eastern and southernmost portions of the region were mainly forested; the western and northernmost portions were primarily tall grass prairie. Most of the prairie areas have been tilled and today are used as pasture or cropland. Some of the forested areas also have been cleared for agricultural uses.

LIGNITE REGION

Mineable lignite is found in the Eastern United States in portions of Arkansas, Louisiana, and eastern Texas. This manual includes limited information on plant species for revegetating land that has been surface-mined for lignite. Undoubtedly, though, many of the problems of revegetation, practices, and recommendations described are applicable to lignite surface mines.