PLANT SPECIES, DISTRIBUTION PATTERNS, SEEDING RATES, AND PLANTING ARRANGEMENTS FOR REVEGETATION OF MINED LANDS

TECHNICAL RECLAMATION MEMORANDUM # 21

Prepared by

KENTUCKY DEPARTMENT OF FISH AND WILDLIFE RESOURCES

and

KENTUCKY DEPARTMENT OF NATURAL RESOURCES, DIVISION OF FORESTRY

and

KENTUCKY DEPARTMENT FOR SURFACE MINING RECLAMATION AND ENFORCEMENT

January 6, 1995

Printed with state funds

TABLE OF CONTENTS

LIST OF TABLES

I. INTRODUCTION

This document is incoroprated by reference in administrative regulations 405 KAR 16:200 and 18:200 relating to revegetation of minesites. Those administrative regulations require that, except for cropland, selection of species, distribution patterns, seeding rates, and planting arrangements shall be approved case-by-case by the cabinet based upon those administrative regulations and this document. With primary emphasis on plant species that have value for wildlife, this document relates to these and other regulatory requirements mentioned below, and does not attempt to address all possible aspects of revegetation.

Use of species listed in Appendix A, or other species recommended by the Kentucky Department of Fish and Wildlife Resources for the permit area based upon site-specific considerations, is required by Section 6(2)(b) of 405 KAR 16:200 and 18:200 for areas where trees or shrubs are planted to create wildlife habitat. This requirement applies not only where the postmining land use is fish and wildlife, but also applies wherever wildlife habitat is created to enhance fish and wildlife on other postmining land uses. The administrative regulations establish minimum numbers of species that must be selected from each of the three groups: hard mast producers, conifers, and shrubs and soft mast producers.

Appendix B provides several categories of information on plant species that are generally suited to reclamation of minesites and have value to wildlife. Table B1 indicates the value of various plant species to wildlife as cover and food. Table B1 also identifies plant species that are suitable as wetland species. In response to Section 6(1)(b) of 405 KAR 16:200 and 18:200, Table B1 further identifies tree species that are considered to have good to excellent commercial value as timber. Table B2 summarizes for various herbaceous species the lower soil pH limit, whether warm or cool growth season, and whether annual or perennial in duration. Table B3 lists herbaceous mixtures for wildlife habitat and erosion control, and their recommended seeding rates and planting dates. Table B4 summarizes for certain tree species the lower soil pH limit, shade tolerance, and maximum elevation. Table B5 summarizes for certain shrub species the lower soil pH limit, shade tolerance, time to produce fruit or seeds, and the months when fruit or seeds are produced.

Appendix C provides an optional plan for tree and shrub selection for non-commercial (unmanaged) forest land. This appendix may be completed and inserted in the permit application, thus providing the permittee flexibility to change his species selection during reclamation without obtaining a permit revision.

II. GENERAL CONSIDERATIONS IN SPECIES SELECTION, DISTRIBUTION PATTERNS, AND PLANTING ARRANGEMENTS

Choose a herbaceous cover that corresponds to the time of year that reclamation and seeding will occur and that will be valuable as food and cover for wildlife (Table B3). In some cases, different seeding mixtures will need

to be applied to different areas within a permit boundary, depending on land use considerations, slope steepness, time of year, etc. Special attention must be given to steep slope areas and other areas where stability is critical. Recommendations concerning plantings in these areas are given in the following section, "Planting Patterns Beneficial to Wildlife."

Plant species selection for a given land use can affect bond release. Two species that have been traditionally used for reclamation of mine lands are KY 31 fescue (Festuca arundinaceae) and the non-prostrate, interstate variety of sericea lespedeza (Lespedeza cuneata). These herbaceous species, though known for their erosion control capability, provide little or no value to wildlife and may even be detrimental, especially when left unmanaged. These species can also increase woody plant mortality through competition.

Regardless of the postmining land use, sowing the above species in seed mixtures that will allow them to become dominants or co-dominants, or use of other highly competitive species or species mixtures that overly inhibit plant succession or impair establishment of vegetative diversity or the achievement of the postmining land use, should be limited to areas where needed to control severe erosion, such as in ephemeral drains, in diversion ditches, and on impoundment embankments. However, some such species may be appropriate for pastureland and cropland, provided that there is an adequate management plan. Where KY fescue is used, a low endophyte variety (less than five (5) percent infected seed) should be seeded except where used for severe erosion areas as set forth above.

The natural occurrence of such species after reclamation will be acceptable if it was demonstrated in the permit application that such species were common within the permit area prior to mining and if the premining soil medium (rather than a topsoil substitute) was used as the vegetative growth medium, and provided that the occurrence of the species does not interfere with achievement of the approved postmining land use.

Of particular significance to wildlife is the establishment of woody species. Whenever practicable, plant strips of shrubs and/or trees around the entire perimeter of the site at a stocking density required under 405 KAR 16:200 and 18:200. These strips should be at least 50 feet wide. Table B1 lists tree and shrub species recommended for mine reclamation. Preference should be given to mast or seed producing species.

Some sites may have several postmining land uses. If such is the case, whenever practicable, completely surround each different land use unit with a shrub and/or tree strip as discussed above.

Contour mines and underground mines developed in upland forests that disturb less than 20 acres may actually enhance wildlife habitat without planting canopy producing species. Establishment of a variety of shrubs in strips or clumps and herbaceous vegetation that provide food and cover for wildlife may sufficiently enhance the area by increasing "edge" and creating interspersion. By the same token, sites with little forest land adjacent to the permit boundary can be greatly enhanced if a large percent of the mined area is planted with trees.

Unless contrary to the postmining land use, a strip of wet site trees or shrubs should be planted along the shoreline of planned permanent impoundments; however, trees and shrubs must not be planted on embankments or near the toe of an embankment. Breaks will need to be provided along this vegetative strip to allow access by wildlife, and any barriers that may prevent wildlife passage to the pond will need to be removed.

When woody plants are to be stocked within the permit area, the permittee will need to incorporate management techniques to ensure the highest possible survival rate at the time of bond release. Even under good conditions, a high percentage of new seedlings can be lost through natural mortality (drought, disease, animal damage, etc.).

Soil degradation, which is attendant to almost any type of land disturbance, can impair seedling survival. Therefore, it will be advantageous to seed or plant a higher number of plants than the desired density to help ensure successful stocking. It may be beneficial to rip areas to be planted in trees to a depth of 50 to 80 cm if soil compaction is a problem (Torbert et al., 1986).

Ground cover can greatly affect woody plant survival. Competition between woody plants and herbaceous species will occur if the ground cover is too thick or too high. Therefore, it is advantageous to stock woody plants as soon as possible, before ground cover has had time to become well established. Spot application of herbicides may also be necessary to curb this competition in areas where woody plants are grown. Furthermore, the use of some species should be restricted around tree and shrub plantings because of their competitive nature. See Table B3 for a recommended ground cover seeding mixture for areas to be stocked with trees or shrubs.

For compatibility with plant and wildlife species in the vicinity of the permit area, consideration should be given to use of native plant species for revegetation, where practicable.

III. PLANTING PATTERNS BENEFICIAL TO WILDLIFE

The arrangement of vegetation plantings on a postmining site is critical to its future productivity for wildlife. High quality wildlife habitat can be created by providing an interspersion of a variety of habitat types, such as a mosaic of shrubby areas, woodlands, and grass/legume areas that furnish an abundance of "edges" between vegetation types. Also crucial to this concept is plant species diversity within a given habitat. Generally, plantings that provide a mixture of plant species supplying either food or cover, or both, will be most beneficial. In short, the principal keys to potential wildlife productivity on a site are plant species selection and habitat diversity.

Revegetated mine sites can be improved for wildlife with alternating plantings of herbs, trees, and/or shrubs rather than solid plantings. For example, where remining of previously mined areas leaves a highwall, bench, and downslope, a basic planting could be as follows: plant two or three rows of conifers and one or two rows of hardwoods in front of the highwall, which

would eventually screen the highwall; plant the bench with alternating strips or blocks of herbaceous species and shrubs; plant the edge of the bench adjacent to the downslope with a few rows of conifers; and plant the downslope with herbs and woody plants. Again, strip plantings on the downslope are more desirable (Rafaill and Vogel, 1978).

Steep slopes should be planted in alternating woody strips and herbaceous cover species that will provide quick erosion control. Steep backfill areas and highwalls may inhibit the movement of some wildlife. It is recommended that access points be provided along any highwalls left by remining operations to allow wildlife to travel freely between newly revegetated areas and undisturbed areas.

Strip plantings of grass/legume mixtures 100 - 150 feet wide alternating with strips of shrubs and/or trees 30 - 50 feet wide is a useful pattern on expansive sites. For smaller areas, the widths of vegetative strips can be proportionally decreased. On cuts less than 100 feet wide, a narrow row of woody vegetation or randomly spaced clumps of woody species may create sufficient diversity. Open areas seeded to grass/legume mixtures must be at least one-half acre in size. Such openings can be created by seeding old roadways.

For single cut contour mining, habitat diversity can be achieved by using bands of different types of vegetation. Diversity can be attained by utilizing plants with differing physical and biological characteristics such as growth forms, foliage retention, and fruit retaining dates. In the case of multiple seam contour operations, a different revegetation plan can be implemented on each contour to diversify the site.

Similar planting patterns can also be incorporated into specific postmining land uses to enhance wildlife habitat. Where extensive areas are to be revegetated for pasture or hay, diversity can be increased by planting strips of shrubs such as amur privet, autumn olive, or bicolor lespedeza, or native shrubs such as dogwood, wild plum, or viburnum. These plantings can also serve as woodland/field borders at the edge of pastures or cropland.

Shrubs can be useful as hedges and natural fences, extending within future crop fields or along crop field and pasture boundaries. These hedges and fences usually consist of one or two rows of shrubs laid out on the contour. Two or three rows of pines planted along one side of a single row of autumn olive, rugosa rose, or native shrubs such as bayberry, can provide an effective windbreak for pastures or cropland and important nesting, escape, and winter cover for wildlife. One to ten rows of trees and shrubs planted at right angles to the direction of the prevailing winds will also serve as windbreaks and cover for wildlife. Scattered clump plantings of trees and shrubs in an open field may also provide needed food and cover.

Random planting patterns may create gaps in cover that some wildlife species are unwilling to cross. Therefore, properly placed travel corridors will further enhance wildlife habitat on a postmining site. These can be developed in large areas of open habitat by establishing one row of a dense growing shrub, such as bristly locust, or two rows of thinner shrubs, such as

autumn olive, bicolor lespedeza, or native shrubs such as wild plum or dogwood. These row plantings provide travel corridors for many ground dwelling birds and mammals. Particularly important are travel corridors to and from water sources, which encourage animals to use the water features.

Christmas tree plantations can be established in a manner that will also benefit wildlife. Proper planning and management will provide harvesting on a continuous rotating basis. In this way part of the understory remains unshaded where vegetational variety can be developed. A double row (six feet apart) or single row of shrubs bordering a conifer plantation will further improve the wildlife value of the area.

Mixed forest stands are more beneficial to wildlife than single species plantings. Planting blocks of conifers within mixed hardwood plantations increases the diversity of food and cover available for wildlife. Hardwood stands may be separated from coniferous rows by grass/legume strips to provide more "edge." Hardwood timber lots will also be more desirable to wildlife if provided with a double or single shrub row border about 40 feet from the edge of the woods. Unless established strictly for commercial purposes, coniferous plantings should include at least 20 percent hardwoods. In selecting hardwoods, preference should be given to mast and fruit producing species.

Food plots can also be planted to benefit wildlife, but cannot serve as substitutes for permanent food-bearing plants. A food plot is a patch of plants set aside for wildlife consumption. These plots should be at least one-eighth acre in size. Generally, one-eighth to one-half acre plots with one patch per 100 acres is sufficient. Long, narrow food patches adjacent to cover are best.

Plant communities change with time, through vegetative succession. For example, trees and shrubs gradually begin to invade pastures that have not been managed in recent years. The same is true with mined land. Areas planted as grasslands should slowly evolve into young forests if abandoned after bond release. If the landowner or operator desires to counteract this natural process, then maintenance procedures may be necessary. Cutting, disking, or controlled burning may be necessary to prevent open areas from becoming overgrown. Recommendations for the best habitat maintenance procedures may be obtained from biologists, foresters or associated professionals.

As discussed earlier, pond areas are very beneficial to wildlife. Unless contrary to the postmining land use (e.g., ponds retained strictly for livestock), pond borders will need to be planted with wet site tree and shrub species, as previously mentioned. The creation of artificial wetlands will also enhance wildlife usage of an area. Wet site species and a recommended seeding mixture for such areas are listed in Tables B1 and B3, respectively.

APPENDIX A

Required Tree and Shrub Species for Wildlife Habitat

Use of species listed in this appendix, or other species recommended by the Kentucky Department of Fish and Wildlife Resources for the permit area based upon site-specific considerations, is required by Section 6(2)(b) of 405 KAR 16:200 and 18:200 for areas where trees or shrubs are planted to create wildlife habitat. This requirement applies not only where the postmining land use is fish and wildlife, but also applies wherever wildlife habitat is created to enhance fish and wildlife on other postmining land uses.

Hard Mast Producers

Mockernut hickory	*Carya alba*
Bitternut hickory	*Carya cordiformis*
Pignut hickory	*Carya glabra*
Native Pecan	*Carya illinoinensis*
Shellbark hickory	*Carya laciniosa*
Shagbark hickory	*Carya ovata*
Black Walnut	*Juglans nigra*
Sawtooth oak	*Quercus acutissima*
White oak	*Quercus alba*
Swamp White oak	*Quercus bicolor*
Scarlet oak	*Quercus coccinea*
Southern Red oak	*Quercus falcata*
Shingle oak	*Quercus imbricaria*
Overcup oak	*Quercus lyrata*
Bur oak	*Quercus macrocarpa*
Black Jack oak	*Quercus marilandica*
Swamp Chestnut oak	*Quercus michauxii*
Chinquapin oak	*Quercus muehlenbergii*
Cherrybark oak	*Quercus pagoda*
Pin oak	*Quercus palustris*
Willow oak	*Quercus phellos*
Chestnut oak	*Quercus prinus*
Northern Red oak	*Quercus rubra*
Shumard oak	*Quercus shumardii*
Post oak	*Quercus stellata*
Black oak	*Quercus velutina*

Conifers

Eastern red cedar	Juniperus virginiana
Shortleaf pine	Pinus echinata
Pitch pine	Pinus rigida
Eastern white pine	Pinus strobus
Virginia pine	Pinus virginiana

Shrubs and Soft Mast Producers

Red maple	Acer rubrum
Sugar maple	Acer saccharum
Common alder	Alnus serrulata
Serviceberry	Amelanchier arborea
Pawpaw	Asimina triloba
American Hornbeam	Carpinus caroliniana
Sugarberry	Celtis laevigata
Buttonbush	Cephalanthus occidentalis
Redbud	Cercis canadensis
Alternate-leaf Dogwood	Cornus alternifolia
Silky Dogwood	Cornus amomum
Flowering Dogwood	Cornus florida
Gray Dogwood	Cornus racemosa
American Hazelnut	Corylus americana
Hawthorn species	Crataegus spp. (native species only)
Persimmon	Diospyros virginiana
Autumn Olive	Elaeagnus umbellata
Burning Bush	Euonymus atropurpureus
White ash	Fraxinus americana
Green ash	Fraxinus pennsylvanica
Bicolor lespedeza	Lespedeza bicolor
Spicebush	Lindera benzoin
Red mulberry	Morus rubra
Wild Plum	Prunus americana
Chickasaw Plum	Prunus angustifolia
Wild Black cherry	Prunus serotina
Common chokecherry	Prunus virginiana
Crabapple species	Pyrus spp. (native species only)
Shining or Winged sumac	Rhus copallinum
Smooth sumac	Rhus glabra
Staghorn sumac	Rhus hirta
Blackberry	Rubus allegheniensis
American Elder	Sambucus canadensis
Sassafras	Sassafras albidum
Steeple Bush	Spiraea tomentosa
Lowbush Blueberry	Vaccinium spp.
Viburnum species	Viburnum spp. (native species only)

APPENDIX B

Plant Species and Characteristics for Revegetation

Information in this Appendix is either taken verbatim or adapted from the following publication: Rafaill, B. L. and W. G. Vogel. 1978. A Guide for Vegetating Surface Mined Lands for Wildlife in Eastern Kentucky and West Virginia. U.S. Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C. Publ. No. FWS 14-16-0009-77-923. 89 pp.

Typically, the species and seeding mixtures given in this appendix (Tables B1 through B5) should be used; however, alternative species and mixtures can be considered if demonstrated to the cabinet, on a case-by-case basis, to be more desirable for achieving the postmining land use and for controlling erosion.

The species recommended in the following paragraphs and tables have differing values to wildlife. Information given in Table B1 summarizes the values of those plant species to the wildlife species which utilize them. In general, plant species choices in reclamation plantings must provide a mixture of species which supply either food, cover, or both. Other important considerations in choosing plant species are tolerance to sunlight, or the lack of it, and pH of the soil where planting is to occur (explained in footnotes to Tables B4 and B5).

The basic components of reclamation plantings are herbs, shrubs, and trees, which are discussed in the following paragraphs.

Herbs:

Herbaceous plants are of a non-woody type which are used to provide coverage to bare or disturbed soil and thus prevent erosion and stabilize the area. They are classified as forbs or grasses. Many of the forbs are legumes which fix atmospheric nitrogen and make it available to other plants. Many herbaceous plants are important food sources for wildlife and also supply needed cover (see Table B1).

Herbaceous plants are either annual, biennial, or perennial. Some species that are well suited to use on strip mined lands are given in Table B2. Annuals are perhaps the most effective species to plant for quick cover because they rapidly establish vegetative growth, flower, and die within a single growing season. Annuals reproduce only from the seed they produce. Some species such as Kobe and Korean lespedeza naturally regenerate a stand from these seeds, but most do not. Biennials establish themselves the first year, flower and produce seed the second year and then die. Perennial plants normally live three years or longer, die back each year, and produce seed crops annually for life.

Also given in Table B2 are pH limits and growth seasonality. Cool season species grow mostly in the spring and fall, but are nearly dormant or grow poorly in the summer. Warm season species grow during late spring and summer and are dormant in early spring and fall. All are dormant in the winter. Generally, stands of cool season species can be established from either spring or fall seedings.

Herbaceous plantings constitute the basic element of soil stability on reclaimed sites. Since they are the basic element of stability, they will also be the basic element of wildlife habitat on the reclaimed site. Mixtures of herbaceous plants that are of particular value to wildlife are given in Table B3. As previously recommended in this document, all herbaceous mixtures should come from the listings in Table B3 and be applied within the times specified.

Trees:

Trees are woody plants which generally have but one main stem arising from ground level. They provide food for wildlife in the form of seeds or mast, have value as wildlife cover, and provide erosion control on outslopes when planted with herbaceous species. Some species which are adaptable to use on strip mined lands are given in Table B4.

The recommended trees can be subdivided into hardwoods and softwoods, or conifers. Hardwoods are deciduous, or drop their leaves each fall, and generally produce seed or mast crops which supply food to wildlife (Table B1). Softwoods, or conifers, are generally evergreen and are particularly valuable as cover for wildlife (Table B1).

Shrubs:

Shrubs are woody plants with few to many stems arising from ground level. They usually are smaller than most trees and are extremely valuable sources of wildlife cover and food. Some shrubs are also useful for controlling soil erosion and can be utilized for screening and windbreaks for cropland. When properly planted and managed, some species such as amur privet form natural fence rows or field borders. Some shrub species that are adaptable to use on strip mined lands are given in Table B5.

When planting to support wildlife populations, it is helpful to know how soon food supplies will be produced. The average time that it takes for the recommended shrubs to begin seed production is shown in Table B5. Many shrubs are important food sources for wildlife and also supply needed cover (Table B1).

Table B1. List of Plant Species Recommended for Revegetating Surface Coal Mined Lands in Kentucky

Plant	Uses to Wildlife*	Wetland Species
Herbs (Perennial grasses)		
Bahiagrass Paspalm notatum	SHC	X
Barnyard grass, Wild millet Echinochloa spp.	CHS	X
Bentgrass Agrostis spp.	CHS	
Bermuda grass Cynodon dactylon	HS	
Blue grama Bouteloua gracilis	HSC	
Bluegrass (Kentucky, Canada) Poa spp.	HS	
Bluestems Andropogon (except annua), Bothriochloa, Schizachyrium, spp.	CHS	
Bromegrass Bromus spp.	CHS	
Buffalograss Buckloe dactyloides	HCS	
Cordgrass Spartins spp.	CHS	X
Cutgrass Leersia spp.	CH	X
Dallisgrass Paspalm dilatatum	SHC	
Deertongue Panicum cladestinum	HSC	X
Eastern gammagrass Tripsacum dactyloides	HSC	X
Indian grass Sorghastrum nutans	CHS	
Nutsedge, Chufa Cyperus spp.	CH	X
Oats Avena sativa (after April 15)	SH	
Orchardgrass Dactylis glomerata	HSC	
Perennial ryegrass Lolium perenne	HS	
Red fescue Festuca rubra (E. Ky. only)	HSC	
Redtop Agrostis alba	CHS	X
Reed canarygrass Phalaris arundacea	CSH	X
Reedgrass Phragmites australis	CSH	X
Rye Secale cereale	SH	
Sideoats grama Bouteloua curtipendula	HSC	
Switchgrass Panicum virgatum	CSH	X
Tall oatgrass Arrhenatherum elatius	HSC	
Timothy Phleum pratense	SH	
Wheat grass Agropyron spp.	HSC	
(Annual grasses)		
Annual ryegrass Lolium multiflorum	HS	
Foxtail millet Setaria italica	S	
Japanese millet Echinochloa spp.	S	X
Oats Avena sativa (before April 15)	SH	
Pearl millet Pennisetum glaucum	S	
Proso (Broomcorn) millet Panicum milaceum	HSC	X
Rye Secale cereale (before April 15)	SH	
Sorghams Sorgham spp.	S	
Sudangrass Sorgham sudanense	S	
Weeping lovegrass Eragrostis curvula	CHS	X
Winter wheat Triticum aestivum	SH	

Table B1 (continued)

Plant	Uses to Wildlife	Wetland Species
(Perennial legumes)		
Alfalfa Medicago spp	HSC	
Alsike clover Trifolium hybridum	HS	X
Appalow lespedeza Lespedeza cuneata cv. Appalow	CSH	
Birdsfoot trefoil Lotus corniculatus	HC	
Crimson clover Trifolium incarnatum	HS	
Hop clover Trifolium spp.	HS	
Kura clover Trifolium spp.	HS	
Red clover T. pratense (binnl/short-lived pernl)	HS	
White, Ladino clover Trifolium repens	SH	
Zig-zag clover Trifolium spp.	HS	
(Annual legumes)		
Big flower vetch Vicia grandiflora	HSC	
Common (Kobe) Lespedeza striata (good seeder)	SH	X
Cowpea (Black-eyed pea) Vigna ungviculata	SH	
Hairy vetch Vicia villosa	HSC	
Korean lespedeza L. stipulacae (good seeder)	S	
Partridge pea Cassia fasciculata	S	
Soybean Glycine max	SH	
(Non-legumous forbs)		
Buckwheat Fagopyrum esculentum	SH	X
Lupine Lupinus spp.	SH	
Sunflower Helianthus annuus	S	X
Sweetflag Acorus calamus	C	X
Woody plants (Trees-Evergreens)		
Eastern redcedar Juniperus virginiana	CSB	
** Eastern white pine Pinus strobus	CSB	
Larch Larix leptolepis	CSB	X
** Loblolly pine Pinus taeda	CSB	
Mugho pine Pinus mugo mughus	CSB	
** Pitch pine Pinus rigida	CSB	
** Pitch X Loblolly hybrid P. rigida X taeda	CSB	
** Red pine Pinus resinosa	CSB	
***Scotch pine Pinus sylvestris	CSB	
** Shortleaf (Yellow) pine Pinus echinata	CSB	
***Spruces Picea spp.	CSB	
** Virginia pine Pinus virginiana	CSB	
(Trees-Deciduous)		
Aspen (Bigtooth, Quaking) Populus spp.	BC	
** American beech Fagus grandifolia	MBC	
** American sycamore Plantanus occidentalis	SB	X
** Baldcypress Taxodium distichum	CSB	X
** Black cherry Prunus serotina (E. Ky. only)	FBC	
Black locust Robina pseudoacacia	SCB	
** Black maple Acer nigrum	SB	
** Black walnut Juglans nigra	MBC	
Black willow Salix nigra	BC	X

Table B1 (continued)

Plant	Uses to Wildlife	Wetland Species
** Bur oak Quercus macrocarpa	MBC	
** Chestnut oak Quercus prinus	MBC	
Chinese chestnut Castanea mollissima	MB	
Crab apple Malus spp.	FCB	
** Eastern cottonwood Populus deltoides (Commercial species W. Ky. only)	BC	X
European black alder Alnus glutinosa	CSB	X
European white birch Betula pendula	BSC	
Flowering dogwood Cornus florida	FBC	
** Green ash Fraxinus pennsylvanica	SB	X
** Hickory Cayra spp.	MBC	X (Shellbark Hickory)
Honey locust Gledista triacanthos	SCB	
** Northern red oak Quercus rubra	MBC	
Osage-orange (Hedge apple) M. pomifera (W. Ky.)	FBC	
Pin oak Quercus palustris	MBC	X
** Red maple Acer rubrum	SB	X
River birch Betula nigra	BSC	X
Russian olive Elaeagnus angustifolia	FC	
Sassafras Sassafras albidum	BSC	
Sawtooth oak Quercus spp.	MBC	
Scarlet oak Quercus coccinea	MBC	
** Silver maple Acer saccharinum	SB	X
Sourwood Oxydendrum arboreum	SB	
** Southern red oak Quercus pagoda	MBC	
** Sugar maple Acer saccharum (W. Ky. only)	SB	X
** Sweet birch Betula lenta	BSC	
** Sweetgum Liquidambar styraciflua	SC	X
** Sycamore Plantanus occidentalis	SC	X
** Tulip, yellow, hybrid poplars Liriodendron spp.	SB	
** White ash Fraxinus americana	SB	
** White oak Quercus alba	MBC	
Willow Salix spp.	BC	X
(Shrubs)		
American elder Sambucus canadensis	CSB	X
Amur privet Ligustrum amurense	FC	
Arrowwood, Cranberry Viburnum spp.	FBC	X
Autumn olive Elaeagnus umbellata	FBC	
Bayberry Myrica pennsylvanica	FCB	
Bicolor lespedeza Lespedeza bicolor	SHC	
Bristly locust Robina fertilis	CS	
Chokecherry Prunus virginiana	FBC	
Coralberry Symphoricarpos orbiculatus	FBC	
Fragrant sumac Rhus aromatica (E. Ky. only)	FBC	
Gray dogwood Cornus foemina	FBC	X
Hawthorne Crataegus spp.	CFB	
Indigobush Amorpha fruticosa (E. Ky. only)	CBS	X
Japan lespedeza Lespedeza japonica	SHC	
Korean barberry Berberis koreana	FBC	
Memorial rose Rosa wichuraiana	CFBS	

Table B1 (continued)

Plant	Uses to Wildlife	Wetland Species
Morrow honeysuckle Lonicera morrowii	FBC	
Purple osier willow Salix purpurea	BC	X
Red-osier dogwood Cornus stolonifera	FBC	X
Rose-acacia locust Robina hispida	CS	
Rugosa rose Rosa rugosa (E. Ky. only)	CFBS	
Serviceberry Amelanchier laevis	FCB	
Shining sumac Rhus copallina (E. Ky. only)	FBC	
Siberian peashrub Caragana arborescens	CBS	
Silky dogwood Cornus amomum (E. Ky only)	FBC	X
Thunberg lespedeza Lespedeza thunbergii	SHC	
Western sandcherry Prunus besseyi	FBC	
Wild or American plum Prunus americana	FBC	

* Cover(C), Browse(B), Herbage or Foliage(H), Mast(M), Fruit(F), Seeds(S):
Browse - bark, buds, twigs, small branches, and whole heads of fruit;
Mast - nuts and acorns (hard mast);
Fruit - soft mast such as fruit and berries;
Seeds - dry fruits, grains, and seeds.
B, H, M, F and S are components of diet used by wildlife species to differing degrees and are arranged in descending order of their overall importance to wildlife.

** Tree species considered to provide good to excellent commercial value.

***Scotch pine and spruces will be considered commercially valuable for Christmas tree plantations.

Table B2. Some Characteristics of Herbaceous Plants Suitable for Revegetating Surface Coal Mined Lands for Wildlife.

Species	Lower pH limit	Season*	Duration*
	Grasses		
Redtop	4.5	Cool	Perennial
Big bluestem	4.5	Warm	Perennial
Little bluestem	4.5	Warm	Perennial
Oats	4.5	Cool	Annual
Bermuda grass	4.0	Warm	Perennial
Orchardgrass	4.5	Cool	Perennial
Japanese millet	4.5	Warm	Annual
Weeping lovegrass	4.0	Warm	Perennial
Annual ryegrass	4.5	Cool	Annual
Perennial ryegrass	4.5	Cool	Perennial
Deertongue	4.0	Warm	Perennial
Proso millet	5.0	Warm	Annual
Switchgrass	4.5	Warm	Perennial
Pearl millet	4.5	Warm	Annual
Reed canarygrass	4.5	Cool	Perennial
Timothy	4.5	Cool	Perennial
Rye	4.5	Cool	Annual
Foxtail millet	4.5	Warm	Annual
German millet	4.5	Warm	Annual
Indian grass	4.5	Warm	Perennial
Grain sorghum	5.0	Warm	Annual
Sudangrass X Sorghum hybrid	4.5	Warm	Annual
Wheat	4.5	Cool	Annual
	Legumes		
Partridge pea	5.0	Warm	Annual
Soybean	5.0	Warm	Annual
Korean lespedeza	5.0	Warm	Annual
Common lespedeza	4.5	Warm	Annual
Kobe lespedeza	4.5	Warm	Annual
Birdsfoot trefoil	4.5	Cool**	Perennial
Alfalfa	5.5	Cool**	Perennial
Sweet clover	5.5	Cool	Biennial
Alsike clover	5.0	Cool	Perennial
Red clover	5.0	Cool	Biennial or Perennial
White clover	5.5	Cool	Perennial
Ladino clover	5.5	Cool	Perennial
Hairy vetch	5.5	Cool	Annual
Cowpea	4.5	Warm	Annual
	Non-Legumous Forbs		
Buckwheat	4.5	Warm	Annual
Sunflower	5.0	Warm	Annual

* See text for explanation.

** These plants normally are planted in the spring or fall (cool season) but will grow in summer as well as in the spring and fall.

Table B3. Suggested Herbaceous Mixtures for Wildlife Habitat and Erosion Control.

	Species	Seeding rate* Pounds/acre PLS
	FEBRUARY 15 to MAY 15	
Principal Species		
I	Orchard grass	10
	or	
	Timothy	8
	White or Ladino clover	2
	Red clover	6
II	Orchardgrass	10
	or	
	Timothy	8
	White or Ladino clover	1
	Red clover	4
	Korean and/or Kobe lespedeza	10
III	Orchardgrass	10
	or	
	Timothy	8
	Birdsfoot trefoil	8
	or	
	Alfalfa	1
	Red clover	4
IV	Wheat	25
	or	
	Spring oats	32
	Switchgrass	10
	Indian grass	10
	Big bluestem	5
	Little bluestem	5
	Birdsfoot trefoil	6
Temporary (Quick Cover) Species Add one of the following species to permanent mixtures I, II, or III. Do not add to mixture IV.**		
	Wheat (before April 15)	30
	Spring oats (before April 15)	32
	Balbo rye (before April 15)	30
	Perennial ryegrass	10
	Annual ryegrass	5
	Weeping lovegrass (after April 1)	2

Table B3 (continued)

Species	Seeding rate* Pounds/acre PLS
MAY 15 to AUGUST 01	
Principal Species	
I Orchardgrass	10
or	
Timothy	8
Korean and/or Kobe lespedeza	15
Red clover	4
White clover	1
or	
Birdsfoot trefoil	6
Alfalfa	12
Temporary Species Add one to the permanent mixture.**	
Sorghum	20
Foxtail (German) millet	12
Japanese millet	15
Soybeans	40
Cowpeas	40
Pearl millet	10

Note: If the perennial legumes or grasses fail to establish from the summer seeding, they can again be sown in late summer (August 15 to September 15) or early the following spring.

AUGUST 01 to OCTOBER 01	
Principal Species	
I Orchardgrass	10
or	
Timothy	8
White or Ladino clover	2
Red clover	6
II Orchardgrass	10
or	
Timothy	8
Alfalfa	15
or	
Birdsfoot trefoil	8
Red clover	4
III Deertongue	12
Birdsfoot trefoil	8
Red clover	4

Table B3 (continued)

Species	Seeding rate* Pounds/acre PLS
Temporary Species Add one to a permanent mixture.**	
Winter wheat	30
Balbo rye or winter rye	30
Winter oats	32
Perennial ryegrass	10
Annual ryegrass	5
Mixture for Wet or Poorly Drained Areas and Pond Borders	
For Spring or Fall (February 15 to May 15; or August 1 to October 1) Seeding	
Redtop	3
Reed canarygrass	15
Alsike clover	6
Japanese millet (February 15 to May 15 only)	10
Common annual lespedeza (temporary species)	10
Mixture for Areas to be Stocked with Woody Plants	
For Spring or Fall Seeding	
Redtop	3
Perennial ryegrass	5
Birdsfoot trefoil and/or Appalow lespedeza	10 / 20
Foxtail millet (temporary species)	5
Note: If both Appalow lespedeza and birdsfoot trefoil are used, cut their seeding rate in half.	

* Seeding rates are for Pure Live Seed (PLS). Seeding rate of the permanent species can be increased if desired, but do not exceed the seeding rate of the temporary species.

** Use only one of the temporary species at the rates shown. If more than one is used, reduce seeding rate of each species according to number of species used; i.e., for two species use one-half seeding rate of each.

Table B4. Some Basic Requirements of Trees Suitable for Revegetating Surface Coal Mined Lands.

Species	Lower limit pH	Shade tolerance*	Elevation
Conifers			
Eastern redcedar	5.0	intolerant	
Shortleaf pine	4.0	intolerant	Below 2,500 feet
Pitch pine	4.0	intolerant	
White pine	4.5	intermediate	
Scotch pine	4.0	intolerant	
Virginia pine	4.0	intolerant	Below 2,500 feet
Loblolly pine	4.0	intermediate	
Hardwoods			
Red maple	4.5	intermediate	
Silver maple	4.0	intermediate	
Sugar maple	4.5	tolerant	
European (black) alder	4.0	intolerant	Below 2,500 feet
Sweet birch	4.5	tolerant	
River birch	4.0	intermediate	Below 2,000 feet
European white birch	4.0	intolerant	
Chinese chestnut	4.5	intermediate	
Flowering dogwood	5.0	tolerant	
Russian olive	5.5	intermediate	
White ash	4.0	intermediate	
Green ash	4.0	intermediate	
Black walnut	5.0	intolerant	
Crabapple	4.5	intolerant	
Sweetgum	4.0	intolerant	Below 3,000 feet
Tulip or yellow-poplar	4.5	intolerant	Below 3,000 feet
Sycamore	4.0	intolerant	Below 2,500 feet
Sawtooth oak	4.0	intolerant	
White oak	5.0	intermediate	
Pin oak	5.0	intolerant	Below 1,500 feet
Red oak	4.0	intermediate	
Black locust	4.0	intolerant	Below 3,000 feet
Sassafras	5.0	intolerant	

* Shade tolerance of species is generally categorized as follows:
tolerant - can withstand completely shaded conditions;
intermediate - partial shade is tolerated, plant requires some sunlight;
intolerant - shade is not tolerated, plant requires full sunlight.

Table B5. Some Basic Requirements of Shrubs Suitable for Revegetating Surface Coal Mined Lands.

Species	Lower limit pH	Shade tolerance*	Time to fruit/seed (years)	Month of mature fruit/seed
Indigobush	4.0	intermediate	3	AUG
Silky dogwood	4.5	tolerant	4 - 5	AUG-SEP
Gray dogwood	5.0	intermediate	5	SEP-OCT
Washington hawthorn	5.5	intolerant	4 - 5	OCT-NOV
Autumn olive	4.0	intermediate	3 - 4	AUG-OCT
Bicolor lespedeza	4.5	intolerant	3	OCT-NOV
Amur privet	4.5	tolerant	4	SEP-NOV
Bayberry	4.0	intermediate	3 - 5	OCT
Fragrant sumac	4.5	tolerant	5	JUL-AUG
Shining sumac	4.0	intermediate	4	SEP-OCT
Smooth sumac	4.5	intermediate	4	SEP-OCT
Bristly locust	3.5	intolerant	3 - 5	SEP-OCT
Rugosa rose	5.0	intolerant	3	JUL-SEP
Coralberry	5.0	tolerant	3	SEP-OCT
Arrowwood viburnum	4.5	tolerant	3 - 5	SEP-OCT
Cranberrybush	4.5	intermediate	3 - 5	AUG-SEP

* Shade tolerance of species is generally categorized as follows:
tolerant - can withstand completely shaded conditions;
intermediate - partial shade is tolerated, plant requires some sunlight;
intolerant - shade is not tolerated, plant requires full sunlight.

APPENDIX C

Optional Selection of Tree and Shrub Species
for Non-commercial (Unmanaged) Forest Land

Category 1	Category 2	Category 3	Category 4
Hardwood - Hard mast producers	Soft mast producers	Cone producing evergreens	Optional species
Black walnut	Amur privet	E. white pine	American elder
Hickory species	Arrowwood	Loblolly pine	Aspen
Oak species	Autumn olive	Pitch pine	Bald cypress
	Barberry	Pitch X Loblolly	Bicolor lespedeza
	Black cherry	Scotch pine	Black alder
	Chokecherry	Shortleaf pine	Black locust
	Coralberry	Virginia pine	Black maple
	Cranberry		Black willow
	Fragrant sumac		Bristly locust
	Hawthorne		Cottonwood
	Memorial rose		Green ash
	Osage-orange		Honey locust
	Red-osier dogwood		Indigobush
	Rugosa rose		Japan lespedeza
	Russian olive		Red maple
	Service berry		River birch
	Shining sumac		Sassafras
	Other sumacs and roses (except multiflora)		Sycamore
			Siberian peashrub
			Silver maple
			Sourwood
			Sugar maple
			Sweet birch
			Sweetgum
			Thunberg lesp.
			Tulip/yllw poplar
			White ash

Use of this appendix is optional. It is intended to assist the applicant in complying with Section 6(1)(a) of 405 KAR 16:200 and 405 KAR 18:200. It provides a simple way to select a beneficial mix of tree and shrub species where the postmining land use is non-commercial (unmanaged) forest land. This appendix may be completed and inserted in the permit application, thus providing the permittee flexibility to change his species selection during reclamation without obtaining a permit revision.

Select at least one species from each of categories 1, 2 and 3 (above), and at least one more species from any of the above four categories. At least two of the selected species must be tree (canopy) species.

This appendix is not appropriate for wetland areas.

APPENDIX D

Literature Cited

Rafaill, B. L. and W. G. Vogel. 1978. A Guide for Vegetating Surface Mined Lands for Wildlife in Eastern Kentucky and West Virginia. U.S. Fish and Wildl. Serv., U.S. Dept. of the Interior, Washington, D.C. Publ. No. 14-16-0009-77-923. 89 pp.

Torbert, J. L., J. A. Burger, and T. J. Nichols. 1986. Reforestation Seed Mixtures for Hydroseeding Reclaimed Mine Land. Virginia Cooperative Extension Service, VA. Publ. 460-112. 6 pp.