
CLASSIFICATION AND REVEGETATING
OF STRIP-MINE SPOIL BANKS*

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The purpose of this paper is to discuss: classification of strip-mine spoils for purposes of determining suitable land use, conditions for plantings, and observational plantings and practices employed by the U. S. Soil Conservation Service in strip-mine reclamation.

PROBLEMS IN CLASSIFICATION OF STRIP-MINED AREAS

At present there is no national system of classifying strip-mine spoil banks. A Soil Survey Manual (2), widely used by soil scientists, provides only for classi-

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fying these areas as miscellaneous land types. The symbol, "S.M.," denoting strip mines has been widely used on soil maps. Pits associated with spoil banks are classified as "pits and dumps," and absence or presence of water is shown by symbols and colors. Highwalls are shown as rock escarpments. Smoothed areas are classed as "made land." Stabilized strip land areas with clearly developed soil characteristics are classified as "soils" provided they can be defined and uniformly mapped.

The conditions most important in classifying strip mined areas are slope, stoniness, acidity, and soil texture. The range in slope conditions necessitates three slope classes. Stoniness conditions vary greatly from no stone cover to a stoniness which prevents use of equipment. Acidity ranges from below 3.5 pH to over 6.0 pH and is highly variable. Soil texture varies with mining methods and characteristics of overburden material.

Basic Factors

The three major characteristics used in the classification of spoil material by the Soil Conservation Service as a basis for plant establishment are pH, stoniness, and slope. Spoil material is classified into four groups based upon pH. Each pH group is further classified by the degree of stoniness and slope as shown in tables 1, 2, 3, and 4. In these tables, land capability classes and adapted vegetation are also indicated for these groups. The tables are used as a guide to Soil Conservation Service personnel in the development of conservation plans for strip mined lands under cooperative agreements with Ohio Soil Conservation Districts.

STANDARD AND SPECIFICATIONS FOR ESTABLISHING VEGETATIVE COVER ON STRIP MINE SPOIL

The problems of establishing vegetative cover on strip-mined land are unique. A major difference is in the rooting medium, which on strip-mined land is often an unorganized mixed mass of material derived from any or all strata between the earth's surface and the coal seam mined, in contrast with undisturbed soil, resulting from the weathering of parent materials near the earth's surface. Depending on the number and kind of strata, overtuned bank surfaces are sometimes rather uniform in character. A great variation, even within small areas, is more common.

Land Use Alternatives

Cropland.—Cropland use is limited to spoils in which all toxic material and stones are buried, the surface is leveled, the topsoil is returned, and slopes do not exceed 12 per cent. Under these conditions the land use and conservation practices needed are the same as for the original soil type.

Hayland, pasture land, woodland, wildlife, and recreation land.—On spoil material that has a pH of 5.5 or more, has been graded, is not stony, and has slopes of more than 12 per cent, the land is best used for hayland, pasture land, woodland, or wildlife land. Under these conditions, seed mixtures similar to those used for ordinary agricultural land can be used, but preferably at slightly higher rates. Under similar conditions, but where the surface is stony, the land can be utilized for pasture land, woodland, wildlife, or recreation land. In very stony areas, broadcast seeding by hand or airplane in the early spring may be necessary.

When the pH can be corrected by the application of lime to test between 6.0 and 6.5, a seed mixture of orchardgrass, brome grass, or timothy with alfalfa can be used. Without lime, best results have been obtained with a mixture of tall fescue (8 lb), orchardgrass (6 lb), Korean lespedeza (6 lb), and alsike clover (4 lb). Soils with a pH below 4.0 are not considered satisfactory for establishment of hayland or pasture land.

TABLE 1

Classification of strip mine spoils and guide for their revegetation
Graded for use of machinery with row crops in the rotation
75 percent of spoil bank is pH of 5.5 and above

Stoniness**	Slope	Land capability class	Suitable land uses	Adapted Species of Plants*		
				Grasses	Legumes	Shrubs
Non-stony top-soil replaced	0-6	II	Cropland ² Hayland Pasture & Woodland Wildlife Recreation	Timothy (<i>Phleum pratense</i>) Smooth brome (<i>Bromus inermis</i>) Orchardgrass ¹ (<i>Dactylis glomerata</i>) Switchgrass ¹ (<i>Panicum virgatum</i>)	Red clover (<i>Trifolium pratense</i>) Alfalfa (<i>Medicago sativa</i>) Birdsfoot trefoil (<i>Lotus corniculatus</i>) Sweet clover ¹ (<i>Melilotus alba</i>)	Japanese lespedeza (<i>Lespedeza japonica</i>) Bicolor lespedeza (<i>Lespedeza bicolor</i>) Autumn olive (<i>Elaeagnus umbellata</i>) Scotch broom (<i>Cytisus scoparius</i>) Indigobush (<i>Amorpha fruticosa</i>) Multiflora rose (<i>Rosa multiflora</i>) Amur honeysuckle (<i>Lonicera maacki</i>) Tatarian honeysuckle (<i>Lonicera tatarica</i>)
	6-12	III	Cropland ³ Hayland Pasture & Woodland Wildlife Recreation	Same as above	Same as above	Same as above
Stony, most of stones removed, but topsoil not replaced & several stones remain on surface.	0-6	III	Hayland Pasture land Woodland Wildlife Recreation	Same as above	Same as above	Same as above
	6-18**	IV	Hayland Pasture land Woodland Wildlife Recreation	Same as above	Same as above	Same as above

*For tree species guide see table 6.

**For stoniness definitions see end of table 5.

¹For Wildlife use.

²Possible rotation of CCWMM with contour strips (Where C=corn, W=small grain and M=meadow).

³Possible rotation of CWMM with contour strips.

TABLE 2
Classification of strip mine spoils and guide for their revegetation
 Graded according to Ohio law¹—75 percent of spoil bank is pH of 5.5 and above

Stoniness**	Slope	Land capability class	Suitable Land Uses	Adapted Species of Plants*		
				Grasses	Legumes	Shrubs
Stony	0-18	VI	Pasture land ² Woodland Wildlife Recreation	Timothy Orchardgrass Tall fescue (<i>Festuca elatior</i>) ³ Smooth brome Kentucky bluegrass ³ (<i>Poa pratensis</i>) Tall oatgrass ³ (<i>Arrhenatherum elatius</i>)	Alfalfa Sericea lespedeza (<i>Lespedeza sericea</i>) Birdsfoot trefoil ³ Crownvetch (<i>Coronilla varia</i>) Sweet clover ³ Alsike clover ³ (<i>Trifolium hybridum</i>)	Japanese lespedeza Bicolor lespedeza Autumn olive Scotch broom Indigobush Multiflora rose Amur honeysuckle Tatarian honeysuckle
Very stony	0-18	VII	Woodland Wildlife Recreation	Orchardgrass ² Tall fescue ² Tall oatgrass ^{2, 3} Switchgrass ^{2, 3}	Sericea lespedeza ^{2, 3} Birdsfoot trefoil ^{2, 3} Crownvetch ^{2, 3}	Same as above
Extremely stony	All slopes	VIII	Wildlife	Tall fescue ³ Switchgrass ³	Sericea lespedeza ³ Crownvetch ³	Bicolor lespedeza Direct seeding

*For tree species see table 6.

**For stoniness definitions see end of table 5.

¹Ohio law provides that spoil banks shall be graded to reduce peaks (and the depression between peaks) to more gently rolling topography, providing for more suitability for grazing of cattle and tree planting. Isolated peaks shall be graded to provide a top width of not less than 20 ft.

²May be necessary to seed grasses and legumes by airplane.

³For wildlife use.

TABLE 3
Classification of strip mine spoils and guide for their revegetation
 Graded according to Ohio law¹—At least 75 percent of spoil bank above 4.5 and less than 75 percent is above 5.5 pH.

Stoniness**	Slope	Land capability class	Suitable land uses	Adapted Species of Plants*		
				Grasses	Legumes	Shrubs
Stony	0-18	VI	Pasture land ² Woodland Wildlife Recreation	Tall fescue Redtop (<i>Agrostis alba</i>) Orchardgrass Switchgrass Tall oatgrass	Sericea lespedeza Crownvetch ³ Birdsfoot trefoil ³	Japanese lespedeza Bicolor lespedeza Autumn olive Scotch broom Indigobush Multiflora rose Tatarian honeysuckle
Very stony	6-18	VII	Woodland Wildlife	Tall fescue Switchgrass	Sericea lespedeza ⁴	Same as above
Extremely stony	18+	VIII	Wildlife	Tall fescue		Bicolor lespedeza Direct seeding

*For tree species see table 6.

**For stoniness definitions see end of table 5.

¹Ohio law provides that spoil banks shall be graded to reduce peaks to more gently rolling topography, providing for more suitability for grazing of cattle and tree planting.

²May be necessary to seed by airplane—lime requirement much higher than table 2.

³When seeding these species it will be necessary to have pH of 5.5.

⁴For wildlife use.

MECHANICAL PRACTICES FOR STRIP-MINED AREAS

Mechanical practices requiring engineering, such as strip cropping, terraces, divisions, waterways, ponds, etc., are a necessary part of the conservation plan development on strip-mined land. Practices used to a more limited extent are: outlets, or grassed waterways, diversions, gradient terraces, drainage channels, tile drains, earth fills, and water control structures.

TABLE 4
Classification of strip mine spoils and guide for their revegetation

Graded according to Ohio Law¹—50 percent of spoil bank, or more, is below 4.5 pH, not more than 50 percent below 4.0 pH.

Stoniness**	Slope	Land capability class	Suitable land uses	Adapted Species of Plant*		
				Grasses	Legumes	Shrubs
Stony and very stony	All slopes	VII	Woodland Wildlife	Tall fescue	Sericea lespedeza	Japanese lespedeza Bicolor lespedeza Autumn olive Scotch broom Multiflora rose
Extremely stony	All slopes	VIII	Wildlife	Tall fescue	Sericea lespedeza	None

TABLE 5
Group "E" spoil material

Graded according to Ohio Law¹—More than 50 percent of the spoil is less than 4.0 pH.

All phases	All slopes	VIII Toxic	Wildlife	Tall fescue above 4 pH Nothing below 4 pH	Sericea lespedeza above 3.5 pH Nothing below 3.5 pH	Scotch broom Nothing below 3.5 pH

¹Ohio law provides that spoil banks shall be graded to reduce peaks (and the depressions between peaks) to more gently rolling topography, providing for more suitability for grazing of cattle and tree planting. Isolated peaks shall be graded to provide a top width of not less than 20 feet.

*For tree species see Table 6.

**For stoniness definitions see end of Table 5.

- Non-stony —Topsoil replaced and stones buried to permit growing of row crops in a rotation.
- Stony —Will not interfere with seed bed preparation or limit the use of mechanical tree planters. Not suitable for row crops. (Fragments less than 4 inches in size).
- Very stony —Sufficient surface or buried stones to restrict seed bed preparation and maintenance, but will not restrict tree planting by hand. May be seeded to grasses and legumes by airplane. (Fragments larger than 4 inches in size).
- Extremely stony—Sufficient surface stones to prevent tree planting. (Essentially paved with stones).

Temporary Erosion Control

In strip-mined areas, mechanical practices may sometimes be used to provide protection from erosion until vegetative cover is established. These practices include diversions or terraces to control runoff and reduce soil movement. Where graded spoil is to be used for cropland, diversions or terraces should be established as a permanent erosion control measure. A grass strip above each diversion will serve as a correction for the contour strip and as a filter strip above the diversion channel.

TABLE 6
Guide to suitable tree species

According to Texture and pH of strip mine spoils.

All slopes and graded areas for spoil banks with spoil material composed chiefly of sand or loose loams and clays.

Species	Alder*	Black locust*	pH
	Percent**	Percent**	
White pine (<i>Pinus strobus</i>)	0	0	4.0-7.2
Shortleaf pine (<i>Pinus echinata</i>)			
Scotch pine (<i>Pinus sylvestris</i>)			
Jack pine (<i>Pinus banksiana</i>)			
Pitch pine (<i>Pinus rigida</i>)			
Virginia pine (<i>Pinus virginiana</i>)			
Sweet gum (<i>Liquidambar styraciflua</i>)	0-50	0	4.0-8.0
Silver maple (<i>Acer saccharinum</i>)			
Red oak (<i>Quercus rubra</i>)			
Chestnut oak (<i>Quercus montana</i>)			
Bur oak (<i>Quercus macrocarpa</i>)			
Cottonwood (<i>Populus deltoides</i>)	0	0	4.5-8.0
Sycamore (<i>Platanus occidentalis</i>)			
Eastern red cedar (<i>Juniperus virginiana</i>)	0-25	0	5.0-8.0

All graded areas, but only slopes with total relief of less than 15 feet or lower 15 feet of slopes with total relief of more than 15 feet, for spoil banks with spoil material composed chiefly of sand or loose loam and clays.

Species	Alder*	Black locust*	pH
	Percent**	Percent**	
White ash (<i>Fraxinus americana</i>)	0-50	0-25	4.0-8.0
Green ash (<i>Fraxinus pennsylvanica</i>)			
Yellow poplar (not on sandy spoils) (<i>Liriodendron tulipifera</i>)	0-50	0-25	4.5-8.0
Sugar maple (not on sandy spoils) (<i>Acer saccharum</i>)			
Black walnut (not on sandy spoils) (<i>Juglans nigra</i>)	25-50	25	5.0-8.0

All slopes of graded areas for spoil banks with spoil material composed chiefly of compact loams and clays.

Species	Alder*	Black locust*	pH
	Percent**	Percent**	
Sweet gum (<i>Liquidambar styraciflua</i>)	0-50	0-25	4.0-8.0
White ash (<i>Fraxinus americana</i>)			
Green ash (<i>Fraxinus pennsylvanica</i>)			
Silver maple (<i>Acer saccharinum</i>)			
Cottonwood (<i>Populus deltoides</i>)	0	0	4.0-8.0
Sycamore (<i>Platanus occidentalis</i>)			
Sugar maple (<i>Acer saccharum</i>)	25-50	25	4.5-8.0

All slopes of ungraded areas for spoil banks with spoil material composed chiefly of compact loams and clays.

TABLE 6—Continued

Species	Alder*	Black locust*	pH
	Percent**	Percent**	
White pine (<i>Pinus strobus</i>)	0	0	4.0-7.5
Yellow poplar (<i>Liriodendron tulipifera</i>)	0-50	0-25	4.5-8.0
Eastern red cedar (<i>Juniperus virginiana</i>)	0-25	0	5.0-8.0
Black walnut (<i>Juglans nigra</i>)	25-50	25	5.0-8.0

*Nurse crop trees are European black alder (*Alnus glutinosa*) and Black locust (*Robinia pseudoacacia*).

**Percent of other than nurse crop trees in the mixture. Planted as a "bucket mix."

NOTE

GROUND COVER. Do not plant following species in dense ground cover such as grass, legumes and weeds; Cottonwood, Sweet gum, Sycamore, Yellow poplar, and all conifers except White pine and Red cedar.

MIXED PLANTINGS. Do not mix conifers and hardwoods; do not plant Cottonwood, Sycamore, or conifers in mixtures, except mixed blocks of one species made up of not less than 5 rows of 5 trees each. Other hardwood species may be randomly mixed.

EROSION CONTROL PLANTING. Long steep, erosive slopes, commonly next to highwall or on outside edge of banks may be planted exclusively to Black locust, or a 50 percent mixture of European alder and other hardwoods, at 6×6 or 7×7 ft spacings.

Table 6 recommended by Forest Tree Planting Committee, Ohio Chapter, Society of American Foresters.

TABLE 7
Plantings on Strip Spoils in Ohio by Years

Year	Established		1962 Condition	
	Number		Active	Inactive
1955	1		1	
1956	4		2	2
1957	1		1	
1958 ¹	6		5	1
1959 ²	6		6	
1960	2		2	
1961	4		4	
1962	3		3	
Total	8	27	24	3

¹1958 and 1961 include two Field Evaluation Plantings in cooperation with the Ohio Power Company and the Ohio Reclamation Association.

²Field Evaluation Plantings in cooperation with Dr. Charles V. Riley include: 1959 (4), 1960 (2), 1961 (1), 1962 (2).

Water Control

Water accumulations in the spoil may cause seepy areas in some locations. Each problem of this type should be studied individually for a solution. It may be possible to drain the seepage area by excavating an open drainage ditch or it may be necessary to intercept the seep with a channel that will lead the water to a nearby waterway. Storage basins may also be constructed to collect the seepage water at locations where containment may be possible. Tile interceptor drains provide an additional tool for eliminating seeps where the seepage planes can be located.

Earth fills can be used to create ponds and lakes which will serve as valuable improvements to recreation and wildlife. Water control structures such as pipe outlets, drop spillways, and surface inlets are often important features of such structures.

A program of continuous observation and evaluation of existing mechanical practices on strip-mine spoils is a necessary part of such operations and is giving valuable information for use in shaping future engineering programs.

OBSERVATIONAL PLANTINGS ON STRIP SPOILS IN OHIO

Since 1955, 27 plantings, using both woody and herbaceous plant species, have been established on strip mine spoils in 12 Soil and Water Conservation Districts in eastern and southeastern Ohio. This includes plantings made cooperatively with the Ohio Power Company and the Ohio Reclamation Association. Field evaluation of plantings have been made each year starting in 1959 in cooperation with Dr. Charles V. Riley, Kent State University. The Ohio Agricultural Experiment Station is kept informed as to all plant materials used. The number of plantings established by years is shown in table 7.

Forty-seven different grasses, legumes, woody shrubs, and trees have been used in these plantings (27 herbaceous and 20 woody plant species). Most plantings to date consist of several species.

SUMMARY

1. The Soil Conservation Service assists landowners in solving land use problems including those on strip-mine spoil land.
2. A mapping system classifying soils on strip-mine land has been developed by Soil Scientists.
3. Spoil material is further classified, on the basis of the pH, stoniness, and steepness of the area, for the purpose of making vegetative plantings, whose recommendation depends on the suitable or chosen land use.
4. Plants are being tested in field trials on strip mine spoils to further define their tolerances for adaptability on these critical areas.

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